



UNIVERSITY OF THE POONCH, RAWALAKOT

{Faculty of Basic & Applied Sciences}

Department of Botany

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Scheme of study for M. Phil Program in Botany

Duration of program:	4-6 Semesters
Courses:	24 Credits
Thesis (BOT-763):	06 Credits
Total Credits:	30 Credits

Scheme of study for Ph.D. Program in Botany

Duration of program:	6-16 Semesters
Courses:	18 Credits
Seminar	02 credits
Thesis (BOT-764):	24 Credits
Total Credits:	44 Credits
Comprehensive Examination (Written & Oral):	Satisfactory/Unsatisfactory basis

List of Courses for M.Phil. and Ph.D Botany

Course Code	Course Title	Credit Hours
BOT-701	Molecular Systematics of Plants	3(2-1)
BOT-702	Advances in Molecular Biology	3 (2-1)
BOT-703	Advanced Botanical Techniques	3 (2-1)
BOT-704	Environmental Biology of Plants	3 (2-1)
BOT-705	Water Relations of Plants	3 (2-1)
BOT-706	Radiation and Molecular Biology	3 (2-1)
BOT-707	Signal Transduction in Plants	3 (3-0)
BOT-708	Principles of Bioinformatics	3 (3-0)
BOT-709	Stress Physiology	3 (2-1)
BOT-710	Plant Nutrition	3 (2-1)
BOT-711	Research Techniques and Instrumentation	3 (2-1)
BOT-712	Evolutionary Biology	3 (2-1)
BOT-713	Research Methodology and Skill Enhancement	3 (3-0)
BOT-714	Economic Botany and Medicinal Plants	3 (2-1)
BOT-715	Applied and Experimental Statistics	3 (2-1)
BOT-716	Advances in Plant Anatomy	3 (2-1)
BOT-717	Principles of Biotechnology	3 (2-1)
BOT-718	Plant Biodiversity and Conservation	3 (2-1)
BOT-719	Plant Physiological Histology	3 (2-1)
BOT-720	Advanced Plant Metabolism	3 (2-1)
BOT-721	Forensic Botany	3 (3-0)
BOT-722	Phytosociology	3 (2-1)

Molecular Biology of DNA, RNA, Protein, DNA replication and DNA repair. Transcription. Translation, Gene expression in prokaryotes and eukaryotes. Molecular biology of DNA and RNA viruses and yeast. Molecular immunology, Oncogenes and cancer.

Practicals

Quantitative estimation of various macromolecules. Demonstration of properties of macromolecules. Methods of bacterial culture.

Suggested Readings

1. Kornberg, A. (1980). DNA Replication, W.H. Freeman, San Francisco.
2. Kornberg, A. (1982). Supplement to DNA Replication, W.H. Freeman, San Francisco.
3. Old, R.W. and Primrose, S.B. (1981). Principles of Gene Manipulation, Blackwell, Oxford.
4. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. (1990). Molecular Biology of the Gene, Benjamin, California.
5. DuPraw, Advances in Cell and Molecular Biology, Academic Press.
6. Bukhari, A.I., Shapiro, J.A., and Adhya, S.L. (1977). DNA Insertion Elements, Plasmids and Episomes, Cold Spring Harbour Laboratories.

BOT-703

Advanced Botanical Techniques

3(2-1)

Theory

Conditions and precautions for plant culture in soil, sand, gravel, hydroponics and aeroponics; Methods of collection, killing, fixing and storage of materials for microtomy. Embedding of tissues, sectioning and staining. Chromatography: Chromatographic techniques used in botanical research. Spectrometry: Principles involved in various types of Spectroscopy; Osmometry: Principles involved in various types of osmometer; Pressure chamber; Principles involved in various types of Pressure chamber; Thermocouple psychrometry; Electrophoresis; Immunolocalization of proteins; PCR.

Practicals

7. Plant growth in various plant culture media.
8. Preparation for killing and fixing of plant samples, their embedding in the wax, sectioning and preparation of permanent slides, using double staining procedure.
9. Use of electron microscope (scanning and transmission).
10. Use of chromatographic techniques for chemical/biochemical analysis of plant samples
11. Use of AAS, flame photometer, double beam spectrophotometer.
12. Use of osmometer and pressure chamber for to measure leaf water relations.
13. Agarose gel electrophoresis for DNA.
14. Fractionation of proteins using PAGE and Western blotting.

Suggested Readings

1. Bhundari, N.N. 1997 Staining Techniques: A Manual. Ultimate Printers, New Delhi.
2. DeLevie, R. 1997. Quantitative chemical analysis. McGraw-Hill Co. Inc. New York
3. Hayat, M.A., 1993. Staining and Cytochemical Methods. Plenum Press, New York.
4. Ruzin, S.E. 1999. Plant Microtechnique and Microscopy. Oxford University Press, New York.
5. Sass, J.E. 2008. Elements of Botanical Microtechnique. Bente Press, New York.
6. Skoog, D.A., Holler, F.J. and Nieman, T.A. 1998. Principles of instrumental analysis. 5th ed. Saunders College Pub., Philadelphia.
7. Zimmermann, A. 2010. Botanical Microtechnique, a Hand-Book of Methods for the Preparation, Standing, and Microscopical Investigation of Vegetable Structures. General Books LLC, New York

BOT-704

Environmental Biology of Plants

3(2-1)

Theory

Environmental pressure; Pollution, its types, sources of each type and their impacts on habitats and remedial measures; Forests, their types, importance, deforestation, desertification and conservation; Ozone layer: its formation, mechanism of depletion and its effects on the biota; Greenhouse effect, its causes and threats; Human population growth and anthropogenic effects on environment; Hydroelectric dams: their short and long-term destruction; Impact assessment of industrial, urban, civil development; Overview of major problems of Pakistan and their solutions; Soil erosion: its causes and control measures; Water logging and salinity, their impacts on environment and vegetation; Wetlands and sanctuaries protection, pressures, problems and solutions; Range management: types of rangelands, potential threats and their sustainable managements; Environment-related policies in Pakistan.

