CURRICULUM FOR 2-YEAR ASSOCIATE DEGREE/BS (4-YEAR) IN BOTANY UNIVERSITY OF MALAKAND

Curriculum for the Department of Botany in Accordance with HEC new Under Graduate Education Policy-2023: Effective from Fall-2023 onward

SCHEME OF STUDIES TWO-YEAR ASSOCIATE DEGREE / BS (4-YEAR) IN BOTANY

First Year

Semester-I				
CHEM 110 / GS 117	**Gen-Ed-02**	Chemistry in Everyday life/General Science	3 (3+0)	100
CS 110	**Gen-Ed-09**	Introduction to Information and Communication Technologies	3 (2+1)	100
ISL 112/ ETH 118	**Gen-Ed-7**	Islamic Studies / Ethics (for Non-Muslim)	2 (2+0)	50
ZOOL 111	**Inter-Disp-01**	Principle of Animal Life -1	3 (2+1)	100
BOT 111	**Major**	Diversity of Plants	3 (2+1)	100
ENG 101	**Gen-Ed-04**	Functional English	3 (3+0)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	17	550

First Year

Semester-II				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
ENG 102	**Gen-Ed-5**	Introduction to Expository Writing	3 (3+0)	100
QR 101	**Gen-Ed-6**	Quantitative Reasoning-1 (Mathematics)	3 (3+0)	100
PSC 111	**Gen-Ed-08**	Ideology and Constitution of Pakistan	2 (2+0)	50
SOC 114	**Gen-Ed- 11**	Civic and Community Engagements	2 (2+0)	50
ISL 113	**Gen-Ed-01**	Seerah and its Contemporary Application سیرت رسولﷺ اور اس کی عصری معنویت / any course can be selected from arts and humanity group in the general category (for non-Muslims)	2 (2+0)	50
CHEM 127	**Inter-Disp-02**	Organic Chemistry	3 (2+1)	100
BOT 121	**Major**	Morphology of Plants (Terminology)	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	18	550

*Any course from arts and humanities in the general category for non-Muslims students

Second Year

Semester-III				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
MGT 215	**Gen-Ed-10**	Entrepreneurship	3 (3+0)	100
QR 102	**Gen-Ed: 06**	Quantitative Reasoning-2 (Statistics)	3 (2+1)	100
LLB 124/PSC 112 /SOC 116	**Gen-Ed-03**	Law /Introduction to Political Science / Introduction to Sociology	2 (2+0)	50
ZOOL 121	**Inter-Disp-03**	Principle of Animal Life-II	3 (2+1)	100
BOT 122	**Major-A-03**	Systematics Anatomy and Development	3 (2+1)	100

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BOT 123	**Major-A-04**	Cell Biology, Genetics and Evolution	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	17	550

Second Year

Semester-IV				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 241	**Inter-Disp-04**	Biodiversity and Conservation	3 (2+1)	100
BOT 242	**Major**	Plant Systematics	3 (2+1)	100
BOT 243	**Major**	Phycology and Bryology	3 (2+1)	100
BOT 244	**Major**	Plant Physiology-1	3 (2+1)	100
BOT 245	**Major**	Diversity of Vascular Plants	3 (2+1)	100
BOT 246	**Major**	Autecology (Plants)	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**18**	**600**

Third Year

Designed for both BS (*4-Year*)/ BS (*4-Year Split*) from semester V-VIII: Effective from Fall-2023

Semester-V				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 351	**Major**	Comparative Morphology of Archegoniate	3 (2+1)	100
BOT 352	**Major**	Environmental Sciences-I	3 (2+1)	100
BOT 353	**Major**	Virology and Bacteriology	3 (2+1)	100
BOT 354	**Major**	Mycology and Plant Pathology	3 (2+1)	100
BOT 355	**Major**	Molecular Biology	3 (2+1)	100
BOT 356	**Major**	Plant Anatomy	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**18**	**600**

Third Year

Semester-VI				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 361	**Major**	Genetics-I	3 (2+1)	100
BOT 362	**Major**	Synecology (Plants)	3 (2+1)	100
BOT 363	**Major**	Research Methodology	3 (2+1)	100
BOT 364	**Major**	Plant Biochemistry-I	3 (2+1)	100
BOT 365	**Major**	Dendrochronology/Optional Paper	3 (3+0)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**15**	**500**

