SCHEME OF STUDIES OF MSc BOTANY PROGRAM

MSc-Two Years Botany program comprises of 4 semesters with 66 credit hours. Outline of the courses is as under.

Duration of the Program:

The duration of MSc BOTANY IS TWO YEARS (04 SEMESTERS)

General courses	01 years (02 semesters)
Specialization	01 year (02 semesters)

Main Features of MSc Botany Program/Credit Requirements

Major Subject: Botany

Duration: 02 years (04 Semesters)

Eligibility: At least 45% marks in BSc with Botany & Zoology (compulsory) & (Chemistry /Psychology/ Geography) etc as an elective subject.

Degree Requirements: Minimum 66 credit hours

Total numbers of credit hours for MSc- Botany is 66

Note: (a) Each semester shell be of 16 to 18 weeks for teaching, no of courses per semester 4-6,one week for the conduct of examination and one week for the preparation of results;

(b) A 02+01 Credit hour course means as course of 3 credit hours i.e. 02 credit hours of theory and 01 credit hour of practical.

MSc BOTANY

I SEMESTER:

Course Code	Description	Credit hours
BOT-501	Biostatistics	3(2+1)
BOT-503	Bacteriology and Virology	3(2+1)
BOT -505	Phycology & Bryology	3(2+1)
BOT -507	Mycology & Plant Pathology	3(2+1)
BOT -509	Diversity of Vascular Plants	3(2+1)
BOT -511	Plant Systematics	3(2+1)
Total Credit hours		18

II SEMESTER:

Course Code	Description	Credit hours
BOT-502	Anatomy of Vascular Plants	3(2+1)
BOT-504	Genetics-I	3(2+1)
BOT-506	Plant Biochemistry-I	3(2+1)
BOT-508	Plant Ecology-I	3(2+1)
BOT-510	Plant Physiology-I	3(2+1)
BOT-512	Molecular Biology	3(2+1)
Total Credit hours		18

III SEMESTER:

Course Code	Description	Credit hours
BOT-601	Plant Biochemistry-II	3(2+1)
BOT-603	Plant Ecology-II	3(2+1)
BOT-605	Plant Physiology-II	3(2+1)
BOT-607	Genetics II	3(2+1)
BOT-	Optional subject/ Thesis/ Research Report	4(3+1)
Total Credit hours		16

IV SEMESTER:

Course Code	Description	Credit hours
BOT-602	Seminar / Presentations	1(1+0)
BOT-604	Biodiversity & Conservation	3(2+1)
BOT-606	Environmental Biology	3(2+1)
BOT-608	Cell Biology	3(2+1)
BOT-	Optional subject / Thesis/ Research Report	4(3+1)
Total Credit hours		14

Total no of Credit Hours: 66

Optional subjects will be offered as approved by academic council and as per available expertise of the University. (Annex-1)

At the beginning of III semester every student shall opt one field of specialization as mentioned below including compulsory course/s.

Research will be offered on the basis of merit and facilities in the field of specialization while remaining students shall have to opt an additional theory course 4(3+1) credit from field other than specialization in lieu of research.

(Annex-1)

List of Optional Papers In lieu Of Thesis

Course	Title	Credit Hours		Course	Title	Credit Hours
BOT-609	Plant Water Relations	4(3+1)		BOT-610	Plant Microtechniques	4(3+1)
BOT- 611	Plant Seed Physiology	4(3+1)		BOT-612	Palynology	4(3+1)
BOT-613	Plant Tissue Culture	4(3+1)		BOT-614	Plant Biotechnology	4(3+1)
BOT-615	Advanced Environmental Biology	4(3+1)		BOT-616	Plant-Conservation Management	4(3+1)
BOT-617	Conservation Genetics	4(3+1)		BOT-618	Ecological Genetics	4(3+1)
BOT-619	Medicinal Plants	4(3+1)		BOT-620	Ethnobotany	4(3+1)
BOT-621	Biodegradation and Bio remediation	4(3+1)		BOT-622	Water-pollution Management	4(3+1)
BOT-623	Air-pollution Management Strategies	4(3+1)		BOT-624	Conservation Ecology	4(3+1)
BOT-625	Plant Stress Physiology	4(3+1)		BOT-626	Advanced Plant Anatomy	4(3+1)

BOTANY

1st Year

1st Semester

BOT- 501 **Biostatistics** **Cr. Hr 3 (2+1)**

Course contents: **Cr,Hr 02**

1. Introduction objectives and scope:

i. Definition ii. Characteristics
iii. Importance and limit iv. Population and samples

2. Frequency distribution:

i. Variable types ii. Formation of frequency table from raw data
iii. Summation, notation and statistical inference iv. Data transformation.

3. Measures of central tendencies and dispersion:

i. Arithmetic Mean ii. Median iii. Mode iv. Range
v. Variance vi. Standard deviation vii. Standard error of the mean
viii. Mean deviation.

4. Organizing and describing data (Standard distributions):

i. Random sampling and the binomial distribution
ii. Probability, Types of Probabilities, Random variables, combining probabilities, Probability distributions Binomial distributions.
iii. Poisson and normal distributions, properties and applications.

5. Basic experimental design:

i. Concept and design ii. Principles of experiments
iii. Observational studies iv. Planning of experiments
v. Replication and randomization vi. Field plot technique
vii. Layout and analysis of completely randomized design
viii. Randomized complete block design ix.Latin square
x. Factorial design xi. Treatment comparison

6. Tests of significance:

i. T-test: (Basic idea, confidence limits of means, significant difference of means.
ii. Chi square test: Basic idea, testing goodness of fit to a ratio, testing association (contingency table).
iii. F-test: Introduction and application in analysis of variance.
Iv.LSD test, Duncan's New Multiple Range test (for comparison of individual means). Bonferroni test

7. Introduction to comparing of means:

Unit organization, Basic one way ANOVA, Types of sums of squares, How ANOVA works, The ANOVA Table. Two-way ANOVA-Factorial designs: (two-way factorial analysis,

calculating and analyzing the two-way ANOVA, Linear combination, multiple comparisons.
8. **Correlation and Regression**.

Lab outline: **Cr. Hr 01**

1. Data collection, arrangement of data in frequency table, calculating frequent cumulative frequency and preparation of curve.
2. Calculating different measure of central tendency such as arithmetic means, harmonic mean, geometric mean, median and mode.
3. Calculation of mean from grouped and ungrouped data.
4. Calculation of variance and standard deviation from grouped and ungrouped data.
5. Calculating dispersion, relative dispersion, standard deviation, standard error, standard score and co-efficient variation by hand and machine method.
6. Problems concerning probability, binomial distribution, T-test
7. Chi square test.
8. Analysis of variance - one factor design.
9. Multiple Analyses of Variance.
10. Determination of correlation by constructing different types of graphs such as scatter diagram, linear positive correlation, linear perfect negative correlation, no correlation and curvilinear correlation (second degree polynomial, third degree polynomial).
11. Linear Regression and multiple regression models.
12. MS Excel, MSTAT or relevant statistical software packages.

