Item NO.3: Revision of course codes in scheme of studies of BS in Botany for session 2018 and onward.

Scheme of studies of BS in Botany session 2018 and Onward

1st Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-1101	Diversity of Plants	3	1	4
ZOO-1123	Principal of Animal Life-I	3	0	3
MAT-1115	Math/STAT-1 (Statistical Packages)	3	0	3
CHE-1104	Inorganic Chemistry	3	0	3
ENG-1117	English-I (Functional English)	3	0	3
PS-1107	Pakistan Studies	2	0	2
		17	**1**	**18**

Comment [i-[1]]: 01 code is for the parent department or for the other departments.

2nd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-1201	Plant Systematics, Anatomy and Development	3	1	4
ZOO-1223	Principalof Animal Life –II	3	0	3
CHE-1204	Organic Chemistry	3	0	3
ENG-1207	English-II (Communication Skills)	3	0	3
ARA-1201	Arabic	3	0	3
ISL-1212	Islamic Studies	2	0	2
		17	**1**	**18**

Comment [i-[2]]: Digits are same as in arabic

Comment [i-[3]]: Same digits

3rd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-2301	Cell Biology, Genetics & Evolution	3	1	4
ZOO-2323	Animal Diversity-I	3	1	4
CHE-2304	Physical Chemistry	3	0	3
ENG-2307	English-III (Technical Report Writing & Presentation Skills)	3	0	3
COM-2305	Introduction to Computer	3	0	3
		15	**2**	**17**

4th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-2401	Plant Physiology and Ecology	3	1	4
BOT-2402	Biodiversity and Conservation	3	1	4
ZOO-2423	Animal Diversity-II	3	0	3
CHE-2404	Analytical Chemistry	3	0	3
STA-2420	Biostatistics	3	0	3
		15	**2**	**17**

5th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs

BOT-3501	Bacteriology & Virology	2	1	3
BOT-3502	Mycology & Plant Pathology	2	1	3
BOT-3503	Phycology & Bryology	2	1	3
BOT-3504	Diversity of ar Plants	2	1	3
BOT-3505	Plant Systematics	2	1	3
		10	**5**	**15**

6th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-3601	Plant Anatomy	2	1	3
BOT-3602	Genetics-I	2	1	3
BOT-3603	Plant Biochemistry-I	2	1	3
BOT-3604	Plant Ecology-I	2	1	3
BOT-3605	Plant Physiology-I	2	1	3
		10	**5**	**15**

7th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-4701	Molecular Biology	2	1	3
BOT-4702	Plant Biochemistry- II	2	1	3
BOT-4703	Plant Ecology-II	2	1	3
BOT-	Research Thesis/ Elective-I	-	-	3
BOT-	Elective-II	2	1	3
		8	**4**	**15**

8th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-4801	Plant physiology –II	2	1	3
BOT-4802	Genetics-II	2	1	3
BOT-4803	Environmental Biology	2	1	3
BOT-	Research Thesis/ Elective-III	-	-	3
BOT- ----	Elective-IV	2	1	3
	Total	**8**	**4**	**15**

Item No.3: List of Optional Papers for BS Botany (4 Years):

Course Code	**Course Title**	Lec. Hrs	Lab. Hrs	Credit Hrs	Approved/Not Approved
BOT-4704	Ethnobotany	2	1	3	Approved
BOT-4705	Phytoremediation	2	1	3	Approved
BOT-4706	Plant Stress Physiology	2	1	3	Approved
BOT-4707	Conservation and Management of Plant Resources	2	1	3	Approved
BOT-4708	Plant Nutrition	2	1	3	Approved
BOT-4709	Phytosociology	2	1	3	Approved
BOT-4710	Economic Botany	2	1	3	Approved
BOT-4711	Flora of Azad Jammu and Kashmir	2	1	3	Approved
BOT-4712	Research Thesis	2	1	3	Approved
BOT-4713	Internship	2	1	3	Approved
BOT-4804	Research Techniques	2	1	3	Approved
BOT-4805	Plant Metabolism	2	1	3	Approved
BOT-4806	Plant Biotechnology	2	1	3	Approved
BOT-4807	Applied Mycology	2	1	3	Approved

BOT-4808	Plant Microbe Interaction	2	1	3	Approved
BOT-4809	Molecular Genetics	2	1	3	Approved
BOT-4810	Phytochemistry	2	1	3	Approved
BOT -4811	Palynology	2	1	3	Approved
BOT-4812	Applied Microbiology	2	1	3	Approved

BOT-1101 **DIVERSITY OF PLANTS** **4(3+1)**

Objectives of course: To introduce the students to the diversity of plants and their structures and significance.

Theory: Comparative study of life form, structure, reproduction and economic significance of: **a) Viruses** (RNA and DNA types) with special reference to TMV; **b) Bacteria** and Cyanobacteria (Anabaena) with specific reference to biofertilizers, pathogenicity and industrial importance; **c) Algae** (Spirogyra, Pinnularia, Polysiphonia) **d) Fungi** (Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications. **e) Lichens** (Physcia), **f) Bryophytes** (Riccia , Anthoceros, Funaria), **g) Pteridophytes;** Lycopsida (Selaginella), **h) Gymnosperms** (Pinus), **i) Angiosperms** ; Monocot (Wheat), Dicot (*Solanum nigrum*)

Lab Outline:

- Culturing, maintenance, preservation and staining of microorganisms.
- Study of morphology and reproductive structures of the types mentioned in theory.
- Identification of various types mentioned from prepared slides and fresh collections.

Recommended Books:

- Prescott, L. M., Harley, J. P. and Klein, A. D. 2004. Microbiology, 3rd Ed. WM. C. Brown Publishers.

- Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. Introductory Mycology. 4th Ed. John Wiley and Sons Publishers.
- Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
- Ingrouille , M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
- Mauseth**,** J**.** D**.** 2003**.** Botany**:** An Introduction to Plant Biology 3rd Ed., Jones and Bartlett Pub. UK
- Marti. J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP

BOT- 1201 PLANT SYSTEMATICS, ANATOMY AND DEVELOPMENT 3(2+1)

Objectives of course: This coarse will equip the students

To understand various systems of classification, identification and nomenclature of Angiosperms

Plant tissue types and structures and functions of tissues and organs

Development of plant body (embryology)

Course outcomes: Knowledge about systematics and its utilization in identification of plants according to rules of ICBN and understanding of plant collection and preservation protocols

knowledge of structure of plant body

Knowledge of the structure of plants from cells and tissues to organs

Skills with methods which deals with plant structures

Theory: Plant Systematic: Introduction to plant systematic its aims, objective and importance. Classification: Importance brief history, introduction various systems of classification, Engler and Prantels System, Bentham and Hooker's System. Brief introduction to nomenclature; Importance of Latin names, systems with an introduction to international code of Botanical Nomenclature (ICBN). Morphology and Phytography – a detailed account of various morphological characters of root, Stem, leaf, inflorescence, flower, placentation and fruit types. Diagnostics characters, economic importance and distribution pattern of the following families: Brassicaceae (Cruciferae), Leguminosae, Rosaceae, Cucurbitaceae, Solanaceae, Lamiaceae (Labiatae), Asteraceae and Poaceae.

Anatomy and Development: Cell wall; structure and chemical composition**.** Tissue and Tissue System: Concept; structure and function of various tissues. e.g, Parenchyma, Chlorenchyma, Collenchyma, Sclerenchyma, Xylem and phloem**.** Primary Structure of root, stem and leaf. Definition and various type of meristems. Primary and secondary growth of dicot stem.Early development of plant body (embryology)*Capsela bursa-pastoris or Arabidopsis.*

Lab Outline:

- Study of simple and compound tissue in macerated and sectional material.
- Study of cross section of bifacial leaf.
- To Study the prepared slides of secondary growth in dicot stem.
- Identification of families given in syllabus with the help of keys.
- Technical description of common flowering plants belonging to families mentioned in theory syllabus.
- Field trips shall be undertaken to study and collect local plants. Students shall submit 40 fully identified herbarium specimens.
- Study of cross section of monocot and dicot stem.

Books Recommended

- Bold, H.C., (1997). Morphology of Plants. Harper & Row, N.Y.
- Dickison, W.C. (2000). Integrative Plant Anatomy, Academic Press, UK.
- Fahn, A. (1990) Plant Anatomy. Pergamon Press, UK.
- Malik, T.A. (1996). *Principles of Botany.* The Carvan Press Darbar Market, Lahore.
- Mauseth, J.D. (1998). An Introduction to Plant Biology: Multimedia Enhanced. Jones and BartlettPub. UK
- Moore, R.C., W.D. Clarke and Vodopich, D.S. (1998) Botany. McGraw Hill Company, USA.
- Pullaiah, T (2007). *Taxonomy of Angiosperms* 3rd Ed. Regency Publication, New Delhi.
- Raven, P.H., Evert, R.E. and Eichhom, S.E. (1999). Biology. Saunders College Publishing, USA.
- Sharma, O.P. (1993). *Plant Taxonomy*. Tata McGraw-Hill 7 Patel Nagar, New Delhi.
- Stuessy, T.F. (1990). Plant Taxonomy. Columbia University Press.

BOT-2301 **CELL BIOLOGY, GENETICS AND EVOLUTION** **4 (3+1)**

Objectives of course: To understand:

Structure and function of cell.

Nature of genetic material and hereditary process

Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes. Associate the processes that unfold in individual cell compartments as preconditions for the functioning of the cell as a whole.

