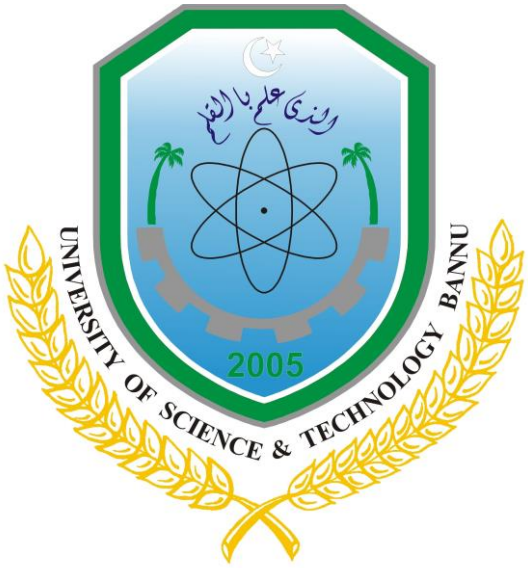
Curriculum

For Ph.D Botany 2010 and onward



Department of Botany,
University of Science & Technology, Bannu.

Scheme of Study

Academic Calendar for the Degree of Ph. D Program (HEC Criteria)

The program for the Degree of PhD will be comprised of course work of = 18 credit hrs
Research/Thesis = 10 credit hrs.

Detail of Courses for First Semester

Course #	Title	Credit Hour
Bot-701	Advanced Genetics	03
Bot-702	Advanced Microbiology	03
Bot-703	Stress Physiology	03
Bot-704	Mushroom Cultivation	03
Bot-705	Biotechnology in Plants Improvement	03
Bot-706	Environmental Microbiology	03
Bot-707	Advanced Taxonomy	03
Bot-708	Plant Nutrition & Soil Fertility	03
Bot-709	Conservation Biology	03
Bot-710	Plant Tissue Culture	03

Detail of Courses for Second Semester

Course #	Title	Credit Hour
Bot-711	Advanced Cytology	03
Bot-712	Edaphology	03
Bot-713	Biostatistics and Computation	03
Bot-714	Recombinant DNA Technology	03
Bot-715	Plant Genetics Resources Conservation:	03
Bot-716	Special Topics in the Biotechnology. (**Compulsory**)	03
Bot-717	Molecular Biology	03
Bot-718	Advanced Ecology	03

Detail of Assignment for Semester 3rd and Semester 4th and onward:

Course #	Title	Credit Hour
	Three Seminars	03
	Research Proposal or synopsis	01
	Research/Thesis/Viva	06
Total Credit Hours:		**10**

OUTLINES OF COURSES

01. Advanced Genetics: Credit Hours: (3)

- Development of gene concept,
- Various types of genes; classical versus modern concepts of gene, genetic material:
- A brief review of identification, structure, functions, organization, replication, and properties of genetic material. Gene interaction: control, basis and importance.
- Gene expression and regulation in prokaryotes and eukaryotes.
- Gene, genetic code, one gene-one polypeptide concept, protein synthesis.
- Mutation: classification, biochemical basis, factors affecting the rate of mutation. Transposable genetic elements. Genetic recombination,; mechanisms of recombination, allelism.
- Genetics of behavior
- Cytoplasmic genetic systems, their origin and Biological, implications, genetics of killer traits.
- Introduction to non-conventional gene manipulation techniques.

Practical:

- Practical will be based on theory and available facilities.

02. Advanced Microbiology: Credit Hours: (3)

Introduction

- History of Microbiology
- Application of Microbiology
- Food and Industry
- Microbes in genetic engineering and Biotechnology
- Microbes in environmental Microbiology
- Microbes in pollution Microbiology
- Microbes in Agriculture
- Microbes in Bioterrorism

Methods in Microbiology

- Isolation & culture of microorganism
- Biophysical & biochemical factor for growth
- Methods of isolation & maintenance of pure culture
- Isolation by streaking
- Isolation by inoculating in animal
- Isolation by using selective or enrichment media
- Growth curve of bacteria
- Measurement of growth
- Growth in continuous culture
- Growth in batch culture

Microbial Genetics

- Transformation:
- Competence
- Mechanism of transformation

Conjugation:

- Roll of surface protein in conjugation
- Conjugal transfer process
- Barriers to conjugation
- High frequency recombination strains.