Recommended Books:

1. Harvey, M. 1995. Intuitive Biostatistics. Oxford University Press. NY. Kuzma J.W. and Bohnenblust, S. E. 2001, Basis Statistics for the Health Sciences, McGraw-Hill International Education or latest edition.
2. Onton, P., Adams, S. and Voelkar, D. H.2001. Cliffnotes for statistics. Blackwell Scientific Publishers.
3. Pacano, M. and Gauvreau, K. 2000. Principles of Biostatistics.
4. Quinn,G. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.
5. Rosner, B. 2005. Fundamentals of Biostatistics. John Wiley & Sons.
6. Samuels, M. L. and Witmar, J. A. 2003. Statistics for life sciences. 3rd Edition. Cambridge University Press.
7. Triola, M. F. and Triola, M. M. 2005. Biostatistics for Biological and Health Sciences. Pearson Addison Wesley.
8. Zar, J. H., 1999. Biostatistical Analysis, Pearson Education.

BOT- 503 **Bacteriology and Virology** **Cr.Hr 3 (2+1)**

Course contents: **Cr,Hr 02**

a) Viruses

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

b) Bacteria

1. History, characteristics and classification.
2. Evolutionary tendencies in Monera (Bacteria, Actinomycetes and Cyanobacteria)
3. Morphology, genetic recombination, locomotion and reproduction in bacteria
4. Bacterial metabolism (respiration, fermentation, photosynthesis and nitrogen fixation)
5. Importance of bacteria with special reference to application in various modern sciences specially agriculture, biotechnology and genetic engineering.
6. Symptoms and preventive measures of major bacterial diseases in Pakistan.

Lab outline: **Cr. Hr 01**

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.
3. Preparation of slides for the study of various forms, capsule/slime layer, spores, flagella and Gram-staining.
4. Growth of bacteria, subculturing and identification of bacteria on morphological and biochemical basis (using available techniques).
5. Microscopic study of representative genera of Actinomycetes and Cyanobacteria from fresh Gram-staining.

Recommended Books:

1. Black, J. G. 2005 Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
2. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005.MicrobiologyMcGraw-Hill Companies, Inc.
3. Arora, D. R. 2004.Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
4. Ross F. C. 1995.Fundamentals of Microbiology. John Willey & Sons, New York.
5. Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens. The Haworth Press, Inc.
6. Hull R. Matthews, 2004, Plant Virology, Academic Press.

7. Tortora, G. J: Funke, B. R. and Case C. L., 2004, Microbiology. Pearson Education.
8. Molecular Plant-Microbe Interactions, Kamal Bouarab, Normand Brisson, Fouad Daayf (eds),Companies, Inc.
9. Plant-Microbe Interactions Gary Stacey, Noel T. Keen (Eds) 2011, springer London .

Journals/Periodicals:

World Journal of Microbiology & Biotechnology, Current Microbiology, Journal of Industrial Microbiology and Biotechnology, Journal of General Virology, Journal of Virology

BOT- 505 Phycology and Bryology Cr. Hr 3 (2+1)

Course contents: Cr,Hr 02

a) Phycology

b)

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

c) Bryology:

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

Lab Outline: Cr. Hr 01

a) **Phycology:**

i. Collection of fresh water and marine algae .
ii. Identification of benthic and planktonic algae
iii. Section cutting of thalloid algae
iv. Preparation of temporary slides
v. Use of camera lucida/micrographs.

b) **Bryology**

Study of the following genera:
Pellia, Porella, Anthoceros and Polytrichum.

Recommended Books:

1. Bold, H. C. and M. J. Wynne 1985. Introduction to Algae: structure and reproduction.
2. Lee. R. E. 1999. Phycology. Cambridge University Press, U.K.
3. Dawson, E. Y., Halt. 1966. Marine Botany. Reinhart and Winstan, New York.
4. Chapman, V. J. and D. J. Chapman. 1983. Sea weed and their uses. MacMillan and Co. Ltd. London.
5. Vashishta. B. R. 1991. Botany for degree students. Bryophytes 8th ed. S. Chand and Co.London.
6. Schofield, W. B. 1985. Introduction to Bryology. MacMillan Publishing Co. London.
7. Hussain, F. and I. Ilahi. 2012. A text book of Botany. Department of Botany, University of London.

8. Barsanti, L. and P. G. Gualtieri.2006. Algae, anatomy, biochemistry, biotechnology. Taylor and Francis, New York.

9. B.N. Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Algae. S. Chand & Co.
10. Bellinger, E. G. and D. C. Sigee. 2010. Fresh water algae (Identification and use as Bio indicators). John Wiley & Sons.
11. Hussain, F. 2013. Phycology. A text book of Algae. Pak Book Empire Lahore.
12. Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Bryophytes. S.
13. Pakistan Journal of Botany, International Journal of Phycology and Phycochemsitry Bryology, Phycology.

BOT- 507 Mycology and Plant Pathology Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

a) Mycology

1. Introduction: General characters of fungi, Thallus, cell structure and ultra structure of fungi.
2. Reproduction: Asexual and sexual reproduction and reproduction structures, life cycle, haloid, heterokaryotic and diploid states.

3. Fungal Systematics: Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of Myxomycota, Chytridiomycota, Zygomycota (Mucrales) Oomycota (Peronosporales), Ascomycota (Erysiphales, Pezizales), Basidiomycota (Agaricales, Polyporales, Uredinales, Ustilaginales) and Deuteromycetes.

4. Symbiotic relationships of fungi with other organisms (lichens and mycorrhiza) and their significance.

5. Importance of fungi in human affairs with special reference to Industry and Agriculture

b) Pathology

1. Introduction and classification of plant diseases.
2. Symptoms, causes and development of plant diseases
3. Loss assessment and disease control
4. Epidemiology and disease forecast

5.Important diseases of crop plants and fruit trees in Pakistan caused by fungi, e.g. damping off ,mildews, rusts, smuts, dieback, red rot of sugarcane etc.

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

Lab Outline: Cr. Hr 01

a) Mycology

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

b) Pathology

Identification of major plant pathogens under lab and field conditions, cultural studies of some important plant pathogenic fungi, application of Koch's postulates for confirmation of pathogencity. Demonstration of control measures through chemotherapeutants.

Recommended Books:

1. Agrios, G. N., 2005. Plant Pathology, Academic Press, London.
2. Ahmad, I. and Bhutta, A. R., 2004. Textbook of Introductory Plant Pathology. Book .
3. Alexopoulos, C. J., Mims, C. W. and Blackwell, M., 1996. Introductory Mycology, 4th Ed. John Wiley & Sons.
4. Khan, A. G. and Usman, R., 2005. Laboratory Manual in Mycology and Plant Pathology.Botany Department Arid Agriculture University, Rawalpindi.
5. Mehrotra, R. S. and Aneja, K. R., 1990. An Introduction to Mycology. Wiley and Eastern Ltd, New Delhi, India.
6. Moore-Landecker, E., 1996. Fundamentals of Fungi.4thEdn. Prentice Hall Inc., New Jersey, USA.
7. Trigiano, R. N., Windham, M. T. and Windham, A. S., 2004. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

Journals / Periodicals:

Pakistan Journal of Botany, Mycotoxin, Mycopath, Phytopathology, Australasian Journal of Plant pathology , Asian Journal of Plant Pathology, Annual Review of Plant Pathology.