Practicals

1. Examination of industrial wastewater and municipal sewage for total dissolved solids, pH, EC, biological oxygen demand (BOD), chlorides, carbonates, bicarbonates and nitrates
2. Examination of water samples from different sites for the presence and diversity of organisms
3. Specific effect of air pollution on plants
4. Visits to environmentally compromised sites and evolution of remediation methods

Suggested Readings

1. Baluška, F. 2009. Plant-Environment Interactions, Springer, The Netherlands.
2. Calver, M., Lymbery, A., McComb, J. and Bamford, M. 2009. Environmental Biology. Cambridge University Press, Cambridge.
3. Eugene, E.D. and Smith B.F. 2000. Environmental Science: A Study of Interrelationships. McGraw Hill, New York.
4. France, H. 2000. Varying Borders: Protecting the Plant in the Age of Globalization W.W. Norton and Co. New York.
5. Newman, E.I. 2001. Applied Ecology. Blackwell Science, London.
6. Nobel, P.S. 2009. Physicochemical and Environmental Plant Physiology. Academic Press, London.
7. Wang, L.K., Hung, Y.T. and Shammas, N.K. 2009. Handbook of Industrial and Hazardous Wastes Treatment, Volume 2, Series: Advances in Industrial and Hazardous Wastes Treatment. CRC Press, New York.

BOT-705

Water Relations of Plants

3(2-1)

Theory

Structure and properties of water and their relevance to cell physiology; Concept of Gibbs free energy and chemical potential of water; Components of water potential; Terminology used to describe the cell and tissue water relations; Pressure-volume curve; Höfler diagram; Factors affecting the water potential components; Water transport processes: diffusion and bulk flow of water; Soil-plant-atmosphere continuum; Mechanism of water uptake and transport; Aquaporins; Thermodynamics of absorption of water and long distance transport; Xylem cavitation and refilling; Transpiration-stomatal and boundary layer conductance/ resistance; Stomatal regulation; Gas exchange by plant canopies-eddies, canopy boundary layer, decoupling factors; Water relations and control of water uptake by growing cells-Lockhart equation and derivation thereof-threshold turgor and wall extensibility; Wall relaxation; Hydraulic conductance; Availability of water to the plants; Soil drought and physiological drought; Plant adaptation to drought; Osmotic adjustment-kinetics, solutes involved and putative benefits; Stable isotopes in water relations research; Major techniques used to study plant water relations e.g., pressure chamber, osmometer, psychrometer; CO₂ fluxes-resistance/ conductance during gradients; Compensation points; Measurement of gas exchange parameters; CO₂ enrichment and water relations

Practicals

1. To determine leaf/tissue water potential using conventional and advanced methods

2. To determine solute potential of inorganic and organic solutions and leaf sap
3. To draw pressure volume curves for estimation different water relations parameters
4. Principle and use of psychometry in water relations
5. Measurement of various water relations parameters

Suggested Readings

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Rockville, Maryland.
2. Epstein, E. and Bloom, A.J. 2005. Mineral Nutrition of Plants: Principles and Perspectives, 2nd edition. Sinauer Associates, Inc., Sunderland, Massachusetts.
3. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Academic Press, London.
4. Kramer, P.J. and Boyer, J.S. 1995. Water Relations of Plants and Soils. Academic Press, San Diego.
5. Marschner, H. 1995. Mineral nutrition of Higher Plants. 2nd edition. Academic Press, London.
6. Noble, P.S. 2005. Physicochemical and Environmental Plant Physiology, 3rd edition. Academic Press, San Diego.
7. Taiz, L. and Zeiger, E. 2010. Plant Physiology, 5th edition. Sinauer Associates Inc., Massachusetts.

BOT-706

Radiation and Molecular Biology

3(2-1)

Theory

Mutations: natural and induced; Mutagenic agents; Mechanism and induction of mutations using radiations and mutagenic chemicals; Use of mutagens in the improvement of agriculture; Genetic material and gene structure; Genes and alleles; Introns: evolution of introns, intron homing and retrohoming; Chromosome structure in prokaryotes and eukaryotes; DNA as genetic material-discovery and structure; DNA replication, repair and recombination; Transcription: structure and function of various RNA species. RNA processing and editing; Translation: protein synthesis, genetic code; Advances in prokaryotes and eukaryotes gene regulation; Post-transcriptional control and evolution of genome system; Gene isolation and cloning; Vectors and their importance to molecular biology; Plasmid, phagemid, cosmid; Molecular breeding techniques; DNA finger printing; Mini- and micro-satellite DNA markers; Functional genomics toolbox; Transcriptome: DNA libraries, their construction, screening and sequencing; Gene chip technology, microarray of gene expression and its types; Serial analysis of gene expression; Proteomics and its types; Methods for proteomic studies; Application of proteomics; Metabolome, technologies involved in metabolomics; Metabolic engineering; Bioinformatics and computational biology, their scope, need and application; Tools to study bioinformatics.