Familiarization with evolutionary processes

Theory: a) Cell Biology; Structure and Function of Bio-molecules, Carbohydrates, Lipids, Proteins, Nucleic Acids**. Cell:** Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell. **Brief description of following cell organelles** Cell wall, Cell membrane, Nucleus, Endoplasmic reticulu, Plastids, Mitochondria, RiDepertmental councilomes, Dictyosomes **,** Vacuoles. **Reproduction** in somatic and embryogenic cell, mitosis, meiosis and cell cycle

b) Genetics ; Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance. **c) Evolution: T**he nature of evolutionary forces, adaptive radiations, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Lab Outline:

- Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs.
- Measurement of cell size.
- Study of mitosis and meiosis by smear/squash method and from prepared slides.
- Study of chromosome morphology and variation in chromosome number.
- Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.

Genetics

- Genetical problems related to transmission and distribution of genetic material.

- Identification of chromosomes in plant material. Carmine/orcein staining.
- Determination of blood groups

Recommended Books:

- Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
- Dyonsager, V. R. (1986). Cytology and Genetics. Tata and McGraw-Hill
- Publication Co. Ltd,, New Delhi.
- Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
- Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini
- Educational Books, New Delhi.
- Strickberger, M. V. (1988), Genetics, MacMillan Press Ltd., London.

Journals/Periodicals:

Theoretical & Applied Genetics, the Cell, Heredity.

BOT-2401 **PLANT PHYSIOLOGY AND ECOLOGY** **4 (3+1)**

Course objectives The main theme of the course is to provide basic knowledge of different metabolic processes occurring in plants, as well as the relationships of plants with their environment. Course also aims to enable the students to assess the effects of various environmental factors and stresses on plant growth and development.

Theory: Plant Physiology; Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation. **Mineral nutrition:** Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients. **Photosythesis:** Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C3 and C4 plants. Factors affecting this process, Products of photosynthesis. **Respiration:** Definition and respiratory substrates. chanism-Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and naerobic respiration, Respiratory quotients.

(**b) Ecology** Introduction, aims and applications of ecology. **Soil:** Physical and Chemical properties of soil (soil formation, texture. pH, EC, organism and organic matter etc) and their relationships to plants. **Light and Temperature.** Quality of light, diurnal and seasonal variations. Ecophysiological responses. **Water:** Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants. **Wind:** Wind as an ecological factor and its importance. **Population Ecology:** Introduction. A brief description of seed dispersal and seed bank. **Community Ecology** i. Ecological characteristics of plant community ii. Methods of sampling vegetation (Quadrat and line intercept) iii. Major vegetation types of the local area. **Ecosystem Ecology** i. Definition, types and components of ecosystem, ii. Food chain and Food web. **Applied Ecology:** Causes, effects and control of water logging and salinity with respect to Pakistan

Lab Outline:

a) Plant Physiology

- Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
- Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
- Measurement of leaf water potential by the dye method.
- Determination of the temperature at which beet root cells lose their permeability.
- Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a porometer/cobalt chloride paper method.
- Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram.
- Study of absorption spectra using spectrophotometer.
- Estimation of oxygen utilized by a respiring plant by Winkler's method.

b) Ecology

- Determination of physical and chemical characteristics of soil.
- Measurement of vegetation by Quadrat and line intercept methods.
- Measurements of wind velocity.
- Effect of light and temperature on seed germination.

Recommended Books:

- Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th. Ed. Sinauers Publ. Co. Inc. Calif.
- Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- Hopkins, W. B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York
- Schultz, J. C. 2005. Plant Ecology. Springer-Verlag, Berlin.
- Ricklefs, R. E. 2000. Ecology. W. H. Freeman and Co., UK.
- Larcher, W. 2003 Physiological Plant Ecology: Ecophysicology and Stress Physiology of Functions Groups – Springer Verlag.

BOT-2402 **BIODIVERSITY AND CONSERVATION** **4 (3+1)**

Objective of course: To familiarize the students with the diversity of nature.
Importance of biodiversity for survival and proper functioning of ecosystem.. To understand the value of biodiversity, methods of conservation and current efforts to conserve biodiversity on global, national and local scales.

Learning Outcomes: Students will be able
To describe the global biodiversity crisis
To outline the main reasons for decline and threats to biodiversity worldwide
To argue the case for and against conserving biodiversity

Theory: **Biodiversity:** Definition, types and threats. **Threats to Biodiversity;** deforestation, over grazing, erosion, desertification, ecosystem degradation, bio invasion, pollution and climate change. **Biodiversity of Pakistan**. **Measuring biodiversity:** Alpha, Beta and Gamma diversity. **Ecological services**, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of Bio resources). **Sustainable and unsustainable** use of biological resources. **Biodiversity Hot spots** of Pakistan and the world. **International treaties/agreements** regarding Biodiversity and conservation; **CBD, CITES, Ramsar**. **Conservation strategies;** *in situ* and *ex situ*, *in vitro* conservation. Conservation *vs* preservation. **IUCN categorized protected areas** in Pakistan; red listing. Use of herbarium and Botanical

Garden in biodiversity and conservation. Concept of pastures and wild life management. Global Biodiversity Information Facility (GBIF)

Lab outline:

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

Recommended Books:

- Maiti, Prabodh K. and Maiti, Paulam. 2017, second edition. Biodiversity: perception, peril and preservation. PHI learning private limited, Delhi.
- Abbasi, A. M., Khan, M. A., M. Ahmad and M. Zafar. 2012. Medicinal plant biodiversity of Lesser Himalaya Pakistan. Springer Publishers USA.
- Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.
- IUCN. 1994. *IUCN Red List Categories.* As Approved by the IUCN Council. IUCN.
- Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.

BOT-3501 **BACTERIOLOGY AND VIROLOGY** **3(2+1)**

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

Theory: a) Viruses;General features of viruses, viral architecture, classification, dissemination and replication of single and double – stranded DNA/RNA viruses. Plant viral taxonomy.Virus biology and virus transmission. Molecular biology of plant virus transmission.Symptomatology of virus-infected plants: (External and Internal symptoms). Metabolism of virus-infected plants. Resistance to viral infection.Methods in molecular virology.

b) Bacteria;History, characteristics and classification.Evolutionary tendencies in Monera (Bacteria, actinomycetes and cyanobacteria). Morphology, genetic recombination, locomotion and reproduction in bacteria. Bacterial metabolism (respiration, fermentation, photosynthesis and nitrogen fixation). Importance of bacteria with special reference to application in various modern sciences specially agriculture, biotechnology and genetic engineering.Symptoms and control of major bacterial diseases in Pakistan.

c) Plant microbe interaction

Lab outline:

a) Viruses

Observation of symptoms of some viral infected plant specimens.

b) Bacteria, Actinomycetes and Cyanobacteria

1. Methods of sterilization of glassware and media etc.

2. Preparation of nutrient medium and inoculation.

Preparation of slides for the study of various forms, capsule/slime layer, spore, flagella and gram-staning.

4. Growth of bacteria, subculturing and identification of bacteria on morphological and biochemical basis (using available techniques).

5. Microscopic study of representative genera of Actinomycetes and Cyanobacteria from fresh collections and prepared slides.

Recommended Books:

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

BOT-3502 **MYCOLOGY AND PLANT PATHOLOGY 3 (2+1)**

Objective of course: To introduce the students mycology and plant diseses caused by fungal pathogen.

To study the development of the diseases and various types of reistance aginst it.

Theory: **a) Mycology: Introduction:** General characters of fungi**,** Thallus, cell structure and ultrastructure of fungi. **Reproduction:** Asexual and sexual reproduction and reproduction structures, life cycle, haploid, heterokaryotic and diploid states. **Fungal Systematics:** Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of **Chytridiomycota**, **Zygomycota** (Mucrales) **Oomycota** (Peronosporales), **Ascomycota** (Erysiphales), **Basidiomycota** (Agaricales, Polyporales, Ustilaginales) and **Deuteromycetes**. **Symbiotic relationships** of fungi with other organisms (lichens and mycorrhiza) and their significance.

b) Pathology: Introduction and classification of plant diseases, Development of plant diseases. Epidemiology and disease forecast. **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.

Systemic resistance: Induced systematic resistance (ISR), Acquired Systematic resistance (ASR).

Lab Outline:

- Macroscopic and microscopic study of common, locally available types representing various taxonomic groups (Algae, Fungi and Algae).
- Study of available genera of fungi, algae and bryophytes in natural habitats.
- Isolation of aquatic fungi
- Basic mycological techniques: Effect of ph, temperature, light, darkness and nutrients on the growth and sporulation of fungi.
- Isolation of soil fungi by different techniques (dilution plates, direct plate and wet sieving and decanting techniques).
- Collection and identification of bryophytes and their preservation.

Recommended books:

- Alexopoulos, G.J., Mims C.W and M. Blackwell. (1996). Introductory mycology (4th ed), Jhon Wiley & Sons, New York.
- Mehrotra, R.S. Aneja L.R. (1990). An introduction to mycology first edition. Wiley eastern limited, New dehli.
- Hafiz, A. (1984). Plant diseases, PARC, Islamabad, Pakistan.

- Ahmed S. (1987 & 1997). Ascomycetes of Pakistan (Vol. I & II), Biological society of Pakistan Lahore.
- Ahmed S. (1992). Gasteromycetes of West Pakistan, publication department of botany, Punjab university Lahore
- Khan, A. G. and Usman, R., 2005. Laboratory Manual in Mycology and Plant Pathology. Botany Department Arid Agriculture University, Rawalpindi.
- Trigiano, R. N., Windham, M. T. and Windham, A. S., 2004. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

BOT-3503 PHYCOLOGY AND BRYOLOGY 3(2+1)

Objective of course: To introduce the students with classification, morphology and economic importance of algae and bryophytes.

Theory: **(a) Phycology** Introduction, general account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

(b) Bryology:

Introduction and general account of bryophytes, classification, theories of origin and evolution. Brief study of the classes: Hepaticopsida, Anthoceropsida and Bryopsida. 29

Lab Outline:

- Macroscopic and microscopic study of common, locally available types representing various taxonomic groups of Algae.
- Section cutting of thalloid algae
- Preparation of temporary slides
- Use of camera lucida/micrographs
- Collection and identification of bryophytes and their preservation.
- Visits to study bryophytes in their natural habitats.

