

UOS/CE/No. 2946
29.17

UNIVERSITY OF SARGODHA, SARGODHA

NOTIFICATION

No. UOS/Acad/762

Dated: 30.08.2017

On the recommendation of Academic Council made in its meeting dated 23.08.2016, the Syndicate in its 1/2017 meeting held on 15-16.05.2017 has approved the curricula of following programs to be implemented from the session mentioned against each:-

1. Revised Scheme of Studies for BS, M.Sc, M.Phil & Ph.D Botany w.e.f 2016 and onward (annex-'A', 'B', 'C' & 'D').
2. Addition of Elective Courses in MS (CS) Curriculum w.e.f 2016 (annex-'E').
3. Addition of courses in scheme of studies of Ph.D program of Computer Science (annex-'F'). (already included and notified vide No.UOS/Acad/573 dated 19.06.2017)
4. Revised curriculum of BS 4-Year Mathematics program w.e.f 2016 & onward (annex-'G').
5. Revised curricula of M.Sc and M.Phil / Ph.D Mathematics w.e.f 2016 (annex-'H', 'I')
6. Revised Scheme of Studies for BS, M.Sc, M.Phil and Ph.D Zoology w.e.f 2016 (annex-'J', 'K', 'L', 'M')
7. Addition of Elective Courses in the Scheme of Studies of MS(CS) program (annex-'N')
8. No. of credit hours for MS (CS) Theses in Computer Science department (annex-'O')
9. Addition of Elective Courses BS (CS) program in Computer Science w.e.f 2016 (annex-'P')
10. Revised curricula of BS & M.Sc program in Biotechnology w.e.f 2016-17 (annex-'Q' & 'R')

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(AMJAD HUSSAIN JANJUA)
Deputy Registrar (Acad)
30/8/17

Distribution:

- Chairman / Incharges of the concerned departments
- Controller of Examinations
- Directors Sub-Campuses
- Principals Affiliated Colleges (concerned)
- Web-Developer (for uploading on university web-site)

C.C:

- Dean, Faculty of Sciences
- Secretary to the Vice-Chancellor
- P.A to Registrar

**DEPARTMENT OF BOTANY
UNIVERSITY OF SARGODHA
SARGODHA**

**M.Sc BOTANY ANNUAL SYSTEM (2016 AND ONWARD)
TWO YEARS PROGRAMME
SCHEME OF STUDIES**

Annexure-A

Part-I

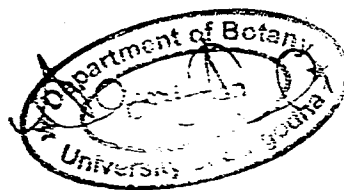
Course #	Title	Marks	Theory	Practical
Paper I	Phycology and Bryology <i>Same</i>	100	75	25
Paper II	Mycology and Plant pathology <i>Dif.</i>	100	75	25
Paper III	Plant Biochemistry <i>Same</i>	100	75	25
Paper IV	Morphology and Anatomy of Vascular Plants <i>Same</i>	100	75	25
Paper V	Bacteriology and Virology <i>Same</i>	100	75	25
Paper VI	Cell and Molecular Biology <i>Same</i>	100	75	25

Part-II

Course #	Title	Marks	Theory	Practical
Paper VII	Genetics <i>Dif.</i>	100	75	25
Paper VIII	Plant Ecology <i>Dif.</i>	100	75	25
Paper IX	Plant Physiology <i>Same</i>	100	75	25
Paper X	Plant Systematics and Taxonomy <i>Same</i>	100	75	25
Paper XI	Biostatistics and Mathematics <i>Dif.</i>	100	75	25
Paper XII*	Optional Paper-I/Thesis	100	75	25
Paper XIII*	Optional Paper-II/Thesis	100	75	25

**In lieu of thesis two optional courses will be offered from the list attached depending upon resources of the department and thesis would be of 200 marks in place of paper XII & XIII.*

Note: Each theory will carry 75 marks, whereas each practical paper will carry 25 marks, whenever applicable.



Annexure-B

List of Optional Papers in Lieu of Thesis

Course #	Title	Marks	Theory	Practical
Optional	Environmental and Conservation Biology <i>Dif-</i>	100	75	25
Optional	Plant Cell Tissue and Organ Culture <i>Same-</i>	100	75	25
Optional	Recombinant DNA Technology <i>Same-</i>	100	75	25
Optional	Trends in Molecular Genetics <i>Same-</i>	100	75	25
Optional	The Biochemistry of the Nucleic Acids <i>Same-</i>	100	75	25
Optional	Biodegradation and Bioremediation <i>Same-</i>	100	75	25
Optional	Plant Biotechnology- I <i>Same-</i>	100	75	25
Optional	Plant Biotechnology- II <i>Same-</i>	100	75	25
Optional	Research Methodology <i>Same-</i>	100	75	25
Optional	Plant Conservation Management <i>Same-</i>	100	75	25



PAPER I

PHYCOLOGY AND BRYOLOGY

MARKS: 100 (75+25)

MARKS: 75

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, Anthocerosida and Bryopsida.

MARKS: 25

Practical:**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:

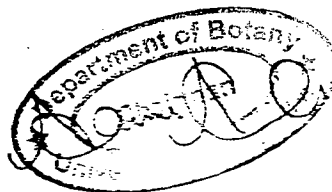
Pellia, Porella, Anthoceros and Polytrichum.

Recommended Books:

1. Bold, H. C. and Wynne M. J. 1985. Introduction to Algae: structure and reproduction. Prentice Hall Inc. Engle Wood Cliffs
2. Lee, R. E. 1999. Phycology. Cambridge University Press, U.K.
3. Dawson, E. Y., Halt. 1966. Marine Botany. Reinhart and Winstan, New York.
4. Chapman, V. J. and Chapman, D. J. 1983. Sea weed and their uses. Mac Millan and Co. Ltd. London.
5. Vashishta, B. R. 1991. Botany for degree students. Bryophytes 8th ed. S. Chand and Co. Ltd. Delhi.
6. Schofield, W. B. 1985. Introduction to Bryology. MacMillan Publishing Co. London.
7. Hussain, F. and Ilahi I. 2012. A text book of Botany. Department of Botany, University of Peshawar.
8. Barsanti, L. and Gualtieri P. G. 2006. Algae, anatomy, biochemistry, biotechnology. Taylor and Francis, New York.
9. Vashishta, B. R., Sinha, A. K. and Kumar, A. 2010. Algae. S. Chand & Co.
10. Bellinger, E. G. and D. C. Sige. 2010. Fresh water algae (Identification and use as bioindicators). John Wiley & Sons.
11. Hussain, F. 2013. Phycology. A text book of Algae. Pak Book Empire Lahore.
12. Vashishta, B. R., Sinha, A. K. and Kumar, A. A. K. Sinha and A. Kumar. 2010. Bryophytes.
13. Fida Hussain, Habib Ahmad and Syed Zahir Shah. 2012. The unicellular algae of District Peshawar, Pakistan. Lambert Publication, Germany. Chand & Co. New Delhi.

Journals / Periodicals:

Pakistan Journal of Botany, International Journal of Phycology and Phycochemistry, Bryology, Phycology.



PAPER II**MYCOLOGY AND PLANT PATHAOLGY****MARKS: 100 (75+25)****Theory:****MARKS: 75****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, haploid, heterokaryotic and diploid states.
3. Fungal Systematics: Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of Myxomycota, Chytridiomycota, Zygomycota (Mucorales), 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).