Practicals

1. Irradiation of seed with different doses of α , β and γ rays and study of mutants after germination
2. Extraction and purification of nucleic acids and their study by agarose gel electrophoresis
3. Extraction and purification of proteins and their study by PAGE
4. Use of software for ESTs. BLAST search
5. Online visit to genomics database websites

Suggested Readings

1. Alberts, B. 2008. Molecular biology of the cell: Reference edition. 5th edition, Garland Science, New York.
2. Cullis, C.A. 2004. Plant Genomics and Proteomics. John Wiley & Sons, New Jersey.
3. Gibson G. and Muse, S.V. 2002. A Primer of Genome Science. Sinauer Associates, Sunderland, Massachusetts.
4. Ignacimuthu, S. 2005. Basic Bioinformatics. Narosa Publishing House, India.
5. Lewin, B. 2008. Genes IX. Oxford University Press, Oxford.
6. Lodish, H., Baltimore, D., Berk, A., Zipursky, S.L., Matsudaira, P. and Darnell, J. 2008. Molecular Biology of the Cell, 6th edition, Scientific American Books. W.H. Freeman and Co., New York.

7. Marco, D. 2010. Metagenomics: Theory, Methods and Applications. Academic Press, London.
8. Primrose, S.B. and Twyman, R.M. 2003. Principles of genome analysis and genomics. Blackwell Publishing, London.
9. Ragoussis, L. 2010. From Structural Genomics to Functional Genomics: Methods and Applications. Imperial College Press, London.
10. Twyman, R.M. 2004. Principles of Proteomics. BIOS Scientific Publishers (Taylor and Francis Group), Oxon, UK.

BOT-707

Signal Transduction in Plants

3(3-0)

Theory

Signaling; Receptors involved in signaling: their nature and location on the cellular membranes; Secondary messengers in plants: their types, nature, role and mechanisms of action; Cascades of reactions and gene expression; Hormones as signaling agents; Environmental induction of signaling; Factors affecting signaling in plants; Use of mutants in understanding signaling phenomena in plants; Gene regulation and signal transduction in prokaryotes and eukaryotes; Emerging trends in signal transduction research in plants.

Suggested Readings

1. Alberts, B. 2008. Molecular Biology of the Cell: Reference edition. 5th edition, Garland Science, New York.
2. Pfannschmidt, T. 2008. Plant Signal Transduction: Methods and Protocols (Methods in Molecular Biology). Humana Press, Laurel, Maryland.
3. Schäfer, E. and Nagy, F. 2006. Photomorphogenesis in Plants and Bacteria: Function and Signal Transduction Mechanisms, 3rd edition. Springer, The Netherlands
4. Taiz, L. and Zeiger, E. 2010. Plant Physiology. 5th edition. Sinauer Associates Inc., Sunderland, Massachusetts.
5. Yoshioka, K. and Shinozaki, K. 2009. Signal Crosstalk in Plant Stress Responses. Wiley-Blackwell, Oxford.

BOT-708

Principles of Bioinformatics

3(3-0)

Theory

Introduction; bio-computing; biological databases - types and retrieval of nucleic acid (or genomic) or protein sequence information; sequence alignment - pairwise, multiple; phylogenetics; in silico identification of protein motifs and domains; structural bioinformatics of proteins and RNAs including protein modeling and prediction of their interactions with other proteins and small molecules; identification of genes and promoter regions within genomes; networks; strategies for whole genome sequencing and assembly.

Suggested Readings

1. Claverie JM and Notredame C, 206. Bioinformatics for Dummies. 2nd Edition; Wiley Publishing.
2. Xiong J, 206. Essential Bioinformatics. 1st Edition; Cambridge University Press.
3. Xia X, 207. Bioinformatics and the Cel: Modern Computational Approaches in Genomics, Proteomics and Transcriptomics. 1st Edition. Springer31
4. Mathura V and Kanguane P, 209. Bioinformatics: A Concept-Based Introduction. Springer
5. Mount DW, 204. Bioinformatics Sequence and Genome Analysis. 2nd Edition; Cold Spring Harbor Laboratory Press.
6. Sperschneider V, 208. Bioinformatics: Problem Solving Paradigms. Springer.

BOT-709

Stress Physiology

3(2-1)

Theory

Types of environmental stresses. Salinity: effects of salinity, physiological changes in plant adaptation to salinity. Water logging: physiological effects on plant growth, plant adaptation. Drought: effect of drought on plant growth, ultra-structural modifications, plant adaptation to drought. Metal ion toxicity: effects on plant growth, physiological adaptation, nutrient deficiency, physiological and biochemical effects. Cold stress: freezing injury and adaptations. High temperature stress: UV, High CO₂ and other minor stresses and plant adaptations. The effects of ionizing radiations on plant metabolism and growth.

Practical

Demonstration of effects of various stresses on plants, methods of stress assessments and ultra-structural and physiological changes associated with various stresses.

Suggested Readings

1. Hale, M. G. and Orcutt, D. M. 1987. The Physiology of Plants under Stress. John Wiley and Sons, N.Y.
2. Kramer, P.J. 1983. Water Relations of Plants. Academic Press.
3. Paleg, L. G. and D. Aspinale, D. 1981. Physiology and Biochemistry of Drought Resistance in Plants. Academic Press London.
4. Recent reviews and research papers on environmental stresses
5. Russel, H. and Staples, R. C. 1979. Stress Physiology in crop plants. by H. Wiley-Interscience, N.Y.
6. Staples, R.C. and G.H. Toenniessen. 1984. Salinity Tolerance in Plants – Strategies for crop improvement. John Wiley & Sons.

BOT-710

Plant Nutrition

3(2-1)

Theory

Plant nutrients, Micro and macro nutrients; Plant water relations; Path of water and nutrient uptake; mechanisms of nutrient uptake; Photosynthesis; Phloem transport, phloem loading and unloading, source sink relationship, Function of mineral elements, Toxicity and Deficiency symptoms of Nutrients. Methods of studying Plant Nutrition, Solution culture techniques, chelating agents, Radiotracer technique, Hydroponic, Mycorrhizae and plant nutrition.