Recommended books:

- Bold H.C. and Wynne M.J. (1985). Introduction to algae. Structures and reproduction. Printice hall Inc. Englewood cliffs.

- Pandey S.N (1993). A text book of botany VOL-II. Bryophyte, pteridophyta and gymnosperms. Pak book corporation, Karachi.
- Pandey, B.P. (1993). A textbook of botany. Vol-I. S Chand & Co., New Delhi.
- Schofield, W.B. (1985). Introduction to Bryology. Macmillan Publishing Co. London.
- Hussain, F. and I. Ilahi. (2003). A text book of Botany. Department of Botany, University of Peshawar.
- Barsanti, L. and P. G. Gualtieri. 2006. Algae, anatomy, biochemistry, biotechnology. Taylor and Francis, New York.

BOT-3504 DIVERSITY OF VASCULAR PLANTS 3 (2+1)

Objective of course: To enable the students to understand and appreciate the diversity of vascular plants and evolution of plants architecture.

Theory:

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*), Sphenopsida (*Equisetum*), Pteropsida (*Ophioglossum, Dryopteris* and *Azolla/Marsilea*).

b) Origin and Evolution of seed habit., c) 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.

d) Angiosperms: Origin, general characteristics, Importance, and life cycle of angiosperms.

e)Palynology: 1. An introduction to Neopalynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey and oil and gas exploration.

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

Lab Outline:

- To study the morphological and reproductive features of available genera.

- Study trips to different parts of Pakistan for the collection and identification of important pteridophytes, gymnosperms and angiosperms.
- Study of pollen morphology

Recommended Books:

- Beck, C. B. 1992. Origin and Evolution of Gymnosperms. Vol-1&II, Columbia University Press, New York,
- Foster, A. S. and Gifford, E. M. Jr. 1998. Comparative Morphology of Vascular Plants. W. H. Freeman and Co.
- Jones, D. 1983. Cycadales of the World, Washington, DC.
- Mauseth, J. D. 1998. An Introduction to Plant Biology, Multimedia Enhanced, Jones and Bartlett Pub. UK.
- Moore, R. C., W.d. Clarke and Vodopich, D. S. 1998. Botany McGraw-Hill Company, USA
- Raven, P. H. Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants, W. H. Freeman and Company Worth Publishers.
- Ray, P.M. Steeves, T. A. and Fultz, T. A. 1998. Botany Saunders College Publishing, USA.
- Taylor, T. N. and Taylor, E. D. 2000. The Biology and Evolution of Fossil Plants, Prentice Hall.
- 9. Stewart, W. N. and Rothwell, G. W. 1993. Paleobotany and the Evolution of Plants, University Press, Cambridge.
- Faegri, K., P. E. Kaland & K. Krzywinski 1989. Text Book of Pollen Analysis, John Wiley & Sons. N. Y.
- Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Pterodophyta. S. Chand & Co. New Delhi.
- B. P. Panday. 2006. College Botany. Vol 1 & II. S. 7th Edition. Chand & Co. New Delhi.
- Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Gymnosperms. S. Chand & Co.

BOT-3505 PLANT SYSTEMATICS 3(2+1)

Course objective: Study of basic principles of plant systematics that includes identification, nomenclature, evolution, and classification within the plant kingdom and a systematic survey of plant families, with emphasis on local representatives of Pakistan and Azad Jammu & Kashmir.

Course Outcomes: The student will demonstrate understanding of the basic principles of systematics, including identification, nomenclature, classification, and the inference of evolutionary patterns from data**.**

The student will demonstrate understanding of evolutionary processes and patterns in the major plant groups**.**

The student will demonstrate the ability to handle and analyze plant materials in the laboratory and herbarium and in the field.

The student will demonstrate comprehension of basic concepts and the ability to use scientific terminology accurately through effective oral and written communication and the use of dichotomous keys in a regional floristic manual..

Theory: Introduction, aims and objectives, major goals and evolution of angiosperms. Concept of species and speciation. **Types of speciation**, reproductive isolation. **Variation**: types, continuous and discontinuous variation. **Taxonomic evidences:** importance and types of taxonomic evidences such as anatomical, cytological, chemical, molecular, palynological, geographical and embryological. **Classification:** Importance, brief history, description of classification system of Linnaeus, Bentham and Hooker, Engler and Prantl, Takhtajan and Dahlgren. **Nomenclature;** Brief introduction, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN). Vienna code. Origin of Angiosperms. General characteristics, distribution and economic importance of following families of angiosperms: **Apocynaceae**, **Arecaceae** (Palmae), **Asclepiadaceae,**

Asteraceae (Compositae), C**henopodiaceae**, **Euphorbiaceae, Liliaceae**, **Malvaceae**, **Moraceae**, **Ranunculaceae**, **Rutaceae**, **Umbelliferae** (Apiaceae).

Lab outlines:

- Technical description of plants of the local flora and their identification upto species level with the help of the Flora of Pakistan.
- Preparation of permanent slide of Pollen grain by acetolysis method and study of different pollen characters.
- Submission of properly mounted and fully identified 50 herbarium specimens at the time of examination.
- Field trips shall be undertaken to study and plants from different ecological zones of Pakistan.

Recommended Books:

- Ali, S.I. and Nasir, Y.J. (1970-1992). *Flora of Pakistan*. Nos. 71, 131, 145, 126, 172, 36, 54, 100, 171, 132, 20, 75, 152. Department of Botany, University of Karachi.
- Ali, S.I. and Qaiser, M. (1992-2010). *Flora of Pakistan.* Nos. 204, 207, 201, 215. Department of Botany, University of Karachi.
- Davis, P.H. and Heywood, V.H. (1963). *Principles of Angiosprms Taxonomy.* Oliver and Boyd, London.
- Lawrence G.H. (1951).*Taxonomy of Vascular Plants.* Prentice Hall College Div.
- Levin, D.A. (2000). *The Origin, Expansion and Demise of Plant Species*. Oxford University Press.
- Malik, T.A. (1996). *Principles of Botany.* The Carvan Press Darbar Market, Lahore.
- Pullaiah, T (2007). *Taxonomy of Angiosperms* 3rd Ed. Regency Publication, New Delhi.
- Sharma, O.P. (1993). *Plant Taxonomy*. Tata McGraw-Hill 7 Patel Nagar, New Delhi.
- Stace, C. (1992). *Plant Taxonomy and Biosystematics*, Edward Arnold.

BOT-3601 **PLANT ANATOMY** **3(2+1)**

Objectives of course: To provide the students understanding about anatomical features of vascular Plants.

Theory: The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body. **Meristematic tissues:** classification, cytohistological characteristics, initials and their derivatives. **Apical meristem:** Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices. **Leaf:** types, origion, internal organization,development of different tissues with special reference to mesophyll, venation, bundle sheath and bundle sheath extension. Enlargement of epidermal cells. **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. 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. **Secretory tissues:** Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals. **Anatomy of reproductive parts:** Flower, Seed, Fruit. Economic aspects of applied plant anatomy. Anatomical adaptations. Molecular markers in tree species used for wood identification.

Lab outline:

- 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.
- Study of abnormal/unusual secondary growth.
- Peel and ground sectioning and maceration of fossil material.
- Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.

Recommended Books:

- Dickison, W. C. 2000. Integrative plant anatomy. Academic Press, U. K.
- Fahn, A. 1990. Plant Anatomy. Pergamum Press, Oxford.
- Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
- Metcalf, C. R. and Chalk, L. 1950. Anatomy of the Dicotyledons. Clerondon Press. Oxford.

- Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.

BOT- 3602 **GENETICS-I** **3 (2+1)**

Objectives of course: To understand the nature and function of genetic material.
To explain the principles and laws of inheritance at the cell, individual and population level.

Theory: **Extensions of Mendelian Analysis**: Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity**. Linkage I:** 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. **Linkage II:** Special Eukaryotic Chromosome Mapping Techniques: Accurate calculation of large map distances, analysis of single meioses, mitotic segregation and recombination, mapping human chromosomes. **The Structure of DNA:** DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene. **The Nature of the Gene:** How genes work, gene- protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites, complementation. **DNA Function:** Transcription, translation, the genetic code, protein synthesis, universitality of genetic information transfer, eukaryotic RNA.

The Extranuclear Genome : Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochrondrial genes in yeast, extragenomic plasmids in eukaryotes. **Developmental Genetics:** Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease. **Population Genetics:** Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Lab Outline:

- **Numerical problems**
- Arrangement of genetic material:
  - Linkage and recombination.
  - Gene mapping in diploid.

        - Recombination in Fungi.
- Iv. Recombination in bacteria
        - Recombination in viruses.
    - Population Genetics:
        - Gene frequencies and equilibrium.
        - Changes in gene frequencies,
    - **Blood group and Rh-factor**
    - **Drosophila**
        - Culture technique
        - Salivary gland chromosome
    - **Fungal Genetics**
- Sacchromyces culture techniques and study.
    - **Studies on variation in maize ear size and colour variation**
    - **Bacterial Genetics.**
        - Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
        - Transformation.
        - Conjugation.

Recommended Books:

- Gelvin, S, B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
- Pierca, B. A. 2005. Genetics. A conceptual approach, W. H. Freeman and Company, New York.
- Synder, L, and Champness, W. 2004. Molecular Genetics of Bacteria. ASM Press, Washington D. C.
- Klug, W. S. and Cummings, M. R. 1997. Concepts of Genetics, Prentice Hall International Inc.
- Roth Well, N. V. 1997. Understanding Genetics, 2nd Edition, Oxford University Press Inc.
- Gardner, E. J., 2004. Principles of Genetics, John Willey and Sons, New York.
- Ringo J, 2004. Fundamental Genetics, Cambridge University Press.
- Griffiths A. J. F: Wessler, S. R; Lewontin, R. C, Gelbart, W. M; Suzuki, D. T. and Miller, J. H., 2005, Introduction to Genetic Analysis, W. H. Freeman and Company.

- Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.
- Hartl, D. L. and Jones, E. W. 2005, Genetics - Analysis of Genes and Genomes, Jones and Bartlett Publishers. Sudbry, USA.
- Hedrick, P. W. 2005. Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.
- Mahmut Caliskan. 2012. The Molecular basis of plant genetic diversity. In Tech Publishers.

BOT-3603 **PLANT BIOCHEMISTRY-I** **3 (2+1)**

Objectives of Course: The course will provide fundamental concepts in biochemistry, major macromolecules and chemical properties of living systems. Structural elucidation and role of primary metabolites in plants and their importance in life of human being.

Course Outcomes: The graduates will be familiar with structural composition of plants and their use as byproducts in daily life.
The students will learn role of plants in life sustenance and climate alteration and homeostasis

Theory: **Carbohydrates:** Definition,Occurrence, classification and scope of carbohydrates. Structure elucidation, chemical composition and significance of riDepertmental councile, deoxyriDepertmental councile, D-glucose, sucrose, maltose, starch, glycogen, cellulose, hemicellulose,mucilages, pectins and lignins. **Lipids:** Definition,Occurrence, classification and scope of Lipids. Structure elucidationand chemical composition and significance of fatty acids, triglycerides, phospholipids, glycolipids, sulpholipids, waxes, cholesterol and sterols. **Proteins:** Definition,Occurrence, classification and scope of Proteins. Structure elucidationand chemical composition, properties ofamino acids all amino acids. Protein targeting, Protein folding and unfolding, posttranslational modifications (PTMs). Transport, storage, regulatory and receptor proteins. **Nucleic Acids:** Definition,Occurrence, classification and scope of Nucleic acids. Structure elucidation, chemical composition and significance of DNA and RNA. DNA barcoding,gene sequencing. DNA and RNA formation, storage and movement mechanism. **Enzymes:** Definition,Occurrence, classification and scope Enzymes. Structure elucidation,

chemical composition and significance ofIsozymes, ribozymes, abzymes. Enzyme specificity and modals of enzyme action, Enzyme kinetics, Nature of active site and mode of action. Allosteric enzymes and feedback mechanism.

Lab Outline:

- To visit lab to be familiar with instruments and learn operating methods, principles and calibration.
- To learn how to measure pH of any solution/ solvent using litmas paper and digital pH meter.
- To prepare basic 1 Molar, 0.5 Molar, 1 Molal, 0.01 Molal and 1 Normal solutions of any given salts and liquids; and buffer formation.
- To learn detect and confirm presence of glucose, sucrose, lactose, cellulose and starch in the given solution and conduct Rf analysis.
- To detect presence of proteins in the solution by using chemical test methods and its estimation by Biuret or Lowry or Dye-binding method.
- To extract and estimate oil from plant material using soxhlet apparatus, checking of its soapnification property and its analysis by TLC methods with/andRf determination.
- To extract leaf and seed proteins and their estimation by Biuret or Lowry or Dye-binding method.
- To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
- To extract of DNA and RNA from plant material and their estimation by UV absorption orcolour reactions.
- To estimate the catalytic property of any enzyme or catalase/ peroxidase extracted from aplant source.

Recommended Books:

- Biochemistry and Molecular Biology of Plant Hormones. (1999). Edited by P. J. J., Haykaas, M.A. Hall, & K.R. Libbenga, Science Pub.Co.
- Conn E E. and Stumpf P.K., 2002. Outlines of Biochemistry, John Wiley and Sons Inc.New York.

- Lehninger, A.L., Nelson, D.L. and Co. N.M., (2008). Principles of Biochemistry. W. H. Freeman; 5th edition.
- McGraw-HilHarpers Illustrated Biochemistry, 27th Ed. (2010). By R.K Murray, D.K Grannar, V. W. Rodwell.
- Fundamentals of Biochemistry. (2008) 3rd Ed. by D. J. Voet, G.J. Voet and C. W. Pratt. J. Wiley & Sons Inc.

BOT-3604 **PLANT ECOLOGY-I** **3(2+1)**

Objectives of Course: To undersatand the role and interaction of plants with their environment.

To enable the students to assess the effect of various environmental factor on plant growth.

Theory: Introduction: history and recent developments in ecology. **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 (brief description), Salt and drought stress and osmoregulation. Soil erosion**. 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. **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. **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.

Lab Outline:

- Determination of physico-chemical properties of soil and water.
- Measurements of light and temperature under different ecological conditions.
- Measurements of wind velocity.
- Measurement of CO2 and O2 concentration of air and water.

- .Effect of light, temperature, moisture, salinity and soil type on germination and growth of plants.
- 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:

- M. Ahmad and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons New Urdu Bazar Karachi.
- Chapin, F. S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
- Barbour, M. G., Burke, J. H and Pitts, W. D. 2004 Terrestrial Plant Ecology, The Benjamin, Cumming Publishing C. Palo Alto, California, USA.
- Hussain. F. 1989 Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education, Islamabad.
- More. P. D. and Chapman S. B. 1986 Methods in Plant Ecology, Blackwell Scientific Publication Oxford.

BOT-3605 PLANT PHYSIOLOGY-I 3(2+1)

Objective of Course: The course provides comprehensive knowledge of fundamental metabolic processes occurring in plant body. It provides an overview of effects of environment on plant physiological processes.

Theory: **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. **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 respitaion.**Translocation of Food**: Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading. **Leaves and Atmosphere**: Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation. **Assimilation of Nitrogen, Sulphur and Phosphorus**: The nitrogen cycle. Nitrogen fixation. Pathways of assimilation of nitrate and ammonium ions. Assimilation of sulphur and phosphorus.

Lab Outline:

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

Recommended Books:

- Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- W.B. Hopkins. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
- Barton, W. 2007. Recent Advances in Plant Physiology.
- Ihsan Illahi, 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
- Nobel, P.S. 1999. Physicochemical and Environmental Plant Physiology. Academic Press, UK.

BOT-4701 **MOLECULAR BIOLOGY** **3 (2+1)**

Objectives of course: To disseminate the knowledge of molecular basis of life.

To explain the fundamental structure, properties and processes in which nucleic acids play a part.

To discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms.

Theory: **Nucleic Acids**: DNA-circular and superhelical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA, Central Dogma. **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, Docking.

Lab Outline:

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.

Recommended Books:

- Cullis, C. A. 2004. Plant Genomics and Proteomics. Wiley-Liss, New York.

- Gibson, G. and S. V. Muse, 2002. A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
- Lodish, H. et al., 2004. Molecular Cell Biology. 5th Edition. W. H. Freeman & Co., New York.
- Malacinski, G. M. 2003. Essentials of Molecular Biology, 4th Edition. Jones and Bartlett Publishers, Massachusetts.
- Watson, J. D. et al. 2004. Molecular Biology of the Gene. Peason Education, Singapore.
- Ignacimuthu, S. 2005. Basic bioinformatics. Narosa Publishing House, India.
- Weaver, R. F. 2005. Molecular Biology. McGraw-Hill, St. Louis.
- Lehninger, A L. 2004. Principles of Biochemistry. Worth Publishers Inc.
- David Figurski. 2013. Genetic manipulation of DNA and protein, example from current research. In Tech Publishers.
- Bruce Alberts et al. 2007. Molecular biology of the cell. 5th Edition. Garland and Sons.
- M. Madan Babu. 2013. Bacterial gene regulations and transcription network. Caister Publishers. Academic Publishers.

BOT-4702 **PLANT BIOCHEMISTRY-II** **3 (2+1)**

Objectives of course: To explicit the fundamentals of metabolic energy production and transference, metabolism and plant constituents.

Theory: **Bioenergetics:** Energy, laws about energy changes. Oxidation and reduction in livingsystems. **Metabolism:** i. Biosynthesis, degradation and regulation of sucrose and starch. Breakdown of fatswith special reference to beta-oxidation and its energy balance. Biosynthesis of fats. **Replication of DNA**. Reverse transcription. Biosynthesis of DNA and RNA. **Components of protein synthesis.** Genetic code, protein synthesis: initiation,elongation and termination. **Alkaloids:** Occurrence, physiological effects, chemical nature with special reference tosolanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role.

Terpenoids: Classification: monoterpenes, sesquiterpenes, diterpenes, triterpenes,tetraterpenes, polyterpenes and their chemical constitution and biosynthesis. **Vitamins:** General properties and role in metabolism.

Lab Outline:

- Basic Introduction to Lab hi-tech Instruments i.e. 1-DE; 2-DE and PCR
- Extraction of Proteins from leaves and seeds of plants and their purification
- Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis (1-DE).
- estimate the amount of vitamin C in a plant organ (orange, apple juice)
- To determine potential alkaloids in plants.
- To estimate terpenoids in plants.
- To quantify saponins in plants.
- To estimate flavonoids in plants.
- To estimate chlorophyll contents in plants
- To Extract DNA and RNA from plant leaf and other partsTo run and analyze DNA by using PCR/ Gel electrophoresis approach

Recommended Books:

- Conn E. E. and Stumpf, P.K. 2002. Outlines of Biochemistry, John Wiley and Sons Inc.New York
- Smith; E L., Hill; R. L., Lehman; R. I., Lefkowits, R J. and Abraham. H. 2012. Principles ofBiochemistry, (General Aspects). White. International Student Edition. McGraw HillInternational Book Company.
- Zubay. G. 2003, Biochemistry, MacMillan Publishing Co., New York.
- Chesworth,. J.M., Strichbury T. and Scaife, J. R. 1998. An introduction to agriculturalbiochemistry. Chapman and Hall, London.
- Heldt, H-W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
- Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition

BOT-4703 **PLANT ECOLOGY-II** **3 (2+1)**

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

Theory: Population Ecology; Population structure and plant demography: Seed dispersal, Dormancy, Seed Bank, Seed dormancy, Recruitment, Demography. Life history pattern and resource allocation : Density dependent and density independent factors, Resource allocation, Reproductive effort, Seed size vs seed weight, Population genetics, Evolution. **Community Ecology:** Historical development of community ecology, community concept and attributes, methods of sampling of plant community, ecological sucession, 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

Lab Outline:

- Determination of seed bank in various populations.
- Seed dispersal pattern of local populations.
- . 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 Azad Kashmir.
- Slide show of the vegetation of Pakistan.
- Slide show of the major formations of the world.