Practicals:**MARKS: 25****a) Mycology**

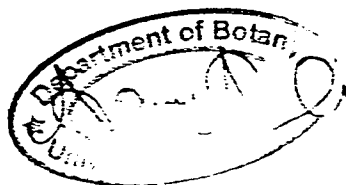
General characters and morphology of fungi. Study of unicellular and mycelial forms with septate and aseptate hyphae. Distinguishing characters of different phyla: study of suitable examples. Study of asexual and sexual reproductive structures in different groups of fungi. Study of some common examples 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 pathogenicity. Demonstration control measures through chemotherapeutants.

Recommended Books:

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

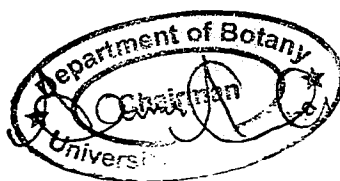


John Wiley & Sons.

4. Khan, A. G. and Usman, R., 2005. Laboratory Manual in Mycology and Plant Pathology. Botany Department Arid Agriculture University, Rawalpindi.
5. Mehrotra, R. S. and Aneja, K. R., 1990. An Introduction to Mycology. Wiley and Eastern Ltd., New Delhi, India.
6. Moore-Landecker, E., 1996. Fundamentals of Fungi, 4th Edn. Prentice Hall Inc., New Jersey, USA.
7. Trignano, 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.



PAPER III

PLANT BIOCHEMISTRY

MARKS: 100 (75+25)

Theory:

MARKS: 75

Carbohydrates:

Occurrence and classification, A general account of ribose, deoxyribose, xylulose, xylose, D-glucose, D-galactose, D-mannose, cellobiose, sucrose, maitose, trehalose, pentosans, fructosans, starch, cellulose, pectins and lignins.

Lipids:

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

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. Transport, storage, regulatory and receptor proteins. Protein purification. Protein sequencing. Biological role.

Nucleic Acids:

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

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.

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.

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

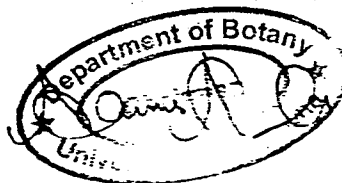
Terpenoids: Classification monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis.

Vitamins: General properties and role in metabolism.

Practicals:

MARKS: 25

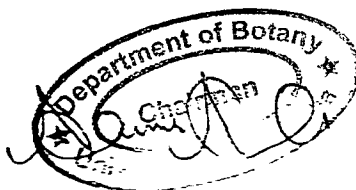
1. Solutions, acids and bases. Electrolytes, non-electrolytes, buffers, pH. Chemical bonds.
2. To determine the R_f value of monosaccharides on a paper Chromatogram.
3. To estimate the amount of reducing and non-reducing sugars in plant material titrimetrically/spectrophotometrically.
4. To determine 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 Rvalue 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 extracted from a plant source.
12. To determine the PKa and isoelectric point of an amino acid.

Books Recommended:

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 PTE Ltd. Singapore.
5. Smith, E L., Hill, R. L., Lehman, R. I., Lefkowitz, R. J., Philip. H and Abraham, W. 1983. Principles of Biochemistry, (General Aspects). 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. and Leegood, R. C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
10. Abides, R. H., Frey P. A. and Jencks, W. P. 1992. 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.
Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition.



PAPER IV

Morphology and Anatomy of Vascular Plants

MARKS: 100 (75+25)

Theory:

MARKS: 75

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), Lycopsidea (Lycopodium, Selaginella), Sphenopsida (Equisetum), Pteropsida (Ophioglossum, Dryopteris and Azolla/Marsilea).

b) Gymnosperms:

Geological history, origin, distribution, morphology, classification and affinities of Cycadofillicales, Bennettitales, Ginkgoales, Cycadales, and Gnetales. Origin and Evolution of seed habit. Distribution of gymnosperms in Pakistan. Economic importance of gymnosperms. An introduction of Gondwana flora of world.

c) Palynology:

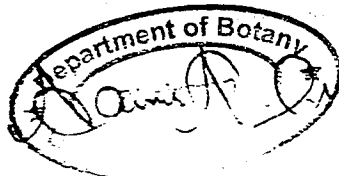
1. An introduction to Neopalynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey and oil and gas exploration.
2. Basic information about the nomenclature, morphology and classification of living and fossil pollen and spores.

d) Angiosperms:

- i. Origin of angiosperms
- ii. Evolution of fruit habit

e) Anatomy

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 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:
 - a. Flower
 - b. Seed
 - c. Fruit
9. Economic aspects of applied plant anatomy
10. Anatomical adaptations



11. Molecular markers in tree species used for wood identification.

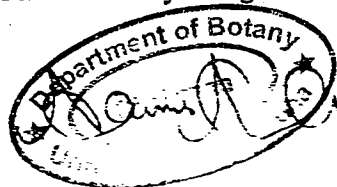
Practicals:

MARKS: 25

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

BOOKS RECOMMENDED

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.
3. Jones, D. 1983. Cycadales of the World, Washington, DC.
4. Mauseth, J. D. 1998. An Introduction to Plant Biology, Multimedia Enhanced, Jones and Bartlett Pub. UK.
5. Moore, R. C., W.d. Clarke and Vodopich, D. S. 1998. Botany McGraw-Hill Company, USA
6. Raven, P. H. Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants, W. H. Freeman and Company Worth Publishers.
7. Ray, P.M. Steeves, T. A. and Fultz, T. A. 1998. Botany Saunders College Publishing, USA.
8. Taylor, T. N. and Taylor, E. D. 2000. The Biology and Evolution of Fossil Plants, Prentice Hall.
9. Dickison, W. C. 2000. Integrative plant anatomy. Academic Press, U. K.
10. Fahn, A. 1990. Plant Anatomy. Pergamum Press, Oxford.
11. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
12. Metcalf, C. R. and Chalk, L. 1950. Anatomy of the Dicotyledons. Clarendon Press. Oxford.
13. Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.
14. Vaughan, J. G. 1990. The structure and Utilization of Oil Seeds. Chapman and Hall Ltd. London.
15. Metcalfe, C.R. 1960. Anatomy of the Monocotyledons. Gramineae. Clarendon Press, Oxford.
16. Metcalfe, C. R. 1971. Anatomy of the Monocotyledons.V. Cyperaceae. Clarendon Press, Oxford.
17. Cutler, D. F. 1969. Anatomy of the Monocotyledons. IV. Juncales. Clarendon Press, Oxford.
18. Cutler, D. F. 1978. Applied Plant Anatomy. Longman Group Ltd. England



PAPER V**VIROLOGY AND BACTERIOLOGY****MARKS: 100 (75+25)****MARKS: 75****Theory:****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.

Practicals:**MARKS: 25****a) Viruses**

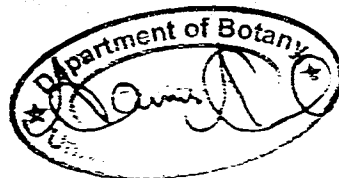
Observation of symptoms of some viral infected plant specimens.

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 collections and prepared slides.

Recommended Books:

1. Black, J. G. 2005 Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
2. Prescott, L. M., Harley, J. P. and Klein, D. A. 2005. Microbiology McGraw-Hill Companies, Inc.
3. Arora, D. R. 2004. Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
4. Ross F. C. 1995. Fundamentals of Microbiology. John Willey & Sons, New York.
5. Khan, J. A. and Dijkstra J. 2002. 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.



