

AGENDA



4th Meeting of Departmental Council (DC)

October 5, 2022

Department of Botany

University of Poonch Rawalakot

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AGENDA ITEM NO. 1

Revised Scheme of Study for M.Phil. Program in Botany

Title of Degree Program:	Master of Philosophy in Botany
Degree Abbreviation:	M.Phil.
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

Title of Degree Program:	Doctor of Philosophy in Botany
Degree Abbreviation:	Ph.D.
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

Note: A minimum course work of 18 credit hours is necessary in the first year for M.Phil. and Ph.D. students. Students can choose any course of their choice according to the nature of their thesis requirement.

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

BOT-721	Forensic Botany	3 (3-0)
BOT-722	Phytosociology	3 (3-0)
BOT-723	Paleobotany and Evolution	3 (3-0)
BOT-724	Nanobiotechnology	3 (3-0)
BOT-725	Recent trends in Ethnobotany	3 (3-0)
BOT-726	Archeology and Evolution	3 (3-0)
BOT-727	Plant Microbe Interaction	3 (3-0)
BOT-728	Plant Growth and Development	3 (3-0)
BOT-729	Forest and Shade Tree Pathology	3 (3-0)
BOT-730	Proteomics and Genomics	3 (3-0)
BOT-731	Advances in Environmental Biology	3 (3-0)
BOT-732	Wild Plants and their Economic Use	3 (3-0)
BOT-733	Environmental Impact Assessment and Solid Waste Management	3 (3-0)
BOT-734	Advances in Plant Ecology	3 (3-0)
BOT-735	Seed and Urban Plant Pathology	3 (3-0)
BOT-736	Plant Quarantine, Sanitary and Phytosanitary Measures	3 (3-0)
BOT-737	Advances in Plant Pathology	3 (3-0)
BOT-738	Climate Change Effects and Mitigation	3 (3-0)
BOT-739	Biodegradation	3 (3-0)
BOT-740	Bioethics	3 (3-0)
BOT-741	Biosafety and Biosecurity	3 (3-0)
BOT-742	Integrated Plant Disease Management	3 (3-0)
BOT-743	Biological Control of Plant Pathogens	3 (3-0)
BOT-744	Plant Ecophysiology	3 (3-0)

3. Soltis, Pamela S., Soltis, Douglas E., Doyle, J.J. (Eds.). 1992. *Molecular Systematics of Plants*. Springer
4. *Vascular Plant Taxonomy*, 5th edition, by Dirk R. Walters, David J. Keil, and Zack E. Murrell 2006,
5. Kendal/Hunt Publishing Company. *Textbook Plant Identification Terminology* by J. G. Harris and M. W. Harris, Spring Lake Publishing, Springer.
6. Stuessy, T.F. 2008. *Plant Taxonomy: The Systematic Evaluation of Comparative Data*. Columbia University Press, Columbia.
7. Takhtajan, A. 1986. *Flowering Plants. Origin and Dispersal*. Oliver and Boyd, Edinburgh, UK.
8. Peter M. Hollingsworth, Richard M. Bateman, Richard J. Gornall. 2002. *Molecular Systematics and Plant Evolution* CRC Press Book.

Theory

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, Quantitative estimation of various macromolecules. Demonstration of properties of macromolecules. Methods of bacterial culture. Vectors, its types and applications. Southern and Northern Blotting. PCR types and applications. Restriction enzyme classes. Gel Electrophoresis. Cloning PCR products. Recombinant DNA technology. GISH and FISH techniques and its uses. DNA Sequencing and Sequence analysis (Bioinformatics). GMOs in crops. Sequence verification and alignment of sequence data. Accessing sequence databases over the internet, BLAST searches. Principles and practice of sequence alignment & comparison

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. Brown, T.A. 2007. *Gene cloning and Genetic Engineering: 2nd Edition*. Wiley-Blackwell.
7. Pherson, M.V. 2011. *Basics of PCR*. 1st edition. Wiley-Blackwell

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 Spectroscopies; 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.

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 Handbook of Methods for the Preparation, Staining, and Microscopical Investigation of Vegetable Structures. General Books LLC, New York

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.

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.

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

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.

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 retro homing; 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.

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, 2006. Bioinformatics for Dummies. 2nd Edition; Wiley Publishing.

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

BOT-709
Stress Physiology
3(3-0)
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.

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(3-0)
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

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.

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 variables, 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. 4th ed. 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.

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

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. Elevitch. 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

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, Experimental Designs, Factorial Designs, Mean Comparison.

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.

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, collenchyma 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

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. Fahn, 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(3-0)

Theory

Micropropagation: 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

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(3-0)

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 categorized protected areas in Pakistan.
10. Environmental Impact Assessment.
11. Use of herbarium and Botanical Garden in biodiversity and conservation.

Suggested Readings

1. Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Program. 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.

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, hydathodes; 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, aleurone 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.

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. Fahh, A. 1990. Plant Anatomy, 3rd edition, Pergamon, Oxford.
5. Taiz, L. and Zeiger, E. 2010. Plant Physiology. 5th edition. Sinauer Associates Inc., Sunderland, Massachusetts.

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

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.MorcellaH. 1996. Forensic Taphonomy. CRC press.

BOT-722

Phytosociology

3(3-0)

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, sulfur, carbon and water cycles as examples. Principal vegetation types of Pakistan.

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

Paleobotany and Evolution

3(3-0)

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

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-724

Nanobiotechnology

3(3-0)

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

Course Contents: Fundamental of nanotechnology and nanobiotechnology; Physical and Chemical Nature of Nanoparticles; characterization of nanoparticles; prokaryotic microbial synthesis of nanomaterials; inspired biological synthesis of nanomaterials using eukaryotic

microbial nano-machinery; current trends in algae-mediated synthesis of metal and metal oxide nanoparticles; biosynthesized nanomaterials via processing of different plant parts; versatile applications of biosynthesized nanoparticles; grand challenges and future perspectives regarding nanobiotechnology.

Suggested Readings

1. Omran, Basma A. *Nanobiotechnology: A Multidisciplinary Field of Science*. Springer International Publishing, 2020.
- 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.

BOT-725

Recent Trends in Ethnobotany

3(3-0)

Introduction Objectives, History of Ethnobotany present concept & scope, Plant systematic: Taxonomy and nomenclature, Phytogeography in applied in Ethnobotany. Resources of Ethnobotany Sources of Data and Methods of Study: Ethnobotanical field Techniques and methods, Collection of ethnobotanical data, Archaeological resources, ethnographic flora other literature. Ethnomedicine or Ethnopharmacology: Ethnopharmacognostic investigation of plant used in traditional medicine. Photochemical analysis. Search of new plant products. Preparation and use of herbal medicines.

Anthropology: Medical anthropology toward the contribution toward health. Economics: Economics and Ethnobotany. The value of forest products. Plant Resources of Pakistan, Commercialization of ethnobotanical materials

Suggested readings

Plants, People and Culture: The Science of Ethnobotany

Plants of the Gods: Their Sacred, Healing, and Hallucinogenic Powers

The Plant Hunter: A Scientist's Quest for Nature's Next Medicines

BOT-726

Archeology and Evolution

3(3-0)

Course Contents:

Archaeobotany, the study of the use of plants by people in the past, examines archaeological plant remains. It is an inherently interdisciplinary sub-field of archaeology that integrates botany, ecology and social theory to explore a broad range of topics. This course will introduce both the debates in archaeobotany, from the discussion surround ‘domestication’ to the use of archaeobotanical remains in reconstructing ‘diet’ and ‘food’, and integrate these debates in practical lab-based classes

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; Evolution and differentiation of species, their phylogenetic and ecological aspects; Evolutionary trends: competition; predation, herbivory, parasitism, symbiosis.

Suggested Readings

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

BOT-727

Plant Microbe Interaction

3(3-0)

Course Contents:

Rhizosphere. Quorum sensing and its role in agriculture. Role of bacteria as biocontrol agent. Classification of microbes. Rhizobia and nodulation, diazotrophs, bioremediation. Microbial responses in rhizosphere & agricultural crops. Symbiosis & beneficial types (BNF) and factor affecting BNF. Microbial metabolites. Bio fertilizers & role of microbes. Microbial biofilms. Associative symbiosis. Molecular basis of Plant microbe interaction. Physiological and molecular actions of PGPRs. Signal transduction around the bacteria. Vascular mycorrhizae. Responses of bacteria under biotic & abiotic stress. Physiological significance of Phyto-hormones produced by microbes. Phosphate solubilization

Suggested Readings:

- 1-BMC (Journal of Bacteriology)
- 2-JMB (Microbiology)
- 3-World Journal of Microbiology and Biotechnology (Springer)

Introduction. Plant Development: Alternation of generation; Growth, differentiation and morphogenesis; Reasons for cell differentiation; Regulation of development. Genetic Analysis of Developmental Processes: Recognition and isolation of developmental genes; Molecular analyses of developmental phenotypes. Structure and Expression of Sub-Genomes: The nuclear genome; The plastome; The chondriome; Interaction between different genetic compartments. Inducers & Modulators of Development: Effects of light; Phytochrome; The biological clock; Phytohormones; Role of Phytohormones in developmental processes. Flowering Plants' Life Cycle: Embryogenesis; Post embryogenesis; Vegetative development; The generative phase.

Suggested Readings:

1. Westhoff, P., H. Jeske, G. Jurgens, K. Klopstech and G link. 1998. Molecular Plant Development Oxford University Press.
2. Srivastava, L. M. 2002 Plant Growth and Development: Hormones and Environment
3. Leyser, O. and S. Day. 2002. Mechanisms in Plant Development. Blackwell Publishing.
4. Steeves, T.A. and I. M. Sussex. 1989. Patterns in Plant Development. 2nd Edition. Cambridge University Press.
5. Howell, S.H. 1998. Molecular Genetics of Plant Development. Cambridge University Press.

Objectives:

To study forest and shade tree diseases and their management.

Course Contents:

Importance of forest and shade tree diseases; introduction to forest and shade tree diseases and their ecology, epidemiology and quantification of losses; forest operations in relation to development and spread of abiotic and biotic diseases; studies on specific diseases of representative groups; nursery plants and shade tree diseases; management of important diseases.

Recommended Books:

1. Agrios, G.N. 2005. Plant Pathology, Elsevier Academic Press, New York, USA

2. Bakhshi, E.K. 1976. Forest Pathology. Forest Institute, Dehradun, India.
3. Khan, A.H. 1989. Pathology of Trees. 2nd Vol. Univ. Agric. Faisalabad.
4. Manson, P.D. 1991. Tree Disease, concepts. 2nd Edition. Prentice Hall Eaglewood Cliffs, New Jersey, USA
5. Strouts, R.G. and T.G. Winter. 1994. Diagnosis of ill-health in trees. H.M.S.O. Publishers, London, UK
6. Zabel, R.A. and J.J. Morell. 1992. Wood Microbiology: Decay and its Prevention. Academic Press, San Diego, California, USA.

BOT-730
Proteomics and Genomics
3(3-0)
Course Objectives:

The course will provide fundamental concepts of:

- current bioinformatics tools involved in proteomics and genome projects
- overview of techniques involved in genomics and proteomics

Course Contents:

Introduction to genomes, transcriptomes and proteomes. Understanding a genome sequence. Locating gene by sequence inspection. Experimental techniques for gene location. Hybridization, cDNA capturing, zoo blotting, RT-PCR, RACE, heteroduplex analysis. Locating exon-intron boundaries. Computer analysis of gene function. BLAST analysis, ORF finder, homology searching for gene identification. Introduction to proteomics and scope of the proteomics. Strategies for protein separation, identification, quantification. Analysis of protein sequence (Proteome databases, Sequence annotation tools. Structural proteomics (comparative analysis), interaction proteomics. Data base for protein structure, function and sequencing. Identification of domain and secondary structures in the given protein sequence.

Suggested Readings:

1. T. A. Brown. (2007) Genomes 3. 3rd edition. Garland Science Publishing.
2. Cecilia Saccone, Graziano Pesole (2003) Handbook of comparative genomics: principles and methodology. Wiley-Liss.
3. Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (2000) by D. Higgins, & W. Taylor (Editors) Oxford University Press.
4. Post-genome Informatics. (1999) by M. Kanehisa, Oxford Univ. Press. Benjamin Lewin (2007) Genes IX. Jones and Bartlett Publishers.
5. Principles of Proteomics by R. M. Twyman (2004). BIOS Scientific Publishers
6. R. Westermeier, T. Naven, and Hans-Rudolf (2008) Proteomics in Practice: A Guide to Successful Experimental Design. 2nd Edition. J. Wiley & Sons.
7. Daniel C. Liebler (2001) Introduction to Proteomics: Tools for the New Biology

BOT-731
Advances in Environmental Biology
(3-0)

Objectives:

The basic objective of the study is to introduce the latest scientific thoughts and to build a knowledge-based interaction with the students to bring them at power to address potential environmental hazardous treatments globally and biological aspects of recent time's environment.

Course Contents:

Environment: definitions; global regional and national environmental problems. Water pollution and treatment techniques: Health and aesthetic aspects of drinking water; Pathogenic organisms, Toxicological evaluation of drinking water contaminants, heavy metals in drinking water, disinfectants and disinfection by products: Chemical disinfection, Ultraviolet light processes; UV disinfection, UV advanced oxidation processes. Coagulation and flocculation of contaminants; stability of particle suspensions, destabilization mechanisms, coagulants. Granular media filtration; slow sand filtration, rapid sand filtration. Adsorption of organic compounds by biomass and activated carbon; adsorption systems, performance of GAC systems, powdered activated carbon adsorption, adsorbent regeneration. Membrane processes; RO-NF configuration, Integrated MF-UF process application and process design. Micro-organisms for water pollution control, Natural treatment systems for water and wastewater. Air pollution and remediation techniques: Criteria air pollutants, Particulate matter removal techniques, Gases removal techniques. Soil pollution and remediation techniques. Phytotechnology for environmental remediation. International treaties and conventions. Environmental policies, Laws and planning, Impact assessment, Environmental acts and regulations of Pakistan, National environmental quality standards. Resources management, Water resources, Solid and hazardous waste management.

Suggested Readings:

1. Basic Environmental Technology: Water Supply, Waste Management and Pollution Control. Fourth Edition, Jerry A. Nathanson, 2003.
2. Environmental Sciences: A Global Concern. William P. Cunningham, Mary Ann Cunningham. Eleventh Edition, McGraw-Hill. 2010.
3. Biology of Wastewater Treatment (2nd Edition), Gray, N. F., Imperial College Press, 2004.
4. Practical Wastewater Treatment, David, L. and Russell, P.E., John Wiley & Sons, Inc. 2006.
5. Water Quality (Principles and Practices of Water Supply Operations) by Joseph A. Ritter, 4th Edition.
6. Journal of Hazardous Materials, Bioresource Technology, Desalination, Journal of Environmental Management.

Course Contents:

Diversity in Physiography. Wild herbs as culinary purpose. Source of aromatic chemicals. Wild plant as Genetic resources. Need of conservation of wild Germplasm. Strategy of conserving the wild flora. Some herbs, shrubs & trees of A. J & K their Economic uses. Importance, present status & scope of Medicinal & Aromatic plants. Classification of Aromatic & Medicinal plants. Importance, scope & present status of species. Conservation Strategies of medicinal plants. Pests and pest management in medicinal plants

Suggested Readings:

1. Beentji, H (1994) Kenya Shrubs, Trees and Lianas. National Museum of Kenya Nairobi.
2. Dashora, L. K., A. Dashora and S. S. Lakhawat, 2006. Production Technology of Plantation Crops, Species, Aromatic and Medical Plants. SSS Printers, New Delhi.
3. Raju, R. A. 2000. Wild Plants of Indian Sub-Continent and their Economic Use. CBS Publisher and Distribution, New Delhi.
4. World Conservation Union, United Nations Environment Programme, Worldwide Fund for Nature (1991) Caring for the Earth: a Strategy for sustainable living WCU, UNEP, WWF, Gland, Switzerland.

BOT-733 Environmental Impact Assessment and Solid Waste Management 3(3-0)

Objectives: The objectives of this course are to provide students with knowledge related to the broad field of environmental risk assessment, general steps involved in the risk assessment process, including statistical characterization of observed data, and several tools that can be used in defining environmental risks, particularly as related to human health. To provide the students with a sound knowledge in managing wastes, management and technical aspects of solid waste.

Course Contents: Linkage between development and environment; global commons: carrying capacity: origin and development of EIA: relationship of EIA to sustainable development: EIA in project planning and implementation: EIA process: evaluation of proposed actions, scoping and base line study, identification and prediction of impacts, mitigation measures. Comparison of alternatives, review and decision making, public participation and compensatory actions: green belts: National Environmental Policies and guidelines in India and Pakistan. Conditions and approach for EIS review. Case studies: river valley projects: thermal power plants: mining projects: oil refineries and petrochemicals.

Waste as a resource, Solid waste stream characteristics, Strategies (process) in integrated solid waste management, Detail methodologies (reduce, reuse, recycle, landfilling, incineration, composting) used in solid waste management., Biorefining, Risk assessment: recognition and elimination of hazards, Microbiological processes involved in the mineralization of solid waste, Recovery of value added products from solid waste, Microbial process used in the production of biofuels from solid waste , Sustainable process development for waste minimization , Planning MSW management programs, Environmental perspectives in SWM , Resource Conservation and Recovery Act (RCRA), Case study: domestic, hospital and industrial waste management.

Suggested Readings:

1. Christensen, T. H. (2010) Solid Waste Technology & Management, John Wiley & Sons, Ltd, Chichester (ISBN: 978-1-405-17517-3).
2. Twardowska, I., H. E. Allen, A. F. Kettrup, W. J. Lacy (2004) Solid Waste: Assessment, Monitoring and Remediation, Volume 4 (Waste Management), Pergamon, ISBN-13 / EAN: 9780080443218.
3. McDougall, F. R., P. R. White, M. Franke, P. Hindle (2003) Integrated Solid Waste Management: a Life Cycle Inventory, Blackwell Science, Inc., 350 Main Street, Malden, MA 02148 5018, USA.
4. Cheremisinoff, N. P. (2003) Elsevier Science, Burlington, MA 01803. Handbook of Solid Waste Management and Waste Minimization Technologies.
5. Wayne, L. T. (1995) Biohazardous Waste: Risk Assessment, Policy, and Management, Lewis Publishers, Inc.
6. Environmental Impact assessment (A comparative review). Wood C. Longman scientific and technical. Longman house. Burnt Hill, harlow Essex, UK, 1995.
7. Public involvement in Environmental impact assessment: requirements, opportunities and issues, World Bank, Environmental assessment sourcebook update, Environmental department, WB, Washington DC, 1993.
8. Environmental and social Impact assessment. Ed Vanclay. F & Bronstein, D A John, Wiley and Sons, Chichester, England, 1995.
9. Sectoral guidelines of environmental Impact assessment, Ministry of Environment, Government of Pakistan.

BOT-734

Advances in Plant Ecology

3(3-0)

Objectives:

Understanding the conceptual bases and empirical approaches used to study trends in the composition, structure, dynamics, and diversity of plant communities, read and discuss some of the most important papers in plant community ecology.

Course Contents:

The history of plant community ecology emphasis on key figures and controversies, plant community dynamics, e.g., competition, zonation, succession, etc., broader controls on plant

communities, such as disturbances, environmental factors, and trophic interactions, central theories of community concept, plant adaptive strategies, diversity-function relationships, etc., plant conservation issues in the context of fundamental ecological principles.

Course emphasizes hypotheses, investigations, uncertainty, disagreements; analytical tools used to summarize/interpret plant community data. Advanced skills in reading and summarizing ecological literature.

Suggested Readings:

1. Vegetation Ecology, Ed Maarel, ED. Blackwell publishing, Oxford, UK, 2005.
2. Introduction to plant population biology, Silvertown, J. & Charlesworth, D. Blackwell Publishing, Oxford, UK, 2005.
3. Plant Ecology, Shulze ED, Beck & Muller-Hohenstein, K Springer, Berlin. 2005

BOT-735

Seed and Urban Plant Pathology

3 (3-0)

Objectives:

To study the effects of plant pathogens on seed health and their management and to acquaint students with the major disease problems associated with urban agriculture

Course Contents:

Importance of seed-borne fungal, bacterial, viral and nematode diseases; Morphology of healthy seed; Histopathology of infected seeds and planting materials; Mechanism of infection and disease transmission; Factors affecting establishment of pathogens in seed; Seed quality control systems and disease free seed production, processing and certification with special reference to Pakistan; Seed crops and seed standards; Seed treatment and equipment; seed processing and storage; Seed health testing of consignment during export/import and testing of germplasm material; Seed borne pathogens and its health hazards.

Importance of urban plant pathology; status and distinguishing features of diseases in fields and urban agriculture; Detailed studies of symptoms, etiology, nature, distribution, extent of losses, disease perpetuation, epidemiology and management of important diseases; post-harvest pathological problems; management of plant diseases in urban ecosystem.

Suggested Readings:

1. Agarwal, V.K. and J.B. Sinclair, 1993. Principles of Seed Pathology. Vol. I & II. CBS Publishers and Distributors, New Delhi.