Practical

Experiments of plant growth under different nutrient supplies. Experiments of plant growth with the application of different fertilizers in soil & hydroponic conditions.

Suggested Readings

1. Maraschner, H. 1986. Mineral Nutrition in Higher Plants: Academic Press. USA.
2. Mengel and Kirkby. 1987. Plant Nutrition, Academic Press. USA.

BOT-711

Research Techniques and Instrumentation

3(2-1)

Theory

Introduction, collection, fixation and storage of plant material. Hand sectioning of fresh material. Dehydration, embedding in paraffin, sectioning with microtome, staining and mounting. Preparation of whole mounts and smears. Construction and use of microscope. Types of light microscopes. Photography. Histochemistry, Understanding of principles and use of the Potentiometry, Spectrophotometry, Osmometry, Atomic absorption. Electrophoresis, Chromatography, Centrifugation techniques.

Suggested Readings

1. Copper, T.G. 1977. The tools of Biochemistry. John Wiley and Sons, NY USA.
2. Deutscher, M.P. 1990. Guide to Protein Purification. Academic Press. Inc. San Diego USA.
3. Lacey, A.J. 1989. Light Microscopy in Biology. IRL Press, NY. USA.
4. O' Brien, T.P. and McCully, M.E. 1981. Study of Plant Structure: Principles and Selected Methods. Termacarphi Pty. Ltd., Melbourne, Australia.
5. Sass, J.E. 1971. Botanical Microtechnique. Iowa State University Press, Ames, Iowa. USA.

6. Scopes, R.K. 1987. Protein Purification: Principles and Practice. Springer-Verlag, NY USA.

BOT-712

Evolutionary Biology

3(2-1)

Theory

The organization and establishment of causal theories; Physical environment of earth; Continental drift; Mechanism of evolution; Evolutionary consequences; Species fitness; Systematic and phylogeny; Convergent and divergent evolution; Coevolution of plants and pollinators; Isolating mechanisms of species formation and extinction; Evidences of evolution; Fossil record: paleontology and paleoecology; Micro-evolutionary concepts; Adaptive evolution; Natural and artificial selection; Mimicry; Levels of selection; Selfish genes; Origin and maintenance of genetic variation (mutations, linkage, recombination, chromosomal alterations) and polyploidy in the species evolution; Spatial patterns (e.g., clines and ecotypes); Resemblances, Polymorphism; Forces of evolution (Gene flow, genetic drift; inbreeding and out breeding, founder effect) Evolution and differentiation of species, their phylogenetic and ecological aspects; Evolutionary trends: competition; predation, herbivory, parasitism, symbiosis.

Practical

Study evolutionary tendencies and characters in the monocot and dicot plant species adapted to diverse habitats based on morphological and anatomical characters; Collection and study of fossils of plants; *In situ* observations on the synergism and antagonism.

Suggested Readings

1. Barton, N.H., D.E.G. Briggs, D.B. Goldstein, J.A. Eisen and H.P. Nipam. 2008. Evolution. CSHL Press, NY, USA.
2. Hall, B.K. and B. Hallgrímsson. 2014. Evolution. Jones and Brothers Publishers, London, UK.
3. Rose, M.R. and L.D. Mueller. 2006. Evolution and Ecology of the Organisms. Pearson Education Ltd., London, UK.
4. Willis, K. and J. McElwain. 2014 The Evolution of Plants. 2nd Ed. Oxford University Press, Oxford, UK.

BOT-713

Research Methodology & Skill Enhancement

3 (3-0)

Theory

Introduction; need of research and research types; extraction and review of literature; identifying a research problem and formulating a hypothesis; designing a study; data collection, interpretation and analysis; writing a research report, project, thesis and/or research article or review; preparing posters; unethical academic practices (plagiarism); making scientific presentations; intellectual property. Research concepts/definition and background: Scientific method and research, nature of biological, natural and social sciences research, attributes of good research, strategic issues in research planning in applied sciences. Scientific background of proposed plan (review of literature), online information collection or need for theoretical framework: research process-from formulation of research question to final publication: type of investigation, formulating and clarifying the research question, identification of problems and defining problems. Research hypothesis and planes (experimentation) to test the hypotheses, quantitative and qualitative research methods. Research designs in biological sciences, sampling designs. Experimental designs, experimental units and setting up experimental layout, data collection, types of data and data collection methods: data analysis: review of statistical application, sample, subject, universe, and population. Types of variable, manipulation of the variables, analyzing qualitative data. Analyzing quantitative data. Use of computer software's (SAS, SPSS, Excel, GIS); Research presentation: writing research report/project/thesis and or a research article; Research ethics: proper acknowledgements, Plagiarism.

Suggested Readings

1. Berg, B.L. 2001. Qualitative research methods for social sciences. 4thed. USA: Allyn & Bacon.
2. Bernard, H.R. 2006. Research methods in anthropology: qualitative and quantitative approaches.

Oxford: AltaMira Press.

3. Bhattacharjee, A. 2012. Social science research: principles, methods and practices. University of South Florida. Florida.
4. Booth, W.C., Colomb, G.G. & Williams, J.M. 2003. The craft of research. 2nd ed. Chicago: The University of Chicago Press.
5. Dawson, C. 2002. Practical research methods: a user-friendly guide to mastering research techniques and projects. Oxford: How To Books Ltd
6. Bryman A, 2001. Social research methods. 2nd Edition; Oxford University Press.
7. Awan JA, 2003. Scientific Presentation. Unitech Communication, Faisalabad, Pakistan.
8. Kumar R, Kindersley D, 2010. Research Methodology: A step by step guide for beginners. Third Edition; SAGE Publications.
9. Kothari CR, 2004. Research Methodology: Methods and Techniques. Second Revised Edition; New Age International Publishers, New Delhi.
10. Durrani SA, 2004. Technical Writing. Higher Education Commission, Islamabad.