PAPER VI

CELL AND MOLECULAR BIOLOGY

MARKS: 100 (75+25)

Theory:

MARKS: 75

1. Structural organization of cell
2. Structure and function of biomolecules. Carbohydrates, Proteins, lipids and Nucleic acids
3. Molecular organization of cell membrane and cell wall
4. The cytoskeleton and cell mobility
5. Ultrastructure and function of cell organelles. Endoplasmic reticulum, Dictyosomes, Mitochondria, Plastids, Ribosomes, Peroxisomes, Glyoxisomes and Lysosomes.
6. Nucleus, Nucleolus and Ultrastructure and morphology of chromosomes. Karyotype analysis.
7. Reproduction, Cell cycle, Mitosis and Meiosis
8. Chromosomal aberrations: Change in chromosome number, aneuploidy and Euploidy, Changes in chromosome structure: deficiency, duplication, inversion and translocation
9. Gene regulation in Eukaryotes
10. The genetic code and Genetic Engineering

Practicals:

MARKS: 25

1. Study of cell structure using compound microscope
2. Measurement of cell size
3. Study of mitosis and meiosis by smear/squash preparation and from prepare slides
4. Biochemical tests for starch, protein, cutin, carbohydrates from plant material
5. Study of different types of plastids
6. Study of streaming of movement in staminal hair of Tradescantia
7. Extraction and estimation of carbohydrates, proteins, DNA and RNA from plant sources

BOOKS RECOMMENDED:

1. De Robertis, E.D.P and De Robertis, Jr. E.M.R. 2001. Cell and Molecular Biology. 8th Edition. Lippincott, Williams and Wilkins Publisers.
2. Karp, G. Cell and Molecular Biology. Concepts and Experiments. John Wiley and Sons publishers.
3. Lodish, H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Gilmartin, P. M. and Bowler, C. 2002. Molecular Plant Biology. Vol. 1 & 2. Oxford Publishers, Massachusetts.
5. Malacinski, G.M. 2003. Essenetiala of Molecular Biology. 4th Edition. Jones and Bartlett Publishers, Massachusetts.
6. Watson, J.D. 2004. Molecular Biology of the Gene. Pearson Education. Singapore.
7. Weaver, R.F. 2005. Molecular Biology. McGraw Hill, St. Louis.



PAPER VII

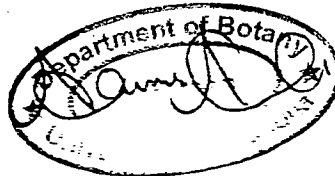
GENETICS

MARKS: 100 (75+25)

MARKS: 75

Theory:

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 meiosis, 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.
7. DNA Function: Transcription, translation, the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA.
8. The Extranuclear Genome: Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochondrial genes in yeast, extragenomic plasmids in eukaryotes.
9. Developmental Genetics: Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease.
10. Population Genetics: Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.
11. Gene Mutation: somatic versus germinal mutation. Mutant types, the occurrence of mutations. Mutation and cancer. Mutagens in genetic disorder, mutation breeding, Evolutionary significance of mutation.
12. 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.
13. Mechanisms of Genetic Change II: Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.
14. 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.
15. 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.
16. Plant Genome Projects: Arabidopsis, achievement and future prospects. Other plant genome projects



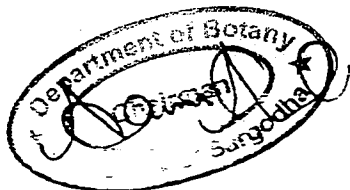
17. Bioinformatics: Application of computational tests to the analysis of genome and their gene products.
18. Bioethics: Moral, Religious and ethical concerns

Practicals:**MARKS: 25****A. Numerical Problems**

- i. Arrangement of genetic material:
 - a. Linkage and recombination.
 - b. Gene mapping in diploid.
 - c. Recombination in Fungi.
 - d. Iv. Recombination in bacteria.
 - e. Recombination in viruses.
- ii. Population Genetics:
 - a. Gene frequencies and equilibrium.
 - b. Changes in gene frequencies,
- iii. Blood group and Rh-factor
- iv. Drosophila
 - a. Culture technique
 - b. Salivary gland chromosome
- v. Fungal Genetics: Saccharomyces culture techniques and study.
- vi. Studies on variation in maize ear size and colour variation
- vii. Bacterial Genetics.
 - a. Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
 - b. Transformation.
 - c. Conjugation.

BOOKS RECOMMENDED:

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.



PAPER VIII

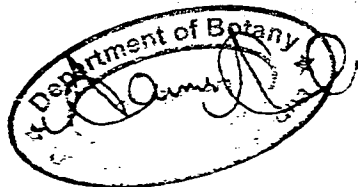
PLANT ECOLOGY

MARKS: 100 (75+25)

MARKS: 75

Theory:

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.
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. Eco physiological effects of changing atmospheric CO₂ concentration. Functional significance of different pathways of CO₂ fixation. Productivity: response of photosynthesis to environmental factors, C and N balance
5. **Water:** Water as an environmental factor, Role of water in the growth, adaptation and distribution of plants, Water status in soil, Water and stomatal regulation, Transpiration of leaves and canopies.
6. **Oxygen deficiency:** Energy metabolism of plants under oxygen deficiency, Morph-anatomical changes during oxygen deficiency, Post-anoxic stress.
7. **Wind as an ecological factor.**
8. **Fire as an ecological factor.**
9. **Carbon credit**
10. **Population Ecology:**
 - a. Population structure and plant demography: Seed dispersal, Dormancy, Seed Bank, Seed dormancy, Recruitment, Demography.
 - b. Life history pattern and resource allocation: Density dependent and Density independent factors, Resource allocation, Reproductive effort, Seed size vs. seed weight, Population genetics, Evolution.
11. **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.
12. **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.



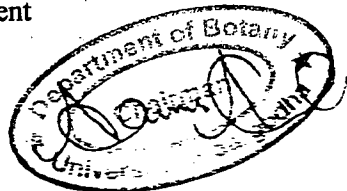
MARKS: 25

Practicals:

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

Recommended Books:

1. Ahmad, M. and Shaukat, S. S. 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: Ecophysiology and Stress Physiology of Function Groups - Springer-Verlag
7. Nobel, P. S. 1999. Physico-chemical and Environmental Plant Physiology, Academic Press.
8. Lambers, H., Pons T. L. and Stuart. F. 2008. Plant Physiological 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. Moore. 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



PAPER IX

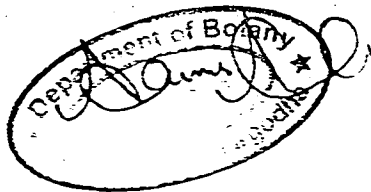
PLANT PHYSIOLOGY

MARKS: 100 (75+25)

MARKS: 75

Theory:

1. **Photosynthesis:** History of photosynthesis. Nature and units of light. Determination of oxygenic and an oxygenic photosynthesis. 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. CO₂ reduction (dark reactions) - C₃ pathway and Photorespiration, Regulation of C₃ pathway, C₄ pathway and its different forms, C₃-C₄ intermediates, CAM pathway. Methods of measurement of photosynthesis.
2. **Respiration:** Synthesis of hexose sugars from reserve carbohydrates. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respiration.
3. **Translocation of Food:** Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.
4. **Leaves and Atmosphere:** Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.
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.
6. **Plant Growth Regulators:** Major natural hormones and their synthetic Analogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action, transport, physiological effects of Auxin, Gibberellins, Cytokinins, Abscisic acid, Ethylene, Polyamines, Brassinosteroids, Jasmonates, and Salicylic acid.
7. **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.
8. **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.
9. **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.