Fourth Year

Semester-VII				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 471	**Major**	Genetics-II	3 (2+1)	100
BOT 472	**Major**	Plant Physiology-II	3 (2+1)	100
BOT 473	**Major**	Medicinal Plants (Pharmacognosy)	3 (2+1)	100
BOT 474	**Major**	Plant Biochemistry-II	3 (2+1)	100
BOT 475	**Major**	Field Experience/ 100 Plants Collection/ Internship	3 (0+3)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**15**	**500**

Fourth Year

Semester-VIII				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 481	**Major**	Environmental Biology-II	3 (2+1)	100
BOT 482	**Major**	Plant Tissue Culture	3 (2+1)	100
BOT 483	**Major**	Plant Taxonomy	3 (2+1)	100
BOT 484	**Major**	Plant Breeding/ Optional Paper	3 (2+1)	100
BOT 500	**Major**	Capstone Project/ Thesis	3 (0+3)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**15**	**500**

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website (www.uom.edu.pk). For any query the office of the Registrar Academics may be approached for clarification/guidance.

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Optional Papers (list attached) both BS (*4-Year*)/ BS (*4-Year Split*): Effective from Fall-2023

Code		Title	Cred. Hrs.
BOT 486	**Major**	**Major-A-25** Survey of International Code of Botanical Nomenclature (ICBN)	3 (2+1)
BOT 487	**Major**	**Major-A-26** Introductory Horticulture	3 (2+1)
BOT 488	**Major**	**Major-A-27** Water Logging and Salinity	3 (2+1)
BOT 490	**Major**	**Major-A-29** Population Structure in Dynamics	3 (2+1)
BOT 491	**Major**	**Major-A-30** Stress Physiology	3 (2+1)
BOT 492	**Major**	**Major-A-31** Advances in Medicinal Plants	3 (2+1)
BOT 494	**Major**	**Major-A-33** Economic Botany	3 (2+1)

Note: If there is any duplication in the BS (*4-Year Split*) or Unavailability of Teacher (colleges); department concern can select optional paper from this list (consultation of Chairman Department of Botany, University of Malakand).

Category	I	II	III	IV	V	VI	VII	VIII	CHR
General Courses	10	12	8	00	00	00	00	00	**31**
Inter dis. Course	03	03	03	03	00	00	00	00	**12**
Major Courses	03	03	06	15	18	15	12	12	**84**
Field Experience	00	00	00	00	00	00	03	00	**03**
Capstone Project	00	00	00	00	00	00	00	03	**03**
Semester-wise CHR	**16**	**18**	**17**	**18**	**18**	**15**	**15**	**15**	**133**

General Education Cluster

BOT 112	**For other Departments only**	Plant Sciences (Botany)	3 (2+1)	100

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First Year

Semester-I				
CHEM 110 / GS 117	**Gen-Ed-02**	Chemistry in Everyday life/ General Science	3 (3+0)	100
CS 110	**Gen-Ed-09**	Introduction to Information and Communication Technologies	3 (2+1)	100
ISL 112/ ETH 118	**Gen-Ed-7**	Islamic Studies/ Ethics (for Non-Muslims)	2 (2+0)	50
ZOOL 111	**Inter-Disp-01**	Principle of Animal Life -1	3 (2+1)	100
BOT 111	**Major**	Diversity of Plants	3 (2+1)	100
ENG 101	**Gen-Ed-04**	Functional English	3 (3+0)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	17	550

ZOOL 111	**Inter-Disp-01**	Principle of Animal Life -1	3 (2+1)	100

Aims and Objectives:

The course aims to impart knowledge and understanding of: a. the concept and status of Zoology in life sciences. b. The common processes of life through its chemistry, biochemical and molecular processes. c. The structure and function of cell organellae and how common animal cell diversified in various tissues, organs and organ systems. d. Biochemical mechanisms eventually generating energy for animal work. e. Animals and their relationship with their environment.

Theory:

Place of Zoology in Science: A one-world view: genetic unity, the fundamental unit of life, evolutionary oneness and the diversity of life, environment and world resources; what is zoology? The classification of animals; the scientific method. 2. The Chemical Basis of Animal Life: Atoms and elements: building blocks of all matter; compounds and molecules: aggregates of atoms; acids, bases, and buffers; the molecules of animals: fractional account of carbohydrates, lipids, proteins, nucleotides and nucleic acids based on their structural aspects. 3. Cells, Tissues, Organs, and Organ System of Animals: Structure and functions of cell membranes; various movements across membranes; cytoplasm, organelles, and cellular components: functional account of ribosomes, endoplasmic reticulum, golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, and vacuoles based on their structural aspects. The nucleus: nuclear envelope, chromosomes and nucleolus. Tissues: diversity in epithelial tissue, connective tissue, muscle tissue and nervous tissue to perform various functions. Structural integrations for functions in organs and organ systems. 4. Energy and Enzymes: Life's Driving and Controlling Forces: Energy and the laws of energy transformation; activation energy; enzymes: structure, function and factors affecting their activity; cofactors and coenzymes; ATP: how cells convert energy? An

overview.