2. Albrechtsen, S.E. 2006. Testing Methods for Seed-Transmitted Viruses: Principles and Protocols, CABI UK.
3. Bashir, M., Z. Ahmad and N. Murata. 2000. Seed-borne Viruses, Detection, Identification and Control. PARC, Islamabad.
4. Bhutta, A.R. and I. Ahmad. 2001. Seed Pathological Techniques and their Application. National Book Foundation, Islamabad, Pakistan.
5. Bhutta. A.R. 2010. Textbook of Introductory Seed Pathology. HEC, Islamabad, Pakistan.
6. Kruse, M. 2004. ISTA Handbook on Seed Sampling. 2nd Ed. ISTA, Switzerland.
7. Singh, D. 2004 Histopathology of Seed-Borne Infections. CRC Press.
8. Chase, A.R. 1997. Foliar Plant Diseases; Diagnosis and Control. American Phytopathological Society, St Paul, Minnesota, USA.
9. Fletcher, J.H. 1984. Diseases of green house plants. John Wiley & Sons. Inc., New York, USA.3.
Mc Maugh, J. 2001. What garden pest or disease is that? New Holland Publishing, Sydney.
10. Nelson, P.Y. 2008. Green house: Operation and Management. Prentice Hall.
11. Pirone, P.P. 1978. Diseases and pests of ornamental plants. John Wiley & Sons. Inc. New York, USA.

BOT-736 Plant Quarantine, Sanitary and Phytosanitary Measures 3 (3-0)

Objectives:

To introduce the concepts and principles of plant quarantine and phytosanitary measures.

Course Contents:

Introduction, concept and principles of plant quarantine and SPS measures; WTO Regime; Plant and seed related issues; International and domestic quarantine standards and rules; seed act 1976 and its implementation in seed import/export; biosecurity; disease reporting; legislative framework; contaminants; outbreaks of some important diseases introduced into Pakistan and elsewhere through import of seed and food items; Impact of SPS and quarantine measures; Quarantine legislations for food and nonfood commodities; Detection methodology used for quarantine object pathogens in import/export consignment. Procedure and measure adopted under

National Animal and Plant Health Inspection Services in Pakistan; Impact of major international agreements on economy of Pakistan; Measures to encounter agriculture bioterrorism.

Suggested Readings:

1. Bhutta, A.R. and I. Ahmad. 2001. Seed Pathological Techniques and their Application. National Book Foundation, Islamabad. Pakistan.
2. Ebbels, D.L. 2003. Principles of Plant Health and Quarantine. CABI Publishing.
3. FAO. 2000. Multilateral Trade Negotiations on Agriculture - A Resource Manual-III – SPS and TBT Agreement. Publ. FAO-UN Rome.
4. Osmanczyk, E.J. and A. Mango. 2003. Encyclopedia of the United Nations

BOT-737

Advances in Plant Pathology

3(3-0)

Objectives:

To acquaint students with recent trends in plant pathology

Course Contents:

Theory: Recent trends and developments in different disciplines of plant pathology; review of developments and future prospects of plant pathology; Pathogenesis and host parasite specificity in bacteria, nematodes, fungi and viruses; Molecular and biological techniques for identification of plant pathogens; Mechanism of genetic variability in pathogens.

Suggested Readings:

Technical Journals, reviews, proceedings, reports in Plant Pathology

BOT- 738

Climate Change Effects and Mitigation

3(3-0)

Course Contents

Introduction to climate research. History of earth's Climate. Climate forcing factors. GCMs & predictions. Climate & biosphere. Mitigation Strategies: Transportation. Electric power & other sectors. Economics of climate change. Environmental law. Culture & climate change

Suggested Readings:

Bloom, A. J. (2010). *Global climate change: Convergence of disciplines*. Sinauer Associates.

Other Resources

Field Notes from a Catastrophe: Man, Nature, and Climate Change by Elizabeth Kolbert, Bloomsbury Publishing Plc, December 2006

Energy in America - A Tour of Our Fossil Fuel Culture and Beyond by Ingrid Kelley, University of Vermont Press-University Press of New England, 2008

Earth: The Sequel - The Race to Reinvent Energy and Stop Global Warming by Fred Krupp and Miriam Horn, W.W. Norton & Co. Inc, March 2008

BOT-739

Biodegradation

3(3-0)

Objectives:

To develop an awareness of the importance of microorganisms in pollutant degradation, to learn the biochemical strategies used by microorganisms to break down selected environmental pollutants.

Course Contents:

Introduction; biodegradation, biotransformation, mineralization, metabolism, microcosms, Biodegradation of natural organic waste, Type, nature and source of recalcitrant, xenobiotics, Behavior of chemicals in the biosphere, Bioremediation and biodegradation; mechanisms and strategies, Role of enzymes in biodegradation, Factors affecting biodegradation of organic compounds; chemical, environmental and biotic, Molecular strategies of microbial adaptation (acclimation) to xenobiotics, Aerobic and anaerobic biodegradation pathways of recalcitrant. Case studies and examples; dyes, plastics, pesticides and hydrocarbon

Suggested Readings:

1. Mitchell, R., G. J-Dong (2010) *Environmental Microbiology*, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey.
2. Jördening H.-J., J. Winter (2005) *Environmental Biotechnology. Concepts and Applications*. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim ISBN: 3-527-30585-8
3. Sing, V. P., D. Raymond, Jr. Stapleton (2002) *Biotransformations: Bioremediation Technology for Health and Environmental Protection*, Elsevier, Amsterdam, The Netherlands.
4. Wackett, L. P., C. D Hershberger (2001) *Biodegradation and Biocatalysis*. ASM Press, American Society for Microbiology, N. W. Washington, DC.

BOT-740

Bioethics

3(3-0)

Objectives:

To discuss controversial issues relating to human subject research, including Phase 1 research, randomization, children in research, international research, etc. Apply appropriate codes, regulations, and other documents governing the ethical conduct of human subject research to their own research

Course Contents:

Introduction; Modern biotechnology and social implications; Biological research and bioethics; Religion and ethics; Ethical Issues in Medical Diagnosis; Ethical Review Board (ERB); National and International Bioethics Committees; Experimentation on human embryos, Stem cell research; Ethical aspects of organ transplantation; Informed Consent; Indigenous Knowledge and Patenting; Commercialization and Benefit sharing; Regulation of biotechnology for benefit sharing; GMO`s, Genetically Modified Food and Biosafety; ISO International Organization of Standardization; Biological samples handling and transportation; Dual use dilemma in modern science; Plagiarism and Bio-piracy; Ethical issues in Synthetic Biology; Bio-business ethics.

Suggested Readings:

1. Amy L. Stenson, T. Kapungu, Stacie Geller, Suellen Miller. September 2010., Navigating the Challenges of Global Reproductive Health Research Journal of Women's Health.
2. M. Chalmer, et al., 2004. Cross-Cultural biotechnology Rowma & Littlefield Publishers.
3. G. Poppy, M. Wilkinson. 2005. Gene Flow from GM Plants. Blackwell Science Publications.
4. Karp, G., (2002). Cell and Molecular Biology: Concepts and Experiments. 3rg Edition. John Wiley Sons, Inc., N.Y.
5. Bioethics: an introduction to the history, methods, and practice running, 2007.
6. Bioethics: Theory and Practice Mairi Levitt, Ruth Chadwick SAGE publications Limited, 2009.

BOT-741

Biosafety & Biosecurity

3(3-0)

Objectives:

To provide an overview of the critical aspects of biosecurity and biosafety.

Course Contents:

Biosafety levels and Standard Microbiological procedures, Biosecurity: Regulatory Impact: Hazard Control: Design of Lab Facilities, Primary Barriers, Personal Protection, Decontamination and Disinfection, Packing and Shipping Biological Materials, Biological Safety Program Management, Principles of Laboratory Biosecurity, Risk management methodology, Developing a Biosecurity Program, Biosecurity Risk Assessment and Management Process, Elements of a biosecurity program, Program Management, Physical Security – Access Control and Monitoring, Personnel Management, Inventory and Accountability, Information Security, Transport of

Biological Agents, Accident, Injury and Incident Response Plans, Reporting and Communication, Training and Practice, Security Updates and Reevaluations.

Suggested Readings:

1. Samuels, S. (2010) Biosafety & Biosecurity Issues in High-Containment Laboratories, Nova Science Publishers Inc ISBN1616687061.
2. Office of Health and Safety (OHS) (2009) Biosafety in Microbiological and Biomedical Laboratories (BMBL) 5th Edition, US Government Printing Office Washington.
3. Salerno, R. M., J. M. Gaudioso (2007) Laboratory biosecurity handbook, CRC Press.

BOT-742

Integrated Plant Disease Management

3(3-0)

Objectives:

To acquaint the students with integrated plant disease management practices.

Course Contents:

Introduction, History, concepts, prospects, principles, components and challenges in Integrated Plant Disease Management (IPDM); Different plant disease control strategies, their integration and application; biological and environmental monitoring for sustainable disease management; Role of biotechnology, microorganism, remote sensing and information technology in IPDM; Disinfection and pesticides application; resistance problems; production and evaluation of bio-control agents; Biosafety regulations regarding release of biocontrol agents; Role of community in IPDM; Technology transfer in IPDM.

Suggested Readings:

1. Arya, A.O. and A.E. Perello. 2010. Management of Fungal Plant Pathogens. CABI, England.
2. Ciancio, A. and K.G. Mukerji. 2008. Integrated Management of Diseases Caused by Fungi, Phytoplasma and Bacteria. Springer.
3. Inderjit and K.G. Mukerji. 2006. Allelochemicals: Biological Control of Plant Pathogens and Diseases. Springer.
4. Kapoor, B.B.S. and N.K. Khatri. 2004. Management of Plant Diseases. Bikaner, Madhu Publications, India.
5. Koul, O. and G.S. Dhaliwal. 2001. Microbial Biopesticides. CRC Press.
6. Nehra, S. 2005. Plant Diseases: Biocontrol Management. Pointer Publishers, India.

7. Razdan, V.K. and M. Sabitha. 2009. Integrated disease management: Concepts and Practices. Springer, Netherland.

BOT-743

Biological Control of Plant Pathogens

3(3-0)

Objectives:

To manage plant pathogens through biological approaches

Course Contents:

Biological control and types of biological interaction; factors involved in biological control; Different biocontrol approaches like antagonistic microorganism, allelopathy, plant and pathogen-derived resistance; Methods for stimulation of indigenous biocontrol agents; Mass production and commercialization of bio-control agents.

Suggested Readings:

4. 1. Bellows, T.S., T.W. Fisher, L.E. Caltagirone, D.L. Dahlsten, G. Gordh and C.B. Huffaker. 1999. Handbook of Biological Control, Principles and Applications of Biological Control. Academic Press, London.
5. 2. Burge, M.N. 1988. Fungi in Biological Control System Manchester University Press UK.
7. 3. Butt, T.M., C. Jackson and N. Magan. 2001. Fungi as Biocontrol Agents: Progress, Problems and Potential. CABI Publishing, UK.
8. 4. Copping, L.G. 2004. The manual of biocontrol agents. British Crop Protection Council, UK.
9. 5. Gnanamanickam, S.S. (Ed.). 2002. Biological control of crop diseases. Marcel Dekker, New York.
10. 6. Trivedi, P.C. 1998. Plant Nematode Management: A biocontrol Approach. CBS Publishers & Distributors, New Delhi

BOT-744

Plant Ecophysiology

3(3-0)

Course Contents:

Introduction: What is the field of Physiological Plant Ecology? [Resource acquisition and allocation, tradeoffs, limitations, acclimation, adaptation, change]. Characterization of the

Physical Environment in the Changing World. Climate & Vegetation, Principle of Limiting Factors, Plants and Microclimates. Resource Acquisition Aboveground. Radiation Balance and Leaf Energy Budgets, Limitations to Photosynthesis: an overview, Photosynthetic Adaptation to Light and Temperature, Stomatal and Biochemical Control of Leaf Gas Exchange, Stable Isotopes, Water-use Efficiency, and Photosynthetic Performance Variation in Photosynthetic Pathways, what is Productivity?

Below Ground Processes and Plant Response. Water on Earth, Root Systems and Water. Acquisition, Water Use and Tissue Water Relations, Plant Hydraulics Adaptation to Water Stress - Drought - Salinity - Flooding Nitrogen Availability, Requirements, Symbiosis, Use efficiencies, Response to Limited Nutrient Availability Soil Factors & Edaphic Adaptations

Resource Balance in Plants. Carbon Allocation - Construction Costs, Storage, Turnover, Patterns. The Ecophysiology of Defense Against Herbivory. Ecophysiology Above the Individual Level, Ecophysiology in Plant Populations, Ecophysiological Aspects of Competition, Physiological Variation and Plant Traits; ecology and evolution Reproductive Ecophysiology, The Ecophysiology of Succession Ecosystem Physiology – Measurements, Models, Scales & Scaling. Physiology and Evolution.

Suggested Readings:

Physiological Plant Ecology. Fourth edition. 2003. Larcher, W. Springer-Verlag, Berlin, Germany.

Taiz & Zeiger (2010) Plant Physiology. 5th ed. Sinauer Assoc. Mass, USA

Lambers, Chapin, & Pons (2008) Plant Physiological Ecology. 2nd ed. Springer-Verlag, New York, USA

Perez-Harguindeguy N, Diaz S, Garnier E, Lavorel S, Poorter H, Jaureguiberry P, Bret-Harte MS, Cornwell WK, Craine JM, Gurvich DE, Urcelay C. New handbook for standardised measurement of plant functional traits worldwide. Aust. Bot. 61, 167–234.

Cornelissen JH, Lavorel S, Garnier E, Díaz S, Buchmann N, Gurvich DE, Reich PB, Ter Steege H, Morgan HD, Van Der Heijden MG, Pausas JG. A handbook of protocols for standardised and easy measurement of plant functional traits worldwide. Australian journal of Botany. 2003; 51(4):335-80.

BOT-745 Advanced Molecular Genetics

3 (3-0)

Objectives:

To understand the organization of human nuclear genome and mitochondrial genome, to develop understanding of different types of gene families and superfamilies' and to equip the student with different modern molecular Techniqu

Course Contents

Genome structure, Human mitochondrial genome, Human Nuclear genome, Protein Coding gene, RNA genes. Gene Families: Solitary gene and gene family, Gene superfamily, Pseudogenes,

Retrogenes, Cluster gene families, Interspersed gene families. Transposable Genetic Elements: LINES, SINES, Fossil Transposons. Repeat Instability and Genetic Disorders, TRED1, TRED2, Fragile X- Syndrome, Myotonic Dystrophy. DNA Methylation and Cancer, Differential methylation and cancer, Imprinting, Epigenetics and its implications in the genome, Telomere and Telomerase and their role in cancer and aging e. RNA interference f. RNAi mediated pathways in nucleus 4. Study of Molecular Techniques, Southern blotting, Western blotting, Northern blotting, RFLP, RAPDS, Microsatellite DNA.

Suggested Readings:

1. Alberts, B., A. Johnson, Jes.
2. Lewis, M. Raff, K. Roberts, and P. Walter. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York. 2002.
3. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick. 250
4. Molecular biology of the gene. Pearson Education. 2004.
5. Snyder, L. and W. Chapness. Molecular Genetics of bacteria. ASM, Press, 2003.
6. Lewin, B. Gene-VIII. Oxford University Press, Oxford.

BOT-746

Climate Change, Ecosystem Resilience and Stability

3(3-0)

Objectives:

To enable the student to understand ecosystem, climate change, Stability and Ecological constraints, to understand the Regime shift, Assembly rules, Theories and biogeography and understand how National and International agencies involved in controlling constraints and increasing biotic and Abiotic resistance.

Course Contents:

The Earth System; a. Introduction b. Climate change c. Ecosystem Resilience d. Resistance e. Stability f. Ecological Constraints. Alternative Stable States; a. Regime shift b. Restoring Alternative Stable States c. Assembly Rules. Sequence Introduction. Species Compatibility. Ecosystem Thresholds and Ecosystem filters. Unified Neutral Theory of Biodiversity and Biogeography. Invasive species, Process of Invasion, Effects of Invasion on Ecosystem, Methods of control, Eradication, Containment. Chemical and Biological Control. Restoration to Constrain Invasion, Niche Preemption, Fire Management, Increasing Biotic and abiotic Resistance

Suggested Readings:

1. Laird, S. A. 2006. Biodiversity and traditional Knowledge, Viva Books Private Limited.
2. Greipsson, S. 2011, Restoration Ecology, Biology and Physics Department, Kennesaw State University, Kennesaw, Georgia

3. Kumar, H. D. 2006. Global Climate Change, Insight, Impacts and concerns, Vitasta Publishing Pvt. Ltd.

4. Plummer, R., Lundholm, C. And Krasny, M. 2011. Resilience in SocialEcological Systems, The Role of Learning and Education, Routledge – 224 pages

5. Baumgartner, R. and Hogger, R. (2004). In search of sustainable livelihood systems: Management Resources and change. Sage publications New Delhi Thousand Oaks London.Pp.380.

BOT-747

Molecular Evolution

3 (3-0)

Objectives:

To understand some basic principles of evolution and genetics, to apply such principles to ecological, environmental and conservation research themes, to interpret genetic data in an applied context and to communicate and disseminate the results of their research in simplified language.

Course Learning Outcomes:

Course Contents:

An overview of the molecular genetic tools used to investigate ecological and evolutionary processes in natural populations. Usefulness of some concepts of ecology, evolution, and genetics. Evolutionary forces; vital force theory for living organisms. Nucleotide sequence, gene structure, genetic code, and mutations. Dynamics of genes in populations. Allele frequencies. Natural selection. Random genetic drift. Effective population size. Polymorphism and divergence. Linkage disequilibrium. Sequence alignment. Evolutionary change of nucleotide sequences. Multiple substitution problem and the inference of the number of evolutionary events. Rates and patterns of nucleotide substitution. Probability of fixation of a new neutral mutation. Rate of neutral substitution. Gene trees and species trees. Methods of reconstruction. Branch length estimation. Molecular clocks. Over-dispersed clocks. Testing the neutral mutation hypothesis. Positive selection and Genome evolution I. Evolution of gene duplications. Paralogy and orthology.

Suggested Readings:

1. Wagner, G.P. 2014. Homology, Genes and Evolutionary Innovation. Princeton Univ. Press, New Jersey, USA.

2. Roderic, D.M., E.C. Holmes. 2000. Molecular Evolution: Phylogenetic approach: Blackwell Sci. Publ., Inc., USA.

3. Bromham, L., 2016. Molecular Evolution and Phylogenetics. Oxford Univ. Press, England.
4. Wiley, E.O., B.S. Lieberman. 2011. Wiley-Blackwell, New Jersey, USA.
5. Yang, Z. 2014. Molecular Evolution. Oxford Univ. Press, Clarent Street, England

Objectives:

To provide thorough knowledge about principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms, and gene therapy. To explore applications of recombinant DNA technology in medical and industrial settings. To familiarize students with the wide variety of research options currently available in biotechnology. To provide theoretical background regarding the applicability of various techniques of recombinant DNA technology to specific scientific inquiries.

Course Contents:

SALIENT FEATURES OF CLONING VECTORS, Types of cloning vectors, Plasmids, cosmids, ssDNA Phages, Yeast cloning vectors, Animal viruses, Ti plasmids and Cauliflower Mosaic Virus. PLASMID BIOLOGY, Structural and functional organization of plasmids, Plasmid replication, Stringent and relaxed plasmids, Incompatibility of plasmid maintenance. BIOLOGY OF BACTERIOPHAGE LAMBDA, Lambda phage as a natural in vivo vector, In vitro construction of lambda vector, Classes of vectors and their use. ENZYMES IN GENETIC ENGINEERING, DNA polymerase, polynucleotide kinase, T4 DNA ligase, Nick translation system, Terminal deoxynucleotidyl transferase, Reverse transcriptase Restriction endonucleases Type I & II. ISOLATION OF GENOMIC AND NUCLEAR DNA, DNA digestion and restriction fragment analysis, Sequencing by chemical, enzymatic and big-bye terminator methods. CLONING AND SUBCLONING STRATEGY, Construction of recombinant DNA and preparation of competent cell transformation, Transfection, recombinant selection and screening; Genomic DNA library; cDNA synthesis strategies–Linkers–Adapter homopolymer tailing, Genomic and cDNA libraries in plasmids and phages. PCR product cloning (TA cloning). Cloning strategies in yeast (*Saccharomyces cerevisiae*) and bacteria (*E. coli* and *B. subtilis*). SELECTION OF rDNA CLONES AND THEIR EXPRESSION PRODUCTS, Direct and indirect methods. Drug resistance, gene inactivation, DNA hybridization, colony hybridization and in-situ hybridization (Southern, Northern and Dot blots and immunological techniques, Western blotting). GENE MODIFICATION & APPLICATION OF RECOMBINANT DNA TECHNOLOGY

Mutagenesis-Deletion mutagenesis, Oligonucleotide derived mutagenesis, Site directed mutagenesis, Applications of rDNA technology in Diagnostics; Pathogenesis, Genetic diversity; Therapeutic proteins-vaccines, Molecular probes (Production, labelling and uses)

Suggested Readings:

1. Brown, T. A., 2016. Gene Cloning and DNA Analysis: An Introduction; 7th Edition, John Wiley and Sons Ltd., Chichester, UK.
2. Glick, B. R., Pasternak, J. J. and Cheryl L. Patten, C. L. 2009. Molecular Biotechnology: Principles and Applications of Recombinant DNA; 4th Edition, ASM Press, Washington, USA. 3. Green, M. R. and Sambrook, J. 2012. Molecular Cloning: A Laboratory Manual; 4th Edition, Cold Spring Harbor Laboratory Press, New York, USA.
4. Howe, H. 2007. Gene Cloning and Manipulation, Cambridge University Press, New York, USA.
5. Jeremy W. Dale, J. W., Malcolm von Schantz, M. V. and Plant, N. 2011. From Genes to Genomes: Concepts and Applications of DNA Technology; 3 rd Edition, John Wiley and Sons Ltd., Chichester, UK.
6. Nicholl, D. S. T. 2008. An Introduction to Genetic Engineering; 3rd Edition. Cambridge University Press, Singapore.