Recommended Books:

- Ahmad, M. and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons, New Urdu Bazar, Karachi.
- Townsend C. R. Begon. M and J. L. Harper 2002. Essentials of Ecology, Blackwell Publishing,
- Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
- Barbour M. G. et al., 1999, Terrestrial Plant Ecology, The Benjamin-Cumming Publishing Co.
- Moore P.D. and Chapman S. B. 1986. Methods in Plant Ecology, Blackwell Scientific Publication, Oxford.

- Hussain, S. Pakistan Manual of Plant Ecology,
- Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education. Islamabad

BOT-4801 **PLANT PHYSIOLOGY-II** **3 (2+1)**

Course objectives: The aim of the course is to acquaint students with the basic life processes of plants, to explain any significant happening and reactions, which affect and makes the life of plants. The course examines various aspects of plant cell biology, physiology, and biochemistry including water relations, mineral nutrition, roles of plant hormones and different plant movements.

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

Theory: Plant Growth Regulators: Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal trasduction and mode of action, transport, physiological effects of Auxins , Gibberellins, Cytokinins, Abscisic acid, Ethylene, Polyamines, Brassinosteriods, Jasmonates, and Salicylic acid. **Water Relations:** The soil -plant -atmosphere continuum - an overview. Structure of water. Physico-chemical properties of water. Water in the soil and its potentials. Water in cell components. Absorption of water in plants (pathways and driving forces, Aquaporins,-their structure and types). Cell water relations terminology. **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. Fertilizers and their significance in Agriculture. **Phytochromes:** Discovery of phytochromes and cryptochromes. Physical and chemical properties of phytochromes. Distribution of phytochromes among among species, cells and tissues and their role in biological processes. **Control of Flowering:** Autonomous versus environmental regulation. Circadien 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. Floral meristem and floral organ development. Floral organ identity genes and the ABC model. Signal transduction in prokaryotes and eukaryotes. **Dormancy;** definition and causes of seed dormancy; methods of breaking seed dormancy; types and physiological process of seed germination. **Plant Movements;** Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements.

Lab Outline:

- To investigate the preferential absorption of ions by corn seedlings and potato slices.
- To determine osmotic potential of massive tissue by freezing point depression method or by an osmometer.
- To investigate water potential of a plant tissue by dye method and water potential apparatus.
- Determination of K uptake by excised roots.
- Measurement of stomatal index and conductance.
- Qualitative determination of K content in Guard cells by Sodium cobalt nitrite method.

Recommended Books:

- Fitter, A. and Hay, R. K. M. 2001. Environmental Physiology of Plants. Academic Press, UK.
- Press, M. C., Barker, M. G., and Scholes, J. D. 2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.
- Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- W. B. Hopkins. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
- Epstein, E. and Bloom, A. J. 2004. Mineral Nutrition of Plants: Principles and Perspectives. 2nd Edition. Sinauer Associates, California, USA.

.

BOT-4802 **GENETICS-II** **3 (2+1)**

Objectives of Course:

To identify the parts, structure, and dimensions of DNA molecules, , and be able to categorize DNA as well as describe how DNA is stored.

To introduce students recombination of genetic material at molecular levels with emphasis on introduction to biotechnology and genomics.

To accurately diagram and describe the PCR, as well as predict the outcomes of these processes.

To describe the processes of gene mutation and predict how a gene will be expressed under specific circumstances.

Theory: Recombinant DNA: Recombinant DNA Technology Introduction, Basic Techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA methodology, Site directed Mutagenesis, DNA sequencing. **Application of Recombinant DNA:** Applications of recombinant DNA technology using prokaryotes, recombinant DNA technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions. **Mechanisms of Genetic Change I:** Gene Mutation: The molecular basis of gene mutations, spontaneous mutations, induced mutations, reversion analysis mutagens and carcinogens, biological repair mechanisms. **Mechanisms of Genetic Change II:** Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements. **Mechanisms of Genetic Change III:** Transposable Genetic Elements: Insertion sequences, transposons, rearrangements mediated by transposable elements, review of transposable elements in prokaryotes, controlling elements in maize. **Human Genome Project:** Strategies and application, achievement and future prospects. **Plant Genome Projects:** Arabidopsis, achievement and future prospects. Other plant genome projects**. Bioinformatics:** Application of

computational tests to the analysis of genome and their gene products. **Bioethics:** Moral, Religious and ethical concerns.

Lab Outline:

- Problems relating to the theory
- Isolation and separation of DNA and protein on Gel electrophoresis.
- Bacterial chromosome
- Plasmid DNA (minipreps)
- Plant DNA
- Protein
- DNA Amplification by PCR

Recommended Books:

- Winnacker, E. L.2003, From Gene to Clones Introduction to Gene Technology, Panima Publishing Corporation, New Delhi.
- Brown, T. A. 2002 Genomes, Bios Scientific Publishers Ltd.
- The Genome of Homo Sapiens, 2003, Cold Spring Harbor Laboratory Press.
- Lwein, B. 2004, Gene VIII, Pearson Education Int.
- Miglani, 2003, Advanced Genetics, Narosa Publishing House, India,.
- Gelvin, S. B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
- Primrose, S. B., Twyman, R. M. and Old R. W. 2004. Principles of Gene Manipulation, an Introduction to Genetic Engineering (6th Edition), Blackwell Scientific Publications.
- Wilson, J. and Hunt, T. 2004. Molecular Biology of the cell – the problems book, Garland publishing Inc.
- Anthony J. F Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart. W. H. 2009. An Introduction to Genetic Analysis, 7th Edition. Freeman and Company.
- Hedrick, P. W. 2005. Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.

- Mahmut Caliskan. 2012. The Molecular basis of plant genetic diversity. In Tech Publishers.
- Ram J. Singh. 2011. Genetic resources, chromosome engineering and crop improvement. Medicinal plants. Vol. 6. CRC Press.
- Daniel Hartl. 2011. Genetics Johns and Bartlett Publishers.
- David Hyde. 2008. Introduction to Genetic principles. McGraw-Hill.

BOT-4803 ENVIRONMENTAL BIOLOGY 3 (2+1)

Objectives of course: To provide updated knowledge of environmental problems and sustainable environmental management

Theory: Environment: Introduction, scope, pressure. P**ollution**: definition, classification and impact on habitats. **i. 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, 2. Adverse effects of acid rains. Chlorofluorocarbons and its effects. **ii. Water pollution:** Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal pollution. **iii. 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.

iv. Noise pollution. **v. Radiation pollution** (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal. **Forest:** importance, deforestation, desertification and conservation. **Ozone layer:** i. Formation, ii. Mechanism of depletion, iii. Effects of ozone depletion. **Greenhouse effect and global warming:** causes, impacts. **Human population explosion:** impact on environment. **Impact assessment:** Industrial urban, civil developments. **National conservation strategy:** Brief review of major problems of Pakistan and their solutions. Sustainable Environmental management. **Wetlands and sanctuaries protection:** The pressures, problems and solutions. **Range management:** Types of rangelands, potential threats, sustainable management. **Aerobiology** (Pollen allergy & dust allergy).

Lab Outline:

- Examination of industrial waste water and Municipal sewage and sludge for

i. Total dissolved solids.

ii. pH and EC.

iii. BOD/COD.

iv. Chlorides, carbonate, and Nitrates.

- Examination of water samples forms different sites for the presence and diversity of organisms.
- Effect of air pollutants on plants.
- Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

- Shah Faisal Muhamamd and Sultan Mehmood. 2012. Lambert Publishers Germany.
- Environmental Biotechnology: Basic Concepts and Applications, I. S. Thakur, I.K. International Publishing House Pvt. Limited, 2006.
- Vandermeer, John H. 2011. The ecology of agro-ecosystems - Jones and Bartlett Publishers; Sudbury, Mass; 2011 - xv, 387 p.
- Greipsson, Sigurdur. 2011. Restoration ecology - Jones and Bartlett Publishers ; Sudbury, MA ; 2011 - xvi, 408 p
- Santra, S. C. 2010. Fundamentals of ecology and environmental biology - New Central Book Agency; London; 2010 - 353p.

LIST OF OPTIONAL COURSE

BOT-4704 **ETHNOBOTANY** **3(2+1)**

Course objectives:

To trained students with local knowledge about plant resources

To prepare students with skills and techniques in handling plant resources

To equip the student with knowledge and skills in conducting Ethnobotanical surveys

	To introduce students to ethical issues in Ethnobotanical studies and practices, including intellectual property rights and conservation of plant resources. To trained the students in understanding sustainable use of plant resources, endangered species, *in situ* and *ex situ* conservation and importance of Botanic Gardens
Corse outcomes:	Students will gain cultural awareness of the importance of native flora to rural and Natives of AJK & Pakistan and will contribute to the documentation of traditional and modern uses of native flora of Pakistan & AJK.

Theory: Introduction, Definition Aims & objective of ethnobotany, significance of ethnobotany, History and status in Pakistan, Importance and nature of plant products, Cereals and Millets, Classification of cereals, Legumes and Nuts, Vegetables, Classification of vegetables,Fruits, Classification of fruits, Economic importance of plants with special reference to food fibers, wood, tannins, rubber, sugar, paper, gums, resins, dyes, beverages, spices, fumitories, masticatories, and oils.