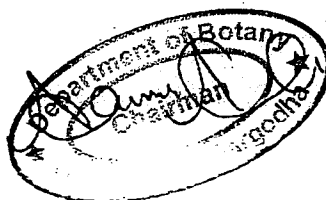
10. Control of Flowering: Autonomous versus environmental regulation. Circadian rhythms. Classification of plants according to photoperiodic reaction, photoperiodic induction, locus of photoperiodic reaction and dark periods in photoperiodism. Role of photoperiodism in flowering. Biochemical signaling involved in flowering. Vernalization and its effect on flowering. Floral meristem and floral organ development. Floral organ identity genes and the ABC model. Gene regulation and signal transduction in prokaryotes and eukaryotes: Genome size and organization. Gene regulation in prokaryotes and eukaryotes Signal transduction in prokaryotes and eukaryotes

Practicals:**MARKS: 25**

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.

BOOKS RECOMMENDED:

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. Sinauer's Publ. Co. Inc. Calif.
11. Hopkins. W.B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.



PAPER X

PLANT SYSTEMATICS AND TAXONOMY

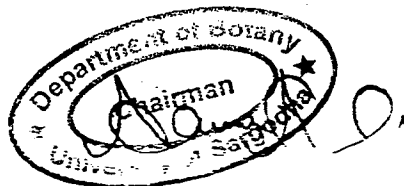
MARKS: 100 (75+25)

Theory:

MARKS: 75

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 Prantle, Bessey, Cronquist, Takhtajan, and Dahlgren).
9. **Numerical taxonomy.**
10. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:

<ol style="list-style-type: none"> 1. Apiaceae (Umbelliferae) 3. Asclepiadaceae 5. Boraginaceae 7. Capparidaceae 9. Chenopodiaceae 11. Cucurbitaceae 13. Euphorbiacea 15. Lamiaceae (Labiatae) 17. Magnoliaceae 19. Myrtaceae 21. Papaveraceae 23. Ranunculaceae 25. Salicaceae 27. Solanaceae 30. Juncaceae 32. Winteraceae 	<ol style="list-style-type: none"> 2. Arecaceae (Palmae) 4. Asteraceae (Compositae) 6. Brassicaceae (Cruciferae) 8. Caryophyllaceae 10. Convolvulaceae 12. Cyperaceae 14. Fabaceae (Leguminosae) 16. Liliaceae 18. Malvaceae 20. Orchidaceae 22. Poaceae (Gramineae) 24. Rosaceae 26. Scrophulariaceae 29. Cannaceae 31. Trochodendraceae
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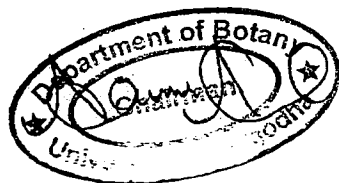
MARKS: 25

Practicals:

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.

BOOKS RECOMMENDED:

1. Ali, S. I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi
2. Ali, S. I. and Qaiser, M. 1992-2007 -todate. Flora of Pakistan. Karachi-Univ. Press, Karachi.
3. Greuter, W., McNeill, J., Barrie, F. R., Burdet, H. M., Demoulin, V., Filguerras, T. S., Nicolson, D. H. Silva, P. C., Skog, J. E., Trehane, P., Turland, N. J. & Hawksworth, D.L.,(eds.) 2000. International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International botanical congress St. Louis Missouri, July -August 1999. Koeltz, Konigstein. (Regnum Veg.138.)
4. Davis, P. H. & Heywood, V. H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London
5. Ingrouille, M. 1992. Diversity and Evolution of Land Plants, Chapman & Hall. London
6. Nasir, E. & Ali, S. I. 1970-89. Flora of Pakistan. Karachi Univ. Press, Karachi.
7. Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.
8. Takhtajan, A. (1986). Flowering Plant: Origin and Dispersal, Oliver and Boyd, Edinburgh
9. Jones, S. B. and Luchsinger, A. E. 1987. Plant Systematic. 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.



PAPER XI BIostatistics AND MATHEMATICS MARKS: 100 (75+25)

Theory

MARKS: 75

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 analysing the two-way ANOVA, Linear combination, multiple comparisons.

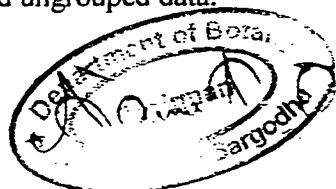
8. Correlation and Regression.

9. Mathematics: Real Numbers, Relations and Functions, Quadratic Functions and Complex Numbers, Sequence and Series, Trigonometric Functions, Trigonometric Applications, Graph of Functions and Modelling, Limits and Continuity, Derivatives, Integration, Ordinary Differential Equations, Probability and Binomial Theorem.

Lab outline:

MARKS: 25

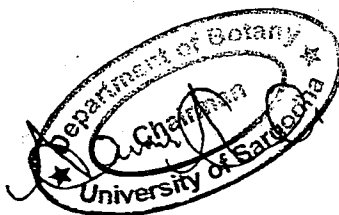
1. Data collection, arrangement of data in frequency table, calculating frequent cumulative frequency and preparation of curve.
2. Calculating different measure of central tendency such as arithmetic means, harmonic mean, geometric mean, median and mode.
3. Calculation of mean from grouped and ungrouped 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.
2. Onton, P., Adams, S. and Voelkar, D. H. 2001. Cliff notes 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.
9. Gantert, A. X., Algebra 2 and Trigonometry, AMCOS School Publication INC. New York, 2009.
10. Swokowski, E. W., Fundamental of Trigonometry, Latest Edition.
11. Kaufmann, J.E., College Algebra and Trigonometry, PWS-Kent Company, Boston, Latest Edition.
12. Anton H., 1999. Calculus: A New Horizon. 6th ed. NY: John Wiley.
13. Stewart J., 1995. Calculus. 5th ed. Brooks/Cole (suggested text).
14. Thomas G.B., Finney A.R., 2002. Calculus. 10th ed. USA: Addison-Wesley.



(Optional Papers)

ENVIRONMENTAL AND CONSERVATION BIOLOGY

MARKS: 100 (75+25)

MARKS: 75

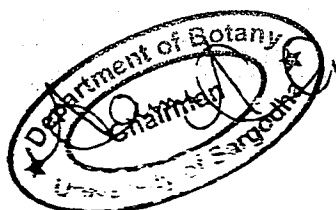
Theory:

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, and remediation. Photochemical smog. Smog.
 - ii. Acid rain
 - a) Theory of acid rain
 - b) Adverse effects of acid rains./Chlorofluorocarbons and its effects.
 - iii. Water pollution: Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, and 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).**
13. **Physical conditions and availability of resources:** Introduction, environment conditions, effect of condition, animal responses, microorganisms, plant resources and animal resources.
14. **Applied issues in conservation:** Sustainability, forming of monoculture and pest control.
15. **Role of natural resources in conservation:** Types of resources (renewable and non-renewable), wild life management, species conservation, conservation of habitat, introduction of exotic species, natural parks, forest resources, soil and water resources, food and agriculture resources.