BOT-509 Diversity of Vascular Plants 3 (2+1)

Course contents: Cr,Hr 02

a) Pteridophytes

Introduction, origin, history, features and a generalized life cycle. Methods of fossilization, types of fossils, geological time scale and importance of pale botany. 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.

c) 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: **Cr. Hr 01**

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

Recommended Books:

1. Beck, C. B. 1992. Origin and Evolution of Gymnosperms. Vol-1&II, Columbia University Press, New York,
2. 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.
3. Mauseth, J. D. 1998. An Introduction to Plant Biology, Multimedia Enhanced, Jones and Bartlett Pub. UK.
4. Moore, R. C., W.d. Clarke and Vodopich, D. S. 1998. Botany McGraw-Hill Company, USA
5. Raven, P. H. Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants, W. H. Freeman and Company Worth Publishers.
6. Ray, P.M. Steeves, T. A. and Fultz, T. A. 1998. Botany Saunders College Publishing, USA.
7. Taylor, T. N. and Taylor, E. D.2000.The Biology and Evolution of Fossil Plants, Prentice Hall.
8. Stewart, W. N. and Rothwell, G. W. 1993. Paleobotany and the Evolution of Plants, University Press, Cambridge.
9. Faegri, K., P. E. Kaland & K. Krzywinski 1989. Text Book of Pollen Analysis, John Wiley & Sons. N. Y.
10. Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Pterodophyta. S. Chand & Co. New Delhi
11. B. P. Panday. 2006. College Botany. Vol 1 & II.S.7th Edition. Chand & Co. New Delhi
12. Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Gymnosperms. S. Chand &Co.

Journals / Periodicals:

Pakistan Journal of Botany, New Phytologist, Review of Palaeobotany & Palynology, Palaeontographica, Palaeobotanist

BOT-511 **Plant Systematic** **3(2+1)**

Course contents: **Cr,Hr 02**

1.Introduction: Importance and relationship with other sciences, Phases of plant taxonomy. Origin and radiation of angiosperm, their probable ancestors, when, where and how did the angiosperms evolve; the earliest fossil records of angiosperms.

2. Concept of Species: What is a species? Taxonomic species, Biological species, Micro and macro species, Species aggregate. Infra specific categories.

3. Speciation: Mechanism of speciation, Mutation and hybridization Geographical isolation, Reproductive isolation, Gradual and abrupt.

4. Variation: Types of variation, Continuous and discontinuous variation, Clinal variation.

5. Systematics and Genecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, Various biosystematics categories Such as ecophene, ecotype, ecospecies, coenospecies and comparium.

6. Taxonomic Evidence: Importance and types of taxonomic evidences: anatomical, cytological, chemical, molecular, palynological, geographical and embryological.

7. Nomenclature : Important rules of botanical nomenclature including effective and valid publication, typification, principles of priority and its limitations, author citation, rank of main taxonomic categories, conditions for rejecting names.

8. Classification: Why classification is necessary? Importance of predictive value. Brief history, Different systems of classification with at least one example of each (Linnaeus, Bentham and Hooker, Engler and Prantl, Bessey, Cronquist, Takhtajan, and Dahlgren.

9. Brief introduction of Numerical taxonomy.

10. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:

1. Apiaceae (Umbelliferae)
2. Arecaceae (Palmae)
3.Asclepiadaceae
4. Asteraceae (Composita
5. Boraginaceae
6. Brassicaceae (Cruciferae)
7. Capparidaceae
8. Caryophyllaceae
9.Chenopodiaceae
10.Convolvulaceae
11. Cucurbitaceae
12.Cyperaceae
13. Euphorbiaceae
14.Fabaceae(Leguminosae)
15.Lamiaceae (Labiatae)
16. Liliaceae
17. Magnoliaceae
18.Malvaceae
19. Myrtaceae
20. Orchidaceae
21.Papaveraceae
22. Poaceae (Gramineae)

23. Ranunculaceae
24.Rosaceae
25.Salicaceae
26. Scrophulariaceae
27.Solanaceae

Lab Outline: **Cr. Hr 01**

1.Technical description of plants of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan.
2. Preparation of indented and bracketed types of keys

3. Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.

4. Study of variation pattern in different taxa.

5. Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination

6.Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

Recommended Books:

1. Ali, S. I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi
2. Ali, S. I. and Qaiser, M. 1992-2007 –to date. Flora of Pakistan. Karachi Univ. Press, Karachi.
3. Greuter, W., McNeill, J., Barrie, F. R., Burdet, H. M., Demoulin, V., Filguerras, T. S., Niclson, D. H. Silva, P. C., Skog, J. E, Trehane, P. Turland, N.J. & Hawks worth, D.L.,(eds.)2000.International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International botanical congress St. Louis Missouri, July -August 1999. Koeltz, Konigstein. (Regnum Veg.138.)
4. Davis, P. H. & Heywood, V. H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London
5. Ingrouille, M. 1992. Diversity and Evolution of Land Plants, Chapman &Hall. London
6. Nasir, E. & Ali, S. I. 1970-89. Flora of Pakistan. Karachi Univ. Press, Karachi.
7. Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.
8. Takhtajan, A. (1986). Flowering Plant: Origin and Dispersal, Oliver and Boyd, Edinburgh
9. Jones, S. B. and Luchsinger, A. E. 1987. Plant Systematics. McGraw-Hill, Inc. New York.
10. Naik, V. N. 2005. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company, New Delhi.
11. Stussy, T. F. 1990. Plant Taxonomy, Columbia University Press, USA.
12. Jeffrey C. 1980. An Introduction to Plant Taxonomy. Cambridge UniversityPress.UK
13. Levin, D. A. 2000. The Origin, Expansion and Demise of Plant Species. Oxford University Press.
16. Sivarajan V. V and N. K. PcRobson 1991 Introduction to the Principles of Plant Taxonomy.
17. Radford, A. E., W. C. Dickison, J. R. Massey, and C. R . Bell. 1998 Vascular Plant

Systematic. Harper and Row, New York.
18. Leadlay, E. and Stephen 2006. Taxonomy and Plant Conservation.
19. Rajput, M. T., S. Saliha and K. M. Khan. 1996 Plant Taxonomy. Nasim Book Depot Hyderabad.
20. Heywood V. H. 1978. Flowering Plants of the World. Oxford University Press.
21. Simpson, M. G. 2006. Plant Systematics. Elsevier Academic Press.
22. Soltis, D. E. P. S. Soltis, P. K Endress, and M. W. Chase, 2005. Phylogeny & evolution of angiosperms. Sinauers associates, Inc. Publishers.
23. Pullaiah, T. 2007 Taxonomy of Angiosperms 3rd Ed. Regency Publication, New Delhi

Journals / Periodicals:
Pakistan Journal Botany, Flora of Pakistan, Taxon, Botanical Journal of the Linnaean Society.

BOTANY

1st Year
2nd Semester

BOT-502 **Anatomy of Vascular Plants** **Cr.Hr 3(2+1)**

1. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body.
2. Meristematic tissues: classification, cytohistological characteristics, initials and their derivatives.
3. Apical meristem: Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices.
4. Leaf: types, origin, internal organization, development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
5. Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions: additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth.
6. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.
7. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
8. Anatomy of reproductive parts:
9. a. Flower b.Seed c.Fruit
10. Economic aspects of applied plant anatomy
11. Anatomical adaptations
12. Molecular markers in tree species used for wood identification.