Lab Outline:

- Collection, identification and preservation of economically important plants and plant products. The students are required to study in nature and in the laboratory economically important local flora.
- Students should be able to write accurate scientific and vernacular name and economic importance of plants and identify them up to species level.
- Cultivation of economically important plants. Germplasm identification

Books Recommended:

- Martin, G. J. (2004). Ethnobotany. Earthscan Publications Ltd. London and Sterling, VA.
- Marty R.K and V.P. Singh (2006). An Introduction to Modern Economic Botany Agrobios India.
- Pandey, S. N. and Chadha, A. (1993). A Textbook of Botany (Plant Anatomy and Economic Botany). Vol. III. Vikas Pub. Co., New Delhi.

- Pandey, B.P. (1984). Economic Botany. S. Chand. Co., New Delhi.
- Simpson, A. (1985). Economic Botany. McGraw Hill Book Co., N. Y.
- Yadav.P.R. and S.R. Mishra. (2004). Environmental Ecology. Discovery Publishing House New Delhi110002.

BOT-4705 **PHYTOREMEDIATION** **3(2+1)**

Objectives of Course: The objectives of the course are make students familiar with plants and their role as remediator of environmental detritus. To make them able to use plants' natural mode to clean or reduce pollution of environment.

Theory: Plant tolerance to different contaminants, Adaptations, Characteristics of plants suitable for phytoremediation, Metal accumulators – hyperaccumulators and accumulators, Remediation: application, limitations (characteristics of roots, growth rate, pollutant concentration), economic and technical aspects, conservation of ecosystems, Phytoremediation mechanisms, Phytoextraction, Phytodegradation, Rhizofiltration, Rhizodegradation, Phytostabilization, Phytovolatilization, Phytoremediation techniques, Phytoengineering.

Lab Outline:

- Cultivation of plants with addition of excessive amounts of pollutants (heavy metals, organic pollutants).
- Determination of pollutants in plant tissues.
- Bioconcentration degree of certain pollutants.
- Collection of plant under stressed condition (heavy metals).

Recommended Books:

- John T. Cookson, Jr. McGraw-Hill, (1995). Bioremediation Engineering: Design and Application. Inc. New York.
- A. Singh O. P. Ward (Eds), (2004). Applied Bioremediation and Phytoremediation. Springer, New York.
- A. Bhandari etc (Eds), (2007). Remediation Technologies for Soils and Groundwater .

- Jan Vymazal, Lenka Kröpfelová, (2008). Wastewater treatment in constructed wetlands with horizontal sub-surface flow. Springer.
- Neil Willey. Phytoremediation: Methods and Reviews. 2006. Humana Publisher USA.
- Ritu Gill, Guy R. Lanza, Lee Newman, 2016. Phytoremediation: Management of Environmental Contaminants Volume-3. Publisher: Springer, Switzerland.

BOT-4706 **PLANT STRESS PHYSIOLOGY** **3 (2+1)**

Course objectives: The course is aimed to provide the basic concepts of environmental stresses effects within biological systems and causality of relationships between plants and their environment. Students will get the knowledge of mechanisms of stress effect on plants, plant resistance against stresses, their acclimation and adaptation to environment.

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.

Lab Outline::

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

Books Recommended:

- Hale, M. G. and Orcutt, D. M. (1987). The Physiology of Plants under Stress. John Wiley and Sons, N.Y.
- Kramer, P.J. (1983). Water Relations of Plants. Academic Press.
- Paleg, L. G. and D. Aspinale, D. (1981). Physiology and Biochemistry of Drought Resistance in Plants. Academic Press London.

- Russel, H. and Staples, R. C. (1979). Stress Physiology in crop plants. by H. Wiley-Interscience, N.Y.
- Staples, R.C. and G.H. Toenniessen. (1984). Salinity Tolerance in Plants – Strategies for crop improvement. John Wiley & Sons.

BOT-4707 CONSERVATION & MANAGEMENT OF PLANT RESOURCES 3(2+1)

Objective of course: The aim of the course is to provide comprehensive knowledge on plant resources, threats to their existence, management and their mportance for survival and proper functioning of ecosystem.

Learning Outcomes: Students will be able

To describe the global biodiversity crisis

To outline the main reasons for decline and threats to biodiversity worldwide

Theory: Introduction of species, Ecology and genetic diversity, Existing wildlife in Pakistan, Pytogeographical zones of Pakistan, Threats to plant diversity, Importance of the Red data book, IUCN categories for threatened species, Concept of *In situ* and *ex situ* conservation of plants, Role of herbaria and botanical gardens in conservation, IUCN protected areas categories, Protected areas of Pakistan, Gene bank management and operation, Biodiversity action plane of Pakistan.

Lab Outline::

- Field visits; visit to National parks, herbarium and gene bank (IABGR).
- Role of NGOs in conservation.
- Preparation of an inventory of the flora of assign region.

Books Recommended:

- Cunnighum, A. B.(2001). Applied Ethnobotany: People, wild plant use and conservation, Earthspan Publications.
- Dyke, F. V. (2003). Conservation Biology. Mc Graw Hill, New York.

- Gotz S., Gustavo A B, Da Fonseca, C. A Harvey, C. Gascon, H. L Vasconcelos and Anne-Marie Izac, (2004). Agroforestry and BiodiversityConservation in Tropical Landscapes.
- John T. and G. P. Nabhan, (2001). People, Plants and Protected Areas: A Guide to "In Situ" Management.
- Krishmamurthy, K. V. (2003). A text book of Biodiversity Science, Publishers Inc. Enfield, NH, USA.
- Peter Feinsinger, (2001). Designing Field Studies for BiodiversityConservation. pp 219.

BOT-4708 **PLANT NUTRITION** **3(2+1)**

Objective of course:

To understand the elements and compounds required as proper plant nutrition.

To understand the mechanisms of uptake of nutrients, their functions, loading and unloading of conducting tissues.

To understand common plant defiencies and toxicities.

To describe how symbiotic relationships help autotrophic plants obtain nutrients.

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

Lab Outline::

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

Books Recommended:

- Maraschner, H. (1986). Mineral Nutrition in Hugher Plants: Academic Press. USA.

- Mengal and Kirkbe. (1987). Plant Nutrition, Academic Press. USA.

BOT-4709 **PHYTOSOCIOLOGY** **3(2+1)**

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

Theory: **The community:** Analytical and synthetic characteristics of a community, Classification of community, Basis and unit of classification, Dynamics of community. Types of changes: Succession on wet and dry habitats, Theories of climax. Ecological characteristics of species and population. **Ecosystem ecology:** Components of ecosystem, Energy transformation in nature and laws governing energy transformation, Food chain, Food web, Pyramid of number in food chain, Trophic levels, Energy flow in an ecosystem. **Biogeochemical cycles with**; Nitrogen, Phosphorus, Sulphur, Carbon and water cycles as examples. Principal vegetation types of Pakistan.

Lab Outline:

- Methods of vegetation sampling.
- Study of floristic composition, preparation of site plan study areas.
- Determination of frequency of occurrence in a plant community, polulation density and cover of species in a plant community.
- Study of decomposition of leaf litter.
- Preparation of profiles of temperature and relative humidity.
- Measurement of height of tree comparison between natural & man mad ecosystem determination of primary productivity of grassland.

Books Recommended:

- Billings, W.D. (2000). Plant and Ecosystem. Wadswoth Pub. Co., California
- Daubenmire, R.F. (1974). Plant Communities. A Textbook of Synecology. Wiley, N.Y. USA.
- Kimmins, J. P. (1996). Forest ecology, Prentice Hall Upper Saddle River, New Jersey. 70

- Shukla R.S & P.S Chandel. (2006). Plant Ecology S. Chand & Company LTD Ram nagar new Delhi
- Stiling, R. D. (1992). Ecology, theories and applications. Prentice Hall International Inc. U.S.A
- Treshow, M. (1970). Environment and Plant Response. McGraw Hill Book. Co., N. Y.
- Schultz et al., (2005). Plant Ecology. SpringerVerlag, Berlin.
- Ricklefs, R. E. (2000). Ecology. W. H. Freeman and Co., UK.
- Subrahmanyam, N. S. and Sambamurthy, A. V. S. S. (2000). Ecology. Narosa Publishing House, New Delhi.
- Townsend, C. R., Harper, J. L. and Begon, M. E. (2000). Essentials of Ecology. Blackwell Scientific Publications UK.

BOT- 4710 **ECONOMIC BOTANY** **3(2+1)**

Coarse objectives: This course deals with man's relationship to plants and their economic interests, including their diversity of use in industry and production of food and medicine.

Course outcomes: At the completion of this course a student will be able to

Develop a basic knowledge of taxonomic diversity and important families of useful plants.

Acknowledge the economic uses of plants in modern society.

Acquire an increased awareness and appreciation of plants & plant products encountered in everyday life.

Develop scientific insights into the development of many plant products that have shaped our society.

Appreciate the diversity of plants and the plant products in human use.

Understand the biological reasons why certain plant resources are important.

Explain the geographical, historical, and cultural contributions of economically important plants on the development of human culture.

Theory: Definition of economic botany, importance of plants, food plants, products from plants, role of plants in soil fertilityand phytoremediation. **Important cereals;** wheat, rice, corn, their morphology, history, cultivation, chemical composition & uses. **Fibers,** Fiber industry, structure & classification of fibers, fiber yielding plants; cotton, lin, jute, sun hemp, Indian hemp, coir, aak, sumbal, paper mulberry, kapas, their morphology, harvesting procedures, importance, rayan fibers and their uses.**Wood industry,** wood for timber,timber industry, ply wood, uses of wood, conversion products of wood, distillation products, secondary products, list of wood yielding plants. **Rubber industry,** physical properties, chemical composition, rubber yielding plants, para rubber, morphology, uses, guayule rubber, asam rubber, panama rubber. **Starch,** chemical composition, uses, starch yielding plants, rice starch, potato starch, wheat starch, sagu starch. **Sugar & sugar yielding plants**, sugar beet by products of sugar. Fumatories & masticatories, beverages, spices & condiments.