MARKS: 25

Practicals:

1. Examination of industrial waste water and Municipal sewage and sludge for
 - i. Total dissolved solids.
 - ii. PH and EC.



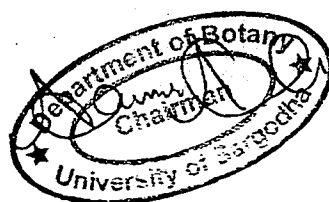
iii. BOD/COD.

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.
5. Visits to disturbed ecosystems
6. Survey of different important species for conservation.
7. Visits to different sanctuaries.

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. 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 University 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. Ashfaq, M., Mushtaq, A. and Saleem, M.A. 2004. Environmental Pollution and Agriculture. B.Z Press, Multan, Pakistan.
11. Wang, L. K., Pereira N. C. and Hung, Y. T. 2005. Advanced Air and Noise Pollution Control, Humana Press,
12. Schnelle, K. B. and Brown, C. A. 2002. Air Pollution Control Technology Handbook, CRC Press, Lambert Publishers Germany.
13. Cheremisin N. P., 2003. Handbook of Solid Waste Management and Waste Minimization Technologies, off, Butterworth-Heinemann.
14. Mahajan, S. P. 1985. Pollution Control in Process Industries, Tata McGraw-Hill.
15. Sell, N. J., Nostr, V. and Reinhold, 1992. Industrial Pollution control: issues and techniques.
16. Thakur, I. S. 2006. Environmental Biotechnology: Basic Concepts and Applications, International Publishing House Pvt. Limited.
17. Vandermeer, and John, H. 2011. The ecology of agro-ecosystems Jones and Bartlett Publishers; Sudbury, Mass; - xv, pp: 387.
18. Greipsson, and 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.



PLANT CELL TISSUE AND ORGAN CULTURE**MARKS: 100 (75+25)****MARKS: 75****Theory:**

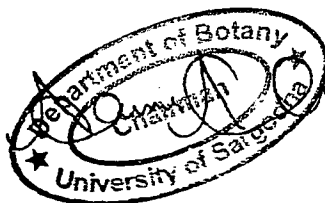
- 1) Plant Tissue Culture-An Introduction
- 2) Cellular Totipotency, differentiation and de-differentiation
- 3) Selection of a suitable explant material in different plant groups
- 4) Initiation and maintenance of callus cultures
- 5) Organogenesis
- 6) Somatic embryogenesis
- 7) Micropropagation
- 8) Role of Somaclonal variation in crop improvement
- 9) Cell suspension cultures
- 10) Isolation, purification and culture of plant protoplasts
- 11) Role of plant protoplasts in crop improvement
- 12) Production of pathogen-free plants using (issue culture techniques)

PRACTICALS:**MARKS: 25**

- 1) An introduction to a Plant Tissue Culture lab
- 2) Laboratory facilities and their use
- 3) Aseptic techniques
- 4) Preparation and use of Stock solutions
- 5) Media composition and preparation protocols
- 6) Preparation of selected media, pouring and sterilization
- 7) Procurement, preparation and sterilization of explants
- 8) Initiation and maintenance of callus cultures and regeneration studies in selected species
- 9) Culture initiation and maintenance for micropropagation of selected species.

BOOKS RECOMMENDED (Latest Edition):

- 1) John, H. Dodds and Lorin, W. Roberts. Experiments in Plant Tissue Culture. Third Edition. Cambridge University Press, New York. USA.
- 2) Bhojwani, S. S. and Razdan, M. K. Plant Tissue Culture: Theory and Practice. Developments in Crop Sciences. Elsevier, New York. USA
- 3) Dixon R. A. and Gonzales, F. A. (Eds). Plant Cell Cultures. A Practical Approach. Oxford University Press. Oxford. New York.
- 4) Kumar, U. Methods in Plant Tissue Culture. Agro Botanica Publishers. Vyas Nagar. Bikaner.



RECOMBINANT DNA TECHNOLOGY

MARKS: 100 (75+25)

MARKS: 75

Theory:

Section A: Basic Techniques:

1. Introduction, Agarose-gel Electrophoresis. Southern (Northern and Western blotting), Transformation of *E. coli*: Transformation of other organisms.
2. Cutting and joining DNA molecules.
Cutting DNA molecules. Host controlled restriction and modification. Nomenclature, Target sites, Mechanical shearing of DNA. Joining DNA molecules, DNA ligase. Double linkers. Adopters, Homopolymer tailing.

Section B: CLONING *E. coli*

3. Plasmids as cloning vehicles.
Basic properties of plasmids: Desirable properties of plasmid cloning vehicles, copy number plasmid vectors.
4. Bacteriophage and cosmid vectors for *E. coli*. Bacteriophage, cosmid vectors, DNA cloning with single stranded DNA vectors, filamentous phage vectors, M13-
5. Site directed mutagenesis.
6. Analysing DNA sequences.
7. Cloning strategies, Genomic DNA libraries, Chromosome walking, cDNA cloning.
8. Recombinant selection and screening. Genetic methods, immunochemical methods. Nucleic acid hybridization methods.
9. Expression in *E. coli* of cloned DNA molecules. The effect of plasmid copy number, plasmid stability.
10. Applications of recombinant DNA technology.

PRACTICALS:

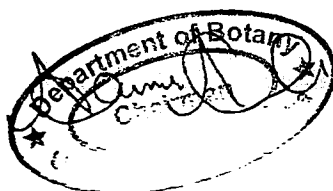
MARKS: 25

Section A: Basic Techniques:

1. *E. coli* culture and growth curve.
2. Transformation of plasmid DNA to *E. coli*.
3. Conjugation.
4. Extraction of plasmid DNA.
5. Gel electrophoresis. Detection of plasmid DNA on gel electrophoresis.
6. Polyacrylamide gel electrophoresis. Detection of bacterial proteins. BOOKS

RECOMMENDED (Latest Edition):

1. Principles of Gene Manipulation, an-introduction to genetic engineering (4th edition). Old, R.W. and Primrose, S.B. Blackwell Scientific Publications.
2. Plasmid, A practical Approach. Hardy, K.G. IRL Press at Oxford University' Press.
3. DNA Cloning, a practical Approach {volume I & II}. Glover, D.M. IRL, Press.
4. Molecular Cloning, A Laboratory Manual. Sambrook. J., Fritsch, E.F. and Maniatis, T. Cold Spring Harbor Laboratory Press.
5. 'Gene Cloning, an introduction (2nd edition). Brown. T.A. Chapman Hall.
6. An introduction to Genetic Engineering. Nicholl, D.S.T. Cambridge University Press.
7. Genetic Engineering, Shaping the Material of Life. Thro, £. Facts on file, New York.
8. Genetic Engineering (Volume I-V). Williamson, R. Academic Press.