Transduction:

- Generalized transduction
- Specialized transduction

Genetic Recombination:

- Mechanism of recombination
- Types of recombination
- Transposable elements

Viral Disease in Plants

- Structure of virus
- Transmission of plants virus
- Symptoms of plant viral diseases (external and internal)
- Metabolism of virus infected plants.

Bacterial Diseases:

- Air borne disease
- Food borne and water borne disease
- Soil borne disease

Viral disease:

- Air borne disease
- Food borne and water borne disease
- Direct contact disease

Practical:

- Method of sterilization
- Preparation of nutrient medium & inoculation
- Preparation of slides, methods of Gram staining
- Isolation of microorganism
- Culture preservation

03. Stress Physiology: Credit Hours: (3)

- Introduction to stress
- Stressful environments (Deserts & less-Dry Areas, Tundra & cold areas)
- Water stress (Drought, cold & salt)
- Mechanisms of plant response to water and related stresses
- Osmotic adjustment (Osmo regulation)
- Chilling injury
- High temperature stress
- Acidic soils
- Radiation stress
- Pollution & altitude stress

Practical:

- Field and laboratory of stress parameters; screening under simulated conditions, analysis of tolerance related traits.
- Screening of plants cultivars for drought resistance and salt tolerance within lab and field conditions.

04. Mushroom Cultivation Credit Hours: (3)

- Introduction and importance of mushroom in Pakistan
- History of Mushroom cultivation, Present status of the mushroom industry in Pakistan.
- Food value of Mushrooms (Proteins, Vitamins, Minerals, Carbohydrates and fats, Energy value of Mushrooms).
- Uses of Mushrooms
- Morphology of Mushrooms (The cap or pileus, the gills or lamellae, the veil, the stipe or stolk, volva)
- Cultivation of white Button Mushroom (Agaricus bisporus), Temperature, Moisture, Ventilation, Good Spawn, suitable growing space, compost and methods of composting, Natural and quality of the basic material, organic and inorganic supplements, Management of the compost during composing, A compost fermentation method by means of forced air circulation, Mechanical composting, spawn and methods of spawning, Advantages of grain spawn, Disadvantages of grain spawn, Methods of preparation of grain spawn, factors determining the amount of spawn needed, Method of spawning, Storage of spawn.
- Cropping and harvesting
- Diseases of Mushrooms
- Inky cap, virus diseases, insect pests, abnormalities of mushroom,

- Preservation of Mushroom
- Storage in fresh conditions, controlled atmosphere, Freeze drying, steeping preservation, Dehydration of mushrooms, canning of mushroom
- Common edible mushrooms of Pakistan

Practical

- collection of Edible species of Pakistan
- Substrate making for mushroom
- spawn production of mushroom
- Tissue culturing of mushroom
- Production of mushroom in different containers

5. Molecular Biology Credit Hours: (3)

- Nucleic Acids: DNA-circular and super helical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA
- Proteins: Basic features of protein molecules. Folding of polypeptide chain, α-helical and β-secondary structures. Protein purification and sequencing.
- Transcription: Enzymatic synthesis of RNA, transcriptional signals & Translation: The genetic code. The Wobbling, polycistronic and monocistronic RNA. Overlapping genes.
- 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.
- Plant Omics: Transcriptomics; DNA libraries, their construction, screening and application. Microarray of gene technology and its application in functional genomics.
- Proteomics; structural and functional proteomics. Methods to study proteomics Metabolomics; methods to study metabolomics; importance and application of metabolomics.
- 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:

- Extraction of RNA, DNA and proteins
- Electrophoreses: One and two dimensional
- Purification of proteins, RNA and DNA.
- Amplification using PCR.
- Northern, Western and Southern Blotting.