Lab outline: **Cr. Hr 01**

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

Recommended Books:

1. Dickison, W. C. 2000. Integrative plant anatomy. Academic Press, U. K.
2. Fahn, A. 1990. Plant Anatomy. Pergamum Press, Oxford.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Metcalf, C. R. and Chalk, L. 1950. Anatomy of the Dicotyledons. ClerondonPress. Oxford.
5. Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.

6. Vaughan, J. G. 1990. The structure and Utilization of Oil Seeds. Chapman and Hall Ltd. London.
7. Metcalfe, C.R.1960. Anatomy of the Monocotyledons. Gramineae. Clerondon Press, Oxford.
8. Metcalfe, C. R.1971. Anatomy of the Monocotyledons. V. Cyperaceae. Clerondon Press, Oxford.
9. Cutler, D. F. 1969. Anatomy of the Monocotyledons. IV. Juncales. Clarendon Press, Oxford.
10. Cutler, D. F. 1978. Applied Plant Anatomy. Longman Group Ltd. England
11. Raymond, E. S. and E. Eichhorn. 2005. Esau's Plant Anatomy; Meristematic cells and tissues of plant body. John Willey Sons.
12. Eames, A. J. and L. H. Mac Daniels. 2002. An introduction to Plant Anatomy. Tat McGraw-Hill Publishing Company Limited, New Delhi.

Journals / Periodicals:

Pakistan Journal of Botany

BOT-504 **Genetics-I** **Cr.Hr 3 (2+1)**

Course contents: **Cr,Hr 02**

1.Extensions of Mendelian Analysis: Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity.

2.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,

3.Linkage II: Special Eukaryotic Chromosome Mapping Techniques: Accurate calculation of large map distances, analysis of single meioses, mitotic segregation and recombination, mapping human chromosomes.

4. Recombination in Bacteria and their Viruses: Bacterial chromosome, bacterial conjugation, bacterial recombination and mapping the E.coli chromosome, bacterial transformation, bacteriophage genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer.

5.The Structure of DNA: DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene.

6.The Nature of the Gene: How genes work, gene- protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites, complementation.

8.DNA Function: Transcription, translation, the genetic code, protein synthesis, universitality of genetic information transfer, eukaryotic RNA.

9.TheExtranuclearGenome : Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochrondrial genes in yeast, extragenomic plasmids in eukaryotes.

10. Developmental Genetics: Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease.

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

Lab Outline: **Cr. Hr 01**

a) Arrangement of genetic material:
i Linkage and recombination
ii. Gene mapping in diploid.
iii. Recombination in Fungi.
iv. Recombination in bacteria.
v. Recombination in viruses.

b) Population Genetics:
i. Gene frequencies and equilibrium.
ii. Changes in gene frequencies,

2. Blood group and Rh-factor

3. Drosophila
i. Culture technique
ii. Salivary gland chromosome

4. Fungal Genetics Sacchromyces culture techniques and study.

5. Studies on variation in maize ear size and colour variation

6. Bacterial Genetics.
i. Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
ii. Transformation.
iii. Conjugation.

Recommended Books:

1. Gelvin, S, B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
2. Pierca, B. A. 2005. Genetics. A conceptual approach, W. H. Freeman and Company, New York.
3. Synder, L, and Champness, W. 2004. Molecular Genetics of Bacteria. ASM Press, Washington D. C.
4. Klug, W. S. and Cummings, M. R. 1997. Concepts of Genetics, Prentice Hall International Inc.
5. Roth Well, N. V. 1997. Understanding Genetics, 2nd Edition, Oxford University Press Inc.
6. Gardner, E. J., 2004. Principles of Genetics, John Willey and Sons, New York.
7. Ringo J, 2004. Fundamental Genetics, Cambridge University Press.
8. 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.
9. Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.
10. Hartl, D. L. and Jones, 2005, Genetics- Analysis of Genes and Genomes, Jones and Bartlett Publishers. Sudbry, USA.
11. Hedrick, P. W.2005. Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.
12. Mahmut Caliskan. 2012. The Molecular basis of plant genetic diversity. In Tech Publishers.
13. Ram J. Singh. 2011. Genetic resources, chromosome engineering and crop improvement. Medicinal plants.Vol.6.CRC Press.
14. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino. 2011. Concepts of genetics. Pearson Educations

15. Daniel Hartl. 2011. Genetics Johns and Bartlett Publishers.
16. David Hyde. 2008. Introduction to Genetic principles. McGraw-Hill.
17. Daniel, L. Hart, Elizabeth W. Jones. 2009. Analysis of genes and genomes. John and Barlett.
18. Noureddine Benkeblia. 2011. Sustainable agriculture and new biotechnologies. CRC Press.

Journals/Periodicals:

J. Genetics, Theoretical and Applied Genetics, Cytologia, Chromosoma, Genome

BOT-506 Plant Biochemistry I Cr.Hr 3(2+1)

Course contents: Cr,Hr 02

Introduction to photosynthetic organisms, Bioenergetics and overview of photosynthesis, Photosynthesis: The Light Reaction Photosystems, ATP Synthesis, CO 2 Fixation, RuBisCo and enzyme kinetic, C-3 Cycle, C-4 Cycle, Regulation of photosynthesis

Introduction to carbohydrates:

Occurrence and classification, Sugar structures, synthesis of polysaccharides, Carbon metabolism in the chloroplast, Starch synthesis Pentose phosphate pathway Carbon export Sucrose synthesis and transport in vascular plants, Cellulose synthesis and composition of primary cell walls

Introduction to lipids:

Occurrence, classification. Structure and chemical properties of fatty acids, Fatty acid biosynthesis in plants, di and triglycerides, phospholipids, glycolipids, sulpholipids, waxes and sterols.

Introduction to Proteins:

Amino acids and their structure. Electrochemical properties and reactions of amino acids. Classification of proteins. Primary, secondary, tertiary and quaternary structure of proteins. Protein targeting. Protein folding and unfolding. ,storage, regulatory and receptor proteins. Protein purification. Protein sequencing. Biological role. Plant defense proteins and peptides, Defensins and related proteins, Synthesis and functions of non-ribosomal peptides.

Introduction to Nucleic Acids: General introduction. Purine and pyrimidine bases, nucleosides, . Structure and properties of DNA and RNA. Types and functions of RNA. Nucleic Acid Metabolism.

Introduction to Enzymes: Nature and functions, I.U.E. classification with examples of typical groups. Isozymes, ribozymes, abzymes. Enzyme specificity. Enzyme kinetics. Nature of active site and mode of action. Allosteric enzymes and feedback mechanism. Enzymes with multiple functions - mechanisms and evolution. Isoprenoid metabolism, Biosynthetic pathways, Monoterpenes, sesquiterpenes, phytosterols, diterpenes, Enzymes with multiple functions - mechanisms and evolution

Lab Outline: Cr. Hr 01

1. Solutions, acids and bases. Electrolytes, non-electrolytes, buffers pH Chemical bonds.
2. To determine the Rf value of monosaccharides on a paper Chromatogram.
3. To estimate the amount of reducing and non-reducing sugars in plant material titrimetrically/ spectrophotometrically.
4. To determine the saponification number of fats.
5. To extract and estimate oil from plant material using soxhlet apparatus.
6. Analysis of various lipids by TLC methods.