5. How Animals Harvest Energy Stored in Nutrients: Glycolysis: the first phase of nutrient metabolism; fermentation: “life without oxygen”; aerobic respiration: the major source of ATP; metabolism of fats and proteins; control of metabolism; the metabolic pool.

6. Ecology I: Individuals and Populations; Animals and their abiotic environment; populations; interspecific interactions.

7. Ecology II: Communities and Ecosystems; Community structure and diversity; ecosystems; ecosystems of the earth; ecological problems; human population growth, pollution, resource depletion and biodiversity.

Practical:

1. Tests for different carbohydrates, proteins and lipids. Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.
2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac). Note: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.
3. Plasmolysis and deplasmolysis in blood.
4. Protein digestion by pepsin.
5. Ecological notes on animals of a few model habitats.
6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Books Recommended:

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of ZoologY, 12th Edition International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 6 th Edition (International), 2005. Singapore: McGraw Hill.
3. Kent, G.C. and Miller, S. Comparative Anatomy of Vertebrates, 2001. New York: McGraw Hill.
4. Hickman, C.P. and Kats, H.L., Laboratory Studies in Integrated Principles of Zoology. 2000. Singapore: McGraw Hill.
5. Molles, M.C. Ecology: concepts and Applications. 6 th Edition. 2005. McGraw Hill, New York, USA.

BOT 111	**Major-A-01**	Diversity of Plants	3 (2+1)	100

Theory:

a) Cell Structure, organization, Cell organelles, function and importance

Comparative study of life form, structure, reproduction and economic significance of:

b) Viruses (RNA and DNA types) with special reference to TMV

c) Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with specific reference to bio fertilizers, pathogenicity and industrial importance

d) Algae (Chlamydomonas, Chara, Pinnularia, Ectocarpus, Polysiphonia)

e) Fungi (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications

f) Lichens, Types and Classification

g) Bryophytes (general important Terminology and Application):
   i. Marchantia
   ii. Anthoceros
   iii. Mosses

f). Pteridophytes (general important Terminology and Application):
   i. Psilopsida (*Psilotum*)
   iii. Lycopsida (*Selaginella)*
   iv. *Sphenopsida (Equi*setum)
   v. Pteropsida (*Marsilea*)

g). Gymnosperms (general important Terminology and Application):
   i. Cycas,
   ii. Pinus
   iii. Ephedra

h). Seed Habit (Trends towards seed habit)

Practical:

- Culturing, maintenance, preservation and staining of microorganisms:
- Preparation of various slides: (Nostoc, Anabaena, Oscillatoria, Chlamydomonas, Chara, Pinnularia, Ectocarpus, Polysiphonia, Mucor, Penicillium, Phyllactinia, Ustilago and Puccinia, Agaricus)

Books Recommended:

1. Agrios, G.N. 2004. Plant pathology. 8th ed. Academic press London.
2. Aleopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. 4th ed. John Wiley and Sons Publishers.
3. Ingrouille, M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
4. Lee, R.E. 1999. Phycology. Cambridge University Press, UK
5. Mauseth**,** J**.**D**.** 2003**.** Botany**:** An Introduction to Plant Biology 3rd ed., Jones and Bartlett Pub. UK

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

First Year

Semester-II				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
ENG 102	**Gen-Ed-5**	Introduction to Expository Writing	3 (3+0)	100
QR 101	**Gen-Ed-6**	Quantitative Reasoning-1 (Mathematics)	3 (3+0)	100
PSC 111	**Gen-Ed-08**	Ideology and Constitution of Pakistan	2 (2+0)	50
SOC 114	**Gen-Ed- 11**	Civic and Community Engagements	2 (2+0)	50
ISL 113	**Gen-Ed-01**	Seerah and its Contemporary Application **سیرت رسولﷺاور اس کی عصری معنویت** / any course can be selected from arts and humanity group in the general category (for non-Muslims)	2 (2+0)	50
CHEM 127	**Inter-Disp-02**	Organic Chemistry	3 (2+1)	100
BOT 121	**Major**	Morphology of Plants (Terminology)	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	18	550

*Any course from arts and humanities in the general category for non-Muslims students

CHEM 127	**Inter-Disp-02**	Organic Chemistry	3 (2+1)	100

Theory:

Isomerism

Introduction; classification of isomerism; optical isomerism: optical activity, chirality and optical activity, symmetry elements and optical inactivity, relative and absolute configuration, R,S notation, method of determining configuration, racemic mixtures and their resolution, asymmetric synthesis, optical activity in biphenyls, allenes and spiro compounds, stereospecific and stereoselective reactions; geometrical isomerism: determination of configuration of geometrical isomers, Z,E convention and *cis trans* isomerism in cyclic systems; conformational isomerism: conformational analysis of mono-substituted cyclohexanes, di-substituted cyclohexanes and decalin systems.