6. Biotechnology in Plants Improvement Credit Hours: (3)

- General introduction
- Vegetative propagation; micro propagation, callus induction, callus culture regeneration of organs
- Embryos, regeneration of plants form single cells
- Production of bacteria, virus and fungal free plants
- Genetics of cultured plant cell. Somaclonal variation and its use in plant improvement.
- Production of haploids; genetic manipulation and its use
- Somatic hybridization, selection procedures after somatic hybridization
- Production and handling of transgenic plants.

Practical

- Introduction to laboratory equipments, preparation and composition of nutrient media, sterilization of plant material, isolation, inoculation and sub culturing.
- Selection of mutants and handling of regenerated plants.
- Visit to national research institutes involved in biotechnology tissue culture research.

7. Environmental Microbiology Credit Hours: (3)

Microbiology of Air (Aero microbiology)

- Indoor microbiology
- Aeroallergens and Aeroallargy
- Phylloplane Micro flora

Water Microbiology

- water pollution
- detection and elimination of polluting bacteria from water
- water purification by various means

Soil Microbiology

- Soil microbes
- Organic matter decomposition
- Factor affecting organic matter decomposition

Microbiology of Food and Milk

- Microbiology of milk (Milk microorganisms)
- Milk products
- Spoilage of different kind of meats
- Food preservation methods

Practical

- Techniques to study microbial ecology
- Distribution of microbes in different ecological niche and their enumeration.
- Role of microorganisms in nitrification, ammonification, nitrogen fixation.
- Anti microbial activities of microbes in habitat
- Biodegradation of environmental pollutants by microorganisms.

- Bacteriology of drinking water.

8. Advanced Taxonomy Credit Hours: (3)

- Introduction
- Important & relationship with other sciences

Nomenclature

- Important rules of B. Nomenclature
- Effective & valid publication
- Typification
- Principles of propriety
- Author citation
- Rank of main taxonomic categories
- Conditions for rejecting names

Different aspects of Taxonomy

- Identification
- Nomenclature
- Classification

Plant Identification

- Expert determination
- Recognition
- Comparison
- Uses of keys & similar devices

Plant Herbarium

- History of the development of a herbarium
- Functions of a herbarium
- Different kind of herbaria of the world

Practical

- Collection of local flora
- Preparation of herbarium sheets of 50 plants
- Identification of the local flora
- Field visit to natural flora

9. Plant Nutrition and Soil Fertility Credit Hours: (3)

Perspectives and scope of mineral nutrition

- Evolution of mineral nutrients
- Essentiality of mineral nitrates
- Plant nutrients and classification
- Utilization of mineral elements

Physiology of crop nutrition

- General role of mineral elements
- Antagonistic and Catalyze effects
- Study of Plant nutrition

- (Plant Analysis mineral contents of plant material)
- Factor effecting mineral contents
- (Genetically and Potential uptake)
- Basic Soil – Plant relationship
- (Ion exchange in soils, cation exchange, effective CEC, Base saturation, nature of change and CEC, Anion exchange, Contact exchange, Root Cation exchange capacities, movements of ions from soils to Roots, Toot intercepting.
  Mass flow, diffusion, complementary ion effect, fertilizer additions, soil factors influence ion transparent ion absorption by plants)

Specific rate of the mineral elements in plants.

- Rate of macro elements
- Rate of micro elements
- Toxic elements
- Chelating Agents

Basic concepts and principles of soils

- What is soil, solid phase, liquid phase, gaseous phase
- Mineral and organic soil
- Soil as a medium for plant growth
- Soil fertility and productivity
- Liebig's law of minimum
- Evaluation of soil fertility
- (soil testing, plant analysis)
- (Deficient , insufficient, Adequate, Toxic)

Soil management for sustainable agriculture

- Fertilizers, types of fertilizer, application of fertilizer management

Practical

- Determination of soil moisture
- Determination of soil ph
- Investigation of different nutrient deficient symptoms in plants
- Calculation of recommended dose for plants (formulation of fertilizer recommendation)
- Determination of bulk density
- Soil sampling guidelines.