BOT-714

Economic Botany and Medicinal Plants

3(2-1)

Theory

Plants as sources of food, feed, fiber, timber, vegetable, phytochemicals and medicine; Study of cryptogams and phanerogams for their economic uses; Cultural, physiological and molecular approaches to improve economic plants for better yield of economic products; Strategies for the domestication and preservation of economic plants; Environmental and eco-physiological considerations of the economic plants; Human and veterinary medicinal plants; Plant toxins and their applications; Ethnobotany: overview, traditional diets, people-plant interaction and social impact of plants on culture; Historical and cultural aspects of medicinal plants; History of medicinal plant usage; Systematics of medicinal plants; Diversity of medicinal plants; Growth habit and ecology of important indigenous medicinal plants; Poisonous Plants; Psychoactive plants; Chemical composition of commonly used medicinal plants in terms of their general effect on the human body; Potential dangers involved in dealing with medicinal plants; Herbal therapeutic properties; Chemical, structural and nutritional aspects of plant products

Practicals

1. Identify local ethnobotanically useful species
2. Survey of medicinally important plants and their products
3. Medicinal plant description and processing
4. Preparation of decoctions, syrups, ointments, and dried plants for domestic medicinal use
5. Field exercises on medicinal plant specimen collection, documentation, storage and gardening

Suggested Readings

1. Bhattacharjee, S.K. 2000. Handbook of Aromatic Plants. Pointer Publishers, Jaipur, India.
2. Cook, M.T. 2008. Applied Economic Botany. Read Books, Verona, New Jersey.
3. Elevation, C.R. 2004. Cultivating Connections with Trees. Permanent Agriculture Resources. The Overstory Book, New York
4. Li, T.S.C. 2000. Medicinal Plants. Culture, Utilization and Phytopharmacy. CRC Press, Florida.
5. Ross, I.A. 2003. Medicinal Plants of the World. Vol. 1. Chemical Constituents, Tradition and Modern Medicinal Uses, 2nd edition. Humana Press, Laurel, Maryland.
6. Simpson, B.B. and Ogorzaly, M.C. 2001. Economic Botany, 3rd edition. McGraw Hill, New York.
7. Sutton, M.Q. and Anderson, E.N. 2009. Introduction to Cultural Ecology. Rowman Altamira.
8. Vaughan, J. and Geissler, C. 2009. The New Oxford Book of Food Plants. Oxford University Press, Oxford.
9. Wickens, G.E. 2004. Economic Botany: Principles and Practices. Springer, The Netherlands

BOT-715**Applied and Experimental Statistics****3(2-1)****Theory**

Importance of statistics in variety of fields including medicine, biological, physical and social sciences, Basic concepts of statistics, frequencies, mean, mode, standard deviation, standard error, range etc. Probability and Normality, Sampling methods, Hypothesis testing, T test (Paired T test, one sample t test), Chi Square test, F test, One way analysis of variance, two way analysis of variance, LSD and DMRT tests, Correlation analysis, simple linear regression analysis, Logistic regression analysis, Odds Ratio.

Practicals

Analysis of given data by T test, Chi square test, Correlation, regression and one way ANOVA applying any of the available statistical software preferably SPSS or Statistix.

Suggested Readings

- 1- Walpole, R E. 1982. Introduction to statistics. McMillon Publishing Co New York
- 2- Muhammad F. 2005. Statistical methods and Data analysis. Kitab Markaz, Faisalabad
- 3- Mariappan P. 2013. Biostatistics: an Introduction (LPE). Pearson, New York, New Dehli
- 4- Forthofer R N. 2011. Biostatistics: a guide to design, analysis and discovery. Elsevier Publishers.
- 5- MONTGOMERY D C. 2014. Design and Analysis of Experiments 8th Ed. Wiley Publishers, New Dehli.

BOT-716**Advanced Plant Anatomy****3(2-1)****Theory**

Fundamental parts of the plant body; Internal organization; Different tissue systems of primary and secondary body; Meristematic tissues: classification and characteristics of the meristematic cells, initials and their derivatives; Apical meristem: delimitation of different growth zones; Evolution of the concept of apical organization of shoot and root apices; Mature tissues; Origin, structure, development, functional and evolutionary specialization of parenchyma, collenchymas and sclerenchyma; Xylem, phloem, epidermis and epidermal emergences and laticifers; Plant body: origin, internal organization and development of different tissues of leaf, stem and root, with special reference to their structure and functions; Secondary growth; Vascular cambium: origin, structure of storied and non-stored cell types; Cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem; Periderm, its presence in woods of angiosperm and gymnosperms; Unusual secondary growth, Forensic Botany and its application in different criminal and other cases, anatomical tool used to solve the identification problems in systematic botany, botanical evidences, plant resources and different methods of identifications

Practicals

1. Study of the organization of shoot and root meristems
2. Study of different primary and secondary tissues from living and preserved materials in macerates and sections
3. Study of hairs, glands and other secondary structures
4. Peel and ground sectioning of maceration and fossil materials
5. Comparative study of wood structure of gymnosperms and angiosperms

Suggested Readings

1. Arora, D.K. 1998. Advances in Plant Morphology and Anatomy. Print House, New Delhi, India
2. Cutler, D.F., Botha, T., Botha, C.E.J. and Stevenson, D.W. 2008. Plant Anatomy: An Applied Approach. Wiley-Blackwell, Oxford
3. Dickison, W.C. 2000. Integrative Plant Anatomy. Academic Press, London
4. Fahne, A. 1990. Plant Anatomy. Pergamon Press, Oxford
5. Gregory, L. 2009. Elements of Plant Anatomy. BiblioBazaar, Charleston, South Carolina
6. MacAdam, J.W. 2009. Structure and Function of Plants. John Wiley and Sons, New York