Lab Outline:

- Identification and collection of food plants of area.
- Study of morphology of cereal crops and their cultivation techniques.
- Collection of fiber yielding plants from local area.
- Field survey to enlist wood yielding plants.
- Study of spices and condiments used in daily food.
- Submission of 30 economically important plants at final Lab Outline: time.

Recommended Books:

- H. D.V. Prendergast, et al. (1998). Plants food and medicine.Kew publishing
- Frances E.M. Cook . (1995). Economic botany data collection standard. Kewpublishing.
- Pooja. (2005). Economic botany. Discovery publishing house.
- B. P. Pandey. (2000).Economic Botany

BOT-4711 FLORA OF AZAD JAMMU AND KASHMIR 3(2+1)

Coarse Objectives: The Flora aim to understand & conserve all AJK native plants.

Coarse outcomes: In the end of this course, Students will be able to:

Identify plant species of Azad Jammu & Kashmir using morphological and habitat clues.

Identify unknown plants using a dichotomous key along with text and web resources

Develop a systematic approach to identifying an unknown plant using knowledge about plant diversity, habitat, and vegetative and reproductive morphology

Outline the geographical, geological and historical influences on local plant communities

Theory: Concept of flora, history of flora, Geomorphology and climatology of plant regions in Pakistan and Azad Jammu and Kashmir, Natural vegetation regions, floristic composition and zones, Types of habitat and their vegetation, Life forms in the flora of Azad Jammu and Kashmir, Plant groups in the flora ofAzad Jammu and Kashmir, endangered, rare, endemic, economic, aromatic, poisonous, grazing, woody and edible species of Azad Jammu and Kashmir, Threats to flora ofAzad Jammu and Kashmir, Methods to study flora in field and lab, tools and technique to preserve flora in field and herbarium.

Lab Outline:

- Submission of properly mounted and fully identified 50 herbarium specimens at the time of examination.
- Collection of Flora data from internet and literature.
- Field trips shall be undertaken to study plants from different ecological zones of Pakistan.

Recommended Books:

- Ali, S.I. and Nasir, Y.J. (1970-1992). *Flora of Pakistan*. Nos. 68, 71, 131, 145, 126, 172, 36, 54, 100, 171, 132, 20, 75, 152. Department of Botany, University of Karachi.
- Ali, S.I. and Qaiser, M. (1992-2010). *Flora of Pakistan.* Nos. 204, 207, 201, 215. Department of Botany, University of Karachi.
- Stewart, R.R., (1972). *An Annotated Catalogue of the Vascular Plants of West Pakistan and Kashmir*. *Flora of West Pakistan.* E. Nasir and S.I. Ali, (eds.) Fakhri Printing Press, Karachi.

- Stewart, R.R., (1957). The Flora of Rawalpindi District, West Pakistan. E.E. Press, Rawalpindi.
- Nasir, Y.J. and R.A. Rafique. (1995). Wild Flowers of Pakistan. Oxford University Press, Karachi: 298.
- Parker (1956). A Forest Flora for the Punjab with Hazara and Dehli. Ed. (3): 230.

BOT-4804 RESEARCH TECHNIQUES 3(2+1)

Objectives of Course: The objective of course is to made students to be independent research designer and conduct research. To make them able to write their research paper, project and thesis.

Theory: **Planning research project:** Definition of research, problem identification and feasibility analysis, validity of problem, objectives and goals, literature search, development of hypothesis, source and review of literature. **Reference writing:** For books, journals, anonymous, internet etc. use of digital libraries for research. **Preparation of a research report:** Types of research reports, structure, Graphics, initial writing, rewriting and editing. Evaluation of a research report, general evaluation criteria, specific evaluation criteria.

Microscopy, Centrifugation, Electrophoresis, Genomic DNA extraction, PCR, DNA fingerprinting, Restriction enzyme analysis and genotyping, Transformation.

Lab Outline::

- To design a report
- Protein Extract,
- SDS- PAGE
- PCR Optimization
- DNA Extraction,
- Thin layer Chromatography and Microscopy

Books Recommended:

- Old R.W. and S.B. Primrose (1994). Principles of Gene Manipulation, an Introduction to Genetic engineering (4th edition). Blackwell Scientific Publications.
- John, H.D .and L.W. Roberts (1985). Plant Tissue culture second edition. Cambridge University Press Cambridge.
- Smith R.H (2000). Plant tissue culture techniques and Experiments second Edition Academic Press.
- Arifullah, S and K.M. Bhatti. (1998). Research process simplified. Pan-Graphic (Pvt) Limited. Islamabad.
- Jones, A., R, Reed and J. Weyers. (1994). Lab Outline: skills in Biology. Longman Scientific and Technical.
- O' Conner, M. (1993). Writing successfully in science. Chapman and Hall. N. Y.
- Hashmi, N. (1983). Style manual of technical writing. Pakistan Economic Analysis Network Project. Islamabad.

BOT-2405 **PLANT METABOLISM** **3(2+1)**

Objectives of course: The aim of the course is to equipe the students with comprehensive knowledge of different metablic processes and pathways in plants and energy equisition.

Theory: Introduction in Plant metabolism**,** Carbohydrates metabolism, Fat metabolism**,** Nitrogen metabolism, Plant hormones, Growth regulators, Mineral nutrition.

Lab Outline:

- Phototropism, Geotropism, Nastic movements and Photoperiodism
- Auxin and Elongation of Barley Seedling
- Effect of Gebberillines on Growth of Lettuce
- Effect of Kinetin on Callus, Tissue Culture
- Plant hormones and differentiation

Recommended books:

- Bowsher, Steer & Tobin (2008). Plant Biochemistry. Garland Science, Taylor & Francis Group, LLC, New York.
- Buchanan, Gruissem & Jones (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. QK 861.B45.

- Calvin (1962) .The path of carbon in photosynthesis. Science 135: 879-889. QH 9 B6.B29.
- Crozier, Clifford, and Ashihara (2006). Plant Secondary Metabolites: Occurance, Stucture, and Role in the Human Diet. Blackwell Publishing. QK 881.P55 2006.
- Dennis (1997). Plant Physiology, Biochemistry, and Molecular Biology. Longman Publishing. QK 881.P54.
- Heldt (1997). Plant Biochemistry and Molecular Biology. Oxford University Press. QK 861 H4513.
- Taiz & Zeiger (2006). Plant Physiology. Sinauer Associates. QK 711.2 T35.

BOT- 4806 **PLANT BIOTECHNOLOGY** **3(2+1)**

Objectives of course: By the study of this course the student should recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant DNA technolog.

Theory: Introduction, Plant gene structure, Micro propagation, Organogenesis, De-differentiation, Re-differentiation, Callus culture, Cell culture, ovule culture, seed culture tissue culture. Embryogenesis; Direct Embryogenesis, Indrect Embryogenesis, Protoplast Culture, Somatic Hybridization, Gene, Vector, Restriction enzyme,Methods of genes transfer in plants, PCR base techniques, GMOS and application of Biotechnology.

Lab Outline: :

- Over-view of plant bio technology lab
- Preparation of MS media
- Isolation of meristem
- Isolation of protoplast
- Preparation of solution for SDS-PAGE
- PCR

Recommended Books:

- Slater, A., N. Scott, M. Fowler (2008). Plant biotechnology. Oxford Univ. Press Stewart,
- C.N. Jr. (2008). Plant Biotechnology and Genetics: Principles, Techniques and applications.
- Trigiano, R.N., D.J. Gray (Eds) (2010). Plant tissue culture, development and biotechnology. CRC Press.

BOT-4807 **APPLIED MYCOLOGY** **3(2+1)**

Objective of course: To give students theoretical and practical knowledge of the fungal kingdom.

To introduce students with the production of fungal secondary metabolites and their use in medicine and growing industry.

To study the technology of cultivation the most popular edible and medicinal mushroom species.

Outcomes of Course: Gaining knowledge of the general characteristics of fungi and the importance of these organisms in nature and the practical activities of man. Introducing the technology of cultivation of mushrooms and their protection.

Theory: General Characteristics of fungi, Taxonomic status and Classification of Fungi, Fungi harmful to mankind, Fungi as pathogen to plants, Animal & Human beings, Spoilage of food stuffs. **Fungi as a food:** Detailed account of mushrooms & their cultivation, Yeast & its related Industries, Single cell proteins & its production. The Economic importance of the fructification of few edible Fungi. **Fungi as medicines:** Industrial production of:- Ergot, Ephedrine , Steroids , Vitamins, Antibiotics **Fungi in Industries:**Brewery, Baking and Dairy Industries. Fungi in Enzyme Production:- Invertase, Zymase, Amylase, Cellulase. Fungi in production of organic Acids: Citric Acid, Gluconic Acid, Gallic Acid, Fumaric Acid.

Lab Outline::

- Basic mycological techniques
- Macroscopic and microscopic study of common fungi
- Preparation of nutrient media
- Collection of fungal infected samples

Recommended Books:

- Alexopoulos, G.J., Mims C.W and M. Blackwell. (1996). Introductory mycology (4th ed), Jhon Wiley & Sons, New York.
- Mehrotra, R.S. Aneja L.R. (1990). An introduction to mycology first edition. Wiley eastern limited, new dehli.
- Hafiz, A. (1984). Plant diseases, PARC, Islamabad, Pakistan.
- Ahmed S. (1987 & 1997). Ascomycetes of Pakistan (Vol. I & II), Biological society of Pakistan Lahore.