10. Plant Tissue and Cell Culture Credit Hours: (3)

- Introduction: Introduction to plant tissue and cell culture concept of Totiopotency, history and development of Plant Tissue and Cell Culture techniques.
- Culture media: different types of media used for tissue and cell culture, preparation of culture media.
- Callus culture: choice and selection of explants. Preparation and sterilization of explants. Callus induction: sub culturing and maintenance. Different types of calluses.
- Cell suspension culture: initiation of cell suspension culture from callus and mesophyll cells. Sub culturing and measurement of growth. Growth dynamics and continues culture.
- Plant protoplasts: definition, parameters for protoplast preparation. Fusion, maintenance and plant regeneration. Physical and biochemical methods for checking protoplast viability.
- Practical application of protoplast. Somatic hybridization and genetic manipulation.

- Germplams storage and Cryopreservation: basic concept, storage and conservation techniques. Cryopreservation and Cryoprotectants. Storages procedures. Minimal growth medium and slow growth.
- Virus and pathogen free plants: preparation of virus and pathogen free plants. Advantages and productivity of virus free plants. Preparation of virus free potato plants as model system.
- Embryogenesis, organogenesis and plant regeneration: Mode of Plant regeneration. Explant factor. Nutrition and growth regulator requirement. Indirect somatic and direct asexual embryogenesis.
- Organogenesis and plant regeneration: Potential and problem in regeneration. Micropropagation. Organ culture. Root culture.
- Practical application and current trends in plant tissue and cell culture techniques.
- Growth hormones: Role of growth hormones in plant tissue and cell culture.

Practical:

- Preparation of glassware and instruments
- Learning to use laminar flow system for tissue and cell culture purpose
- Preparation of plain agar medium and its autoclaving procedure
- In vitro seed germination
- Preparation of tissue culture medium I & II
- Callus formation I & II
- Production of embroyogenic callus
- Organogenesis I (Root formation form callus)
- Organogenesis II (Shoot formation fro callus)
- Preparation of cell suspension culture I & II.

11. Advanced Cytology: Credit Hours: (3)

- Concepts of cell, cellular organization. Chemistry of cell.
- Structure and Function Cytoplasmic Organelles.
- Structure and Function of Nucleus.
- Cell Division Mitosis and Meioses.
- Mechanism and physiology of cell Division.
- Chromosomes. Morphology, Physical Structure,
- Chemical Structure and Number.
- Radiation Cytology.

Practical:

- Microscope Use and Calibration.
- Survey of Cytological Techniques,
- Isolation of cell components,
- Outlines of Smear method for meiosis.
- Acetocammine smear method
- Outlines of squash method for mitosis.
- Feuglew techniques for tips.
- Study of Chromosomes.
- Morphology.
- Structure and numbers.

Recommended books:

- Cytology and cygenetics by C.P Swansor.
- Animal cytology and evolution by White.
- Cell in Development and Heredity by Wilson.
- Chromosome Atlas of flowering Plants by Darlington and sylie.
- Cytology by Wilson and Morrison.
- Textbook of Practical Botany by MacLean and Ivimery-Cook.

12. Edaphology: Credit Hours: (3)

- Definition and concept of Soil and Edaphology.
- Origin, Nature, and classification of Parent materials,
- Soil Geneses, Classification, Development and Characteristics, physical properties of Soil, Chemical properties of Soil, Soil Organisms their role.
- Organic matter and its importance to soil and plants.
- Macro and Micro nutrients of Soil, their availability and effects on the crops and vegetation.
- Fertilizers and fertilizers Management .Lime and its oil plant relationships, Chemical pollution of soil.
- Major soil groups of the world, Major Soil groups of Pakistan.
- Soil resources and fool Supply Soil Conservation and Management.

Practical:

- Laboratory and Field practicals would be related to and based upon the topics discussed in the theory.
- Field trips to study the soil characteristics in the nature and visits to soil laboratories would also be part of the practical.

Recommended Books.

- Brady ,NC ,1974.the Nature and properties of soil 8th Edition. Macmillan Publisher.
- Foth ,E.D .1978 .Fundamental of Soil Science .6th Edition. john willy and sons. New yark.