7. Mauseth, J.D. 1988. Plant Anatomy. Benjamin/Cummings Publishing Co., California
8. Peterson, R.L. and Melville, L.H. 2007. Teaching plant Anatomy through Creative Laboratory Exercises. NRC Research Press, England
9. Stevens, W.C. 2007. Plant Anatomy. Read Books, London
10. Bock, J. H., M. A. Lane, D. O. Norris. 1988. Identifying Plant Food Cells in Gastric Contents for Use in Forensic Investigations: A Laboratory Manual. U. S. Dept. of Justice, National Institute of Justice Research Report, January 1988.
11. Bruce, R. G. and M. E. Dettmann. 1996. Palynological analyses of Australian surface soils and their potential in forensic science. *Forensic Science International* 81: 77- 94.
12. Bryant, V. M., Jr. and G. D. Jones. 2006. Forensic palynology: current status of a rarely used technique in the United States of America. *Forensic Science International*: in press.
13. Bryant, V. M., Jr. and D. C. Mildenhall. 1990. Forensic palynology in the United States of America. *Palynology* 14: 193-208.
14. Graham, A. 1997. Forensic palynology and the Ruidoso, New Mexico plane crash – the pollen evidence II. In: Graham, A. Symposium Ed., *Forensic Chemistry, Soil Analysis, Entomology, Botany, Palynology, and other Aspects of Non-genetic-marker Biology*. *Journal of Forensic Sciences* 42: 391-393.
15. Graham, A. and G. Barker. 1981. Palynology and tribal classification in the Caesalpinioideae, Pp 801-834 in: R. M. Polhill and Peter Raven, Eds., *Advances in Legume Systematics*. HMSO, London.

BOT-717

Principles of Biotechnology

3(2-1)

Theory

Micropropagatin: Explant Sources, Comparison with field multiplication, Virus Elimination, Advantages. Callus culture, Cell culture, Protoplast culture and Somatic hybridization, Regeneration: Organogenesis, Somatic Embryogenesis, Haploid culture, Cloning and expression techniques, Cutting and joining DNA molecules, Polymerase Chain Reaction, Molecular Characterization, RFLP, RAPD and AFLP, Microarray, electrophoresis Gene Libraries and cDNA cloning, Analyzing DNA sequences, Restriction Analysis, Sequencing, Genetic engineering of plants:-Transformation with the Ti plasmid of *Agrobacterium tumefaciens*. – Biolistics mediated transfer genetically modified crops: species, concerns, future scope

Practicals

1. Overview of plant tissue culture/plant biotechnology lab.
2. Preparation of MS medium
3. Micropropagatin of potato Initiation and maintenance of callus Organogenesis
4. Isolation and quantification of DNA
5. Agrose gel electrophoresis of DNA
6. SDS PAGE
7. Plasmid isolation
8. RE digestion

Suggested Readings

1. Dodds, J. H. and L.W Roberts, 1997. *Experiments in Plant Tissue Culture*. Cambridge University Press, Cambridge.
2. Old, R.W and S.B. Primerose, 1994. *Principles of Gene Manipulation*. Blackwell, Oxford, London.
3. Glick, B.R. and J.J. Pasternak. 2003. *Molecular Biotechnology: principles and applications of recombinant DNA*.

BOT-718

Plant Biodiversity and Conservation

3(2-1)

Theory

1. Definition of biodiversity as defined in the convention of biological diversity (CBD).

2. Introduction of species on each other for their survival.
3. Extent of known and estimated biodiversity of earth.
4. Measuring biodiversity: Alpha, Beta, and Gamma diversity, Systematic diversity, functional diversity, taxic diversity.
5. Ecological services, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of living resources).
6. Sustainable and unsustainable use of ecosystem resources, consequences of unsustainable use, ecosystem degradation, extinct species, desertification and deforestation.
7. Biodiversity Hot spots of the world.
8. International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar.
9. IUCN categorised protected areas in Pakistan.
10. Environmental Impact Assessment.
11. Use of herbarium and Botanical Garden in biodiversity and conservation.

Practicals

1. Inventory of plant biodiversity in various habitats.
2. Field survey for baseline studies and Impact Assessment.
3. Identification of wild plant species used by local communities in different ecosystems.

Suggested Readings

1. Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.
2. Falk, D.A. & Holsinger, K.E. 1991. Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, Oxford, UK.
3. Frankel, O.H., Brown, A.H.D. & Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press, Cambridge, UK.
4. IUCN. 1994. IUCN Red List Categories. As Approved by the IUCN Council. IUCN.
5. Leadlay, E. and Jury, S. 2006 Taxonomy and Plant Conservation. CUP.
6. Bush, M.B. 1997 Ecology of a changing Planet. Prentice hall. New Jersey.
7. French, H. 2000 Vanishing Borders- protecting the Planet in the age of globalization. W.W. Norton & Co.
8. Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.