BOT-749

Plant Nanotechnology

3(3-0)

Course Objectives: To acquaint students with key integrative technologies and understanding of the potential of nanotechnology in plant and crop sciences

Course contents

1. Plant Nanotechnology: An overview on concepts, strategies, and tools: use of nanoparticles in agriculture, medicine, and environment; Types of nanoparticles and their relative merits
2. Methods of Using Nanoparticles: Incubation via seeds, roots; Hydroponic treatment; Direct injection; Spraying; Biolistics;
3. Effects of Nanoparticles on Plant Growth and Development: Effect of silver nanoparticles; effect of gold nanoparticles; effect of metal oxide nanoparticles; effect of carbon-based nanoparticles
4. Uptake, Translocation, Accumulation, Transformation, and Generational Transmission of Nanoparticles in Plants
5. Nanotechnology for Crop Improvement: Demonstration of Nanoparticle-Mediated Enhancement of Plant Biomass and Yield
6. Future Roadmap for Plant Nanotechnology

Suggested Readings

1. Misra, P., P. K. Shukla, K. Pramanik, S. Gautam, and C. Kole. "Plant nanotechnology: principles and practices." (2016): 219-256.
2. Abd-Elsalam, Kamel A., and Ram Prasad, eds. Nanobiotechnology applications in plant protection. Springer, 2018.
3. Al-Khayri, Jameel M., Mohammad Israil Ansari, and Akhilesh Kumar Singh, eds. Nanobiotechnology: mitigation of abiotic stress in plants. Springer Nature, 2021.
4. Hakeem, Khalid Rehman, and Tanveer Bilal Pirzadah. Nanobiotechnology in Agriculture. Springer International Publishing, 2020.

AGENDA ITEM NO. 2

REVISED SCHEME OF STUDIES FOR BS 4 YEAR (8 SEMESTERS) PROGRAM IN BOTANY W.E.F. FALL 2022 & ONWARD

BS Botany

Duration:	8-10 Semester
Courses & Labs:	121 Credits
Thesis/Elective Courses:	6 Credits
Comprehensive Oral Examination:	S/U Basis
Total Credit Hours:	127 Credits

Year-I

Semester-I (Cr. 16)

Course Code	Course Title	Lecture Credit's
BOT-3101	Diversity of Plants	3(2-1)
ENG-3102	Functional English	3(3-0)
COM-3103	Introduction to Computer	2(1-1)
MAT-3104	Mathematics-I (Pre-calculus)	2(2-0)
CHM-3105	Foundation Chemistry	3(3-0)
ZOO-3106	Principles of Animal Life-I	3(2-1)
Total Credit Hour's		16

Semester-II (Cr. 16)

Course Code	Course Title	Lecture Credit's
BOT-3201	Plant Systematics, Anatomy and Development	3(2-1)
ENG-3202	Communication Skills	3(3-0)
PKS-4302	Pakistan Studies	2(2-0)
CHM-3204	Organic Chemistry	3(2-1)
ZOO-3205	Principles of Animal Life-II	3(2-1)

STA-3206	Introduction to Statistics	2(2-0)
Total Credit Hour's		16

Year-II

SEMESTER-III (Cr. 15)

Course Code	Course Title	Lecture Credit's
BOT-4301	Cell Biology, Genetics and Evolution	3(2-1)
ISL-3203	Islamic Studies/Ethics	3(3-0)
ENG-4303	Technical Report Writing & Presentation Skills	3(3-0)
CHM-4304	Physical Chemistry	3(2-1)
ZOO-4305	Animal Diversity-I	3(2-1)
Total Credit Hour's		15

SEMESTER-IV (Cr. 16)

Course Code	Course Title	Lecture Credit's
BOT-4401	Plant Physiology and Ecology	3(2-1)
BOT-4402	Environmental Biology	3(2-1)
ARB-4403	Arabic	3(3-0)
ZOO-4404	Animal Diversity-II	3(2-1)
CHM-4405	Inorganic Chemistry	3(2-1)
Total Credit Hour's		15

Year-III

Semester-V (Cr. 16)

Course Code	Course Title	Lecture Credit's
BOT-5501	Bacteriology and Virology	3(2-1)
BOT-5502	Diversity of Vascular Plants	3(2-1)
BOT-5503	Phycology and Bryology	3(2-1)
BOT-5504	Mycology and Plant Pathology	3(2-1)
BOT-5505	Cell Biology	3(2-1)
BOT-5506	Field Botany-I	1(0-1)
Total Credit Hour's		16

Semester-VI (Cr. 16)

Course Code	Course Title	Lecture Credit's
BOT-5601	Plant Ecology-1	3(2-1)
BOT-5602	Plant Systematics	3(2-1)
BOT-5603	Plant Biochemistry-I	3(2-1)
BOT-5604	Principles of Genetics	3(2-1)
BOT-5605	Biostatistics	3(2-1)
BOT-5606	Field Botany-II	1(0-1)
Total Credit Hour's		16

Year-IV

Semester-VII (Cr. 18)

Course Code	Course Title	Lecture Credit's
BOT-6701	Plant Ecology-II	3(2-1)
BOT-6702	Plant Physiology- I	3(2-1)
BOT-6703	Research Methodology	3(2-1)
BOT-6704	Plant Biochemistry-II	3(2-1)
BOT-6705	Molecular Genetics	3(2-1)
BOT-6706	Thesis/Optional Paper	3(3-0)
Total Credit Hour's		18

Year-IV

Semester-VIII (Cr. 15)

Course Code	Course Title	Lecture Credit's
BOT-6801	Principals of Biotechnology	3(2-1)
BOT-6802	Plant Anatomy	3(2-1)
BOT-6803	Plant Biodiversity and Conservation	3(2-1)
BOT-6804	Plant Physiology-II	3(2-1)
BOT-6706	Thesis/Optional Paper	3(3-0)
Total Credit Hour's		15

9. Angiosperm

Practical:

1. Field visit for basic understanding of life forms and floral diversity.
2. Identification of microbial diversity through prepared slides, charts/video demonstrations.
3. Slide preparation of microorganism, lower plants and reproductive/anatomical features of higher plants.
4. Collection, preservation and identification of representative species from different plant groups.

Recommended Books:

1. Lee, R.E. 1999. Phycology. Cambridge University Press, UK
2. Prescott, L.M., Harley, J.P. and Klein, A.D. 2004. Microbiology, 3rd ed. W.M. C. Brown Publishers.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. 4th ed. John Wiley and Sons Publishers.
4. Agrios, G.N. 2004. Plant pathology. 8th ed. Academic press London.
5. Vashishta, B.R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
6. Mauseth, J.D. 2003. Botany: An Introduction to Plant Biology 3rd ed., Jones and Bartlett Pub. UK
7. Marti.J.Ingrouille & Plant: Diversity and Evolution. 2006 CUP.
8. Mauseth, J.D. 2003. Botany: An Introduction to Plant Biology 3rd ed., Jones and Bartlett Pub. UK
9. Marti.J.Ingrouille & Plant: Diversity and Evolution. 2006 CUP
10. Taylor, T.N. & Taylor, E.D. 2000. Biology and Evolution of Fossil Plants. Prentice Hall. N.Y.

ENG-3102

Functional English

3(3-0)

Objectives

Enhance language skills and develop critical thinking.

Course Contents

Basics of Grammar in detail, Parts of speech and use of articles in detail, Sentence structure, active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling

Comprehension

Answers to questions on a given text

Discussion

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening

To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills:

Urdu to English

Paragraph writing

Topics to be chosen at the discretion of the teacher

Presentation skills

Introduction

Note: Extensive reading is required for vocabulary building

Recommended books

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506.
3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7, Pages 20-27 and 35-41.
4. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 45340.

COM-3103

Introduction to Computer

2(1-1)

Aims and Objectives

The course is designed to aim at imparting a basic level appreciation program for students. After completing the course, the students must be able to use the computer for basic purposes of preparing their personnel reports, presentation letters, viewing information on Internet (the web), sending mails, receiving mail, using internet etc.

Course Outlines

History, classification, basic components, CPU, memory, peripheral devices, storage media and devices, machine cycle, Computer Bus, Data Bus, Address Bus, Control Bus, programs and software, system software, application software, operating systems, types of programming

languages, compilation and interpretation, basic concept of computer networks, LAN, MAN, WAN, client /server network, peer to peer network, network topology and it types.

Lab Outline

Networking devices, Introduction to office tools (Microsoft word, excel and power point), Introduction to various operating systems, Use of internet, viewing information on internet, sending and receiving emails, searching topics on internet.

Recommended Books

1. Brian Williams and Stacey Sawyer, Using Information Technology, Latest Edition, McGraw-Hill, ISBN: 0072260718.
2. Behrouz A. Forouzan, Data Communication and Networking, Latest Edition, Alan R. Apt, ISBN:13 978-0-07-296775-3.
3. William Stallings, Computer Organization and Architecture: Designing for

Performance, Latest Edition, Prentice Hall, ISBN: 0131856448

MATH-3104

Mathematics I

2(2-0)

Specific Objectives of the Course

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. **Matrices:** Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule. **Quadratic Equations:** Solution of quadratic equations, qualitative analysis of roots of a quadratic equation, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations. **Sequences and Series:** Arithmetic progression, geometric progression, harmonic progression. **Trigonometry:** Fundamentals of trigonometry, trigonometric identities.

Recommended Books

1. Dolciani M. P, Wooton W, Beckenback E F, Sharron S, Algebra 2 and Trigonometry, 1978, Houghton & Mifflin,
2. Boston (suggested text)

3. Kaufmann J. E, College Algebra and Trigonometry, 1987, PWS-Kent Company, Boston
4. Swokowski E. W., Fundamentals of Algebra and Trigonometry (6th edition), 1986, PWS-Kent Company, Boston

CHM-3105

Foundation Chemistry

3(3-0)

1. Introduction to Inorganic Chemistry

History and development of Inorganic chemistry

2. The Periodic Law and Periodicity

Modern Periodic Table: Classification of elements based on *s*, *p*, *d* and *f* orbitals; group trends, and periodic properties in *s*, *p*, *d* and *f* block elements, i.e. atomic radii, ionic radii, ionization potential, electron affinities, electronegativities and redox potential; anomalies in group trends and periodic properties, the uniqueness principle, the diagonal effect and the inert pair effect

3. Introduction to Classes and Nomenclature of Organic Compounds

Classification of organic compounds; development of systematic nomenclature; IUPAC nomenclature of hydrocarbons and heteroatom functional groups up to bi functional compounds.

4. Chemical Bond

Localized and delocalized chemical bonding; concept of hybridization leading to bond angles, bond lengths, bond energies and shapes of organic molecules.

5. Introduction to Biochemistry

Applications of Biochemistry, disciplines related to Biochemistry, biochemistry of the cell. Introduction to biomolecules, classification, composition and biological roles of nucleic acids, proteins, carbohydrates, lipids, vitamins and minerals

6. Introduction to Physical Chemistry

Introduction; physical states of matter.

Recommended Books

1. Mingos D. M. P. "Essential Trends in Inorganic Chemistry" Oxford University Press, First Indian Edition, 2004.

2. Madan R. D. "Satya Prakash's Modern Inorganic Chemistry" S. Chand and Company Limited, 2011.

3. Rodgers G. E. "Introduction to Coordination, Solid State and Descriptive Inorganic Chemistry" McGraw-Hill, Inc.

ZOO-3106

Principles of Animal Life-I

3(2-1)

Aims and Objectives

The course aims to impart knowledge and understanding of:

1. The concept and status of Zoology in life sciences.
2. The common processes of life through its chemistry, biochemical and molecular processes.
3. The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
4. Biochemical mechanisms eventually generating energy for animal work.
5. Animals and their relationship with their environment.

Course Contents

Scope of Zoology: Introduction; significance and applications of zoology; animal diversity; the scientific method; environment and world resources. **The Chemical Basis of Animal Life:** Brief introduction to biomolecules; carbohydrates, lipids, proteins, and nucleic acids. **Cellular Organization:** Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, and vacuoles; ribosomes, endoplasmic reticulum, the nucleus: nuclear envelope, chromosomes and nucleolus. **Animal tissues:** Types: epithelial, connective, muscle and nervous tissue; organs and organ systems. **Enzymes:** Structure, types; function and factors affecting their activity; cofactors and coenzymes. **Energy Harvesting:** Aerobic and anaerobic respiration: glycolysis, citric acid cycle and electron transport chain; fermentation, the major source of ATP. **Reproduction and Development:** Types; asexual and sexual, gametogenesis, fertilization, metamorphosis, zygote and early development. **Ecological Concepts:** Individuals and Populations: Animals and their abiotic environment; populations and limiting factors; Communities and Ecosystems: Community structure and diversity; interspecific interactions. Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles; Ecological problems; human population growth, pollution, resource depletion and biodiversity.

Practical

1. Tests for different carbohydrates, proteins and lipids.

Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.

Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac). *Note: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.*

2. Preparation of blood smears.
3. Plasmolysis and deplasmolysis in blood.
4. Protein digestion by pepsin.
5. Ecological notes on animals of a few model habitats.
6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 12th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 6th Edition (International), 2005. Singapore: McGraw Hill.
3. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
4. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.
5. Hickman, C.P. and Kats, H.L., Laboratory Studies in Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.
6. Molles, M.C. Ecology: Concepts and Applications. 6th Edition. 2005. McGraw Hill, New York, USA.
7. Odum, E. P. Fundamentals of Ecology. 3rd Edition. 1994. W.B. Saunders. Philadelphia.

Cucurbitaceae, Solanaceae, Lamiaceae (Labiatae), Asteraceae (Compositae), Liliaceae and Poaceae (Gramineae)

b. Anatomy

Concept, structure and function of various tissues like: Parenchyma, Collenchyma, Sclerenchyma, Epidermis (including stomata and trichomes), Xylem, Phloem, Meristem: types, stem and root apices, Vascular cambium, Structure and development of root, stem and leaf. Primary and secondary growth of dicot stem, periderm, Characteristics of wood: diffuse porous and ring –porous, sap and heart wood, soft and hard wood, annual rings.

c. Development / Embryology

Early development of plant body: *Capsella bursa-pastoris*, Structure and development of Anther Microsporogenesis Microgametophyte, Structure of Ovule Megasporogenesis Megagametophyte, Endosperm formation, Parthenocarpy, Polyembryony

Practical

Anatomy

1. Study of stomata, epidermis,
2. Tissues of primary body of plant
3. Study of xylem 3-dimensional plane of wood.
4. T.S of angiosperm stem and leaf.

Taxonomy

1. Identification of families given in syllabus with the help of keys.
2. Technical description of common flowering plants belonging to families mentioned in theory syllabus.
3. Field trips shall be undertaken to study and collect local plants.
4. Students shall submit 40 fully identified herbarium specimens.

Recommended Books:

1. Mauseth, J.D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R.C., W.D. Clarke and Vodopich, D.S. 1998. Botany. McGraw Hill Company, U.S.A.
3. Raven, P.H., Evert, R.E. and Eichhorn, S.E. 1999. Biology of Plants. W.H. Freeman and Company Worth Publishers.
4. Stuessy, T.F. 1990. Plant Taxonomy. Columbia University Press, USA.
5. Lawrence, G.H.M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
6. Panday, B.P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
7. Raymond E, S. E. Eichhorn. 2005. Esau's Plant Anatomy. Meristems cells and tissues of the plant body, 3rd ed. John Wiley & Sons. Inc.
8. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
9. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
10. Maheshwari, P.1971. Embryology of Angiosperms, McGraw Hill. New York.

11. Eames A.J. and L.H Mac Daniels. 2002. An Introduction to Plant Anatomy. Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.
12. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition Regency Publications, New Delhi.
13. Naik, V.N. 2005 Taxonomy of Angiosperms. 20th Reprint. Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.

ENG-3202

Academic Reading and Writing

3(3-0)

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises
2. 3rd Edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 4534030.
2. Reading and Study Skills by John Langan
3. Study Skills by Riachard York.

ISL-3203

Islamic Studies / Ethics

2(2-0)

Objectives

This course is aimed at:

1. To provide Basic information about Islamic Studies
2. To enhance understanding of the students regarding Islamic Civilization
3. To improve Students skill to perform prayers and other worships
4. To enhance the skill of the students for understanding of issues related to faith and religious life.

Course contents

Basic Concepts of Quran, History of Quran, Uloom-ul –Quran, Verses of Surah Al-Baqra Related to Faith (Verse No-284-286), Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77), Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154), Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56, 57,58.), Verses of Surah Al-Hashar (18,19,20), Verses of Surah Al-Saf Related to

Tafakar, Tadabar (Verse No-1,14), Life of Muhammad Bin Abdullah (Before Prophet Hood), Life of Holy Prophet (S.A.W) in Makkah, Important Lessons Derived from the life of Holy Prophet in Makkah, Life of Holy Prophet (S.A.W) in Madina, Important Events of Life Holy Prophet in Madina, Important Lessons Derived from the life of Holy Prophet in Madina ,Basic Concepts of Hadith, History of Hadith, Kinds of Hadith, Uloom-ul-Hadith, Sunnah & Hadith, Legal Position of Sunnah, Basic Concepts of Islamic Law & Jurisprudence, History & Importance of Islamic Law & Jurisprudence, Sources of Islamic Law & Jurisprudence, Nature of Differences in Islamic Law, Islam and Sectarianism, Basic Concepts of Islamic Culture & Civilization, Historical Development of Islamic Culture & Civilization, Characteristics of Islamic Culture & Civilization, Islamic Culture & Civilization and Contemporary Issues, Basic Concepts of Islam & Science, Contributions of Muslims in the Development of Science, Quranic & Science, Basic Concepts of Islamic Economic System, Means of Distribution of wealth in Islamic Economics, Islamic Concept of Riba, Islamic Ways of Trade & Commerce, Basic Concepts of Islamic Political System, Islamic Concept of Sovereignty, Basic Institutions of Govt. in Islam, Period of Khlaft-E-Rashida, Period of Ummayyads, Period of Abbasids, Basic Concepts of Social System of Islam, Elements of Family, Ethical Values of Islam.

Reference Books:

- 1) Hameed Ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed Ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed Ullah Muhammad, 'Introduction to Islam
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001).

CHM-3204

Organic Chemistry

3(2-1)

Properties of Organic Molecules

Dipole moment; inductive and field effects; resonance; aromaticity; tautomerism; hyperconjugation; hydrogen bonding; acids and bases; factors affecting the strengths of acids and bases.

Hydrocarbons

Discussion on the preparation, properties and reactions of alkanes, alkenes, alkynes and aromatics.

Oxygenated Hydrocarbons

Discussion on the preparation, properties and reactions of alcohols (phenols), ethers, aldehydes, ketones, carboxylic acids and derivatives.

Introductory Organic Spectroscopy

Introduction to IR, UV, ¹H-NMR and Mass spectrometric methods, and their usage for structure elucidation of some simple organic compounds.

Practicals:

Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

Books Recommended:

- 1) Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th ed., Longman, UK, (1989).
- 2) Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/ Cole Cengage Learning, (2013).
- 3) Mayo, D. W., Pike, R. M. and Forbes, D. C., Microscale Organic to Laboratory with Multistep and Multisacle Syntheses, 5th ed., John-Wiley & Sons, Inc., (2011).
- 4) Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale and Microscale Approach, 5th ed., Brooks/ Cole Cengage Learning, (2010).
- 5) Brown, W. H., Fotte, C. S., Iverson, B. L. and Anslyn, E. V., Organic Chemistry, 6th ed., Brooks/ Cole Cengage Learning, (2012).

ZOO-3205

Principles of Animal Life-II

3(2-1)

Aims and Objectives

The course will impart knowledge and understanding of:

1. Cell division and its significance in cell cycle.
2. Concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
3. Animal behavior and communication.
4. Theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

Course Contents

Cell Division: Cell cycles: Mitosis and meiosis; control of the cell cycle. **Inheritance Patterns:** Mendelian genetics; inheritance patterns; gene, structure, chemical composition and types. **Chromosomes and Gene Linkage:** Eukaryotic chromosomes; linkage and crossing over; chromosomal aberrations. **Molecular Genetics: Cellular Control: DNA:** the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA and applications of genetic technologies. **Animal Behaviour:** Behaviour and its types, proximate and ultimate causes; anthropomorphism; development of behavior; learning; factors controlling animal behavior; communication; behavioral ecology; social behavior. **Evolution: A Historical Perspective:** Theories of evolution: Lamarckism and natural selection, neo lamarckism, Darwinism, and neo-Darwinian. **Evolution and Gene Frequencies:** Hardy-Weinberg principle; evolutionary mechanisms: population size, genetic drift, gene flow, de Vries mutation theory and rates of evolution, polymorphism; species and speciation; molecular evolution; mosaic evolution.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. Comparative Anatomy of Vertebrates. 2000. New York: McGraw Hill.
5. Campbell, N.A. Biology, 6th Edition. Menlo Park, California: 2002. Benjamin/Cummings Publishing Company, Inc.