- Thornbury ,W,D 1969.Principlas of Geomorphology ,2nd Ed.John Willey and Sons,NewYork.
- Black,C.A 1960 soil plant Relationships .john willey and sons Inc.newyork.
- USDA.1957.Soil, The Year book of agriculture ,1957 .United States Department of Agriculture ,Washington.DC
- Jackson.R.M and F.Raw 1981.Life in the soil.studies in biology No:2.Edward Arnold.
- Morgon,R.P.C and D.A Dividson 1981.soil Erosion and conservation. Longman Scientific and technical Group Limited. Hong Kong.
- Ayres Q.C 1936.Soil Erosion and its Controle .McGraw Hill BooK Inc.
- Joffe.J.S.1949.pedogology . pedogology Publication ,New Yark somerset Press.
- WalkWork ,j.a.1970.Ecology of Soil Animals .Mc Graw Hill book Inc.
- Soil Survey Report for Various districts of Pakistan by Soil Survey of Pakistan, Govt of Pakistan,Lahore.
- Hussain F.1989,Field and laboratory Manual of Plants Ecology .university Grants Commission ,Monograph series ,Islamabad.
- Jackson,A.B.1968,Soil Chemical Analysis Constable and CO.Ltd .London.
- Capman,H.D and P.F pratt 1961.methods of Analysis for soils ,Plant and Water,University of California ,Division of Agriculture Sciences.
- USDA.1954.Diagnosis and improvement of Saline and Alkaline soils,united States Department of Agriculture Handbooks 60.Washington DC.
- Miscellaneous recent publications dealing with soil and soil-plant relationship s in the various national and International Journal.

13. <u>Biostatistics and Computation</u>: Credit Hours: (3)

- Introduction to Biostatistics,
- Data Analysis: Collection of Primary,Secondary data,
- Editing of Data,
- Diagramatic representation of Data.,
- Concept of probability.,
- Measur of central Tendencies and Despersion:

- Arithmetic Mean ,Standard error,of the mean ,median,mode
- rang variance and Standard Deviation.
- Binomal,Poison and Normal Distribution properties and application.
- Test of Significance's-test ,X-test.F-test,L.S.D test, Duncan Multipale rang Test.
- Regression.
- Experimental Design.

Practical:

- Computation Skill:MS Office (Word ,Excel, power point ,Publisher)
- Coral Draw,origin,Graphics,Vidio Coferncing.
- Manipulation of Data.
- Application of defferent statistical test
- Experimental Design(CRD,RCBD,Split plot arrangement,factorial,etc)

Books Recommended.

.Robin H Mc celery.(2007) Introduction to Statistics for Bioliogy,3rd ed.CRC Press.
.Ralf Blossey (2006)Computational Biology.CRC Press.
.Semuels ,M.L (1991) Statistics for the Life sciences .Dellen Publishing.
Yule,G.U and Kendall ,M.G.(1991) Introduction to the theory of Statistics Charles Griffin and Co.
.Santon,A.G (2001)Primer Of Biosttistics .Mc graw Hill.
.Streiner ,n Norman ,G.R (2000) Biostatistics :The Bare essentials B,C Decker,Inc.
.Rosner ,b.(2000)Fundamental of biostatistics .Cole Pub.co.
.Flower ,j ,cohen,L and jarris,P (1998).practical Statistics for the field biology .John wiley and Son
Zar.(1998).Biostatistical Analysis .
.Bailey,N.T.J,(1981).Statistical Method in Biology,English University Press.
.Mead,R Currow,R.N and Hasted ,A.M (1993).Statistical Methods Agriculture and experimental Biology ,2nd edition .Chapman and Hall.
.Sanjeev B .Sarmukaddam, Abhaya Indrayan(2001).Medical Biostatistics.

14. Recombinant DNA Technology Credit Hours: (3)

- Introduction to recombinant DNA technology ,
- DNA replication,
- Structure of RNA and proteins ,
- Restriction endoncleases ,DNA ligation ,

- Vector systems including T-A cloning vectors. Vectors based on Bacteriophages Lamba and M13,genomic Libraries and functional genomics
- Advantages and Steps in Making cDNA ,Methods of CDNA library development /screening ,
- Introduction to identification of recombinant clones ,DNA sequence determination ,
- DNA sequence analysis,
- Regulation of gene expression in prokaryotes and eukrayotes, E.coli expression system, Transient expression ,site directed mutagenesis.
- Practical. Vector construction,
- Bacterial transformation and selection of recombinants on antibiotics and color marker system.