7. To estimate soluble proteins by Biuret or Lowry or Dye-binding method.
8. To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
9. To determine the Rf value of amino acids on a paper chromatogram.
10. Extraction of Nucleic acids from plant material and their estimation by UV absorption or colour reactions.
11. To estimate the catalytic property of enzyme catalase or peroxidase extractedfrom a plant source.
12. To determine the **p**Ka and isoelectric point of an amino acid.

Recommended Books:

1. Conn E E. And Stumpf P. K., 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
2. Lehninger, A L. 2004. Principles of Biochemistry. Worth Publishers Inc.
3. Voet, D., Voet J. G. and Pratt, C. W. 1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
4. Dey, P. M. and Harborne, J. B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
5. Smith, E. L, Hill, R L, Lehman, R I., Lefkowits, R J. Handler and Abraham. 2003, Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
6. Zubay G,.2003, Biochemistry, MacMillan Publishing Co., New York.
7. Chesworth,.J. M., Strichbury T. and Scaife., J. R. 1998. An introduction to agricultural biochemistry. Chapman and Hall, London.
8. Mckee, T. and Mckee, J. R. 1999. Biochemistry - An Introduction. WCB/McGraw-Hill, New York, Boston, USA.
9. Lea, P. J.. andLeegood, R. C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
10. Abdes, R. H. Frey, P. A. and Jencks W. P. 2004, Biochemistry, Jones and Bartlet, London.
11. Goodwin T. W. and Mercer, E. I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.
12. Heldt, H. W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U. K.
13. Bowsher, C. 2008. Plant Biochemistry.
14. Campbell, M. K. and F. Shawn. 2008. Biochemistry 6th Edition.

Journals / Periodicals:

Plant Physiology and Biochemistry, Annual Review of Biochemistry, Biochemistry Journal, Critical Review in Biochemistry and Molecular Biology

BOT-508 Plant Ecology-I Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

1. **Introduction:** history and recent developments in ecology .

2. Soil: Nature and properties of soil (Physical and Chemical).Water in the soil-plant-atmosphere continuum. The ionic environment and plant ionic relations, Nutrient cycling. Physiology and ecology of N, S, P and K nutrition. Heavy metals (brief description), Salt and drought stress and osmoregulation. Soil erosion .

3. **Light and temperature**: Nature of light, Factors affecting the variation in light and temperature, Responses of plants to light and temperature, Adaptation to temperature extremes,

4. **Carbon dioxide**: Stomatal responses, water loss and CO2-assimilation rates of plants in contrasting environments .Ecophysiological effects of changing atmospheric CO2concentration.Functional significance of different pathways of CO2 fixation. Productivity: response of photosynthesis to environmental factors, C and N balance .

5. **Water:** Water as an environmental factor, Role of water in the growth, adaptation and distribution of plants, Water status in soil, Water and stomatal regulation, Transpiration of leaves and canopies.

6. **Oxygen deficiency: Energy** metabolism of plants under oxygen deficiency, Morph-anatomical changes during oxygen deficiency, Post-anoxic stress

7. **Wind as an ecological factor.**

8. **Fire as an ecological factor.**

Lab Outline: **Cr.Hr 01**

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

Recommended Books:

1. M. Ahmad and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons New Urdu Bazar Karachi.
2. Schultz, J. C. 2005. Plant Ecology, Springer-Verlag
3. Bazzaz, F. A. 2004. Plants in Changing Environments: Linking Physiological, Population, and Community Ecology, Cambridge University Press
4. Chapin, F. S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
5. Lambers, H. et al. 2002. Plant Physiological Ecology, Springer-Verlag
6. Larcher, W.2003., Physiological Plant Ecology: Ecophysicology and Stress Physiology of Function Groups - Springer-Verlag
7. Nobel, P. S1999, Physico-chemical and Environmental Plant Physiology, Academic Press.
8. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Phyiological Ecology.
9. Smith, R. L. 2004. Ecology and field Biology. Addison Wesley Longman, Inc., New York.
10. Barbour, M. G., Burke, J. H and Pitts, W. D. 2004 Terrestrial Plant Ecology, The Benjamin, Cumming Publishing C. Palo Alto, California, USA.
11. Smith R. L. 1998 Elements of Ecology. Harper & Row Publishing.
12. Townsend. C. R. Begon. M and J. L Harper.2002 Essentials of ecology. Blackwell Publishing.
13. Gurevitch. J. Scheiner, S. M. and G. A Fox. 2006 The Ecology of Plants\. Sinaur Associate Inc.
14. Hussain. F. 1989 Field and Laboratory Manual of Plant Ecology, National Academy

of Higher Education, Islamabad.
15. Hussain. S. S.1989 Pakistan Manual of Plant Ecology. National Book Foundation Islamabad.
16. More. P. D. and Chapman S. B. 1986 Methods in Plant Ecology, Blackwell Scientific Publication Oxford.
17. Rashid, A. 2005. Soil Science. National Book Foundation, Islamabad. Journals / Periodicals:
Pakistan Journal of Botany, Journal of Ecology, Journal of Applied Ecology, Ecology, Journal of Arid Environment

BOT-510 Plant Physiology-I Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

1. **Photosynthesis**: History of photosynthesis. Nature and units of light. Determination of oxygenic and an oxygenic photosynthesis. Ultra structure of thylakoid vesicle. Various pigments and photosynthetic activity. Ultra structure and composition of photo system-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. CO_2 reduction(dark reactions) - C3 pathway and Photorespiration, Regulation of C3 pathway, C4 pathway and its different forms, C3-C4 intermediates, CAM pathway. Methods of measurement of photosynthesis.
2. Respiration: Synthesis of hexose sugars from reserve carbohydrates. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration . Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respiration.
3. Translocation of Food: Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.
4.Leaves and Atmosphere: Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.
5. 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: Cr. Hr 01

1. To determine the volume of CO2 evolved during respiration by plant material.
2. To determine the amount of O2 used by respiring water plant by Winkler Method.
3. Separation of chloroplast pigments on column chromatogram and their quantification by spectrophotometer.
4. To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.

5. To categorize C3 and C4 plants through their anatomical and physiological characters.
6. To regulate stomatal opening by light of different colours and pH.

Recommended Books:

1. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B.1997. Plant Metabolism.2nd Edition. Longman Group, U.K.
2. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
3. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
4. Heldt, H-W. 2004. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
5. IhsanIllahi, 1991. Plant Growth, UGC Press, Islamabad.
6. IhsanIllahi, 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
7. Nobel, P.S.1999. Physicochemical and Environmental Plant Physiology. Academic Press, UK.
8. Press, M.C., Barker, M.G., and Scholes, J.D.2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.
9. Salisbury F.B. and Ross C.B. 1992. Plant Physiology.5th Edition. Wadsworth Publishing Co. Belmont CA.
10. Taiz, L. and Zeiger, E. 2006. Plant Physiology.4th Edition. Sinnauers Publ. Co. Inc. Calif.
11. W.B. Hopkins. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
12. Epstein, E. and Bloom, A.J. 2004. Mineral Nutrition of Plants: Principles and Perspectives. 2nd Edition. Sinauer Associates, California, USA.
13. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
14. Barton, W. 2007. Recent Advances in Plant Physiology.