Practicals

1. Study of mitosis in onion root tip.
 1. Study of meiosis in grasshopper testis (students should prepare the slide).
 2. Problem based study of Mendelian ratio in animals.
 3. Multiple alleles study in blood groups.
 4. Survey study of a genetic factor in population and its frequency.
 5. Study of karyotypes of *Drosophila*, mosquito.
 6. Study of cytochemical detection of DNA in protozoa and avian blood cell.
 7. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).
 8. Study to demonstrate social behaviour (documentary film be shown, honeybee, monkey group in a zoo).
Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).

Recommended Books

1. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.

- Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.

STA-3206

Introduction to Statistics

2 (2-0)

What is Statistics?

Definition of Statistics, Population, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, rounding of a number, Collection of primary and secondary data, Sources, Editing of Data.

1. Presentation of Data

Introduction, basic principles of classification and Tabulation, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Histogram, Ogive for Discrete Variable. Types of frequency curves.

2. Measures of Central Tendency

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. Properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

3. Sampling and Sampling Distributions

Introduction, sample design and sampling frame, bias, sampling and non-sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions.

4. Hypothesis Testing

Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, general procedure for testing of hypothesis.

Recommended Books:

- Walpole, R. E. 1982. "Introduction to Statistics", 3rd Ed., Macmillan Publishing Co., Inc. New York.
- Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEAR PROGRAM IN BOTANY

Year-II
SEMESTER-III (Cr. 15)

Course Code	Course Title	Lecture Credit's
BOT-4301	Cell Biology, Genetics and Evolution	3(2-1)
PKS-4302	Pakistan Studies	2(2-0)
ENG-4303	Report writing	3(3-0)
CHM-4304	Physical Chemistry	3(2-1)
ZOO-4305	Animal Diversity-I	3(2-1)
Total Credit Hour's		14

Note: The course contents of courses other than Botany will be adopted as prescribed by the relevent departments/University/HEC.

BOT-4301 Cell Biology, Genetics and Evolution 3(2-1)

Aims and Objectives

To understand

Structure and functions of cell, nature of genetic material and hereditary process and familiarization with evolutionary processes.

Course Contents

a) Cell biology

1. Structures and Functions of Biomolecules; Carbohydrates, Lipids, Proteins, Nucleic Acids
2. Cell: Physico-chemical nature of plasma membrane and cytoplasm.
3. Ultrastructure of plant cell with a brief description and functions of the following organelles:
Cell wall, Endoplasmic reticulum, Plastids, Mitochondria, Ribosomes, Dictyosomes, Vacuole, Microbodies (Glyoxysomes and Peroxisomes)
4. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis

5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
6. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

b) Genetics

1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.
5. Sex linked inheritance, sex linkage in *Drosophila* and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex-linked characters, sex determination.
6. Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.
7. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g., *lac* operon).
8. Transmission of genetic material in Bacteria: Conjugation and gene recombination in *E. coli*, transduction and transformation.
9. Principles of genetic engineering / biotechnology; Basic genetic engineering techniques.
10. Application of genetics in plant improvement: Induction of genetic variability (gene mutation, recombination), physical and chemical mutagens, selection, hybridization and plant breeding techniques. Development and release of new varieties.
11. Introduction to germplasm conservation

c) Evolution

The nature of evolutionary forces, adaptive radiations, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Practical

Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs

1. Measurement of cell size.
2. Study of mitosis and meiosis by smear/squash method and from prepared slides.
3. Study of chromosome morphology and variation in chromosome number.
4. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources

Genetics

1. Genetical problems related to transmission and distribution of genetic material.
2. Identification of DNA in plant material. Carmine/orcein staining.
3. Study of salivary gland chromosomes of *Drosophila*.

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V.R. (1986). Cytology and Genetics. Tata and McGraw Hill Publication Co. Ltd., New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.

4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
5. Strickberger, M.V. (1988), Genetics, MacMillan Press Ltd., London.
6. Carroll, S.B., Grenier, J.K. and Welnerbee, S.d. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Strickberger, M. W. 2000 Evolution. Jones & Bartlet Publishers Canada
9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press.

PKS-4302

Pakistan Studies

2(2-0)

Introduction/Objectives:

Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outlines:

Historical Perspective

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam M. Ali Jinnah. Factors leading to Muslim separatism. PEOPLE AND LAND: Indus Civilization, Muslim advent, Location and geo-physical features. GOVERNMENT AND POLITICS IN PAKISTAN: Political and constitutional phases, 1947-58, 1958-71, 1971-77, 1977-88, 1988-99 and 1999 onward, CONTEMPORARY PAKISTAN: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan

Books Recommended:

1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
5. Wilcox, Wayne. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson & sons Ltd, 1980.

9. Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.
15. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.

ENG-4303

Report writing

3(3-0)

Objectives:

Enhance language skills and develop critical thinking

COURSE CONTENTS: PRESENTATION SKILLS: ESSAY WRITING: Descriptive, narrative, discursive, argumentative, ACADEMIC WRITING: How to write a proposal for research paper/term paper. How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency), TECHNICAL REPORT WRITING: PROGRESS REPORT WRITING. Extensive reading is required for vocabulary building.

Recommended Books:

Technical Writing and Presentation Skills

- a) Essay Writing and Academic Writing
 1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
 2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
 3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
- b) Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Quantum theory and structure of atom

Bohr's atomic model, defects of Bohr's atomic model, classical mechanics, failure of classical mechanics, quantum mechanics, dual nature of matter, de-Broglie's equation, Heisenberg's uncertainty principle, limitation of Heisenberg's uncertainty principle, concept of atomic orbitals, quantum numbers, Pauli exclusion principle, electronic distribution of elements.

Physical states of matter**1. Gases**

General characteristics of gases, Gay Lussac's law, ideal gas equation, kinetic molecular theory of gases, molecular velocities (average velocity, mean square velocity, root mean square velocity, most probable velocity), ideal and real gases, deviation of gas from ideality, derivation of kinetic gas equation, molecular collisions, collision diameter, critical phenomenon of gases, liquefaction of gases, mean free path, Vander Waal's equation for real gases.

2. Liquid

General characteristics of liquids, physical properties like surface tension, viscosity, parachor value, rheochor value and their applications, refractive index, specific and molar refraction and their applications, optical activity, specific rotation, dipole moment and molecular structure.

3. Solids

General characteristics of solids, types of solids, isotropy and anisotropy, habit of a crystal, crystal lattice and unit cell, crystal systems and Bravais lattices.

Chemical Thermodynamics

Introduction, thermodynamic terms like system, surrounding, boundary of system, states and state function, internal energy, extensive and intensive properties, first law of thermodynamics, enthalpy of a system, relationship between free energy change and enthalpy change, heat capacity of gases at constant volume and at constant pressure, , heat capacities relationship, 2nd law of thermodynamics, change in free energy and equilibrium constant.

Chemical Kinetics

Introduction, concept of rate of chemical reaction, rate law, velocity constant, elementary and complex reaction, order and molecularity of reaction, zero, first and second order reactions, derivation of kinetic equation for first order and 2nd order reaction when initial concentration of both reactants is same, various methods for determining the rate of chemical reaction, Arrhenius equation, Lindemann's theory for unimolecular reaction, introduction to transition state theory, transition state theory for bimolecular reaction.

Basic Electrochemistry

Introduction, conductors and insulators, electrolytic and electronic conduction, specific conductance, measurement of specific conductance, cell constant and its determination, Ostwald's dilution law (dependence of degree of dissociation constant on dilution), electrochemical cells, types of cells, EMF and its measurement.

Solutions

Introduction, types of solution, concentration units, ideal and non-ideal solutions, Raoult's law, molecular interactions in solution, colligative properties (lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure and their determination), concept of zeotropic and azeotropic mixture.

Surface Chemistry

Absorption and adsorption, types of adsorptions, characteristics and factors which affect adsorption, applications of adsorption, catalysis, types of catalysis, enzyme catalysis, characteristics of catalysis.

Practicals:

- Determination of viscosity and parachor values of liquids.
- Determination of percent composition of liquid solutions viscometrically.
- Determination of refractive index and molar refractivity.
- Determination of percent composition of liquid solutions by refractive index measurements.
- Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
- Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
- Determination of heat of solution by solubility method.
- Determination of heat of neutralization of an acid with a base.

ZOO-4305

Animal Diversity-I

3(2-1)

(Classification, Phylogeny and Organization)

Aims and Objectives

The course is designed to provide students with:

1. Concepts of evolutionary relationship of animal kingdom.
2. Knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

Course Contents

Introduction: Architectural pattern of an animal, taxonomy and phylogeny, major subdivisions of animal kingdom. **Animal-Like Protists:** The Protozoa Evolutionary perspective; life within a single plasma membrane; symbiotic lifestyles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations. **Multicellular and Tissue Levels of Organization** Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations. **Triploblastics and Acoelomate Body Plan:** Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations. **Pseudocoelomate Body Plan:** Aschelminths Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations. **Molluscan Success:** Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations. **Annelida:** The Metameric Body Form Evolutionary perspective: relationship to other animals, metamerism and tagmatization; classification up to class. External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development, in polychaeta, oligochaeta and hirudinea; further phylogenetic considerations. **Arthropods:** Blueprint for Success Evolutionary perspective: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations. Crustaceans, Hexapods and Myriapods, general nature, classification, phylogeny and adaptive diversification. **Echinoderms:** Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, and chaetognaths.

Practicals

1. Museum study of representative phyla, permanent slide preparations
2. Study of *Euglena*, *Amoeba*, *Entamoeba*, *Plasmodium*, *Trypanosoma*,
3. *Paramecium* as representative of animal like protists. (Prepared slides).
4. Study of sponges and their various body forms.
5. Study of principal representative classes of phylum Coelenterata.
6. Study of principal representative classes of phylum Platyhelminthes.
7. Study of representative of phylum Rotifera, phylum Nematoda.
8. Study of principal representative classes of phylum Mollusca.
9. Study of principal representative classes of phylum Annelida.
10. Study of principal representative classes of groups of phylum Arthropoda.
11. Brief notes on medical/economic importance of the following:
12. *Plasmodium*, *Entamoeba histolitica*, *Leishmania*, Liverfluke, Tapeworm, Earthworm,
13. Silkworm, Citrus butterfly.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 15th Edition (International), 2011. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 8th Edition (International), 2011. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology Of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

1. Introduction of ecology from a physiological perspective and applications of ecological concepts in understanding the relationship of plants with abiotic factor of the environment.
2. Soil: Physical and Chemical properties of soil (soil formation, texture. pH, EC, organism and organic matter etc) and their relationships to plants.
3. Light and Temperature. Quality of light, diurnal and seasonal variations. Eco-physiological responses.
4. Wind: Wind as an ecological factor and its importance.

Practical:

a. Plant Physiology.

1. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
2. Determination of the temperature at which beet root cells lose their permeability.
3. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a porometer/by cobalt chloride paper method.
4. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
5. Estimation of oxygen utilized by a respiring plant by Winkler's method.
6. Measurement of carbon dioxide evolution during respiration of germinating seeds by the titration method.
7. Effect of light and temperature on seed germination.

b. Ecology

1. Determination of physical and Chemical characteristics of soil.
2. Field trips to ecologically diverse habitats.
3. Measurements of wind velocity.

Recommended Books:

1. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Ed. Sinauers Publ. Co. Inc. Calif.
2. Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
3. Hopkins, W.B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York
4. Schultz, J.C. 2005. Plant Ecology. Springer-Verlag, Berlin.
5. Ricklefs, R.E. 2000. Ecology. W.H. Freeman and Co., UK.
6. Ricklefs, R.E. 2001. The Economy of Nature. W.H. Freeman and Co., UK.

Aims and Objectives

To provide updated knowledge of environmental problems and sustainable environmental management.

Course Outline:

1. Environment: Introduction, scope, pressure
2. Pollution: definition, classification and impact on habitats
3. Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, remediation. Photochemical smog. Smog. Acid rain: 1. Theory of acid rain, Adverse effects of acid rains. Chlorofluorocarbons and its effects.
4. Water pollution: Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal pollution.
5. Sediments pollution: fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control remediation. Heavy metal pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and polluted waters.
6. Noise pollution.
7. Radiation pollution (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal
8. Pollution by Pesticides
9. Environmental Buffers. Forest importance, deforestation, desertification and conservation
10. Ozone layer: Formation, Mechanism of depletion, Effects of ozone depletion, Greenhouse effect and global warming: causes, impacts.
11. National conservation strategy: Brief review of major problems of Pakistan and their solutions.
12. Range management: Types of rangelands, potential threats, sustainable management.
13. Aerobiology (Pollen allergy & dust allergy).
14. Natural disaster management
15. Environmental impact Assessment: (Sustainability of the Environment)

Lab Outline:

1. Examination of industrial wastewater and Municipal sewage and sludge for
 - i. Total dissolved solids.
 - ii. pH and EC.
 - iii. BOD/COD.
 - iv. Chlorides, carbonate, and Nitrates.
2. Examination of water samples forms different sites for the presence and diversity of organisms.
3. Effect of air pollutants on plants.
4. Examination of the Effects of Automobile Exhaust on the Adjacent Vegetation.
 - i) Lead Count
 - ii) Chlorophyll Content
 - iii) Symptoms
 - iv) Soot and Particulate Matter.
5. Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

1. Newman, E. I. 2001. Applied Ecology. Blackwell Science. UK
2. Mooney, H. A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
3. Eugene, E. D. and Smith, B. F. 2000. Environmental Science: A study of interrelationships. McGraw-Hill. USA.

4. French, H. 2000. Vanishing Borders: Protecting the Planet in the Age of Globalization. W. Norton and Company, NY.
5. Hall, C. A. S. and Perez, C. L. 2000. Quantifying Sustainable Development. Academic Press, UK.
6. Bazzaz, F. A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.

ARB-4403

Arabic

3(3-0)

I . اللغة العربية .

الف) القواعد

تدرس في هذه المرحلة القواعد الأساسية للغة العربية ، التي تكون وسيلة لتقويم اللسان و صحة الكلام في القراءة والكتابة والتحدث . كما يلرب الطلاب على الترجمة من العربية إلى الأردية وبالعكس .

١ - الأهداف :

- الف. تنمية قدرات الطلاب على ضبط إعراب الكلمات
- ب. توسيع مادة الطلاب اللغوية و تدربهم على كيفية الاشتقاق
- ج. تعريفهم ما تؤدبه العوامل اللفظية والمعوية في أواخر الكلمة
- د. تدربهم على الترجمة من العربية إلى الأردية وبالعكس
- ٢ - يراعى في تدريس هذه المادة :
- الف. أن العناية بالتطبيق هي أعظم وسيلة لترسيخ القاعدة في أذهان الطلاب
- ب. أن يتخذ المدرس من دروس القراءة والإنشاء مجالات يستغلها لتطبيق « و تدرب الطلاب على القواعد التي درسوها .

٣ - الموضوعات :

أنواع الكلمة : اسم و فعل و حرف . المذكر والمؤنث . أنواع الفعل . الإعراب . الجملة الاسمية والفعلية . المبتدأ والخبر . الفعل والمفاعيل . المفعول به . إعراب الفعل المضارع . أهم حروف الجر . المركب : الإضافي والتوصيفي . كان وأخواتها . إن وأخواتها . أدوات الاستفهام . المفرد والمثنى والجمع .

(ب) القراء ة و التعبير

قراءة طريق للمصنوع على جودة النطق وحسن الأداء و المصير على تطبيق القواعد ومنخرج الحروف ومقاطع الجملة و سرعة إدراك المعاني ودقة الفهم بواسطتها .

يراعى في القراء ة :

٤٢ أن يألش المعلم للاميل ة على الانتباه و حسن الإصغاء والإحاطة بالمعاني وإدراك العلاقات التي تلور في القراء ة .

٤٣ أن ينظم المعلم القراء ة بحيث يقرأ كل طالب بعد الآخر قراء ة متصلة ، و يرشد التلاميذ إلى صحة القراء ة و إصلاح النطق والأخطاء النحوية .

٤٤ أن يقدم المفردات الجديدة مع مراعات اختيار الكلمات من ذوات المعنى الحسي الذي يمكن إيضاحه بالصورة .

والتعبير هو الإفصاح عما في النفس من أفكار و مشاعر بالكأابة والمحادثة . ينقسم التعبير إلى تحويري و شفوي .

يراعى في التعبير :

٤٥ أن يصوب التلاميذ الجملة الخاطئة ٤٦ أن يعللوا الفراغ بكلمات مناسبة

٤٧ أن يربوا الكلمات غير مرتبة حتى تكون جملة مفيدة ٤٨ أن يتمرنوا على الأساليب المألوفة

٤٩ أن يحيوا على الأسئلة بالعربية .

الكتب المقررة :

١- عبدالمستار عربي كالمعلم الجزء الأول

٢- علي الجارم و مصطفى أمين النحو الواضح في قواعد اللغة العربية ، الجزء الأول

٣- ذرف عبد الرحيم قروس اللغة العربية ، الجزء الأول

٤- أبو الحسن علي الندوي قصص السنين ، الجزء الأول

٥- قديبات علي كتاب قصص السنين

Objectives

The course provides knowledge and understanding about the different animal groups, emphasizing their phylogenetic relationships.

Hemichordates and Invertebrate Chordates: Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations. **Fishes:** Vertebrate Success in Water: Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations. **Amphibians:** The First Terrestrial Vertebrates Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations. **Reptiles:** The First Amniotes Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonina, rhynchocephalia, squamata, and crocodylia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations. **Birds:** Feathers, Flight, and Endothermy Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation. **Mammals:** Specialized Teeth, Endothermy, Hair, and Viviparity: Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 15th Edition (International), 2011. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 8th Edition (International) 2010. Singapore: McGraw Hill.
3. Kent, G.C. and Miller, S. Comparative Anatomy of Vertebrates. Latest Edition 200?. New York: McGraw Hill.

4. Campbell, N.A. BIOLOGY, 9th Edition. 2011. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Practicals:

1. Museum study of representative phyla.
2. Study of a representative of Hemichordate and Chordate.
3. Study of representative groups of class Fishes.
4. Study of representative groups of class Amphibia.
5. Study of representative groups of class Reptilia.
6. Study of representative groups of class Aves.
7. Study of representative groups of class Mammalia.
8. Field trips to study animal diversity in an ecosystem.

Note: Preserved specimen and/or colored projection slide and/or CD ROM projection of computer must be used.

Recommended Books

1. Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles of Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.

CHM-4405

Inorganic Chemistry

3(2-1)

1. Introduction to Chemical Bonding

Attainment of a stable configuration, types of bonds (ionic bonds, covalent bonds, coordinate bonds), oxidation number and formal oxidation number. The localized bonding approach (Introduction to valence bond theory and hybridization. The delocalized bonding approach (MOT applied to homonuclear diatomic molecules).

2. Acids and Bases

Concepts of acids and bases (Arrhenius, Lowry-Bronsted, Lewis and SHAB concept), relative strength of acids and bases. pH, pKa, pKb and buffer solutions and their significance. Theory of Indicators, solubility, solubility product, common ion effect and their applications.

3. Chemistry of p-block Elements

General characteristics of the following group of p-block elements with reference to the aspects given against each:

Boron and Aluminum

Gradation of the characteristic properties within the group. Structures, properties and applications of electron deficient molecules such as boron hydrides and aluminium hydrides.

Carbon and Silicon

Gradation of the characteristic properties within the group). Production of pure silicon for solar energy and silicon chips. Structural aspects of ortho and metasilicates and their industrial applications.

Nitrogen and Phosphorus

Gradation of the characteristic properties within the group. Oxides of nitrogen (NO and NO₂) and their role in air pollution, oxyacids (HNO₂ and HNO₃) of nitrogen. Industrial preparation of urea and superphosphate fertilizers.

Oxygen and Sulfur 26 Gradation of the characteristic properties within the group. Role of sulphur dioxide in air pollution. Thionic acids (H₂SO₃ and H₂SO₄) and uses of hypo in photography.

The Halogens

Gradation of the characteristic properties within the group, anomalous behavior of fluorine. Preparation of oxyacids of halogens (HClO₃ and HClO₄) and their uses. Interhalogens, pseudohalogens.

The Noble Gases

Preparation, properties and uses of xenon fluorides; Commercial uses of noble gases.

4. Chemistry of d-block Elements

Electronic configuration and general characteristics of d-block elements. Industrial applications of transition metals. Werner's concept and nomenclature of coordination compounds.

5. Introduction to Modern Materials

Liquid crystals, engineering ceramics, fiber glass and thin films.