TRENDS IN MOLECULAR GENETICS

MARKS: 100 (75+25)

MARKS: 75

Theory:

1. Autonomous Replicating Genetics Entities:

a. Plasmid:

- i. Plasmid replication and maintenance.
Plasmid replication, different mechanisms of regulation of plasmid replication, genes involved instable maintenance.
- ii. Plasmid born functions. Transfer function, resistances to antibiotics and loxk ions, Bacteriocin and toxin production, plasmid involvement in host metabolism.
- iii. Nomenclature of plasmids and plasmid born functions.

b. Transposable Elements:

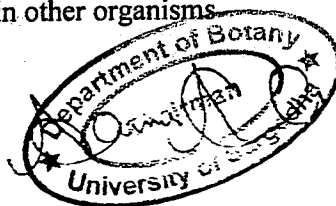
- I. Symbols and nomenclature
- ii. Transposable elements in Gram-negative bacteria
- iii. Structure of transposable elements: Class I. Class II. Class III. Class IV. Class V.
- iv. Genetic features associated with transposition
- v. Transposition mechanisms
- vi. Role of mobile elements in evolution
2. Protection DNA Integrity. DNA Methylation and the Restriction:
 - a. Modification, System
 - i. Restriction-modification phenomenon
 - ii. Discovery
 - iii. General features of DNA methylation
 - iv. The host specificity of DNA (Hsd) systems
 - v. The methylated-adenine (Mar or Mrr) and methylated cytosine (Mcr) restriction system of *E. Coli*.
 - b. Other modification and/or restriction system.
 - vi. The DNA adenine-methylation (Dam) and DNA cytosine-methylation(Dem) systems
 - vii. Restriction-modification and evolution

3. DNA Repair:

- i. Classification of repairable lesions
- ii. Direct repair
- iii. Base excision repair
- iv. Nucleotide-excision repair
- v. Recombination (or post replication) repair.
- vi. Cross-link repair
- vii. Mismatch repair
- viii. Inducible repair

4. Homologous Genetic Recombination:-

- i. The Rec. A pathway of *E. coli*
- ii. Mechanism of recombination
- iii. The recombination pathways in other organisms



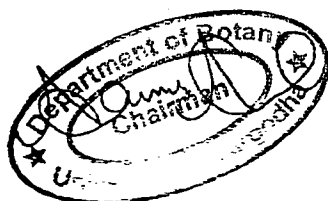
5. Genetics with Transposons:
- i. Transposons-induced mutagenesis
 - ii. Transposable elements and the development of genetics in new species
 - iii. *In vitro* gene fusion

PRACTICALS:**MARKS: 25**

1. Transformation
2. Conjugation
3. Mutagenesis
4. Plasmid DNA preparation's (mini preps) Agarose gel electrophoresis

BOOKS RECOMMENDED (Latest Edition):

1. Prokaryotic Genetics. Jost, F. and Michel, J.G. Blackwell Scientific Publications.
2. Gene V.B. Lewin. Oxford University Press.
3. Molecular Biology of the Gene. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Waver, A.M. The Benjamin/Cummings Publishing Company, Inc.
4. Concepts of Genetics. Klug W.S. and Cummings. M.R. Prentice Hall International Inc.
5. Molecular Biotechnology, principles and applications of recombinant DNA. Glick, B.R. and Pasternak, J.J ASM Press. Washington.
6. Methods for General and Molecular Bacteriology. Gerhardt. R.G-H. Murray. W.A. Wood and Krieg, N.R. American Society for Microbiology. Washington, D.C.
7. Modern Genetic Analysis. Griffiths A.J.F., Gelbert W.M., Lewontin R.C. and Miller J.H. W.H. Freeman and Co., New York.
8. Molecular Biotechnology. Glick B.R. and Pasternak J.J. ASM Press Washington DC.
9. Cell & Molecular Biology. Karp G. John Wiley and Sons. Inc.
10. Molecular Biology of the Cell. Alberts, B., Johnson. A., Lewis. J., Raff M., Roberts. K. and Walter P.



THE BIOCHEMISTRY OF THE NUCLEICACIDS**MARKS: 100 (75+25)****MARKS: 75****Theory:****1. Nucleic Acids, Transcription & Translation.**

DNA as a carrier of genetic information; double-helical structure of DNA; forces stabilizing nucleic acid structures; supercoiled DNA; nucleic acid fractionation and sequencing; chemical synthesis of oligonucleotides; DNA polymerases; DNA replication-general aspects and enzymes involved; prokaryotic and eukaryotic replication mechanisms; repair of DNA: recombination and mobile genetic elements; DNA methylation.

RNAs and their role in- protein synthesis; RNA polymerases and transcription; - regulation of transcription in prokaryotes; post transcriptional processing; the genetic code; structure of transfer RNA; ribosome structure; translational process, protein synthesis inhibitors; control of eukaryotic translation; post translational modification; protein degradation; non ribosomal polypeptide synthesis; structure and genomic organisation; regulation of eukaryotic gene expression; cell differentiation; oncogenes and cancer.

2. Regulation of gene activity in prokaryotes & Eukaryotes:

Principles of regulation; the E.coli Lactose system and the Operon model; the Tryptophan Operon - A biosynthetic system auto regulation; feedback inhibition; gene families; gene dosage and gene amplification, regulation of transcription; regulation of processing; hypersensitive sites and upstream: regulatory sites; translational control; multiple proteins from a single segment of DNA: gene rearrangement: joining coding sequences in the immune system.

3. Recombinant DNA and Genetic Engineering:

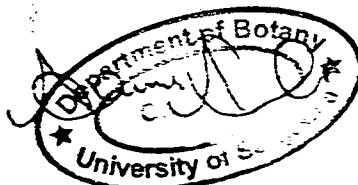
An outline of DNA cloning experiment, cloning vectors including plasmids, bacteriophages, cosmids, YAC vectors, shuttle and expression vectors; gene splicing, genomic libraries, screening methods for gene libraries; DNA cloning methods, tumor inducing (TI) plasmids; Southern and Northern blotting; chromosome walking; site specific mutagenesis, potentials of recombinant DNA technology; PCR; production of proteins; tissue culture techniques: transgenic organisms and gene therapies, restriction fragment polymorphism and disease detection (e.g. cystic fibrosis); human genome project; social considerations.

PRACTICALS:**MARKS: 25**

1. Measurement of DNA and RNA in leaf (Perchloric acid methods).
2. Extraction and estimation of RNA from seedling tissues (Phenol method)
3. Extraction and estimation of DNA from leaf tissue (CDTA - Na Cl method)
4. Fractionation of nucleic acid by column chromatography.
5. Estimation of soluble proteins by Lowry methods.
6. Separation of seeds proteins by polyacrylamide gel electrophoresis.

BOOKS RECOMMENDED (Latest Edition):

1. The Biochemistry of the Nucleic acids. Adams, R.L.P., Burdon, R.H., Cambell, A.M., Leaden, C.P., Smith, R.M.S., Chapman L. & Hall. London, New York.
2. Cell and Molecular Biology. De Robertis, E.P. and De Robertis I.M.F. Holt & Saunders. Philadelphia.
3. Essentials of Molecular Biology. Freifelder, D. Narosa Publishing House. India.
4. Molecular Biology of the Cell. Alberts, B., Brey, D., Lewis, J., Raff, M., Roberts K. and Watson, J.D. Garland Publishing Inc. New York.
5. Phytochemical methods. Harborne, J.B. Chapman & Hill London.