Recommended Books.

1.Brown,T.A.2006.Gene Cloning and DNA analysis : An Introduction 5th Edition, Black well publisher,UK.
2.Sambrook and Russel ,2001.Molecular Cloning,3rd edition .Cold spring Harbor, USA.
3.Snustad ,D.P and Simmons M.J.2000 Principle of Genitics .John Wiley and Sons,Inc.

15. Plant Genetics Resources Conservation: Credit Hours: (3)

- Introduction of genetic resources,
- Center of Diversity, Evolution of Crop Plants ,
- Cyro-Preservation ,
- Use of geneticsresource in corp improvement ,
- Germplasm characterization ,
- *In-Situ* Conversation,Gene-Bank management,
- population genetics,Taxonomy and biological species concept in cultivated plants,
- significance of polyploidy in the Origin of Species and Species group,
- Climate and Corp Distribution.

Practical:

- Morphological and Biochemical evaluation of Corp germplasm, assessment of diversity, Methods of conversation.

Recommended Books:

- Jarvis, D.I C.Padoch, and H.D Cooper (2007).Managing Biodiversity in Agricultural Ecosystem.Columbia University Press.pp 492.
- brough, Stephen B.(2000)genes in the Fields .Lewis Publisher.pp288.

16. Special Topics in the Biotechnology. Credit Hours: (3)

The Course includes oral presentations and intensive small –group discussion of selected topics in the area of specialization of each faculty member .course content emphasis recent advances in the special topic area and varies accordingly.

- Plant Stress Genomics.
- Photosynthesis, electron Transfer and O2 Evaluation.
- Plant gene Expression.
- Molecular Farming.

17. Conservation Biology CH (3)

- What is Conservation Biology, origins of Conservation Biology, Current status of conservation Biology, Statement of ethical principles
- What is Biological Diversity, Importance of biodiversity :Species diversity, Ecological diversity, Genetic diversity.

- Where Biological diversity is found, how many species exist worldwide?
- Threats to Biological diversity, Loss of Biological diversity, past rates of extinction, Human caused extinctions, Types of extinctions,Habitate destruction, Fragmentation and Degradation, Exotic Species introductions, Disease and Overexploitation.

- Causes and depletion of biodiversity: Habitat loss, Habitat fragmentation, Over-exploitation, Climatic changes, Invasive species, .Seawater intrusion.

- The Values of Diversity, Direct economic values of diversity, indirect economic values. The value of species, How species become endangered?
- Conservation of Biodiversity, *In situ* and *ex situ* conservation of plants, Implementation of laws (protection and conservation of various taxa. Sustainable use of biodiversity (plant wealth), Protected areas of Pakistan, Criteria for determining different categories of protected areas. Role of herbaria and botanical gardens in conservation.Inventory and monitoring of biodiversity, Importance of red data book, Management plan for protected area, IUCN categories for threatened species, Criteria for recognizing different categories of threatened species , Gene bank management and operation, Public awareness strategies, Biodiversity action plan for Pakistan.

Practical

- Causes of local species extinction.
- Field excursion.
- Data collection.
- Preparation of an inventory of the flora of a given region.
- To carry on base line study of any designated category.

Book Recommended

- Bush, M.B. 1997. Ecology of a Changing Planet. Prentice Hall.
- Cunnighum, A.B. 2001. Applied ethnobotany: People, wild plant use and conservation. Earthspan Publications.

- Cotton, C.M. (1996). Ethnobotany Principle Application. John Wiley & Sons Chichester, UK.
- De Klemm, C. (1990) Wild plant conservation, IUCN, Gland.
- Dyke, F.V. (2003). Conservation Biology. Mc Graw Hill, New York.
- Grombridge, B. & Jenkins, M. D. (2002). World Atlas of Biodiversity: Earths Living Resources in the 21st. Century, University. California Press, Berkeley.
- Heywood, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press and UNEP.
- Krishmamurthy, K.V. 2003. A Textbook of biodiversity Science publishers Inc. Enfield, NH, USA.
- Levine, D.A. 2000. The origin, expansion and demise of plant species. Oxford University Press.
- Ministry of Environment, IUCN, WWF. 1998. Biodiversity Action Plan for Pakistan.
- Primack, R.B. 1998. Essentials of conservation Biology. Sinaur Association Pub. Mass. USA.