Journals/Periodicals: Pakistan Journal of Botany, Plant Physiology, Physiologia Plantarum, lanta, AnnuaReview of Plant Biology, Journal of Plant Physiolog

BOT- 512 Molecular Biology Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

1. **Nucleic Acids:** DNA-circular and super helical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA, Central Dogma

2. **Proteins:** Basic features of protein molecules. Folding of polypeptide chain, α-helical and β-secondary structures. Protein purification and sequencing.

3. **Transcription:** Enzymatic synthesis of RNA, transcriptional signals Translation: The genetic code. The Wobbling, polycistronic and monocistronic RNA. Overlapping genes.

4. **Gene regulation in Eukaryotes**: Differences in genetic organization and prokaryotes and eukaryotes. Regulation of transcription, initiation, regulation of RNA processing, regulation of nucleocytoplasmic mRNA transport, regulation of mRNA stability, regulation of translation, regulation of protein activity.

5. **Plant Genomic**s: Transcriptomics; DNA libraries, their construction, and screening and application. Microarray of gene technology and its application in functional genomics.

6. **Proteomics;** structural and functional proteomics. Methods to study proteomics Metabolomics; methods to study metabolomics; importance and application of metabolomics

7. Bioinformatics and computational biology. Levels, scope, potential and industrial application of bioinformatics and computational biology, Docking.

Lab Outline: **Cr. Hr 01**

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

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

Recommended Books:

1. Cullis, C. A. 2004. Plant Genomics and Proteomics. Wiley-Liss, New York.
2. Gibson, G. and S. V. Muse, 2002. A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
3. Gilmartin, P. M. and C. Bowler. 2002. Molecular Plant Biology. Vol. 1 & 2. Oxford University Press, UK.
4. Lodish, H. et al., 2004. Molecular Cell Biology.5th Edition.W H Freeman & Co., New York.
5. Malacinski, G. M. 2003. Essentials of Molecular Biology, 4th Edition. Jones and Bartlett Publishers, Massachusetts.
6. Watson, J. D. et al. 2004. Molecular Biology of the Gene. Peason Education, Singapore.
7. Ignacimuthu, S. 2005. Basic bioinformatics. Narosa Publishing House, India.
8. Weaver, R. F. 2005. Molecular Biology. McGraw-Hill, St. Louis.
9. Lehninger, A L. 2004. Principles of Biochemistry. Worth Publishers Inc.
10. Bruce Alberts et al. 2007. Molecular biology of the cell.5thEdition.Garl

2nd YEAR

3rd Semester

BOT--601 **Plant Biochemistry-II** **Cr.Hr 3 (2+1)**

Course contents: **Cr,Hr 02**

1. **Bioenergetics**: Energy, laws about energy changes. Oxidation and reduction in living systems.

2**. Metabolism**:

i. Biosynthesis, degradation and regulation of sucrose and starch.

Breakdown of fats with special reference to beta-oxidation and its energy balance. Biosynthesis of fats.

ii. Replication of DNA. Reverse transcription. Biosynthesis of DNA and RNA.

iii. Components of protein synthesis. Genetic code, protein synthesis: initiation, elongation and termination.

3. **Alkaloids**: Occurrence, physiological effects, chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role.

4.**Terpenoids**:Classification.monoterpenes,sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis.

5. **Vitamins**: General properties and role in metabolism.

Lab Outline: **Cr. Hr 01**

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

Recommended Books:

1. Conn E. E. and Stumpf, P. K. 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
2. Albert L. Lehninger, 2004. Principles of Biochemistry. Worth Publishers Inc.
3. Voet, D. Voet J. G. and Pratt, C. W.1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
4. Dey, P. M. and Harborne, J. B. 1997. Plant Biochemistry. Harcourt Asia PTELtd. Singapore.
5. Smith; E L., Hill; R. L., Lehman; R. I., Lefkowits, R J. and Abraham. H. Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
6. Zubay. G. 2003, Biochemistry, MacMillan Publishing Co., New York.
7. Chesworth,. J. M., Strichbury T. and Scaife, J. R. 1998. An introduction to Agricultural Biochemistry. Chapman and Hall, London.
8. Mckee, T. and Mckee, J. R. 1999. Biochemistry - An Introduction. WCB /McGraw-Hill, New York, Boston, USA.
9. Taiz, L. and Zeiger, E. 2006. Plant Physiology.4thEdition. Sinnauers Publ. Co. Inc. Calif.
10. Lea, P. J. and Leegood, R. C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
11. Abides, R. H., Frey P. A. and Jencks, W. P. 1992. Biochemistry, Jones and Bartlet, London.
12. Goodwin T. W. and Mercer, E. I.1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.

13. Heldt, H. W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U. K.
14. Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition.

Journals / Periodicals:Plant Physiology & Biochemistry, Annual Review of Biochemistry, Journal, Critical Review in Biochemistry and Molecular Biology.

BOT-603 Plant Ecology-II Cr.Hr 3(2+1)

Course contents: Cr,Hr 02

A. Population Ecology

1. Population structure and plant demography: Seed dispersal, Dormancy, Seed Bank, Seed dormancy, Recruitment, Demography

2. Life history pattern and resource allocation: Density dependent and Density independent factors, Resource allocation, Reproductive effort, Seed size vs seed weight, Population genetics, Evolution

B. Community Ecology:

Historical development of community ecology, Community concepts and attributes, Methods of sampling of plant communities, Ecological succession, Community soil-relationship, Local Vegetation, Vegetation of Pakistan, Major formation types of the world

C. 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: Cr. Hr 01

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

Recommended Books:

1. Ahmad, M. and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons, New Urdu Bazar, Karachi.
2. Schultz J. C. 2005. Plant Ecology, Springer-Verlag.
3. Townsend C. R. Begon. M and J. L. Harper 2002. Essentials of Ecology, Blackwell Publishing,
4. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
5. Gurevitch, et al., 2002.The Ecology of Plants, Sinauer Associates, Inc.
6. Barbour M. G. et al., 1999, Terrestrial Plant Ecology, The Benjamin-Cumming Publishing Co.
7. Smith, R. L. 1998. Elements of Ecology by Harper & Row Publishers,
8. Moore P.D. and Chapman S. B. 1986. Methods in Plant Ecology, Blackwell Scientific Publication, Oxford.
9. Hussain, S. Pakistan Manual of Plant Ecology,
10. Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education. Islamabad
11. Larcher. W. 2003 Physiological Plant Ecology. Ecophysiology and Stress Physiology of Function Groups. Springer- Verlag.

Journals/Periodicals: Ecology, Journal of Ecology, Journal of Applied Ecology .