BIODEGRADATION AND BIOREMEDIATION**MARKS: 100 (75+25)****MARKS: 75****Theory:**

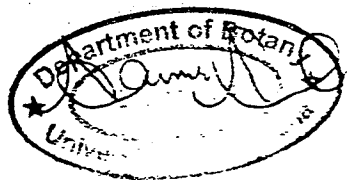
1. The environment and pollution:
Introduction, Environmental laws.
2. Treatment technologies:
 - a) Traditional approaches to pollution control.
 - b) Biotreatment technologies for pollution control.
3. Biocatalyst selection and genetic modification:
 - a) Enrichment and screening strategies.
 - b) Design of enrichment strategies relating to the environmental source.
 - c) Microbiological techniques for enrichment and selection.
 - d) Genetical approach.
4. The carbon cycle and xenobiotic compounds:
5. Biodegradation and microbial technologies by microorganisms:
 - a) Acclimation
 - b) Detoxification
 - c) Activation
 - d) Sorption
 - e) Bioavailability: Sequestering and complexing.
 - f) Cometabolism
 - g) Environmental effects.
6. Effects of metals and radionuclide on environment:
7. Metal and radionuclide microbial treatment:
8. Biotechnology for metal and radionuclide removal and recovery:
9. Recalcitrant molecules:

MARKS: 25**Practicals:**

1. Isolation of bacteria from oil wastes, polluted water from industries and sewage.
2. Spray plate technique for testing the degradation ability of bacteria for different aromatic hydrocarbons.
3. Bioremediation from culture by metal resistant bacteria.

BOOKS RECOMMENDED (Latest Edition):

1. Environmental Microbiology. Mitchell, R. Wiley Liss.
2. Metal Microbe Interaction. Poole R.K. and Gadd. G.M. IRL Press.
3. Pollution Ecology and Biotreatment. McEldowney, S., Hardmen, DJ., Waite, S. Longman Scientific Technical.
4. Biodegradation and Bioremediation. M- Alexander. Academic Press, Inc.



PLANT BIOTECHNOLOGY-I**MARKS: 100 (75+25)**
MARKS: 75**Theory:****Genetic Engineering****Unit I**

- (a) Genetic engineering - Definition & explanation, restriction enzymes and restriction modification system.
- (b) Cloning and expression vectors - Definition and explanation: plasmids, cosmids, phagemids, and transposons vectors.

Unit II

- (b) Cloning in bacteria vs. cloning in Eukaryotic cells.
- (c) Preparation of molecular probes and their uses; labelling of probes, radioactive vs non-radioactive. Techniques used in probing DNA, RNA & Protein electrophoresis. Southern, Northern and Western blotting.

Unit III

- (a) Polymerase chain reaction—Principles, techniques and modification, gene cloning vs. PCR, application and uses of PCR.
- (b) Chromosome walking, Chromosome jumping, Chromosome landing, map based cloning.
- (c) Compliment DNA, its cloning and cDNA library.

Unit IV

- (a) RFLPs & RAPD and their applications.
- (b) Gene sequencing.

Biotechnology-1: Environmental Biotechnology**Unit I**

Ecosystem Stability: Concept (resistance and resilience), Ecological Perturbations (natural and anthropogenic) and Their Impacts on Plants and Ecosystems, Ecology of Plant Invasion, Environmental Impact Assessment (EIA), Ecosystem Restoration. Environment and energy, Energy resources- Renewable and Non-renewable. Natural resources, loss of Diversity, causes and consequences, Environmental Auditing, Conservation of Biodiversity.

Unit II

Ecological Management: Concepts-Sustainable Development, Remote Sensing and GIS as Tools for Resource Management.

Unit III

Phytoremediation: - Prevention and Control, Methods of reducing Environmental impacts of Chemicals, Weedicides, Pesticides and Fertilizers. Biotechnological advances in pollution control through OEMs.

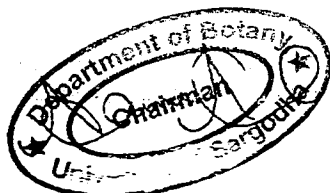
Practicals:**MARKS: 25**

Biodegradation. of environmental pollutants by microorganisms.

Bacteriology of Drinking water, Microscopic studies of water specimens collected from various locations.

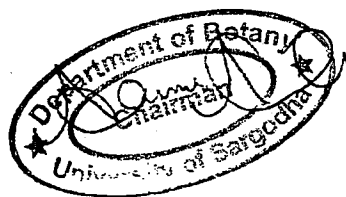
Field survey of polluted areas, Field study for pollution indicators (Plants, Microorganisms).

DNA and plasmid isolation and agarose gel electrophoresis, conjugation, transformation, route of mutagenic agents in mutation, Blotting techniques.



Suggested Readings

- A Text Book of Biotech by R.C. Dubey.
- Boyce, C.O.L.: Novo's Handbook of Practical Biotechnology. Novo Industry, A/S, 1986.
- Kumar H.D.: Molecular Biology and Biotechnology, Vikas Pb. New Delhi, 1993.
- Molecular Biotechnology, Principles and Applications of Recombinant DNA- Bernard and Glick and J.J Pasternals.-Ason Press Washington 1984.
- Trehan K. Biotechnology, Wiley Eastern Ltd.. New Delhi 1994. Trends in Biotechnology.
- Chawla, H.S. 2000. Introduction to Plant Biotechnology. Science Publishers, Inc.
- Chopra, V.L., Malik, V.S. Bhatt, S.R. 1999. Applied Plant Biotechnology. Oxford & IBM
- Glick, D. and Pasternak 1993. Molecular Biotechnology
- Maulik, S. and Patel.S.D. 1997. Molecular Biotechnology. Wiley-Liss, USA.
- Murray, P. 1994. Recombinant DNA Technology. Portland Press Ltd. USA.
- Qld.-R.-W and Primrose, S, B. 2002. Principles of Gene Manipulation. Blackwell Science.



PLANT BIOTECHNOLOGY-II**MARKS: 100 (75+25)****MARKS: 75****Theory:****Microbial Biotechnology****Unit I**

- (a) Sources and characters of industrial microbes, their isolation and methods for induction of mutations; stabilization of mutants and their isolation.
- (b) Fermentation technology; microbial growth, application of fermentation; batch, fed batch and their continuous cultures of microbes.
- (c) Patent protection for biological inventions.

Unit II

- (a) Bioreactors: Principles and their design.
- (b) Microbial transformations with special reference to steroids and alkaloids, polysaccharides.

Unit III

- (a) Microbiology and up gradation of alcoholic beverages.
- (b) Commercial production of organic acids like acetic, lactic, citric and gluconic acids.
- (c) Commercial production of important amino acids, insulin, steroids, vitamins and perfumes.
- (d) Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives.

Unit IV

- (a) Immobilization of microbial enzymes and whole cells and their applications in industries.
- (b) Use of microbes in food, feed and dairy; Bioprocess engineering; Downstream processing, various steps for large-scale protein purification.
- (c) Single, cell proteins, physiological aspects, SCP from hydrocarbons. Waste materials and renewable resources. Improvement in SCP production.

- (d) Industrial sources of enzymes: Celluloses, Xylanases, Pectinases, Amylases, Lipases, and Proteases, their production and applications.

Unit V

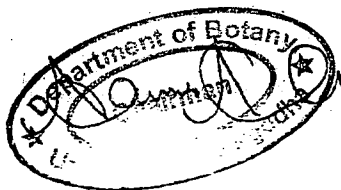
- (a) Bioconversion of waste for fuel and energy.
- (b) Petroleum Microbiology
- (c) Commercial production of bio fertilizers and bio pesticides.

Plant Cell, Tissue and Organ Culture**Unit I**

- (a) Planning and organization of tissue culture laboratory; Basic techniques of plant tissue culture.
- (b) Induction and maintenance of callus and cell suspension culture.
- (c) Study of differentiation through organogenesis and embryogenesis.

Unit II

- (a) Cell line selection through suspension culture for the production of stress resistant plants, their application in crop improvement.
- (b) Tissue culture techniques for haploid production and their application in agriculture.
- (c) Meristem culture for mass and clonal propagation of ornamental plants, virus resistant plants and forests trees.