Practicals

1. Laboratory Ethics and safety measures

Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations

2. Qualitative analysis

Analysis of four ions (two anions and two cations) from mixture of salts

3. Quantitative analysis

a. Acid-Base Titrations (minimum 02)

- b. Redox Titrations (minimum 02)
- c. Complexometric Titrations (minimum 02)
- 4. Inorganic Preparations
 - a. Preparation of Ferrous sulphate
 - b. Preparation of Ferric alum
 - c. Preparation of Barium sulphate

Recommended Books

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001
2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
3. Clyde Day, M. & Selbin, J., "Theoretical Inorganic Chemistry", 2nd Ed., Van Nostrand Reinhold, 1969.
4. Lee, J.D., "Concise Inorganic Chemistry", Chapman and Hall, 5th Edition, 1996.
5. Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2nd Edition, 1994.
6. Cartmell E. and Fowles G. W. A. "Valency and Molecular Structure" Adlard and Sons Limited 3rd Edition (1966)
7. Douglas B., McDaniel D. and Alexander J. "Concepts and Models of Inorganic Chemistry" John Wiley & Sons, Inc. 3rd Edition (1994)
8. Harvey K. B. and Porter G. B. "Introduction to Inorganic Physical Chemistry" Addison-Wesley Publishing Company, Inc. (1963)
9. Hill J. W. and Petrucci R. H. "General Chemistry" Prentice-Hall, Inc. (1996)
10. Marr G. and Rockett B. W. "Practical Inorganic Chemistry" Van Nostrand Reinhold Company. (1972)
11. Miessler G. L. and Tarr Donald A. "Inorganic Chemistry" Prentice-Hall International, Inc. Prentice-Hall International Edition (1991)
12. Moody B. "Comparative Inorganic Chemistry" Routledge, Chapman and Hall, Inc. 3rd Edition (1991)

13. Kennedy, Friedlander, "Nuclear and Radiochemistry" (latest edition).

Bassette, J., Denney, G. H. and Mendham, J., "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4th Edition, 1981.

Vogel, A. I., "A Textbook of Micro and Semi-micro–Qualitative Inorganic Analysis" Longman Green & Co. 1995.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS (5TH SEMESTER) PROGRAM IN BOTANY

Year-III SEMESTER-V (Cr. 16)

Course Code	Course Title	Lecture Credit's
BOT-5501	Bacteriology and Virology	3(2-1)
BOT-5502	Diversity of Vascular Plants	3(2-1)
BOT-5503	Phycology and Bryology	3(2-1)
BOT-5504	Mycology and Plant Pathology	3(2-1)
BOT-5505	Cell Biology	3(2-1)
BOT-5506	Field Botany-I	1(0-1)
Total Credit Hour's		16

BOT-5501

Bacteriology and Virology

3(2-1)

Aims and objectives

To understand the morphology, structure and economic importance of Viruses and Bacteria

Course outline:

a) Viruses

1. General features of viruses, viral architecture, classification, dissemination and replication of single and double – stranded DNA/RNA viruses.
2. Plant viral taxonomy.
3. Virus biology and virus transmission methods.
4. Molecular biology of plant virus transmission.
5. Symptomatology and of virus-infected plants: (External and Internal symptoms).
6. Metabolism of virus-infected plants.
7. Resistance to viral infection.
8. Methods in molecular virology (Virus cultivation: Cell cultures, Isolation of viruses. Centrifugation: Differential centrifugation and Density gradient centrifugation).

a) Bacteria

1. History, characteristics and classification.
2. Evolutionary tendencies in Monera (Bacteria, actinomycetes and cyanobacteria).
3. Morphology, genetic recombination, locomotion and reproduction in bacteria.
4. Bacterial metabolism (respiration, fermentation, photosynthesis and nitrogen fixation)
5. Importance of bacteria with special reference to application in various modern sciences specially agriculture, biotechnology and genetic engineering.
6. Symptoms (Crown gall, Canker, Fruit spot, Leaf spot, Sheperd's crook stem ends on woody plants, Necrosis, Chlorosis) and control of major bacterial diseases in Pakistan

b) Plant microbe interaction

Rhizosphere, Quorum sensing and its role in agriculture, Role of bacteria as biocontrol agent, Rhizobia and nodulation, diazotrophs, bioremediation, Bio fertilizers & role of microbes, Associative symbiosis, Signal transduction around the bacteria, Vascular mycorrhizae, Responses of bacteria under biotic & abiotic stress, Physiological significance of Phyto-hormones produced by microbes, Phosphate solubilization

Practicals

a) Viruses

Observation of symptoms of some viral infected plant specimens (Mosaic leaf pattern, Crinkled leaves, Yellowed leaves, Plant stunting).

Observation of symptoms of some viral infected plant specimens (Crown gall, Canker, Fruit spot, Leaf spot, Sheperd's crook stem ends on woody plants, Necrosis, Chlorosis)

1. Methods of sterilization of glassware and media etc.
2. Preparation of nutrient media and inoculation.
3. Preparation of slides for the study of various forms, capsule/slime layer, spores, flagella and Gram-staining.
4. Growth of bacteria, subculturing and identification of bacteria on morphological and biochemical basis.
- 5: Microscopic study of representative genera of Actinomycetes and Cyanobacteria from fresh collections and prepared slides.

Recommended Books:

1. Black, J. G. 2005 Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
2. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. Microbiology McGraw-Hill Companies, Inc.
3. Arora, D. R. 2004. Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
3. Ross F. C. 1995. Fundamentals of Microbiology. John Willey & Sons, New York.
4. Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens. The Haworth Press, Inc.
7. Hull R. Matthews, 2004, Plant Virology, Academic Press.
8. Tortora, G. J: Funke, B. R. and Case C. L., 2004, Microbiology. Pearson Education.
9. Molecular Plant-Microbe Interactions, Kamal Bouarab, Normand Brisson, Fouad Daayf (eds), 2009 MPG Books Group, Bodmin, UK.
10. Plant-Microbe Interactions Gary Stacey, Noel T. Keen (Eds) 2011, springer London.

Journals/Periodicals: World Journal of Microbiology & Biotechnology, Current Microbiology, Journal of Industrial Microbiology and Biotechnology, Journal of General Virology, Journal of Virology.

BOT-5502

Diversity of Vascular Plants

3(2-1)

Aims and objectives

To enable the students to understand and appreciate the biology and evolution of plant architecture

Course Contents:

a. **Pteridophytes**

Introduction, origin, history, features and a generalized life cycle. Methods of fossilization, types of fossils, geological time scale and importance of paleobotany. First vascular plant - Rhyniophyta e.g., *Cooksonia* General Characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilopsida Psilotum), Lycopsida (Lycopodium, Selaginella with emphasis on origin and evolution of seed habit, Sphenopsida (Equisetum), Pteropsida (*Ophioglossum*, *Dryopteris* and *Azolla/Marsilea*).

b. **Gymnosperms:**

Geological history, origin, distribution, morphology, anatomy, classification and affinities of Cycadofillicales, Bennettitales, Ginkgoales, Cycadales and Gnetales. Distribution of gymnosperms in Pakistan. Economic importance of gymnosperms. An introduction to the Gondwana flora of world.

c. **Angiosperms:**

Origin, general characteristics, Importance, and life cycle of angiosperms

d. **Palynology:**

Basic information about the nomenclature, morphology and classification of living and fossil pollen and spores.

Practicals:

1. To study the morphological and reproductive features of available genera.
2. Study trips to different parts of Pakistan for the collection and identification of important pteridophytes, gymnosperms and angiosperms.

BOT-5503

Phycology and Bryology

3(2-1)

Aims and objectives

To understand the classification, morphology and economic importance of Algae and Bryophytes

Course Contents:

1. Phycology

2. Algae: Introduction, Basic characteristics of algae, Structure of algal cell, evolution and fossil record, classification and economic importance.

3. Prokaryotic Algae: Cyanobacteria basic characteristics, morphology, cell wall and gliding, pili and twitching, protoplasmic structure, Nitrogen fixation, reproduction and economic importance.

4. Evolution of Chloroplast: Glaucophyta and Rhodophyta basic characteristics, cell structure secretory cells, epiphytes and parasites, defense mechanism, reproduction, commercial utilization.
5. Chlorophyta: Basic characteristics, cell structure, photo-taxis and eyespot, reproduction and economic importance.
6. Evolution of one membrane of chloroplast ER: Euglenophyta and Dinophyta basic characteristics, cell structure and reproduction.
7. Evolution of two membrane of chloroplast ER and chlorarachniophyta: Cryptophyta, Heterokontophyta (Bacillariophyceae, Xanthophyceae, Phaeophyceae) basic characteristics, cell structure reproduction and economic importance.
8. Bryology
9. Introduction and evolutionary significance of bryophytes: Why do we call a bryophyte, bryophytes and embryophytes, land plant evolution evidence from fossils, affinities, classification, theories of origin and evolution and ecological significance of bryophytes?
10. Brief study of the structure and development, macroevolution, reproduction with one example of each: Hepaticopsida (Riccia), Bryopsida (Funaria) and Anthocerosida (Anthoceros).

Practical:

1. Phycology: Collection and section cutting of Spirogyra, Volvox, Chlamydomonas, Chara and Vaucheria. Identification of benthic and planktonic algae on the basis of species composition and habitat association. Preparation and preservation of slides of fresh samples of Volvox, Spirogyra, Chlamydomonas, Chara and Vaucheria.
2. Bryology: Preparation and preparation of fresh samples of Marchantia, Anthoceros, and Funaria.
Collection and identifying characters of Riccia, Marchantia, Pellia, Anthoceros, Polytrichum and Funaria.

Recommended Books

1. Bold, H. C. and M.J. Wynne 1985. Introduction to Algae: structure and reproduction. Prentice Hall Inc. Engle Wood Cliffs
2. Lee. R.E. 1999. Phycology. Cambridge University Press, U.K.
3. Dawson, E.Y., Halt. 1966. Marine Botany. Reinhart and Winstan, New York.
4. Chapman, V.J. and D.J. Chapman. 1983. Seaweed and their uses. McMillan and Co. Ltd. London.
5. Vashishta. B. R. 1991. Botany for degree students. Bryophytes 8th ed. S. Chand and Co. Ltd. Delhi.
6. Schofield, W.B. 1985. Introduction to Bryology. Macmillan Publishing Co. London.
7. Hussain, F. and I. Ilahi. 2004. A textbook of Botany. Department of Botany, University of Peshawar.

Aims and objectives

To introduce the students to Mycology and Diseases caused by Fungi.

Course Contents

a) Mycology

1. Introduction: General characters of fungi, Thallus, cell structure and ultrastructure of fungi.
2. Reproduction: Asexual and sexual reproduction and reproduction structures, life cycle, haploid, heterokaryotic and diploid states.
3. Fungal Systematics: Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of lower fungi (Myxomycota, Oomycota, Chytridiomycota), Zygomycota (Mucor), Ascomycota, Basidiomycota and Deuteromycetes.
4. Symbiotic relationships of fungi with other organisms (lichens and mycorrhiza) and their significance.
5. Importance of fungi in human affairs with special reference to Industry and Agriculture

b) Pathology

1. Introduction and classification of plant diseases.
2. Symptoms, causes and development of plant diseases
3. Loss assessment and disease control
4. Epidemiology and disease forecast
5. Important diseases of crop plants and fruit trees in Pakistan caused by fungi, e.g. damping off, mildews, rusts, smuts, dieback, red rot of sugarcane etc.
6. Plant defense strategies, systemic resistance, induced systematic resistance (ISR), Acquired Systematic resistance (ASR).

Practical:

a) Mycology

- 1: General characters and morphology of fungi.
- 2: Study of unicellular and mycelial forms with septate and aseptate hyphae.
- 3: Distinguishing characters of different phyla: study of suitable examples.
- 4: Study of asexual and sexual reproductive structures in different groups of fungi.
- 5: Study of some common examples of saprophytic, parasitic and air-borne fungi belonging to different phyla.

b) Pathology

- 1: Identification of major plant pathogens under lab and field conditions,
- 2: Cultural studies of some important plant pathogenic fungi,
- 3: Application of Koch's postulates for confirmation of pathogenicity.
- 4: Demonstration of control measures through chemotherapeutants.

Recommended Books:

1. Agrios, G. N., 2005. Plant Pathology, Academic Press, London.
2. Ahmad, I. and Bhutta, A. R., 2004. Textbook of Introductory Plant Pathology. Book Foundation, Pakistan.
3. Alexopoulos, C. J., Mims, C. W. and Blackwell, M., 1996. Introductory Mycology, 4th Ed.

John Wiley & Sons.

4. Khan, A. G. and Usman, R., 2005. Laboratory Manual in Mycology and Plant Pathology. Botany Department Arid Agriculture University, Rawalpindi.
5. Mehrotra, R. S. and Aneja, K. R., 1990. An Introduction to Mycology. Wiley and Eastern Ltd., New Delhi, India.
6. Moore-Landecker, E., 1996. Fundamentals of Fungi. 4th Edn. Prentice Hall Inc., New Jersey, USA.
7. Trigiano, R. N., Windham, M. T. and Windham, A. S., 2004. 7. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

BOT-5505

Cell Biology

3(2-1)

Aims and Objectives

To understand the structure and functions of cell and main functions of all of the major organelles in eukaryotic cells

Course outline:

1. Life Begins with Cells

The Diversity and Commonality of Cells, The Molecules of a Cell, The Work of Cells, Investigating Cells and Their Constituents, A Genome Perspective on Evolution

2. Basics of cell: cell theory, structure of plant cell, prokaryotes and Eukaryotes cell

3. Cell: Physio-chemical nature of plasma membrane and cytoplasm.

4. Ultrastructure of plant cell with a brief description and functions of the following organelles

a. Cell wall b. Endoplasmic reticulum c. Plastids

d. Mitochondria e. Ribosomes f. Dictyosomes

g. Vacuole h. Microbodies (Glyoxysomes and Peroxisomes)

5. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis.

6. Chromosomes: Morphology and molecular structure of prokaryotic and eukaryotic chromosome, significance of histones and high mobility proteins in packing of chromosome and gene expression.

7. Signaling at the Cell Surface: Signaling Molecules and Cell-Surface Receptors, Intracellular Signal Transduction.

8. Cell Cycle: General description and significance of mitosis and meiosis, Chromosomal aberrations.

Practical:

1. Cell structure demonstration using compound microscope.

2. Measurement of cell size by micrometry.

4. Observation of Plastids in various plants cells.

5. Mitosis: Smear / squash preparation of onion roots.

6. Meiosis: Smear / squash preparation from anthers of plants such as oat, onion, wheat, maize etc.

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8. Demonstration of cell structure through photograph of electron microscope

Books Recommended

1. De. Robertis, E.P. and De. Robertis, E.M.F. Cell and Molecular Biology, 8th Edition, 2001, Holt Lea and Febiger, New Yark.
2. Lodish, H. Baltimor, D. Berk, A. Zipurshy, S.L. Matsudaira, P. Darnell, J. 2001. Molecular Biology of the Cell. Scientific American Books, W.H. Freeman and Company, New Yark.
3. Alberts, B., Bray, D. Lewis, J: Raff, M., Roberts, K and Watson, J.D 1994, Molecular Biology of the cell, Garland Publishing Inc. New Yark.
4. Darnell, Jr. J. Lodisch, H. and Baltimore, D. 1990. Molecular Biology of the cells, Scientific American Inc. N.Y.
5. Swanson, C.P., Merz, T. and Young, W.J. 1990 (second edition) Cytogenetics: The chromosome in division, inheritance and evolution. Prentice-Hall Inc.

BOT-5506

Field Botany-I

1(0-1)

Aims and Objectives

The basic objective of this course is to acquaint the students with natural flora in various regions through field trips.

Contents

1. Scope and importance of field botany, introduction and importance of regional flora; Equipment's required for field trips; information recorded during field trips.
2. Identification of different groups of plants based on morphological appearance (bryophytes, pteridophytes, gymnosperms, angiosperms, dicotyledons, monocotyledons).
3. Herbarium: importance of herbarium, herbaria of the world, standard herbarium techniques for preservation and storage.
4. Descriptive terminology for root, stem leaf, inflorescence, flower, flower, placentation, fruit.
5. 3-day field trip of tropical and subtropical areas
6. Collection and identification of plants in field.
7. Identification of Ranunculaceae, Brassicaceae, Apiaceae, Solanaceae, Caryophyllaceae, Fabaceae, Salicaceae, Fagaceae, Moraceae, Rosaceae, Asteraceae, Lamiaceae, Poaceae, Cyperaceae, Liliaceae, Orchidaceae in field.
8. Construction of identification taxonomic key for families identified during field trips and for genera and species.
9. Submission of 40 fully identified, dried herbarium specimens (sheet size: 42 cm × 28 cm)

10. Filed reports, must include, number of field trips conducted, date, area, climatic zone, number of plants collected, identified, supervised by, photographs of field trips.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS (6TH SEMESTER) PROGRAM IN BOTANY

**Year-III
SEMESTER-VI (Cr. 16)**

Course Code	Course Title	Lecture Credit's
BOT-5601	Plant Ecology-1	3(2-1)
BOT-5602	Plant Systematics	3(2-1)
BOT-5603	Plant Biochemistry-I	3(2-1)
BOT-5604	Principles of Genetics	3(2-1)
BOT-5605	Biostatistics	3(2-1)
BOT-5606	Field Botany-II	1(0-1)
Total Credit Hour's		16

BOT-5601

Plant Ecology-I

3(2-1)

Aims and objectives:

To understand the role and interaction of plants with their environment.

Course Contents:

1. Introduction: History and recent developments in ecology
2. Soil: Nature and properties of soil (Physical and Chemical). Water in the soil-plant-atmosphere continuum. The ionic environment and plant ionic relations, Nutrient cycling. Physiology and ecology of N, S, P and K nutrition. Heavy metals, salt and drought stress and osmoregulation. Soil erosion
3. Light and temperature: Nature of light, Factors affecting the variation in light and temperature, Responses of plants to light and temperature, Adaptation to temperature extremes,
4. Carbon dioxide: Stomatal responses, Water loss and CO₂-assimilation rates of plants in contrasting environments. Ecophysiological effects of changing atmospheric CO₂ concentration. Functional significance of different pathways of CO₂ fixation. Productivity: response of photosynthesis to environmental factors, C and N balance
5. Water: Water as an environmental factor, Role of water in the growth, adaptation and distribution of plants, Water status in soil. Water and stomatal regulation, Transpiration of leaves and canopies.

6. Oxygen deficiency: Energy metabolism of plants under oxygen deficiency, Morpho-anatomical changes during oxygen deficiency, post-anoxic stress
7. Wind as an ecological factor.
8. Fire as an ecological factor.

Practical:

1. Determination of physico-chemical properties of soil and water.
2. Measurements of light and temperature under different ecological conditions.
3. Measurements of wind velocity.
4. Measurement of CO₂ and O₂ concentration of air and water.
5. Effect of light, temperature, moisture, salinity and soil type on germination and growth of plants.
6. Measurement of ions, stomatal conductance, osmotic potential, water potential, xylem pressure potential, leaf area and rate of CO₂ exchange in plants in relation to various environmental conditions.

Recommended Books:

1. Körner, C., 2021. Plant ecology at high elevations. In *Alpine Plant Life* (pp. 1-22). Springer, Cham.
2. Körner, C., 2018. Concepts in empirical plant ecology. *Plant Ecology & Diversity*, 11(4), pp.405-428.
3. Keddy, P.A., 2017. *Plant ecology*. Cambridge University Press.
4. Pugnaire, F. and Valladares, F. eds., 2007. *Functional plant ecology*. CRC press.
5. Schultz, J. C. 2005. *Plant Ecology*, Springer-Verlag
6. Bazzaz, F.A. 2004. *Plants in Changing Environments: Linking Physiological, Population, and Community Ecology*, Cambridge University Press
7. Lambers, H. et al. 2002. *Plant Physiological Ecology*, Springer-Verlag
8. Larcher, W. 2003., *Physiological Plant Ecology: Ecophysiology and Stress Physiology of Function Groups* - Springer-Verlag
9. Nobel, P.S. 1999, *Physico-chemical and Environmental Plant Physiology*, Academic Press.
10. Lambers, H., T. L. Pons and F. Stuart. 2008. *Plant Physiological Ecology*.
11. Smith R.L. 1998 *Elements of Ecology*. Harper & Row Publishing.
12. Townsend. C.R. Begon. M and J.L Harper. 2002 *Essentials of ecology*. Blackwell Publishing.
13. Gurevitch. J. Scheiner, S.M. and G.A Fox. 2006 *The Ecology of Plants*. Sinaur Associate Inc.

BOT-5602

Plant Systematics

3(2-1)

Aims and objectives

To know floral composition/ system of classification focusing on identification, classification, description nomenclature and flora writings, monographs.