BOT—605 Plant Physiology-II Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

1. Plant Growth Regulators: Major natural hormones and their syntheticAnalogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action, transport, physiological effects of Auxin ,Gibberellins, Cytokinins, Abscisic acid, Ethylene, Polyamines, Brassinosteriods, Jasmonates, and Salicylic acid.

2. 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. Hoflerdiagram - analysis of change in turgor, water and osmotic potential with changes in cell volume. Modulus of elasticity coefficient; Hydraulic conductivity. Osmoregulation, Methods for measurement of water , osmotic and turgor potentials- Pressure chamber, psychrometry, pressure probe, pressure volume curve.

3.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 energetic. Essential and beneficial elements-their functions and deficiency symptoms in plants. Fertilizers and their significance in Agriculture.

4. **Phytochromes:** Discovery of phytochromes and cryptochromes. Physical and chemical properties of phytochromes. Distribution of phytochromes among species, cells and tissues and their role in biological processes. Phytochromes and gene expression.

5.**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 signalling involved in flowering. Vernalization and its effect on flowering. Floral meristem and floral organ development. Floral organ identity genes and the ABC model.

6.**Signal transduction in prokaryotes and eukaryotes.**

7.**Dormancy;** definition and causes of seed dormancy; methods of breaking seed dormancy; types and physiological process of seed germination.

8. **Plant Movements**; Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements.

Lab Outline: Cr. Hr 01

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

Recommended Books:

1. Dennis, D. T., Turpin, D. H., Lefebvre, D. D. and Layzell, D. B. 1997. Plant Metabolism. 2nd Edition.Longman Group, U. K. Dey, P. M. and Harborne, J. B. 1997.Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
2. Fitter, A. and Hay, R. K. M.2001. Environmental Physiology of Plants. Academic Press, UK.
3. Heldt, H. W. 2004. Plant Biochemistry.3rd Edition, Academic Press, U.K.
4. IhsanIllahi, 1991. Plant Growth, UGC Press, Islamabad.
5. IhsanIllahi, 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
6. Nobel, P. S. 1999. Physicochemical and Environmental Plant Physiology. Academic Press, UK.
7. Press, M. C., Barker, M. G., and Scholes, J. D. 2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.
8. Salisbury F. B. and Ross C. B. 1992. Plant Physiology.5th Edition. Wadsworth
9. Publishing Co. Belmont CA.
10. W. B. Hopkins. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
11. Epstein, E. and Bloom, A. J. 2004. Mineral Nutrition of Plants: Principles and Perspectives. 2nd Edition. Sinauer Associates, California, USA.
12. Kirkham, M. B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
13. Barton, W. 2007. Recent Advances in Plant Physiology.
14. Taiz, L. and Zeiger, E. 2006. Plant Physiology.4thEdition.Sinnauers Publ. Co. Inc. Calif.

Journals / Periodicals:

Pakistan Journal of Botany, Plant Physiology, Physiologia Plantarum, Planta, Annual Review of Plant Biology, Journal of Plant Physiology

BOT--607 Genetics-II Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

1. **Recombinant DNA:** Recombinant DNA Technology Introduction, Basic Techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA methodology, Site directed Mutagenesis, DNA sequencing.

2**. Application of Recombinant DNA**: Applications of recombinant DNA technology using prokaryotes, recombinant DNA technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions.

3. **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.

5. **Mechanisms of Genetic Change II:** Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.

6. **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.
7. **Human Genome Project:** Strategies and application, achievement and future prospects.
8. **Plant Genome Projects:** Arabidopsis, achievement and future prospects. Other plant genome projects
9. **Bioinformatics**: Application of computational tests to the analysis of genome and their gene products
10**. Bioethics**: Moral, Religious and ethical concerns

Lab Outline:

Problems relating to the theory
1. Isolation and separation of DNA and protein on Gel electrophoresis.
i. Bacterial chromosome
ii.Plasmid DNA (miniprints)
iii. Plant DNA
iv. Protein.
2 . DNA Amplification by PCR

Recommended Books:

1. Trun, N and Trempy J.2004, Fundamental Bacterial Genetics, Blackwell Publishing House.
2. Winnacker, E. L.2003, From Gene to Clones Introduction to Gene Technology, Panima Publishing Corporation, New Delhi.
3. Beaycgamp T. L. and Walters L., Contemporary Issues in Bioethics, Wadsworth Publishing Company.
4. Brown, T. A. 2002 Genomes, Bios Scientific Publishers Ltd.
5. The Genome of Homo Sapiens, 2003, Cold Spring Harbor Laboratory Press.
6. Ignacimuthu, S. 2005, Basic Bioinformatics, Narosa Publishing House, India,.
7. Lwein, B. 2004, Gene VIII, Pearson Education Int.
8. Miglani,2003, Advanced Genetics, Narosa Publishing House, India,.
9. Hartt, D. L, and Jones, E. W. 2005. Genetics, Analysis of Gene and Genomes. Jones and Bartlett Publishers, Sudbury, USA
10. Gelvin, S. B 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
11. Primrose, S. B., Twyman, R. M. and Old R. W. 2004. Principles of Gene Manipulation, an Introduction to Genetic Engineering (6^{th} Edition), Blackwell Scientific Publications.
12. Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.
13. Wilson, J. and Hunt, T. 2004. Molecular Biology of the cell - the problems book, Garland publishing Inc.
14. 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, 7^{th} Edition. Freeman and Company.
15. Hedrick, P. W. 2005. Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.
16. Mahmut Caliskan. 2012. The Molecular basis of plant genetic diversity. In Tech Publishers.
17. Ram J. Singh. 2011. Genetic resources, chromosome engineering and crop improvement. Medicinal plants. Vol.6.CRC Press.
18. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino. 2011. Concepts of Genetics. Pearson Educations.
19. DanielHartl. 2011. Genetics Johns and Bartlett Publishers.
20. David Hyde. 2008. Introduction to Genetic principles. McGraw-Hill.

21. Daniel, L. Hart, Elizabeth W. Jones. 2009. Analysis of genes and genomes. John and Barlett.
22. NoureddineBenkeblia. 2011. Sustainable agriculture and new biotechnologies.CRC Press.
Journals / Periodicals:
J. Genetics, Theoretical and Applied Genetics, Cytologia, Chromosoma, Genome

BOTANY
2nd YEAR
4th Semester

BOT-602 Seminar/Presentations Cr.Hr 1(1+0)

Each student will be allotted a topic from about sixty latest and advance topics according to current needs.

Bot-604 Biodiversity and Conservation Cr.Hr 3 (2+1)
Course contents: Cr,Hr 02

1. Introduction and importance of biodiversity: Species diversity, Ecological diversity, Genetic diversity and Social diversity.
2. Causes and depletion of biodiversity: habitat loss, habit fragmentation, over exploitation, climate changes, invasive species, sea water intrusions.

ii . The value of species.
iii. How species become endangered.
iv Extinction of species, present rate. Theory of mass extinction.
v. Inventory and monitoring of biodiversity .
vi. Importance of red data book.
vii *In situ and ex situ* conservation of plants.
viii. Implementations of laws (protection and conservation of various taxa).
ix. Sustainable use of biodiversity (plant wealth).
x. Protected areas of Pakistan.
xi. Criteria for determining different categories of protected areas.
xii. Baseline study .
xiii. Impact Assessment.
xiv. Management plan for protected areas .
xv.. IUCN categorized for of threatened species.
xvi Criteria for recognising different categories of threatened species.
xvii Gene bank management and operation.
xviii. Public awareness strategies.
xix. Population explosion.
xx. Biodiversity action plan for Pakistan
xxi. Role of herbarium and Botanical Garden in biodiversity conservation.