BOT-719

Plant Physiological Histology

3(2-1)

Theory

Fine structure of cell wall, cuticle and wax; Plasmodesmata and trafficking between the cells; Histological system: their types and physiological roles; Epidermal appendages; Structure of epidermis: typical epidermal cells; lenticels, hydathods; Root hairs their structure in relation to function; Aerenchyma, its development and significance to plant growth; Structural details of guard cells of monocots and dicots, and their physiological significance; Pathways and transport of ions via glands and trichomes; Detailed histology and functions of xylem, phloem and associated tissues and cells; Xylogenesis: its developmental physiology and molecular biology; Seed types and their structures: seed coat, scutellum, aleuron layer, endosperm and cotyledons, and their physiological importance; Structural and functional differences in the leaves of C₃, C₄ and CAM species at cellular and ultrastructural levels; Significance of interveinal distance; Bundle sheath: its structure in relation to function in C₃ and C₄ species; Twining stems: their histology in relation to physiology.

Practicals

2. Microscopic observations by differential staining of various cells and tissue of root, stem and leaf
3. Microscopic study of glands and other epidermal appendages
4. Study of living and dead tissues by vital staining

5. Study of various stress related adaptations including formation of sclerenchytous tissue, development of cuticle and aerenchyma in different plant parts

Suggested Readings

1. Cutler, D.F., Botha, T., and Stevenson, D.W. 2008. *Plant Anatomy: An Applied Approach*. Wiley-Blackwell, Oxford.
2. Dickison, W.C. 2000. *Integrative Plant Anatomy*. Academic Press, New York.
3. Evert, R.F. and Eichhorn, S.E. 2006. *Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development*, 3rd edition. John Wiley & Sons, New Jersey.
4. Fahn, A. 1990. *Plant Anatomy*, 3rd edition, Pergamon, Oxford.
5. Taiz, L. and Zeiger, E. 2010. *Plant Physiology*. 5th edition. Sinauer Associates Inc., Sunderland, Massachusetts.

BOT-720

Advanced Plant Metabolism

3(2-1)

Theory

Metabolic compartments of plant cell and their properties; Physical and biological forms of energy: their inter-conversion and flow from physical to biological systems; Enzyme kinetics and regulation of their levels and activity; Energy change during enzyme functions; Major classes of secondary metabolic pathways of plants and their salient features; Plant defense mechanisms: general properties, occurrence and distribution in plant taxa; Metabolism and physiological effects of vitamins, terpenes, phenolics, alkaloids, aflatoxins, cyanogenic glycosides, glucosinolates, phytoalexins, cutin, suberin and wax; Physiology, enzymology and molecular biology of N, S and P; Biosynthesis of amino acids and ureides; Rhizobial-plant interaction

Practicals

1. To estimate soluble phenolics and anthocyanins in leaf tissue
2. To estimate the amount of vitamin-C in leaf and fruit juice
3. To estimate potential alkaloids and saponins in plants
4. To estimate terpenoids and photosynthetic pigments

Suggested Readings

1. Buchanan, B.B., Grueissem, W. and Jones, R.L. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Rockville, Maryland.
2. Epstein, E. and Bloom, A.J. 2005. *Mineral Nutrition of Plants: Principles and Perspectives*, 2nd edition. Sinauer Associates Inc., Sunderland, Massachusetts.
3. Heldt, H.-W. 2005. *Plant Biochemistry*, 3rd edition. Elsevier, San Diego.
4. Nicholls, D.G. and Ferguson, S.J. 2002. *Bioenergetics*. 3rd edition. Academic Press. San Diego.
5. Seigler, D.S. 2001. *Plant Secondary Metabolism*. Springer, Heidelberg, Germany.
6. Taiz, L. and Zeiger, E. 2010. *Plant Physiology*, 5th edition. Sinauer Associates Inc., Sunderland, Massachusetts.
16. Verpoorte, R. and Alfermann, A.W. 2006. *Metabolic Engineering of Plant Secondary Metabolism*. Springer, The Netherlands.

BOT-721

Forensic Botany

3(3-0)

Theory

Introduction to Forensic botany; Palynology: Fossil and modern pollen grains, spores, etc Source of pollens (Dirt and mud, Hair and fur, Cloth and ropes, Packing materials, Human remains; from the soft tissues of the stomach and intestines of corpses or the nasal passages of skeletons, Imported/exported goods, often to verify country of origin, Antique goods, to validate age and authenticity, Air filters, to determine where private vehicles may have traveled, Money suspected to have been used in drug transactions may be sampled for pollen of narcotic species); Anatomy, Dendrochronology (dating of wooden objects, matching objects with

crime scenes using the wood's morphological features, Art Fraud provenance of wooden art objects and musical instruments); Ecology: Plant succession, Soil, Species diversity, Limnology: Fresh water ecology; disturbance in hydro-ecology. Study of Diatoms in dead bodies.

Suggested Readings

1. Bock, Jane, H., 2006. Handbook of Forensic Botany. Amazon publishers.
2. Laurie Kelly, H. Miller and C. Miller Colly, 2005. Forensic Botany: Principles and Applications to Criminal Casework. Amazon publishers
3. Stuart, J. and J. Nordby, 2005. Forensic Science: An Introduction to Scientific and Investigative Techniques, Second Edition. CRC publications.
4. William, C. Dickison, 2000. Forensic botany: Plant sciences in the courts. Am. J. Bot. Supplement
5. William, D. Haglund and S. Morcella H. 1996. Forensic Taphonomy. CRC press.

BOT-722

Phytosociology

3(2-1)

Theory

Phytosociology. The community: analytical and synthetic characteristics of a community, classification of community, basis and unit of classification, dynamics of communities. Types of changes: succession on wet and dry habitats, theories of the nature of climax. Ecological characteristics of species and population. Ecosystem ecology: components of ecosystem, energy transformations in nature and laws governing energy transformation, food chain, food web, pyramid of number in food chain, trophic levels, energy flow in an ecosystem. Biogeochemical cycles with nitrogen, phosphorus, sulphur, carbon and water cycles as examples. Principal vegetation types of Pakistan.