Course Contents

Course Contents

1. Introduction: Importance and relationship with other sciences, Phases of plant taxonomy. Origin and radiation of angiosperm, their probable ancestors, when, where and how did the angiosperms evolve, the earliest fossil records of angiosperms.
2. Nomenclature: Important rules of botanical nomenclature including effective and valid publication, typification, principles of priority and its limitations, author citation, rank of main taxonomic categories, conditions for rejecting names. Classification: Brief history of artificial, natural, phylogenetic and modern classification systems with one example of each system.
3. Systematics and Genecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, Various biosystematics categories such as ecophene, ecotype, ecospecies, coenospecies and comparium.
4. Concept of Species: What is a species? Taxonomic species, biological species, Micro and macro species, Species aggregate. Infra specific categories. Speciation: allopatric, peripatric, sympatric, parapatric, artificial
5. Taxonomic Evidence: Importance and types of taxonomic evidence: anatomical, cytological, chemical, molecular, palynological, geographical and embryological.
6. Brief introduction of Numerical taxonomy.
7. General characteristics, distribution, evolutionary trends, phyletic relationships, and economic importance of the following families of angiosperm:
 Apiaceae (Umbelliferae), Juncaceae, Arecaceae (Palmae), Lamiaceae (Labiatae), Asclepiadaceae, Liliacea, Asteraceae (Compositae), Magnoliaceae, Boraginaceae, Malvaceae, Brassicaceae (Cruciferae), Myrtaceae, Cannaceae, Orchidaceae, Capparidaceae, Papaveraceae, Caryophyllaceae, Poaceae (Gramineae), Casuarinaceae, Ranunculaceae, Chenopodiaceae, Rosaceae, Convolvulaceae, Salicaceae, Cucurbitaceae, Scrophulariaceae, Cyperaceae, Solanaceae, Euphorbiaceae, Fabaceae (Leguminosae), Winteraceae.

Practical:

1. Technical description of families (of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan
2. Preparation of indented and bracketed types of keys
3. Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.
4. Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination
5. Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

Recommended Books:

1. Ali, S.I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi
2. Ali, S.I. and Qaiser, M. 1992-2007 -todate. Flora of Pakistan. Karachi Univ. Press, Karachi.
3. Greuter, W., McNeill, J., Barrie, F.R., Burdet, H. M., Demoulin, V., Filguerras, T.S., Nicolson, D.H. Silva, P.C., Skog, J.E., Trehane, P., Turland, N.J. & Hawksworth, D.L., (eds.)

2000. International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International botanical congress St. Louis Missouri, July –August 1999. Koeltz, Konigstein. (Regnum Veg.138.)

4. Davis, P.H. & Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London
5. Ingrouille, M. 1992. Diversity and Evolution of Land Plants, Chapman & Hall. London
6. Nasir, E. & Ali, S.I. 1970-89. Flora of Pakistan. Karachi Univ. Press, Karachi.
7. Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold..
8. Takhtajan, A. (1986). Flowering Plant: Origin and Dispersal, Oliver and Boyd, Edinburgh
9. Jones, S. B. and Luchsinger, A.E. 1987. Plant Systematics. McGraw Hill, Inc. New York.
10. Naik, V.N. 2005. Taxonomy of Angiosperms. Tata McGraw Hill Publishing Company, New Delhi.

BOT-5603

Plant Biochemistry-I

3(2-1)

Aims and objectives:

To elucidate the structure and role of primary metabolites in plants

Course Contents:

1.Carbohydrates:

Occurrence and classification. A general account of ribose, deoxyribose, xylulose, xylose, D-glucose, D-galactose, D-mannose, cellobiose, sucrose, maltose, trehalose, pentosans, fructosans, starch, cellulose, hemicellulose, amino sugars, derived acids and alcohols, glycosides, mucilages, pectins and lignins.

2Lipids:

Occurrence, classification. Structure and chemical properties of fatty acids, triglycerides, phospholipids, glycolipids, sulfoxides, waxes and sterols.

3.Proteins:

Amino acids and their structure. Electro chemical properties and reactions of amino acids. Classification of proteins. Primary, secondary, tertiary and quaternary structure of proteins. Protein targeting. Protein folding and unfolding. Transport, storage, regulatory and receptor proteins. Protein purification. Protein sequencing. Biological role.

4.Nucleic Acids:

General introduction. Purine and pyrimidine bases, nucleosides, nucleotides. Structure and properties of DNA and RNA. Types and functions of RNA. Chemical synthesis of oligonucleotides and DNA sequencing. DNA restriction enzymes. Properties of DNA polymerase I, II and III.

5.Enzymes:

Nature and functions, I.U.E. classification with examples of typical groups. Isozymes, ribozymes, abzymes. Enzyme specificity. Enzyme kinetics. Nature of active site and mode of action. Allosteric enzymes and feedback mechanism.

Practical:

1. Solutions, acids and bases. Electrolytes, non-electrolytes, buffers, pH. Chemical bonds.
2. To perform the qualitative tests for carbohydrates

3. To estimate the amount of reducing and non-reducing sugars in plant material titrimetrically/spectrophotometrically.
4. To perform the qualitative tests for lipids.
5. To determine the amount of crude fat in plant samples.
6. To perform qualitative tests for proteins
7. To estimate soluble proteins by Bradford's method.
8. Extraction of Nucleic acids from plant material and their estimation by UV absorption or colour reactions.
9. To estimate the catalytic property of enzyme catalase or peroxidase extracted from a plant source.

Recommended Books:

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). 2015. Biochemistry and molecular biology of plants. John Wiley & sons.
2. Conn E E. and Stumpf P.K., 2006. Outlines of Biochemistry, 5th edition. John Wiley and Sons Inc. New York.
3. Lehninger, A L. 1998. Principles of Biochemistry. Worth Publishers Inc.
4. Voet, D., Voet J.G. and Pratt, C.W. 1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
5. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
6. Smith, E. L., Hill, R L, Lehman, R I., Lefkowitz, R J. Handler and Abraham. 2003, Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
7. Zubay G .2003, Biochemistry, MacMillan Publishing Co., New York.
8. Chesworth, J.M., Strichbury T. and Scaife, J. R. 1998. An introduction to agricultural biochemistry. Chapman and Hall, London.
9. Mckee, T. and Mckee, J.R. 1999. Biochemistry – An Introduction. WCB/McGraw-Hill, New York, Boston, USA.
10. Lea, P.J. and Leegood, R.C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
11. Abdes, R.H. Frey, P.A. and Jencks W.P. 2004, Biochemistry, Jones and Bartlet, London.
12. Goodwin T.W. and Mercer, E.I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.
13. Heldt, H-W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
14. Bowsher, C. 2008. Plant Biochemistry. Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition.

BOT-5604

Principles of Genetics

3(2-1)

Aims and Objectives:

This course includes concepts regarding inheritance patterns, recombination in bacteria, linkage and mapping, extranuclear inheritance, developmental and population genetics.

1. Study of Inheritance Patterns: Mendel's laws of inheritance, extensions of mendelian analysis, dominant and recessive alleles, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity, quantitative inheritance.

2. Linkage and Mapping: Basic eukaryotic chromosome mapping. The discovery of linkage, recombination, linkage symbolism, linkage of genes on the X chromosome, linkage maps, three-point testcross, interference, linkage mapping by recombination in humans, accurate calculation of large map distances, mapping human chromosomes.

3. Genetic Change-Recombination: General homologous recombination, recombination and chromosomal rearrangements.

3. The Nature of the Gene: Structure of gene, how genes work, gene- protein relationships.

4. The Extra nuclear Genome: Extra nuclear genes their inheritance and importance in eukaryotes and prokaryotes.

5. Developmental Genetics: Introduction, basic concepts, a brief description of developmental Genetics in drosophila melanogaster.

6. Population Genetics: Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Practicals:

1. Numerical problems with reference to the basic genetics and population genetics.
2. To study Gene Linkage and recombination (Single and Double cross over)
3. Gene mapping in drosophila
4. Determination of various Blood group types and Rh factor in human.

Recommended Readings:

1. S. B. Gelvin. (2000). Plant Molecular Biology Manual. Kluwer Academic Publishers.
2. B. A. Pierca. (2005) Genetics.A conceptual approach, W. H. Freeman and Company, New York.
3. L. Synder and W. Champness. (2004) Molecular Genetics of Bacteria.ASM Press, Washington D.C.
4. W. S. Klug and M. R. Cummings (1997) Concepts of Genetics, Prentice Hall International Inc.
5. N. V. Roth Well (1997) UnderstandingGenetics, second edition, Oxford University Press Inc.
6. E. J. Gardner (2004) Principles of Genetics, John Willey and Sons, New York.
7. J. Ringo (2004) Fundamental Genetics, Cambridge University Press.
8. A. J. F. Griffiths, S. R. Wessler, R. C. Lewontin, W. M. Gelbart, D. T. Suzuki, and J. H. Miller (2010) Introduction to Genetic Analysis, W.H. Freeman and Company. 11thed.
9. L. Snyder and W. Champness (2003) Molecular Genetics of Bacteria, ASM Press.
10. D. L. Hartl, and E. W. Jones (2005) Genetics -Analysis of Genes Genomes, Jones and Bartlett Publishers. Sudbary, USA. 11. P. W. Hedrick (2005) Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.

Aims and Objectives

The objective of this course is to equip the students with statistical concepts and methods: The emphasis will be on learning how to collect, summarize, analyze, and interpret real-world data in a practical manner.

Course Contents

1. **Introduction and scope:** Definition: Characteristics, importance and limitations, population and samples.
2. **Frequency distribution and probabilities:** Formation of frequency table from raw data, histograms. Applications of probabilities to simple events.
3. **Measures of central tendencies and dispersion:** Arithmetic mean, median, mode, range, variance and standard deviation, standard error of the mean, mean deviation, semi-interquartile range.
4. **Tests of significance:** Introduction:
 - 1- t-test: Basic idea, confidence limits of means, significant difference of means.
 - 2- χ^2 – test: Basic idea, testing goodness of fit to a ratio, testing association (contingency table).
 - 3- F-test: Introduction and application in analysis of variance.
 - 4- L.S. D. test, Dancunn Multiple Range Test (for comparison of individual means).
5. **Design of experiment:** Concept of design, principles of experiment, planning of an experiment, replication and randomization, Field plot technique, Layout and analysis of completely randomized design, randomized complete block design, Latin square, factorial design, treatment comparison.
6. **Correlation and regression:** Brief account of correlation and regression.

Practical:

1. Probability of simple events.
2. Data collection, arrangement of data in frequency table.
3. Calculation of mean from group and ungrouped data.
4. Calculation of variance and standard deviation from grouped and ungrouped data.
5. T-test.
6. χ^2 – test.
7. Analysis of variance – one factor design
8. Analysis of variance – two-way analysis
9. Analysis of variance – for latin square
10. Analysis of variance – for factorial design.
11. Correlation.
12. Linear Regression.

Books Recommended

- 1- Bailey. N.T.J. 1994. Statistical Methods in Biology, Cambridge University Press.

- 2- 2- Quinn, G. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press. 3- Wonnacott, T.H. and Wonnacott, R.J. 1990. Introductory Statistics, John Willey and Sons.

BOT-5606

Field Botany-II

1(1-0)

Aims and objective

In this course students will learn about basic techniques of plant sampling, community dynamics and functioning. They will learn about the basic plant community and local ecosystems.

1. Identification of numerous flowering plants to species using technical and popular identification keys
2. Demonstration of reproductive biology and pollination ecology of plants in bloom encountered in the field.
3. Teaching of family concepts for developing field identification skills.
4. 3-day field trip of temperate and alpine areas
5. Collection: A collection of dried plants (25 species representing at least 20 families).
 - Specimens must be dry, flat, and complete (include flowers and/or fruit and a sample of the roots)
 - Do not include cultivated plants.
 - Present specimens mounted on Herbarium Sheet.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS (7TH SEMESTER) YEAR PROGRAM IN BOTANY

**Year-IV
SEMESTER-VII (Cr. 18)**

Course Code	Course Title	Lecture Credit's
BOT-6701	Plant Ecology-II	3(2-1)
BOT-6702	Plant Physiology- I	3(2-1)
BOT-6703	Research Methodology	3(2-1)
BOT-6704	Plant Biochemistry-II	3(2-1)
BOT-6705	Molecular Genetics	3(2-1)
BOT-6706	Thesis/Optional Paper	3(3-0)
Total Credit Hour's		18

BOT-6701

Plant Ecology -II

3(2-1)

Aims and Objectives

To provide comprehensive knowledge of population, community, ecosystem ecology and its relevance to mankind.

Course Contents

1. The plant community: discrete and continuum concepts with modern synthesis.
2. Community attributes: leaf Spectra, life form distribution pattern, Periodicity, Phenology, Fidelity, Constancy, Raunkiaer law of frequency, Homogeneity and Heterogeneity, age class etc.
3. Species diversity concepts, Plant community structure, Plant community dynamics (succession).
4. Method of sampling of plant community: quadrat, line intercept, Point centered quarter methods, Quantitative community description, Gradients analysis.
5. Ordination techniques and classification, Productivity, measurement, energy flow and efficiency.

Practical

1. Measurement of plant biomass and net primary productivity.
2. Measurement of water relation components: conductance.
3. Measurement of radiation, temperature, humidity and wind velocity.
4. Community attributes.
5. Exploratory survey of different local communities.
6. Detailed sampling of local vegetation including gradient, ordination, and classification.
7. Study of local ecosystem.

Books Recommended:

1. Pearcy, R.W., Ehleringer, J.R., Mooney, H. and Rundel, P.W. eds., 2012. Plant physiological ecology: field methods and instrumentation. Springer Science & Business Media.
2. Karasov, W.H. and del Rio, C.M., 2020. Physiological ecology. In Physiological Ecology. Princeton University Press.
3. Townsend C.R. Begon. M and J.L. Harper 2002. Essentials of Ecology, Blackwell Publishing,
4. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
5. Gurevitch, et al., 2002. The Ecology of Plants, Sinauer Associates, Inc.
6. Barbour M. G. et al., 1999, Terrestrial Plant Ecology, the Benjamin-Cumming Publishing Co.
7. Smith, R. L. 1998. Elements of Ecology by Harper & Row Publishers,
8. Moore P.D. and Chapman S. B. 1986. Methods in Plant Ecology, Blackwell Scientific Publication, Oxford.
9. Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education. Islamabad
10. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.

11. Larcher. W. 2003 Physiological Plant Ecology. Ecophysiology and Stress Physiology of Function Groups. Springer- Verlag.

BOT-6702

Plant Physiology-I

3(2-1)

Aims and objectives

To provide comprehensive knowledge on some vital functions and mechanisms of plants.

Course Contents

1. **Photosynthesis:** History of photosynthesis. Nature and units of light. Determination of oxygenic and anoxygenic photosynthesis. Ultrastructure of thylakoid vesicle. Various pigments and photosynthetic activity. Ultrastructure and composition of photosystem-I and II. Absorption and action spectra of different pigments. Mechanism of photosynthesis - light absorption, charge separation or oxidation of water (water oxidizing clock), electron and proton transport through thylakoid protein-pigment complexes. Photophosphorylation and its mechanism. CO₂ reduction (dark reactions) - C₃ pathway and Photorespiration, Regulation of C₃ pathway, C₄ pathway and its different forms, C₃-C₄ intermediates, CAM pathway. Methods of measurement of photosynthesis.
2. **Respiration:** Synthesis of hexose sugars from reserve carbohydrates. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respiration.
3. **Translocation of Food:** Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.
4. **Leaves and Atmosphere:** Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.

Practical:

1. To determine the CO₂ Production during respiration by plant material.
2. To determine the amount of O₂ used by respiring water plant by Winkler Method.
3. Separation of chloroplast pigments on column chromatogram and their quantification by spectrophotometer.
4. To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
5. To categorize C₃ and C₄ plants through their anatomical and physiological characters.
6. To regulate stomatal opening by light of different colors and pH.

BOT-6703

Research Methodology

3(2-1)

Aims and Objectives

To enable the students to know the theoretical aspects of planning research, handling, presentation of data, writing and submission of research papers and thesis.

Course Contents

1. **Research Methods** (planning research, various methods, analyzing results, giving reports, etc.).
2. **Research process including** formulating research questions; sampling (probability and no-probability).
3. **Collection of data** (Surveys, interviews, case studies, documents record observation etc.).
4. **Measurement of data** (Scaling, Quantitative, Qualitative, descriptive, unobtrusive etc.).
5. **Research design** (Experimental and quasi-experimental).
6. **Data analysis** (Quantitative and qualitative analyzing method).
7. **Writing the research paper** (Basic steps to write a research paper).
8. **The Major theoretical and philosophical underpinnings of research including:** the idea of validity in research; reliability of measures; and ethics

Recommended Books

1. Brizuela, B.M., Stewart, J.P., Carrilo, R.G., and Berger, J.G. 2000. Acts of Inquiry in Qualitative Research. Harvard Education Press, Cambridge.
2. Leedy, P.D., and Ormond, J. E. 2004. Practical Research: Planning and Design. 8th Edition. Prentice Hall, Inc., London.
3. Shank, G.D. 2001. Qualitative Research: A Personal Skills Approach. 2nd Edition. Pearson Education Inc., New York.
4. Brandret, M., Mchille, L., and Peterson, L. 1996. Practical Methods in Mycorrhizal Research. Mycologue Publications, University of Guelph, Guelph, Ontario.
5. Harley, J.L., and Smith, S.E. 1983. Mycorrhizal Symbiosis. Academic Press, London.
6. Kendrick, B. 2001. The Fifth Kingdom. 3rd Edition. Focus Publishing/R. Pullins Company, Massachusetts.
7. Schenk, N.C. 1982. Methods and Principles of Mycorrhizal Research. The American Phytopathological Society. St. Paul, Minnesota.

BOT-6704

Plant Biochemistry-II

3(2-1)

Aims and Objectives

To explicit the fundamentals of metabolic energy, Metabolism and Plant constituents.

Course Outline

1. Bioenergetics: Energy, laws about energy changes. Oxidation and reduction in living systems.
2. Metabolism:
 - a) Biosynthesis, degradation and regulation of sucrose and starch. Breakdown of fats with special reference to beta-oxidation and its energy balance. Biosynthesis of fats.
 - b) Replication of DNA. Reverse transcription. Biosynthesis of DNA and RNA.
 - c) Components of protein synthesis. Genetic code, protein synthesis: initiation, elongation and termination.

3. Alkaloids: Occurrence, physiological effects, chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role.
4. Terpenoids: Classification: monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis.
5. Vitamins: General properties and role in metabolism.

Practical:

1. Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.
2. Separation of nucleic acids by gel electrophoresis.
3. To estimate the amount of vitamin C in a plant organ (orange, apple juice).
4. To determine potential alkaloids in plants.
5. To estimate terpenoids in plants.

Recommended Books:

1. Conn E. E. and Stumpf, P.K. 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
2. Albert L. Lehninger, 1998. Principles of Biochemistry. Worth Publishers Inc.
3. Voet, D. Voet J.G. and Pratt, C.W. 1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
4. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
5. Smith; E L., Hill; R. L., Lehman; R. I., Lefkowitz, R J. and Abraham. H. Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
6. Zubay. G. 2003, Biochemistry, MacMillan Publishing Co., New York.
7. Chesworth,. J.M., Strichbury T. and Scaife, J. R. 1998. An introduction to agricultural biochemistry. Chapman and Hall, London.
8. Goodwin T.W. and Mercer, E.I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.
9. Heldt, H-W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
10. Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition.

BOT-6705

Molecular Genetics

3(2-1)

Aims and Objectives:

To enable the students to understand the structural and functional basis of genes and gene expression, DNA and genetic changes including mutation, recombination and transposable elements.

Contents:

1. **DNA Structure and Function:** Structure of DNA, Various types of DNA, DNA replication, Transcription, translation, the genetic code, protein synthesis, wobble hypothesis.
2. **RNA Processing:** Exons & introns, splicing, RNA interference, siRNAs, miRNAs, ncRNAs.

3. **Control of Gene Expression:** Discovery of the lac system: negative control, catabolite repression of the lac operon: positive control, transcription: gene regulation in eukaryotes.
4. Introduction to transcriptomics and proteomics.
5. **Gene Mutation:** The molecular basis of gene mutations, spontaneous mutations, induced mutations, mutagens and carcinogens, biological repair mechanisms.
6. **Transposable Genetic Elements:** Insertion sequences, transposons, review of transposable elements in prokaryotes, controlling elements in maize.
7. **Human Genome Project:** Strategies and application, achievement and future prospects.
8. **Plant Genome Projects:** Arabidopsis, achievement and future prospects.

Practicals:

1. DNA extraction by CTAB method
2. Isolation and separation of DNA and protein on Gel electrophoresis.
3. Quantitative separation of macromolecules (Plasmid DNA, plant DNA, Protein) using electrophoresis.
4. Primer designing for PCR.
5. Primer dilution by standard method.
6. DNA Amplification by PCR.
7. Assessment of Polymorphism based on DNA mutations by SSR, RAPD, AFLP and RFLP.