Lab outline: Cr.Hr. 01

1 Causes of local species extintion
2 Field excursion.
3 Data collection
4 Preparation of an inventory of the flora of given region.
5 To carryon baseline study of any designated category.

Recommended Books:

1. Bush, M. B. 1997.Ecology Of Changing Planet. Parentiee Hall.
2. Cunninghum, A.B., 2001. Applied Ethnobotany: People Wild Plant Use And Conservation. Earthspan Publiations.
3. Cotton,C. M.1996.Ehtnobotany Principle Application. John Wiley & Sons Chechester.UK.
4. De Klem. C. 1990. Wild Plant Conservation, IUCN, Gland.
5. Dyke, E. V.2003. Conservation Biologyy. Cambridge University Press, Cambridge, UK.
6. Grombridge, B. And Jenkins, M. D.2002. World Atlas of Biodiversity. Earth Living Resources In The 21 Century University, California Press, Berkley.
7. Heywood, V. H. 1995 Global Biodiversity Assessment. Cambridge University Press And UNEP
8. Krishma Murthy K V.2003 A Textbook Of Biodiversity, Science Publishers Inc Enfield, Nh , Usa
9. Levine, D.A. The Origin Expansion And Demise Of Plant Species. Oxford University Press
10. Ministry Of Environment, IUCN,WWF,1998. Biodiversity Action Plan for Pakistan.
11. Primack , R.B. 1998. Essential of Conservation Biology. Sinaur Association Pb, Mass USA.
12. Virchow, D. (1998). Conservation of Genetic Resources. Springer-Verlag, Berlin.

Journals /Periodicals :

Systematics and Biodiversity, Biological Conservation.

BOT-606 Environmental Biology Cr.Hr 3 (2+1)

Course contents: Cr,Hr 02

1. **Environment:** Introduction, scope, pressure
2. **Pollution:** 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

ii. Theory of acid rain, ii 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 .

3. **Forest:** importance, deforestation, desertification and conservation.

4.**Ozone layer:**

i. Formation

ii. Mechanism of depletion

iii. Effects of ozone depletion

5. **Greenhouse** effect and global warming: causes, impacts.

6. **Human population explosion**: impact on environment.

7. **Impact assessment**: Industrial urban, civil developments.

8. **National conservation strategy**: Brief review of major problems of Pakistan and their

solutions.

9. **Sustainable Environmental management**.
10. **Wetlands and sanctuaries protection:** The pressures, problems and solutions.
11. **Range management:** Types of rangelands, potential threats, sustainable management.
12. **Aerobiology** (Pollen allergy & dust allergy).

Lab Outline: **Cr. Hr 01**

1. 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.

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

Recommended Books:

1. Newman, E. I. 2001. Applied Ecology. Blackwell Science. UK
2. Mooney, H. A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
3. Eugene, E. D. and Smith, B. F. 2000. Environmental Science: A study of interrelation ships.
4. McGraw-Hill. USA. French, H. 2000. Vanishing Borders: Protecting the Planet in the Age of Globalization. W. W. Norton and Company, NY.
5. Hall, C. A. S. and Perez, C. L. 2000. Quantifying Sustainable Development. Academic Press, UK.
6. Bazzaz, F. A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
7. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
8. Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.
9. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.
10. MohamamdAshfaq and Mushtaq A. Saleem. Environmental Pollution and Agriculture.
11. Shah Faisal Muhamamd and Sultan Mehmood. 2012. Lambert Publishers Germany.
12. Advanced Air and Noise Pollution Control, L. K. Wang, N. C. Pereira and Y. T.Hung, Humana Press, 2005.
13. Air Pollution Control Technology Handbook, K. B. Schnelle and C. A. Brown, CRC Press, 2002. Handbook of Solid Waste Management and Waste Minimization Technologies, N. P. Cheremisin off, Butterworth-Heinemann, 2003.
14. Pollution Control In Process Industries, S. P. Mahajan, Tata McGraw-Hill, 1985.
15. Industrial Pollution control: issues and techniques, N. J. Sell, Van Nostr and Reinhold, 1992.
16. Environmental Biotechnology: Basic Concepts and Applications, I. S. Thakur, I.K. International Publishing House Pvt. Limited, 2006.
17. Vandermeer, John H. 2011. The ecology of agro-ecosystems - Jones and Bartlett Publishers; Sudbury, Mass; 2011 - xv, 387 p.

18. Greipsson, Sigurdur. 2011. Restoration ecology - Jones and Bartlett Publishers; Sudbury, MA; 2011 - xvi, 408 p
19. Santra, S. C. 2010. Fundamentals of ecology and environmental biology –New Central Book Agency; London; 2010 - 353p.
20. Singh, M.P. 2007 Forest environment and biodiversity Daya; New Delhi; 2007 -556p.
Journals/Periodicals: Environmental Biology, Environment, Bioremediation

BOT-608 Cell Biology Cr.Hr 3(2+1)

Course contents: Cr,Hr 02

Introduction of prokaryotes and eukaryote cell, Animal and Plant cell structure. Brief description of ultra structure and functions of plant cell organelles
Endomembranous systems:
Cell cycle and cell division; meiosis in sexual reproduction in plants.
Cellular metabolism and enzymes.
Cellular respiration and photosynthesis.
Biological information flow; transcription and translation.
Informational molecules; carbohydrates proteins and nucleic acids.
Cytoskeleton in cell cycle and mitosis.
Extra cellular matrix;, various types of extra cellular matrix proteins; elastic fibronectin, glycoprotein, collagen, dyanin and motor proteins
Vesicular trafficking, cell migration, cell adhesion, cancer growth factors, disorders in cell cycle, apoptosis and gap junction

Lab outline; Cr.Hr 01

1. Study of mitosis and meiosis in onion root tip and pollen grains.
2. Study of cell organelles in plant cell by compound microscope.
3. Measurement of cell size.
4. Separation of different sized DNA fragments on agarose gel.
5. Study of chromosomes morphology and variation in chromosomes number.
6. Counting of prokaryotic cells (bacteria) and blood cells by using haemocytometer.
7. Extraction and estimation of carbohydrates, proteins and DNA from plant sources.

Books Recommended

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. And Watson, J.D. Molecular Biology Of The Cell, 1989. Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H. And Balimore, D. Molecular Cell Biology, 1990. Scientific American Inc. N.Y.
3. De Robertis, E. D. P. And De Robertis Jr. E. N. F. Cell And Molecula Biology, 1987. Lea &Febiger, New York.
4. Karp, J. Cell And Molecular Biology, Concepts And Experiments, 2005.Jhon Wiley And Sons, Inc.
5. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2007. Sinauer Associates, Inc.
6. Bruce Albert Et Al. 2009. Essential Cell Biology. Garland Sciences Publishers
7. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman And Co.