Practical

Methods of vegetation sampling. Field study of vegetation characteristics of different ecological regions. Determination of frequency of occurrence in a plant community, population density and cover of species in a plant community. Preparation of association table. Study of decomposition of leaf litter. Preparation of profiles of temperature and relative humidity.

Suggested Readings

1. Billings, W.D. (2000). Plant and Ecosystem. Wadsworth Pub. Co., California
2. Daubenmire, R.F. (1974). Plant Communities. A Textbook of Synecology. Wiley, N. Y. USA.
3. Kimmins, J. P. 1996. Forest ecology, Prentice Hall Upper Saddle River, New Jersey.
4. Shukla R.S & P.S Chandel. 2006. Plant Ecology S. Chand & Company LTD Ram nagar new Delhi
5. Stiling, R. D. 1992. Ecology, theories and applications. Prentice Hall International Inc. U.S.A.
6. Treshow, M. (1970). Environment and Plant Response. McGraw Hill Book. Co., N. Y.

BOT-723

Advanced Plant Metabolism

3(2-1)

Theory

Metabolic compartments of plant cell and their properties; Forms of energy and their interconversion; Enzyme properties and classification, kinetics and regulation of their levels and activity; Energy changes during enzyme functions; Metabolic energy conversion; Metabolism of photosynthetic pigments (chlorophylls, carotenoids, phycobilins); Major classes of secondary metabolic pathways in plants and their salient features; Metabolism and physiological effects of nitrogen containing and non-nitrogen containing secondary metabolites, and vitamins; Plant defense mechanisms; Aflatoxins; Metabolic engineering: glycinebetaine synthesis as an example.

Practical

Determination of soluble phenolics and anthocyanins in leaf tissue; The amount of vitamin-C in leaf and fruit juice; Determination of alkaloids, saponins, and terpenoids and photosynthetic pigments in leaf samples

Suggested Readings

- 1 Buchanan, B., W. Grissem and R. Jones. 2015. *Biochemistry & Molecular Biology of Plants*, 2nd Ed. Wiley-Blackwell, Oxford, UK
- 2 Epstein, E. and A.J. Bloom. 2005. *Mineral Nutrition of Plants: Principles and Perspectives*, 2nd Ed. Sinauer Associates Inc., Sunderland, MA, USA.
- 3 Gutzeit, H.O, and J. Ludwig-Müller. 2014. *Plant Natural Products: Synthesis, Biological Functions and Practical Applications*, 1st Ed. Wiley-Blackwell, Oxford, UK.
- 4 Nicholls, D.G. and S.J. Ferguson. 2002. *Bioenergetics*. 3rd Ed. Academic Press, London, UK.
- 5 Raymond, S.O. 2014. *Biochemistry*. Jones Brothers and Company, Bossier City, LA, USA.
- 6 Taiz, L., E. Zeiger, I.M. Møller and A. Murphy. 2015. *Plant Physiology and Development*, 6th Ed. Sinauer Associates Inc., Sunderland, MA, USA.

BOT-724

Paleobotany and Evolution

3(2-1)

Classification and modes of fossil preservation; Methods of fossilization; Geological time scale and importance of paleobotany; Neopalynology and palaeopalynology; Structure, morphology, ornamentation pattern of spores and their technical description; Chemical composition of exine and organic thermal maturity; Sampling techniques in paleobotany; Palynomorphs and field work; Use of pollens as evidence in the plant evolution; Evolutionary tendencies in biology; Theories and mechanism of evolution: Darwinism and Lamarkism; Hardy-Weinberg Law; Progressive and retrogressive evolution; Parallelism; Micro- and macroevolution; Speciation

Practical

Collection of materials for paleobotanical studies; Studying the fossilized rocks; Pollens collection for studying their morphology and preservation

Suggested Readings

1. Ingrouille, M.J. and B. Eddie. 2006. *Plant Diversity and Evolution*. Cambridge University Press, Cambridge, UK.
2. Stewart, W.N. and G.W. Rothwell. 2010. *Paleobotany and the Evolution of Plants*, 2nd Ed. Cambridge University Press, Cambridge, UK.
3. Ward, L.F. 2010. *Sketch of Paleobotany*. BiblioLife-Nabu Press, Charleston, SC, USA.
4. Willis, K. and J. McElwain. 2014. *The Evolution of Plants*, 2nd Ed. Oxford University Press, Oxford, UK.

BOT-725

Nanobiotechnology

(3(3-0))

Course Objectives: To acquaint students with key integrative technologies and use of nanoparticles in biological systems

Course Contents: Introduction; interface between nanotechnology and bio-nanotechnology; manipulating molecules; carbon fullerenes and nanotubes; non-carbon nanotubes and fullerene-like materials; quantum dots; nanowires, nanorods and other nanomaterial's; magnetic nanoparticles; natural biological assembly at the nanoscale and nanometric biological assemblies (complexes); nanobionics and bio-inspired nanotechnology; applications of biological assemblies in nanotechnology; medical, cosmetics, agriculture, water and other applications of nano-biotechnology; future prospects of nano-biotechnology; use of nanotechnology for diagnosing and curing disease.

Suggested Readings

1. Gazit E, 2007. *Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology*. 1 st Edition; Imperial College Press.
2. Renugopalakrishnan V and Lewis RV, 2006. *Bio-nanotechnology: Proteins to Nano devias*. Springer.
3. Greco et al., 2004. *Nano Scale Technology in Biological Systems*. CRC Press.
4. Mirkin CA and Niemeyer CM, 2007. *Nano-biotechnology II: More Concepts and Applications*. John Wiley & Sons.
5. Niemeyer CM and Mirkin CA, 2004. *Nano-biotechnology*. 1 st Edition; Wiley VCH.