Recommended Readings:

1. Tymoczko, J. L., Berg, J. M., & Stryer, L. (2011). *Biochemistry: a short course*. Macmillan.
2. Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P. & Matsudaira, P. (2008). *Molecular cell biology*. Macmillan.
3. Brown, T. A. (2002). *Genomes*, Bios Scientific Publishers Ltd.
4. Gelvin, S. B. (2000). *Plant Molecular Biology Manual*. Kluwer Academic Publishers.
5. Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C., Gelbart, W. M., Suzuki, D. T. and Miller, J. H. (2010). *Introduction to Genetic Analysis*, W.H. Freeman and Company. (11th Edition)
6. Primrose, S. B., Twyman, R. M. and Old, R. W. (2004). *Principles of Gene Manipulation, an Introduction to Genetic Engineering*, Blackwell Scientific Publications.
7. Cullis, C.A. 2004. *Plant Genomics and Proteomics*. Wiley-Liss, New York.
8. Gilmartin, P.M. and C. Bowler. 2002. *Molecular Plant Biology*. Vol. 1 & 2. Oxford University Press, UK.
9. Malacinski, G. M. 2003. *Essentials of Molecular Biology*, 4th edition. Jones and Bartlett Publishers, Massachusetts.
10. Watson, J.D. et al. 2004. *Molecular Biology of the Gene*. Peason Education, Singapore.
11. Snyder, L. and Champness, W. (2003). *Molecular Genetics of Bacteria*, ASM Press.

LIST OF ELECTIVE COURSES FOR BS (7TH SEMESTER) PROGRAM IN BOTANY

Course code	Course Title	Credit Hrs.
BOT-6707	Biological techniques	3(2-1)

BOT-6708	General Biotechnology	3(2-1)
BOT-6709	Plant Pathology	3(2-1)
BOT-6710	Industrial and Microbial Biotechnology	3(2-1)
BOT-6711	Energy Plantation and Biofuels	3(2-1)
BOT-6712	Biodiversity and Climate Change	3(2-1)
BOT-6713	Principles and Applications of Bioremediation	3(3-0)
BOT-6714	Bioinformatics	3(1-2)
BOT-6715	Agriculture Biotechnology	3(3-0)
BOT-6716	Molecular Biology	3(2-1)

BOT-6707

Biological Techniques

3(2-1)

Aims and Objectives

1. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
2. Scientific drawing -Purpose and principle, Basic understanding on principle and uses of the following:

Course Contents

- 1. Microscopy:** Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopes, Bright field (Compound Microscope), Scanning microscopy, Eyepiece micrometers, Camera Lucida Phase Contrast Dark Field Interference microscope, Electron microscope.
- 2. Micrometry and Morphometry:** Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter).
- 3. Standard system for weight, length, volume:** Calculations and related conversions of each: - Metric system- length; surface; weight - square measures- Cubic measures (volumetric)- Circular or angular measure- Concentrations- percent volume; ppt; ppm - Chemical molarity, normality - Temperature- Celsius, centigrade, Fahrenheit. Preparation of stock solutions of various strengths.
- 4. Specimen preparation for optical microscopy: Microtomy:** Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections.
- 5. Extraction techniques:** Centrifugation, Ultra centrifugation, cell fractionation, filtration, Distillation, Use of Soxhlet and Rotary evaporator for extraction.
- 6. Separation Techniques:** Chromatography: Principle, applications, types, thin layer, paper, column, gas, ion exchange chromatography. Electrophoresis: Principle, applications, types.
- 7. Spectrophotometry:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.
- 8. Basic principles of Sampling and Preservation:** Sampling soil organisms,

Invertebrates, Aquatic animals, Mammals, Estimation of population size, Preservation of dry and wet specimens. Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field.

Recommended Books

1. Dean, J. R. Extraction methods for environmental analysis. 1999. John Wiley and Sons Ltd. UK.
2. Curos, M. Environmental sampling and analysis: Lab Manual. 1997. Crc Press Llc. USA. 38
3. Curos, M. Environmental sampling and analysis: For Technician. 1997. CRC Press LLC. USA.
4. Cheesbrough, M. District laboratory practice in tropical countries. Part i. 1998. University Press Cambridge, UK.
5. Cheesbrough, M. District laboratory practice in tropical countries. Part ii. 1998. University Press Cambridge, UK.
6. Slingsby, D. and Cock, C. Practical ecology. 1986. Mcmillan Education Ltd. London.

BOT-6708

General Biotechnology

3(2-1)

Aims and Objectives

To understand the basic techniques and principles of tissue culture and DNA Recombinant Technology

Course Contents

1. Restriction and modification system: Types, Enzyme, classification, Nomenclature, Genetics and applications. Cloning Vectors: Plasmids (Bacterial and yeast), Viruses (Ca, MV, SV40, BPV) phages (Lambda, Mu, M13). Cosmids and phagmids. Cutting and joining of DNA:
2. Purification and ligation of DNA, Ligation of DNA molecules, blunt ends and cohesive termini.
3. Cloning Strategies; selection and characterization molecules, verification and amplification of desired genes,
4. Gene Banks, PCR, RFLP, DNA sequencing techniques, DNA cloning, Southern blotting, Northern blotting, western blotting, site specific mutagenesis. Protein engineering. Applications of recombinant DNA technology with comprehensive theoretical know-how macromolecules of desired characters for transgenic.

Practical

1. Isolation of plasmids and chromosomal DNA from bacteria and yeast.
2. Screening of bacteria for plasmids by electrophoresis of total cell lysate.
3. Gel electrophoresis of plasmids DNA chromosomal DNA & RNA.
4. Comparing plasmids of different molecular weights using Molecular Weights markers.

Recommended Books

1. Rehm, J.J. 1998. Fundamentals of Biotechnology, VCH Publishers, N.Y.
2. Lee, B.H. 1996. Fundamentals of Food Biotechnology, VCH Publishers, N.Y.
3. Pirt, J.B. 1975. Microbes and Cell Cultivation, Blackwell Scientific Publishers, London.
4. Bailey, J.E. and Ollis, D. F., 1986. Biochemical Engineering Fundamentals, McGraw Hills.
5. Watson, J.D., Tooze, J. and Kurta, D.T. 1983. Recombinant DNA-A short Course, Scientific American Books, New York.

6. Old, R.W. and Primrose, S.B. 1989. Principles of gene manipulation. 4th edition, Blackwell Scientific Publishers, London.
7. Molecular cloning, 1989. A Laboratory manual, 2nd edition, Cold spring Harbor Laboratory.
8. Higgins, I.J., Best, D.J. and Jones, J. 1988. Biotechnology Principles and Applications. Blackwell Scientific Publishers, London.
9. Rehm, J.J. 1988. Biotechnology: Special Microbial Process, Vol. 6 (b), VCH Publishers, N.Y.

BOT-6709

Plant Pathology

3(2-1)

Aims and Objectives

1. To study selected microbial plant diseases and their importance for economy.
2. To identify fungal and bacterial diseases of plant.
3. To develop the strategies for the control of plant diseases.

Course contents

Study of major microbial plant diseases. Importance of plant diseases in Pakistan. Nature and classification of plant diseases. Etiology and symptoms of plant diseases of field crops, fruits and vegetables. Fungal diseases: Rusts, Smuts, Wilts and Rot rots. Bacterial diseases: Blights, Cankers, Leaf spots and Rots. Viral diseases: Mosaics, Dwarfs, Stunts, Yellows, Leaf curl, Witches Broom, Ring spots and Wilts' □ Quarantine, eradication and International Plant Protection. Cultural practices in disease control, chemical control. Resistant varieties. Future problems and prospects of Plant Microbiology.

Practical

1. Sample collection, isolation and identification of plant pathogen (farms, orchards, nurseries).
2. Field trips.

Recommended Books

1. Nautiyal, C.S., Dion, P., (Editor), V. L. Chopra , V.L., 208. Molecular Mechanisms of Plant and Microbe Coexistence.1st Edition. Springer- Verlag New York, LC.
2. Aneja K. R. 209. Experiment in Microbiology: Plant Pathology & Biotechnology. New Age Int. Pvt. Ltd.74
3. Narayanasamy, P., 2010. Molecular Biology in Plant Pathogenesis and Disease Management: Microbial Plant Pathogens. 1st Edition. Springer-Verlag New York, LC
4. Chen, J., 201. Experimental Plant Virology.1st Edition. Springer- Verlag New York, LC
5. Van Regenmortel M. H. V. and Fraenkel-Conrat H. 2013 The Plant Viruses. Springer.

BOT-6710

Industrial and Microbial Biotechnology

3(2-1)

Aims and Objectives

To make students familiar with the applications of biotechnology in the practical field to enhance the productivity at industrial side.

Course Contents

1. Application of biotechnology in industry; biotechnology of raw ore processing (bioleaching of sulphides, carbonates, silicates etc.) accumulation of metals by microbial cells, biopulping, biofuels, microbial enhanced oil recovery; application in agriculture, food and livestock products; biofertilization; production of cheese, probiotics, bread, single cell protein, citric acid, amino acid, acetic acid, production in drinks; microbial enzymes in industry, enzyme immobilization.
2. Significance of Industrial Microbiology, Classification of microorganisms, fermentation principles,
3. Culture techniques, Measurement and control of microbial processes, Introduction of probiotics.
4. Introduction to industrial biotechnology, Biotechnology in textile, Chemical, Food, Pharmaceuticals, Agricultural industries, Industrial biocatalysts, Industrial waste, Industrial strain improvement, Screening for new metabolites, Recombinant DNA technology, Substrates for industrial fermentation,
5. Design and development of industrial bioreactors, Problems and possibilities in fermentation scale up procedure, Bioreactors, Fermenters and controls, Bioenergy and Biofuels, Product recovery and refinement.

Practical:

Screening of enzymes of industrial significance, enzyme immobilization; Production of cheese, yogurt, citric acid, amino acid and acetic acid.

Recommended Books

1. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic engineering (4th Edition). Blackwell Scientific Publications. 1994.
2. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
3. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
4. Yount L., Genetic Engineering, Gale group, 2002.
5. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002.
6. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001.

BOT-6711

Energy Plantation and Biofuels

3(2-1)

Aims and Objectives

To develop understanding regarding the prospects and possibilities of raising bioenergy plantations, bio-fuel production, and conversion technologies.

Course Contents

1. Introduction and advantages of energy plantations. Global overview of energy and biomass consumption patterns. Energy and biomass consumption patterns in Pakistan
- 2 Environmental impacts of biomass energy. Basic concepts of forest production ecology; the biomass production potential of a forest ecosystem; production of energy wood at special short-rotation plantations; use of residual biomass from traditional forestry operations for energy; harvesting and transportation logistics of energy wood production.

3. A brief introduction to bio-energy conversion technologies; utilization of bioenergy with reference to the global carbon cycle and climatic change, especially with regard to CO₂ emissions and carbon storage; and the role of bioenergy in Pakistan and other countries, especially its potential for the development of rural areas.

4. Assessment of bio-energy programs in Pakistan. Power generation from energy plantation, biomass gasification-producer gas. High Density Energy Plantations (HDEP). Land and biomass availability for sustainable bio energy. Bio-fuels introduction, Tree Born Oils (TBO's), potentials and advantages, bio-diesel trans-esterification, important bio-fuel species and their silvicultural management.

5. Overview of the markets for wood biomass for energy production globally and within the Pakistan this includes the supply, quantity, demand, and consumption as well as consumer market aspects. Fundamentals of the policies that have impacts on the supply and consumption of the energy wood; wood-based fuels; and/ or bioenergy and bio-fuels' markets, Need for research and development on environment friendly and socio economically relevant technologies. Energy from plants-problems and prospects. Petro-crops.

5. Criteria for evaluation of different species for energy plantation. Advanced energy technologies in the production of biofuels

Practical

1. Identification of important fuel woods and petro-crops. Study of different properties of biofuels used in Pakistan.

2. Determination of calorific value, moisture and ash content in biomass. Study of energy consumption pattern in rural and urban areas through survey. Visit to nearby Bio-energy units.

Recommended Books

1. Donald L. Klass. 2010. Biomass for Renewable Energy, Fuels, and Chemicals. Amazon Publishers
2. Snelder, D.J. & Lasco. R. 2008. Small Holder Tree Growing for Rural Development and Environmental Services. Springer Publisher.
3. Kumar V. 1999. *Nursery and Plantation Practice in Forestry*. Scientific Publications.
4. Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.
5. Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu
6. William, B. R. & Gowen. 1994. Forest Resources and Wood based biomass. Oxford and IBH New Delhi.

BOT-6712

Biodiversity and Climate Change

3(2-1)

Aims and Objectives

To equip the students with knowledge and importance of biodiversity and climate change and learn skills and techniques to conserve biodiversity and mitigate global warming and climate change.

Course Contents

1. Biodiversity and its scope.

2. Factors affecting biodiversity of flora and fauna (human population, industrialization and

- unsustainable land uses). Biodiversity status of flora and fauna in various zones/regions.
3. Threatened and endangered mammals, birds, and plant species in Pakistan. Biodiversity rich areas and hotspots.
 4. Conservation and management strategy for biodiversity in Pakistan. Ecosystem based adaptation.
 5. The concept of climate change and its harmful effects. Causes of climate change. Climate change assessment and predictions. Recommended actions to reduce global warming and climate change.

Practical:

Field: Visit different sites to assess the status of biodiversity.

Filed: Visit to biodiversity conservation projects.

Field: learning various methods to reduce global warming.

Recommended Books:

1. IUCN (1996): Sarhad Provincial Conservation Strategy, Government of NWFP.
2. Khattak, A.K. (2006): Resource Management Plan for Palas Forests, Lower Kohistan Forest Division, NWFP Forest Department.

BOT-6713 Principles & Applications of Bioremediation 3(2-1)

Aims and Objectives

To equip the students with the knowledge of biological techniques to overcome different types of environmental pollution

Course Contents

1. Introduction to biodegradation and bioremediation.
2. Types and nature of recalcitrant, xenobiotics. Types and mechanisms of biodegradation and bioremediation. Bioremediation of organic pollutants (hydrocarbons, PCBs, PAHs, halogenated compounds, plastics, dyes, herbicides and pesticides).
3. Bioremediation of heavy metals. Various methods and technologies used for remediation. Role of enzymes in bioremediation. Factors effecting bioremediation.
4. Aerobic and anaerobic degradation pathways of contaminants. Microbial ecology and metabolism. Microbial community dynamics during bioremediation. Molecular strategies used to explore the role of microbes in bioremediation.

Recommended Books:

1. Environmental Microbiology, 2nd Edition, Mitchel, T., G. J-Dong. John Wiley & Sons, Inc., Hoboken, New Jersey (2010).
2. Bioremediation: Applied Microbial Solutions for Real-World Environment Cleanup by Ronald M. Atlas and Jim Philp (205).
3. Environmental Biotechnology. Concepts and Applications. Jordening H.-J., J. Winter. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim (205).
4. Biodegradation and Bioremediation- Vol 2. Singh and Ajay Springer- Verlag Berlin and Heidelberg GmbH & Co. Kg, Germany (204).
5. Biodegradation and Biocatalysts. Wacket, L. P., C. D Hershberger. ASM Pres, American Society for Microbiology, N. W. Washington, DC (201).

BOT-6714**Bioinformatics****3(2-1)****Aims and Objectives**

To familiarize students with biological data mining from online databases and the use of various bioinformatics tools for extracting and processing biological data.

Course Contents

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.

Recommended Books

1. NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc.
2. Bioedit, Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molsript, Treview, Alscript, Genetic Analysis Software, Phylip, MEGA4.0 etc.

Recommended Books:

1. Claverie JM and Notredame C, 206. Bioinformatics for Dummies. 2nd Edition; Wiley Publishing.
2. Xiong J, 206. Essential Bioinformatics. 1st Edition; Cambridge University Pres.
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 Pres.
6. Sperschneider V, 208. Bioinformatics: Problem Solving Paradigms. Springer.

BOT-6715**Agriculture Biotechnology****3(3-0)****Aims and Objectives**

To acquaint students with techniques and skills employed for producing transgenic crops.

Course Contents

1. Agriculture biotechnology and its applications in crop improvements.
2. Cell and plant tissue culture methodology; improvement of plants via plant cell culture; plant molecular biomarkers; direct and indirect methods of plant and animal transformation: gene gun method of transformation,
- 3 Agrobacterium mediated transformation, chloroplast transformation and polyethylene glycol (PEG) mediated transformation; transgenic crops with herbicide, biotic and abiotic stress resistance; problems related to transgenic plants.
4. Genetically modified organisms (GMOs); field evaluation and commercialization of GMOs; possible effects of releasing GMOs into the environment; bio-fertilizers, bio-pesticides and their types; non-symbiotic nitrogen fixers; present and future prospects of biofertilizers.

Practical

1. Preparation of Murashige and Skog medium and stocks of macronutrients, micronutrients, and hormones; selection of ex-plant,
2. Medium preparation and callus induction; culturing Agrobacterium and using it to infect plant callus; selection of trans formant's; regeneration of plantlets and acclimatization.
3. Plant DNA extraction and PCR for detecting introduction of foreign DNA into plants.

Recommended Books

1. Qaim M, 2010. Agricultural Biotechnology in Developing Countries: Towards Optimizing Benefits for Por. Springer
2. Kemp Ken F, 2010. Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry). Springer.
3. Heren RV, 2012. Introduction to Agricultural Biotechnology.2nd Edition; Delmar Cengage Learning.
4. Slater A, 208. Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Edition; Oxford University Pres, USA
5. Altman A, 201. Plant Biotechnology and Agriculture: Prospects for the 21st Century. 1st Edition; Academic Pres.

BOT-6716

Molecular biology

3(2-1)

Aims and Objectives

To disseminate the knowledge of molecular basis of life.

Course Contents:

1. Nucleic Acids: DNA-circular and super helical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA
2. Proteins: Basic features of protein molecules. Folding of polypeptide chain, α -helical and β -secondary structures. Protein purification and sequencing.
3. Transcription: Enzymatic synthesis of RNA, transcriptional signals Translation: The genetic code. The Wobbling, polycistronic and monoisotopic RNA. Over lapping genes.
4. Gene regulation in Eukaryotes: Differences in genetic organization and prokaryotes and eukaryotes. Regulation of transcription, initiation, regulation of RNA processing, regulation of nucleocytoplasmic mRNA transport, regulation of mRNA stability, regulation of translation, regulation of protein activity.
5. Plant Omics: Transcriptomics; DNA libraries, their construction, screening and application. Microarray of gene technology and its application in functional genomics.
6. Proteomics; structural and functional proteomics. Methods to study proteomics
7. Metabolomics; methods to study metabolomics; importance and application of metabolomics.
8. Bioinformatics and computational biology. Levels, scope, potential and industrial application of bioinformatics and computational biology.

Practical:

Following techniques will be used for the isolation and analysis of different components:

1. Extraction of RNA, DNA and proteins
2. Electrophoreses: One and two dimensional
3. Purification of proteins, RNA and DNA.
4. Amplification using PCR.
5. Northern, Western and Southern Blotting.

Recommended Books:

1. Cullis, C.A. 2004. Plant Genomics and Proteomics. Wiley-Liss, New York.
2. Gibson, G. and S.V. Muse, 2002. A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
3. Gilmartin, P.M. and C. Bowler. 2002. Molecular Plant Biology. Vol. 1 & 2. Oxford University Press, UK.
4. Lodish, H. et al., 2004. Molecular Cell Biology. 5th Edition. W.H. Freeman & Co., New York.
5. Malacinski, G. M. 2003. Essentials of Molecular Biology, 4th edition. Jones and Bartlett Publishers, Massachusetts.
6. Watson, J.D. et al. 2004. Molecular Biology of the Gene. Peason Education, Singapore.
7. Ignacimuthu, S. 2005. Basic bioinformatics. Narosa Publishing House, India.
8. Weaver, R.F. 2005. Molecular Biology. Mc|Graw Hill, St. Louis.

5. Restriction enzyme digestion
6. Colony PCR
7. Primer designing for PCR and Gene cloning
8. Vector construction and transformation.
9. Selection of Recombinant.

Books Recommended

1. Glick, B. R., & Patten, C. L. (2022). *Molecular biotechnology: principles and applications of recombinant DNA*. John Wiley & Sons.
2. Brown, T. A. (2020). *Gene cloning and DNA analysis: an introduction*. John Wiley & Sons.
3. Dodds, J. H. and L.W Roberts, 1997. *Experiments in Plant Tissue Culture*. Cambridge University Press, Cambridge.
4. Old, R.W and S.B. Primerose, 1994. *Principles of Gene Manipulation*. Blackwell, Oxford, London.
5. Glick, B.R. and J.J. Pasternak. 2003. *Molecular Biotechnology: principles and applications of recombinant DNA*.
6. Ignacimuthu, S. 2005. *Basic bioinformatics*. Narosa Publishing House, India.
7. Weaver, R.F. 2005. *Molecular Biology*. Mc|Graw Hill, St. Louis.

BOT-6802

Plant Anatomy

3(2-1)

Aims and Objectives:

To provide comprehensive knowledge about internal organization and anatomy of vascular plants.

Course Contents

1. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body.
2. Meristematic tissues: classification, cytohistological characteristics, initials and their derivatives.
3. Apical meristem: Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices.
4. Leaf: types, origin, internal organization, development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
5. Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions: additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth.
6. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.

7. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
8. Anatomy of reproductive parts:
 - Flower
 - Seed
 - Fruit
9. Economic aspects of applied plant anatomy
10. Anatomical adaptations
11. Molecular markers in tree species used for wood identification.

Practical:

1. Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures.
2. Study of abnormal/unusual secondary growth.
3. Peel and ground sectioning and maceration of fossil material.
4. Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.