Unit III

- (a) In vitro pollination, shotgun wedding, embryo rescue technique and embryo culture.
- (b) Encapsulation of somatic embryos and shoot apices for artificial seeds.
- (c) Cryopreservation techniques for germplasm conservation.

Unit IV

- (a) Protoplast isolation, culture and regeneration.
- (b) Somatic hybridization and selection mechanism for hybrids and cybrids, with special reference to crop plants.
- (c) Delivery systems for gene transfer in plants through co-cultivation of explants and Agrobacterium, or through direct methods-electroporation, silicon carbide method.

Unit V

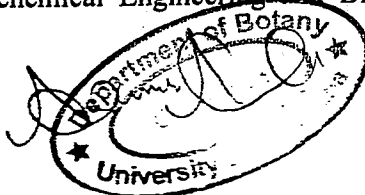
- (a) Transgenic plants: Use of transgene for ~ herbicides, insecticides, virus, drought, salinity and insect resistance; male sterility and restoration system, molecular farming.
- (b) Industrial application of plant tissue culture for:
 - i) Secondary metabolites for commercial purpose.
 - ii) Scale up and down stream processing for secondary metabolites.

MARKS: 25**Practicals:**

Isolation and screening of potential microbes from different environmental sources. Lab scale production of bacterial enzymes, lab scale production of alcohol by yeast, use of microbes in bioleaching, use of microbes in microbial enhanced oil recovery. Preparation of stock and working solutions, preparation of culture media (liquid) semi-liquid and semi-solid) Explants preparation, callus culture and organogenesis. Preparation and fusion of protoplasts.

Books Recommended

- Ammirato, P.V., Evans, D.A- Sharp, W.R. and Yamada, Y.(eds.) 1984, Hand Book of Plant Cell Culture, Mac Millan, N.Y.
- Bhojwani, S.S. and Rajdan, S.K. 1998. Plant Cell Tissue and Organ Culture, Narosa Publ.
- Lai, R. and Lai, S. 1993. Genetic Engineering of Plants for Crop Improvement. CRC Press,
- Reinert, J. and Bajaj, Y.P.S. 1976. Plant Tissue and Organ Culture. Springer -Verlag.
- Street, H.E. 1977. Plant Tissue and Cell Culture, Blackwell Scientific Publ., UK
- Singh, B.D. 2005. Biotechnology,
- Gupta, P.K. 2005. Biotechnology, Rastogi Publications, Meerut
- Aneja K.P.; Experiments in Microbiology, Plant pathology tissue culture and mushroom cultivation.
- Dodds, J.H. and L. W. Roberts: Experiments in plant tissue culture, Cambridge Univ. Press, Cambridge, 1985.
- Gamburg, O.L., G.C. Phillips : Plant Cell, Tissue and organ culture, Fundamental Methods. Narosa Pub. House, New Delhi, -1995.
- General Microbiology by S.B. Sullia and S Shantharam. Oxford & IBH, Pub. Co. 2005
- Razdan, M.K.: An Introduction to plant tissue culture oxford & IBH Pbl. Ltd., New Delhi, 1994
- Reinhert, J. and Y.P.S. Bajaj.: Applied and fundamental aspects plant cell, tissue and organ culture, Springer Verlag, Berlin, 1977.
- Tauro, P. Kapoor, K.K. and K.S. Yadav: An Introduction to Microbiology, Wiley Estem Ltd., New Delhi 1996.
- Miller, B.M. and Litsky, W. 1976. Industrial Microbiology. Me Graw Hill Book Co., NY
- Schefer, T. (ed.) Advances in Biochemical Engineering and Biotechnology. Vol. 57, 61, Springer Verlag, Berlin

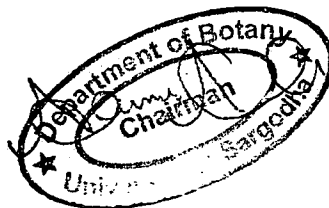


RESEARCH METHODOLOGY**MARKS: 100 (75+25)**

Research Methods (planning research, various methods, analysing results, giving reports, etc.) research process including: formulating research questions; sampling (probability and nonprobability); measurement (surveys, scaling, qualitative, unobtrusive), research design (experimental and quasi-experimental); data analysis; and, writing the research paper, the major theoretical and philosophical underpinnings of research including: the idea of validity in research; reliability of measures; and ethics

BOOKS RECOMMENDED

1. Shank, G. D. 2002. Qualitative research: a personal skills approach. Upper Saddle River, N. J. Columbus, Ohio: Prentice Hall; Merrill/Prentice Hall.
2. Brizuela, B. M. 2000. Acts of inquiry in qualitative research. Cambridge, M. A: Harvard Educational -Review
3. Shank, G. D. 2001, Qualitative Research: A Personal Skills Approach
4. Paul Leedy. 2004, Practical Research: Planning and Design (8th, Edition), Jeanne Ellis Ormrod



PLANT CONSERVATION MANAGEMENT**MARKS: 100 (75+25)****Theory:****MARKS: 75****1-Plant Conservation;**

Introduction, Philosophy; Origin, Scope, objectives. Definitions

2-Understanding of Conservation:

Biodiversity (types). Species (number), Advantages of Conservation (Food, drugs and medicine)

3- Extinction of Plant Species:

Natural causes of Extinction, Anthropogenic (man made) extinction, habitat destruction, Invasive species. Pollution, over harvesting, commercial products and life specimen, introduced species, predator and pest control, threats to species, over exploitation, introduced species, genetic problems in small population, risks reviews, dynamics of small population

4-Threats to Communities:

Chains of extinctions, emergence of new species from old. Functional integrity in relation to fragment size

5-Conservation in Practice:

Endangered species management and biodiversity protection, categorization of plant species, endangered species law. Bunting and fishing laws, the endangered species act, recovery plans, captive breeding and management plans, types of conservation (Ex-situ conservation), protected areas, conservation towards restoration of ecology, healthy approach to save biodiversity, saving rare species in the wild, habitat protection, private land and land critical habitat. Reauthorizing the endangered species.

6-Conservation Techniques:

Parks and natural preserves, trouble in our parks and management. New parks establishment. Wildlife in parks, wilderness areas, wildlife refuges, refuge management, world conservation strategy.

7-Conservation and Economic Development:

Indigenous communities and biosphere reserves, International wildlife preserves. transboundary peace parks, preserving functional ecosystem and landscapes, landscape dynamics, size and design of nature preserves, wetland conservation.

Practicals:**MARKS: 25**

- 1- Visit to botanical garden. Governor House, Lahore
- 2- Visit to Bagh-e-Jirmah Lahore
- 3- Visit to Soon Valley, Pakistan
- 4- Visit to Botanical Garden, University of Agriculture. Faisalabad

Recommended Books:

- 1-Cunningham W.P., Cunnigham, M., and Saigo, B.W. 2005. Environmental Science. McGraw Hill. New York. NY
- 2- Singh. S. K .2005. Plant Ecology. Campus Books International, New Delhi
- 3- Townsend. C. R., Begon. & I. L Harper, 2003, Essentials of Ecology, Blackwell publishing company. Oxford, UK
- 4- Odum. E. P.2001. Fundamentals of Ecology, W.B Saunders Company. London. Toronto
- 5- Shukla. R. S. P. S. Chandel. 2006. A Text Book of Plant Ecology. S. Chand and Company LTD. New Delhi. India