18. Advance Ecology **Credit Hours: (3)**

- 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.
- Oxygen deficiency: Energy metabolism of plants under oxygen deficiency, Morpho-anatomical changes during oxygen deficiency, Post-anoxic stress
- Wind as an ecological factor.
- Fire as an ecological factor.
- Community Ecology **:** Historical development of community ecology, Community concepts and attributes, Methods of sampling of plant communities, Ecological succession, Community soil-relationship, Local Vegetation, Vegetation of Pakistan, Major formation types of the world
- Ecosystem Ecology : Ecological concepts of ecosystem ,Boundaries of ecosystem? Compartmentalization and system concepts, Energy flow in ecosystem, Biogeochemical cycles: water carbon and nitrogen Case studies: any example

Practical:

- Determination of seed bank in various populations.
- Seed dispersal pattern of local populations. Demography and life history of local annual population. Study of community attributes.
- Sampling of vegetation including Quadrat, plotless, transect and Braun-Blanqut. Correlate soil properties with vegetation type.
- Field trip to study different communities located in different ecological regions of Pakistan. Slide show of the vegetation of Pakistan.
- Slide show of the major formations of the world.
- Soil physical and chemical properties

Recommended Books:

1. Schultz, J. C. 2005. Plant Ecology, Springer-Verlag
2. Bazzaz, F.A. 2004. Plants in Changing Environments: Linking Physiological, Population, and Community Ecology, Cambridge University Press
3. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
4. Lambers, H. et al. 2002. Plant Physiological Ecology, Springer-Verlag
5. Larcher, W. 2003., Physiological Plant Ecology: Ecophysiology and Stress Physiology of Function Groups - Springer-Verlag
6. Nobel, P.S 1999, Physico-chemical and Environmental Plant Physiology,.Academic Press.
7. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Phyiological Ecology.
8. Smith, R. L. 2004. Ecology and field Biology. Addision Wesley Longman, Inc., New York.
9. Barbour, M.G., Burke, J.H and Pitts, W.D. 2004 Terrestrial Plant Ecology, The Benjamin, Cumming Publishing C. Palo Alto, California, USA.
10. Smith R.L. 1998 Elements of Ecology. Harper & Row Publishing.
11. Townsend. C.R. Begon. M and J.L Harper. 2002 Essentials of ecology. Blackwell Publishing.
12. Gurevitch. J. Scheiner, S.M. and G.A Fox. 2006 The Ecology of Plants\. Sinaur Asssoicate Inc.
13. Hussain. F. 1989 Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education, Islamabad.
14. Hussain. S.S. 1989 Pakistan Manual of Plant Ecology. National Book Foundation Islamabad.
15. More. P.D. and Chapman S.B. 1986 Methods in Plant Ecology, Blackwell Scientific Publication Oxford.
1. Schultz J.C. 2005. Plant Ecology, Springer-Verlag .
2. Townsend C.R. Begon. M and J.L. Harper 2002. Essentials of Ecology, Blackwell Publishing,
3. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
4. Gurevitch, et al., 2002.The Ecology of Plants, Sinauer Associates, Inc.
5. Barbour M. G. et al., 1999, Terrestrial Plant Ecology, The Benjamin-Cumming Publishing Co.
6. Smith, R. L. 1998. Elements of Ecology by Harper & Row Publishers,
7. Moore P.D. and Chapman S. B. 1986. Methods in Plant Ecology, Blackwell Scientific Publication, Oxford.
8. Hussain, S. Pakistan Manual of Plant Ecology,
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 Phyiological Ecology.
11. Larcher. W. 2003 Physiological Plant Ecology. Ecophysiology and Stress Physiology of Function Groups. Springer- Verlag.