Recommended Books:

1. Dickison, W.C. 2000. Integrative plant anatomy. Academic Press, U.K.
2. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Metcalf, C.R. and Chalk, L. 1950. Anatomy of the Dicotyledons. Clarendon Press. Oxford.
5. Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.
6. Vaughan, J.G. 1990. The structure and Utilization of Oil Seeds. Chapman and Hall Ltd. London.
7. Metcalfe, C.R. 1960. Anatomy of the Monocotyledons. Gramineae. Clarendon Press, Oxford.
8. Metcalfe, C.R. 1971. Anatomy of the Monocotyledons. V. Cyperaceae. Clarendon Press, Oxford.
9. Cutler, D.F. 1969. Anatomy of the Monocotyledons. IV. Juncales. Clarendon Press, Oxford.
10. Cutler, D.F. 1978. Applied Plant Anatomy. Longman Group Ltd. England
11. Raymond, E.S. and E. Eichhorn. 2005. Esau's Plant Anatomy; Meristematic cells and tissues of plant body. John Willey Sons.
12. Eames, A.J. and L.H. Mac Daniels. 2002. An introduction to Plant Anatomy. Tat Mac-Graw Hill Publishing Company Limited, New Delhi.

Aims and Objectives

To familiarize the students with the diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystems

Course Contents

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 categorized protected areas in Pakistan.
10. Environmental Impact Assessment.
11. Use of herbarium and Botanical Garden in biodiversity and conservation.

Practical

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.

Books Recommended

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.

Aims and Objective

To give it comprehensive and advance knowledge of growth regulators, mechanism of water uptake and role of essential nutrients in plant metabolism

Course Contents

1. Plant Growth Regulators: Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action, transport, physiological effects of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Polyamines, Brassinosteroids, Jasmonates, and Salicylic acid.
2. **Plant secondary metabolism: mechanism of plant defense, offence and allelopathy. Chemical composition, types and functions of important secondary metabolites such as Alkaloids, phenolics, steroids, tannins, glycosides.**
3. Phytochromes: Discovery of phytochromes and cryptochromes. Physical and chemical properties of phytochromes. Distribution of phytochromes among species, cells and tissues and their role in biological processes. Phytochromes and gene expression.
4. Control of Flowering: Autonomous versus environmental regulation. Circadian rhythms. Classification of plants according to photoperiodic reaction, photoperiodic induction, locus of photoperiodic reaction and dark periods in photoperiodism. Role of photoperiodism in flowering. Biochemical signaling involved in flowering. Vernalization and its effect on flowering.
5. Plant Mineral Nutrition: Inorganic composition of plant and soil. Absorption of mineral nutrients - roots, mycorrhizae. Effect of soil pH on nutrient availability. Ion traffic into root. The nature of membrane carriers, channels and electrogenic pumps. Passive and active (primary and secondary) transports and their energetics. Essential and beneficial elements-their functions and deficiency symptoms in plants.

Practical

1. To investigate the preferential absorption of ions by corn seedlings and potato slices.
2. To determine osmotic potential of massive tissue by freezing point depression method or by an osmometer.
3. Preliminary phytochemical screening; Alkaloids, Flavonoids, Saponins, Tannins etc.
4. To investigate water potential of a plant tissue by dye method and water potential apparatus.
5. Determination of K uptake by excised roots.
6. Measurement of stomatal index and conductance.
7. Qualitative determination of K content in Guard cells by Sodium cobalt nitrite method.

Recommended Books

1. Press, M.C., Barker, M.G., and Scholes, J.D. 2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.

Practical

Bioremediation of heavy metals through invertebrates, consortia of microorganism, myco remediation.

Recommended Books

1. Environmental Science (Earth as a living planet). 2000. 1st ed. Botkin, D. and Keller, E. John Wiley and Sons Inc. New York, USA.
2. Practical Environmental bioremediation the field guide, 1977. R. Barry. King, Gilbert M. Long John K. Sheldon, Lewis Publishers.
3. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
4. Biotechnology, 1996. Smith, J.F., Cambridge University Press.
5. Environmental Biotechnology Principles and Applications, 2000. Puce, R. Hmana, Parry McCarty, McGraw Hill.
6. Biodegradation and Remediation, 1999. Martin Alexander Academic Press Inc.

BOT-6806

Environmental Issues

3(2-1)

Aims and Objectives

This course is designed to provide students with an appreciation for the complexity of environmental issues and an awareness of the tools that can be applied to understand and solve problems involving the environment.

Course Contents

1. Life a factor of rapid change in the environment, Population increases of diversified life in an ecosystem, 2. Population system in an ecosystem balance; Mechanisms inter-playing in balance, consequences of imbalance,
3. Endangering and extinction of species, decline of biodiversity, consequences of losing biodiversity.
4. Human population: Main actor in an environment, Human population explosion, Technologies in sustaining population and affluence, addressing population problem, population and development. Poverty: integrated approach to alleviate poverty, Lifestyle: Urban sprawl, consequences of ex-urban migration, Health in lifestyle; Environment and health.
5. Food production (Crops and livestock). Land for cultivation and farming. Food production, its distribution, economics and politics, Hunger, malnutrition and famine, Soil, irrigation, Stalinization,
6. Desertification, Losing soil/ground. Pests and pest controls: Need and approach to pest control. Alternate pest control methods. Socio-economic pressure and pest management,
7. Environmental policy in pest management. Water: Water cycle and water management, Human impact on water resources. Pollution. Bi products of production systems: Sediments, Nutrients and eutrophication, the process and symptoms of eutrophication, combating eutrophication, long term strategies. Sewage pollution: Sewage hazards and potential, sewage management, recycling and impediment to recycling. Hazardous chemical pollution: Nature and chemical risks, pollution

sources and control. Major atmospheric changes: Acid deposition, Global warming/cooling, Greenhouse effect, Ozone depletion. Solid wastes (trash): Landfills, combustion, solutions and management.

8. Energy resources (Fuel of production and development): energy sources and uses, fossil fuel, alternate fossil fuel; Nuclear Power, promises and problems, sustainable energy option, solar and other renewable energy sources. Environmental issues of Pakistan: Ecological issues (Soil erosion, deforestation, issues related to irrigated system, natural hazards), issues related to conservation of habitat and biodiversity (major threats to biodiversity in Pakistan, conservation strategy), pollution and industrial resources (water issues, air issues, soil issues, mineral resources issues, energy issues, food, population issues and socio-economic issues.

Practical:

Review, reports, field trips, discussions on current local, national, regional and global issues. Approaches and strategies, mitigation measures.

Recommended Books

1. Botkin, D.B. and Keller, E.A. 2008. Environmental science (Earth as a living planet). 3rd Ed. John Wiley and Sons Inc. N.Y, USA.
2. Ahmad, R.Z. 2000. Pakistan-A-descriptive Atlas (A comprehensive geopolitics Course). 1st Ed. Ferozsons Pvt. Ltd. Lahore Pakistan.
3. Nebel, B.J. and Wright, R.t. 1998. Environmental Sciences (the way the world works). 1st Ed. Prentice Hall International Inc. London, UK.
4. Gaston, K.J. and Spicer, J.I. 1998. 'Biodiversity (An Introduction), 1st Ed. Blackwell Science Ltd. UK.
5. Brandbury, I.K. 1998. The Biosphere. 2nd Ed. John Wiley and Sons Inc. UK.
6. Mckinny, M.L. and Schoch, R.M 1998. Environmental Science (systems and solutions). Jones and Artlett Publications Inc. USA.
7. Emiliani, C. 1997. Planet Earth (Cosmology, geology and the evolution of life and environment). 3rd Ed. Cambridge. University Press, UK.
8. Khan, F.K. Geography of Pakistan Environment (Environment, People and economy). 1993. Oxford University Press, NY, USA.
9. Hussain, S.S. 1992. Pakistan Manual of Plant Ecology (A textbook of plant ecology for degree students). National Book Foundation, Islamabad, Pakistan.
10. Daily newspapers for current issues.

Aims and Objectives

Aim of this course is to let the students know about the science of microbiology, to work with microorganisms, their pathogenicity, and various diseases and problems caused by microorganisms.

Course Contents

1. Morphology and fine structure of bacteria: Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, the cytoplasm, nuclear material.

2. Microbiology and Medicine, antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of the infections in the community. Immunological principles, antigen, antibodies and antigen-antibody reactions.

3. Bacterial pathogens and associated diseases. *Staphylococcus*, skin and wound infections. *Streptococcus*, sore throat, scarlet fever, glomerulonephritis. *Pneumococcus*, respiratory infections. *Corynebacterium*. *Diphtheriae* *Mycobacterium tuberculosis*: Pulmonary and other tuberculosis infections. *Actinomyces*. *Neisseria meningitis*, Gonorrhoea, *Salmonella*, *Shigella*, *Escherichia coli*, *Klebsiella proteus*, *Providencia*, *Bacillus anthracis*. *Clostridium tetani*. Pox viruses, Herpes viruses. Herpes simplex. Cytomegalovirus infections. Adenoviruses. Influenza viruses. Hepatitis viruses. Arbovirus, Rickettsia, Pathogenic. Fungi and Protozoa.

Practicals

1. Basic techniques of Staining of microorganisms: Simple stains, positive staining; negative staining.

2. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, 3. Laboratory diagnosis and control of infections: Streptococcus. Corynebacterium, Listeria, Mycobacterium. The Enterobacteriaceae: Salmonella. Escherichia, Klebsiella and Clostridium. Blood tests: TLC, DLC, RBC.

Recommended Books

1. Kenneth Ryan, C. George Ray, Nafees Ahmad, W. Lawrence Drew, James Plorde. (2010). Sherris Medical Microbiology, Fifth Edition. McGraw Hill Publishers, Washington DC
2. Patrick R. Murry, Ken S. Rosenthal, Michael A. Pfaller: Medical Microbiology, 5th edition, Philadelphia: Elsevier/Mosby, 2005.
3. P.K. Murray, Ph.D., K.S. Rosenthal, Ph.D., G.S. Kobayashi, Ph.D., and M.A. Pfaller, MD, 4th Edition, Mosby, Inc. 2002. ISBN #0323012132
4. Sherris medical microbiology: an introduction to infectious diseases C. George Ray, Editor; McGraw-Hill/Appleton and Lange 5th edition, McGraw-Hill/Appleton & Lange, 2003. ISBN#0838585299
5. Microbial Applications (Complete Version) Laboratory Manual in General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.
6. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.
7. Brock Biology of Microorganisms, 1997. Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall, London.

8. Cruickshank, R, Duguid, J.P., Hermion, B.P. and Swain, R.H.A., (2003). Medical Microbiology. Churchill Livingstone, N.Y.
9. The Microbial World, 1986. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. Prentice Hall, London.
10. Foundations in Microbiology. (1998). Talaro & Talaro. WCB Publishers, New York.
11. Microbiology: A Human Perspective, 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education

BOT-6808

Advances in Molecular Biology

3(2-1)

Aims and objectives

Objectives of the course are to impart knowledge about the macromolecules in animal cell and their complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.

Course Contents

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

Practical

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

Recommended Books

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.
7. Stent, G.S., (1971). Molecular Genetics, Freeman, San Francisco.
8. Glass R.E., (1982). Gene Function: E. coli and its Heritable Elements, Croom Helm, London.
9. Adams, R.L.P., Knowler, J.T. and Leary, D.P. (1986). The Biochemistry of the Nucleic Acids, Chapman and Hall.
10. Davis, R.W., Botstein, D. and Roth, J.R. (1980). Advanced Bacterial Genetics, Cold Spring Harbor Lab., N.Y.
11. Freifelder, D. (1983). Molecular Biology, A Comprehensive Introduction to Prokaryotes and Eukaryotes. Science Books International, Boston.

BOT-6809**Cell and Tissue Culture****3(2-1)****Aims and Objectives:**

The aim of this course is to provide students with a thorough understanding of the importance of cell, tissue and organ culture and its application in life sciences.

Course Contents:

1. Plant cell and tissue culture: requirements for in vitro cultures; culture facilities; sterile techniques; media preparation and handling; callus cultures; cell suspension cultures; protoplast culture; haploid cultures, organ culture; meristem culture for virus elimination; embryo culture and embryo rescue; regeneration of plants and micro-propagation; soma clonal variation; industrial uses of plant cell culture; tissue culture in genetic engineering and biotechnology
2. Mammalian cell culture: origin and principles of cell culture; qualitative characteristics of cell cultures; cell counting and analysis; cryopreservation; cell banking and subculture (variety of different systems); primary cell culture techniques; development of immortalized cell line; detection of microbial contaminants; animal cells for bioassays and bioproducts; design and operation of animal cell culture bioreactors for therapeutic protein production; growth environment; Stem cell culture

Recommended Books:

1. Setlow JK, 200. Genetic Engineering: Principles and Methods. Kluwer Academic Publishers.
2. Nichol DST, 202. An Introduction to Genetic Engineering. 2nd Edition; Cambridge University Pres.
3. Gale YL, 202. Genetic Engineering.
4. Razdan MK, 203. Introduction to Plant Tissue Culture. 2nd Edition; Intercept, New York, USA.
5. Lanza et al., 200. Principles of Tissue Engineering. 2nd Edition; Academic Press, California.
6. Ignacimutu S, 197. Plant Biotechnology. Oxford IBH Publisher.
7. Punia MS, 199. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers.

BOT-6810**Virology****3(3-0)****Aims and Objectives**

Aim of this course is to provide a generalized overview of virology as it stands today.

Course Contents

1. Historical perspective; general properties of viruses.
2. Classification and nomenclature; virus structure and assembly.
3. Replication cycle and genetics of viruses; animal and plant viruses.
4. Propagation, detection and quantification of viruses; pathogenesis and immune response of viral infections; laboratory diagnosis of viral diseases; vaccines and antiviral drugs; epidemiology; tumor viruses; viral vectors and gene therapy; emerging viruses; specific aspects of selected viral diseases

Recommended Books:

1. Flint et al., 209. Principles of Virology. ASM Pres, USA.
2. Lal S, 207. The Biology of Emerging Viruses. Wiley-Blackwel, USA.
3. Carter J Saunders V. Virology: Principles and Applications. First Edition; Wiley.

Course Contents

1. Organization and structure of genomes; genetic mapping (RFLP, microsatellite, SNP); high-resolution physical mapping (STS, EST); flow cytometry; somatic cell and radiation hybrids.
2. Artificial chromosomes in bacteria and yeast.
3. Hierarchical and whole genome shotgun sequencing; DNA sequencing strategies - manual and automated sequencing, pyrosequencing, Solexa, Helicos, Roche 454, real-time and nanopore sequencing; sequence assembly, obstacles and solutions; estimating gene number – over-prediction and under-prediction, homology searches, exon prediction programs, integrated gene-finding software packages; structural variation in the genome and its applications; microarray and RNA interference.

Recommended books:

1. Strachan T and Read AP, 2010. Human Molecular Genetics.4th Edition; Garland Science.
2. Sacone C and Pesole G, 2003. Handbook of Comparative Genomics: Principles and Methodology. 1st Edition; Wiley-Lis.
3. Town C, 2002. Functional Genomics.1st Edition; Springer.
4. Krebs et al., 2010. Lewin Genes X. 10th Edition; Jones and Bartlet Publishers.
5. Al-Rubeai M and Fuseneger M, 2010. Systems Biology (Cell Engineering). 1st Edition; Springer

BOT-6813

Biodiversity of Plants and Fungi

3(2-1)

Aims and Objectives

To learn about the evolutionary history and phylogenetic relation between plants and fungi.

Course Contents

1. Introduction: Diversity of life. Arranging the diversity of life into Kingdoms. Prokaryotes and origin of metabolic diversity.
2. The origin of eukaryotic diversity: Eukaryotic origin by symbiosis among prokaryotes. Eukaryotic algae as key producers in aquatic ecosystem. Major characteristics of phyla of kingdom Plant and colonization of land.
3. Plant diversity and evolutionary history of plant kingdom, structural and reproductive adaptation for colonization of land. Plant structure and Growth.
4. Reproduction & Development: Life cycle of plant.
5. Evolutionary adaptation in germination of seeds, methods of reproduction and their role in agriculture, overview of developmental mechanism in plants. Control systems of Plants to cope with environmental stress. Body plan and nutritional modes in Fungi Classification of Fungi.

Practical

1. Study of morphology and reproductive structures of eukaryotes and prokaryotes specimens mentioned in course outline.
2. Identification of various types mentioned from prepared slides and fresh collection.
3. Collection of specimens of plants and their identification.

Recommended Books

1. Schafer, 2006. Photo morphogenesis in plant and Bacteria.
2. Barbara J. E.s., Christine J. C. B. and Thomas N. S. 2010. Microbial Rots Endophytes. Springer.
3. Shely, 2010. Stern's Introductory Plant Biology. McGraw-Hil Sciences.37

4. Ana M. P. and A. Carolina F. 201. Endophytes of forest Trees. Springer.
5. Alexopoulos, 2012. Introductory Mycology.
6. Teij S., Hideki K. et al. 2013. Species Diversity and Community Structure. Springer.

BOT-6814

General Microbiology

3(2-1)

Aims and Objectives

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

Course Contents

- 1. The beginnings of Microbiology:** Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology. Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual.
- 2. Viruses:** Bacteriophages and phages of other protests. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.
- 3. Morphology and fine structure of bacteria:** Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material.
- 4. The Cultivation of Bacteria:** Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation.
- 5. Reproduction and growth of bacteria:** Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth.
- 6. Pure cultures and cultural characteristics:** Natural microbial populations, selective methods; Chemical methods, Physical methods, biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures.
- 7. Eukaryotic Microorganisms:** Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa.
- 8. Prokaryotic diversity Bacteria:** Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid

bacteria, Zymomonas and Chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

9. Prokaryotic Diversity: Archaea: Extremely Halophilic archaea, Methane producing archaea: Methanogens, Hyperthermophilic archaea, Thermoplasma.

10. Microbial Ecology: Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

Practical:

The culture of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates. Isolation of a bacterial culture, Quantitative plating methods. The turbidimetric estimation of microbial growth.

Recommended Books

1. Pelczar, Jr., Chan, E.C.S. and Kreig, M.R. (1986). Microbiology, McGraw Hill, London.
2. Peltler, G.L. A Laboratory Manual of Microbiology.
3. Benson, H.J. Microbial Applications: Laboratory Manual in General Microbiology, 1994. WMC Brown Publishers, England.
4. Madigan, M.T., Martinko, J.M. and Parker, J. Brock Biology of Microorganisms, 1997. Prentice-Hall, London.

BOT-6415

Recombinant DNA Technology

3(2-1)

Aims and Objectives

To elucidate to the students the techniques of recombinant DNA technology.

1. Basic Techniques: Extraction of nucleic acids, measurement of nucleic acids, gel electrophoresis, nucleic acid probes, hybridization of nucleic acids, nucleic acid blotting: southern blotting, northern blotting, dot or slot blots,

2. Cutting and Joining DNA molecules; Restriction enzymes, host-controlled restriction and modification, types of restriction enzymes, nomenclature, isoschizomers, physical methods of breaking DNA, DNA ligases, linkers, adapters, homopolymer tailing,

3. Vectors: Desirable properties of vectors, plasmid vectors, bacteriophage λ vectors, cosmids, M13 vector, phasmids, supervectors: BACs, YACs, HACs.

4. Polymerase Chain Reaction (PCR); PCR reaction, primers, reverse transcriptase PCR, real time PCR, PCR application: PCR cloning strategies, analysis of recombinant clones, diagnostic application,

5. Gene transfer to Plants; *Agrobacterium tumefaciens* mediated transformation, direct nuclear transformation, viral vectors, chloroplast transformation,

6. Application of Transgenic Plants; Insecticidal resistance, herbicidal resistance, virus resistance, fungal resistance, delayed ripening, salt tolerance, enhancing production and quality of food

Practical

- 1. Plasmid DNA isolation from bacterial cells**
- 2. Chromosomal DNA isolation from bacterial cells**
3. Agarose gel electrophoresis of isolated DNA
4. Restriction enzyme digestion of plasmid DNA
- 5. DNA amplification through PCR**

Recommended Books

1. Brown, T.A. 2010. Gene Cloning and DNA Analysis.6th Edition. Wiley-Blackwell, London.
2. Dale, J.W., and Schantz, M.V. 2007. From Genes to Genomes.2nd Edition. John Wiley & Sons, Inc., London.
3. Hughes, M.A. 1996. Plant Molecular Genetics. Addison-Wesley Longman, London.
4. Nicholl, D.S.T. 2008. An Introduction to Genetic Engineering.3rd Edition. Cambridge University Press, London.
5. Primrose, S.B., and Twyman, R.M. 2002. Principles of Genome Analysis.3rd Edition. Blackwell Science, Oxford.

AGENDA ITEM NO. 3

REVISED LIST OF SUBJECT EXPERTS / EXTERNAL EXAMINERS

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39.	Dr. Noshin Ilyas	40.	Dr. M. Naveed Iqbal Raja

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47.	Dr. M. Farooq Hussain Munis Associate Professor, Department of Plant Sciences, Quaid-i-Azam University Islamabad. Ph: +92-51 9064-3149 Email: munis@qau.edu.pk	48.	Dr. Faheem Irshad Assistant Professor, Department of Botany, University of Okara, Okara, Pakistan. Ph: +923348705490 Email: fahim.arshad@uo.edu.pk

The agenda is presented before the honorable forum for recommendation.

Decision: The Departmental Council approved the agenda.