BOT- 4808 PLANT MICROBE INTERACTION 3(2+1)

Objective of course: To allow students to explore the various ways in which microbes interact with plants. The focus is on examination of the physiological, biochemical and genetic basis of these interactions. To draw connections between the biology of plant microbes relationships and imapct of these relationship on ecosystem and human socity.

Course objectives: At the end of this course students will be able to: Distinguish between the different types of plant-microbe interactions. Explain the physiological and biochemical processes underlying major symbiotic and pathogenic relationships. Recognize the processes common to all plant-microbe interactions. Draw connections between the biology of plant-microbe relationships, the impacts of those relationships on human society and the ecosystem.

Theory: Soil and soil ecosystem, Microbial responses in the Rhizosphere and Agriculture soil, Beneficial type of symbiosis, Both beneficial and pathogenic microbe for plants, infection and defense mechanisms in plants, PGPR and process of nodulation and nitrogen fixation, Microbial products influence plant growth, Biofertilizers, Role of microbe, Precursor inoculums interaction, Physiosignificanse of phytohormones produced by microbes, Effect of root exudates, Molecular basis of plant microbe interaction with special reference to rhizobial symbiosis, Associative symbiosis, Introduction of biofilm, Microbial biofilm.

Lab Outline::

- Study of mycorrhizal associations. Clearing and staining of mycorrhizal roots.

- Estimation of root length and colonization by mycorrhizal fungi.
- Bioassay measurements of mycorrhizal inoculums in soil.
- Isolation and identification of Glomalean fungi from field and other soils.
- Synthesis of mycorrhiza from spore inoculums and from root inoculums.
- Assessment of plant growth response by mycorrhizal infection in some seasonal crops.

Books Recommended:

- Hock, B. and A. Verma, (2002). Mycorrhiza. Springer publications.
- Manohara Chary and C. Chamola, (eds) (2002). Techniques in Mycorrhizal Studies.
- Michael, F. Allen, (1991). Ecology of Mycorrhiza. Cambridge University press.
- Peterson, Larry, R., H. B. Massicotte and L. H. Melville, (2003). Mycorrhizas. CABI pulications.
- Prell H.H and P.Day. (2001). Plant Fungal Pathogen Interaction. Springer**.**
- Stacey G. and N. T. Keen. (1996). Plant Microbe Interaction. Springer.

BOT-4809 **MOLECULAR GENETICS** **3(2+1)**

Objective of course: To identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored. To describe the processes of gene regulation and predict how a gene will be expressed under specific circumstance

Theory: The structure of DNA: DNA the genetic material, DNA replication in eukaryotes, DNA and the gene. **The Nature of the Gene:** How genes work, gene protein relationship, genetic observation explained by enzyme structure, genetic fine structure,mutationl sites, complementation. **DNA Function:** Transciption, translation, the genetic code, protein synthesis, universitality of genetic information trsansfer,eukaryotic RNA**. Recombinant DNA:** Restriction enzymes, the formation of recombinant DNA, recombinant DNA methodology, recombinant DNA and social responsibility. Application of Recombinant DNA.

Lab Outline:s:

- Numerical problems
- Arrangment of genetic material
- DNA extraction Introduction to PCR technonology
- Recombination in virus bacteria and fungi
- Population genetics
- Blood group and RH factors
- Fungal Genetics
- Bacterial genetics

Books Recommended:

- Gelvin, S. B. (2000). Plant Molecular Biology Manual. Kluwer Acedemic Publishers.
- Pierca, B.A. (2005). Genetics, A conceptual approach. W.H. Fermin and Company, New York.
- Synder, L, and Champness, W. (2004). Moleculan Genetics of Bacteria. ASM Press, Washington D.C.
- Hartl, D. L. and Jones, E.W. (2005). Genetics –Analysis of Gene and Genomics, Jones and Bartlett Publishers. Sudbary, USA.
- Hedrick, P.W. (2005). Genetics of Population. Joness and Bartlett Publishers, Sudbary, USA.

BOT-4810 PHYTOCHEMISTRY 3(2+1)

Coarse objectives: The course aims to provide students with understanding secondary metabolites and skills for separation of the active constituents obtained from natural sources.

Coarse outcomes: The student after completing the course, should be able to

Acquire the principle of pharmaceutical science in the field of phytochemistry

Define the physicochemical properties of natural products

Illustrate, how to separate, identify and estimate the different active chemical constituents (alkaloids – glycosides – hallucinating and anticancer drugs) of the medicinal plants

Acquire good knowledge about the uses of the different active constituents (essential oils – carbohydrates – bitter principles – resins – tannins) of the medicinal plants

Theory: Phytochemistry: Definition, purpose of photochemistry, Brief history, Characteristics and their uses in taxonomy.Chemical constituents or comparative data and their evolutionary interpretation. **Directly visible chemical components:** Starch grains, Raphids, Drusses, Silica, Alkaloids, Glycosides, Tannins, Phenolic glycosides, Chemical test character, Flavonoids, Terpenoids, Serology.

Lab Outline::

- Electrophoresis.
- Collection of plants for phytochemical study.
- Iodine brown colour pigment.

Recommended Books:

- J, B. Harbora. (2004). Phytochemical methods.
- Markham, Techniques of flavonoid identification.
- Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (1999).Concepts in Photobiology: Photosynthesis and Photomorphogenesis, Narosa Publishing House, N.D.
- Goodwin,T.W. and Mercer, E.I. 1987. Plant Biochemistry. Pergamon Press,Oxford.

BOT -4811 **PALYNOLOGY** **3(2+1)**

Objectives of course: The students will learn basic of plants life and regeneration patterns by knowing about the pollens. To make the

students familiar how to isolate and identify pollens from plants to confirm taxonomic and genetic research.

Course outlines:

Introduction and scope of Palynology in Botany and life

To study about Pollens, types, spore morphology and taxonomy.

To study Neopalynology and Paleopalynology,

Composition and structure of pollen, sculpturing types of pollen grain.

Apertures of pollen grain.

Methods of collecting pollen and microscopic examination of pollen.

Aeropalynology, importance, production of air borne pollen.

Role of pollen in allergy, Wind, water and insect pollinated pollens.

Morphology of angiosperm and gymnosperm pollen.

Application of Palynology study in botany, phylogenetic analysis, geology, archaeology, criminology, medicines, honey and oil and gas exploration.

Theory: Introduction, scope and branches, Pollen and spore morphology and taxonomy, Composition and structure of pollen, Structure of exine and Intine, Sculpturing types of pollen grain, Apertures of pollen grain, Methods of collecting pollen, Microscopic examination of pollen, Aeropalynology, importance, production of air borne pollen, Role of pollen in allergy, Wind and insect pollinated pollens, Morphology of angiosperm and gymnosperm pollen, Fossil palynology.

Lab Outline:s:

- Collection of angiosperm pollen of dicot and preservation.
- Preparation of pollen for microscopic examination.
- Collection of angiosperm pollen of monocot and preservation.

- Preparation and microscopic study.
- Collection of plants responsible for pollen allergy.
- Study of pollinia of different plants.

Recommended Books:

- Palynology by A, Treatise.
- Palynology: spores and pollen by Marjorie D. Munir and Willian Antony S.
- Palynology:new directions other applications and floral history by J. Jansonius and Duncan Colin Mcgregor.

BOT-4812 APPLIED MICROBIOLOGY 3(2+1)

Objective of Course: To provide knowledge about structure and function of microbes. Their role in genetic diversity in industrial and medical. Their role in environment and their pathogenicity.

Theory: **Introduction**- Main groups of microorganisms and their characteristics (Prions, Viroids, Viruses Rickettsia, Bacteria, Mycoplasma, Cyanobacteria, protests, Algae & Fungi.

Structure; of microbial cells- prokaryotic and eukaryotic cells, structure of the sub cellular organisms- virus, viroids & prions . **Morphology**;ultra structure, reproduction and classification of bacteria. Major groups of bacteria. **Viruses**-; symmetry of viruses, composition, transmission, replication- plant, animal and bacterial viruses. **Immunology**-; Cells of immune systems, antigens recognition and antibody formation, acquired immunity, hypersensitivity and allergies; serology. **Microbes in Nature:** (1) Microbes in soil, water and air- general account; (2) Nitrifying and denitrifying bacteria, rhizosphere biota, phyllosphere biota and caulosphere micro flora. Microbes and microbial action in Bio-gas production, bio-fertilizers, sewage decomposition and compost formation. **Microbial spoilage of food**- aflatoxicosis, staphylococcus poisoning, botulism and salmonellosis. **Industrial microbiology**: Alcoholic beverages and bread, Microbes and Oriental fermented food- dosa, idly and appam, Microbes and microbial action involved in diary products- cheese and butter, Microbiology of single cell proteins and antibiotics.

Lab Outline::

- Isolation of microbes from soil – dilution plate method.
- Isolation of microbes from different water sources – dilution plate method.
- Isolation of microbes from Juices – dilution plate method.
- Isolation of microbes from Meat, Cheese, Milk etc – dilution plate method.
- Streak out a bacterial culture on an agar plate and isolation of colonies.
- Preparation of bacterial smear – staining with methylene blue and Gram's stain.
- Measurement of turbidity of a culture using colorimeter – as indication of microbial growth.

Recommended books:

- Talaro, k. and a. Talaro (1996). Foundation in Microbiology. Wm, .C. Brown. Publ. Co. N.Y.
- Ketchum, P. A. (1988). Microbiology, John Wiley and Sons. N. Y.
- Marmion, B. P. (1989). Lab Outline: medical microbiology churchil fiving stone. London and New York.
- Prescot, L.M; Herley, J. P and Klein, D.A (1999). Microbiology. 4th ed. McGraw Hill Book, Co. N.Y.