Introductory Organic Spectroscopy

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

Aliphatic Substitution Reactions

Aliphatic Nucleophilic Substitution Reactions: Mechanisms─study of

SN2, SN1, SNi, SN2′, SN1′, SNi′ mechanisms; neighbouring group participation─intramolecular displacement by neighbouring oxygen, nitrogen, sulphur and halogen; structure and reactivity─effects of the substrate structure, entering group, leaving group and reaction medium on the mechanisms and rates of substitution reactions.

Aliphatic Electrophilic Substitution Reactions: Mechanisms─study of SE1, SE2 (front), SE2 (back) and SEi mechanisms; structure and reactivity─effects of substrate, leaving group and medium on the rates of

these reactions.

Elimination Reactions

Eliminations Proceeding by Polar Mechanisms: Study of E1, E1cB and E2 mechanisms; orientation: Saytzeff and Hofmann rules; structure and reactivity─the effects of substrate structure, attacking base, leaving group and the reaction medium on the rates and mechanisms of elimination reactions; competition between elimination and substitution reactions.

Eliminations Proceeding by Non-polar Mechanisms: Pyrolyticeliminations─study of Ei and free-radical mechanisms; orientation in pyrolytic eliminations.

Practical:

Laboratory work illustrating topics covered in the lecture of Bot-127

Recommended Books:

1. Loudon, G. M., "Organic Chemistry", Oxford University Press, New York.
2. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
3. Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
4. Norman, R. O.C. and Coxon, J. M., "Principles of Organic Synthesis", Nelson Thornes, Cheltenham.
5. Kalsi, P.S. "Spectroscopy of Organic Compounds", Wiley Eastern Ltd., New Delhi.
6. Pavia, D. L., Lampman, G. M. and Kriz, G. S., "Introduction to Spectroscopy: A Guide for Students of Organic Chemistry", Saunders Golden Sunburst Series, London.
7. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.
8. McMurry,J., "Organic Chemistry", Brooks/Cole Publishing Company, California.
9. Carey, F. A., "Organic Chemistry", McGraw-Hill, New York.Solomons, T. W. G. and Fryhle, C. B., "Organic Chemistry", John Wiley & Sons, New York.

BOT 121	**Major-A-2**	Morphology of Plants (Terminology)	3 (2+1)	100

Specific Objective of Course: To familiarize the students with terminology used in describing seed plants.

Theory:

1.Seed: Definition and structure, types of seeds.

2. Germination: Definition; types of germination. Explanation of Pea, Gram, Castor oil, Grain of maize

3. Habit: Definition, types of habit: Herbs, shrubs, trees, Annual, Biennial, Perennial, climbers, epiphyte, types of vegetative and floral buds.

4. Root: Definition, characteristics and morphology of roots; types and classification of roots. Tap roots: fibrous, tuberous. Adventitious roots: Subterranean or underground roots, partly subterranean roots. Aerial roots: clinging and absorbing roots. Parasitic roots. Aquatic roots.

5. Stem: Definition; forms of stem: Aerial stems, Reduced stems, Erect stems, Weak stems; twiners, climbers. Trailers: creepers, runners, suckers. Underground stems: rhizome, bulb, stem tuber. Stem tendrils. Phyylclades, Cladodes. Types of stems. Bud:

Definition; Types of buds; leaf buds, floral buds, mixed buds. Classification of stems: Aerial, underground, specialized. Morphology and functions of various types of stems.
6. Branching: Types of branching: Lateral and dichotomous branching.
7. Leaf: Definition, characteristics of leaves, Parts of leaf. Types of leaves. Phyllotaxis: arrangement of leaves on stem. Venation and types of leaf venation: Parallel, Reticulate venation. Shape of leaf lamina. Types of leaf margins. Terminology for leaf surface. Texture of leaf. Types of leaf incisions. Simple and compound leaves. Types of prefoliation. of Venation. Types of modified leaves. Leaf duration (Persistence), Presence/absence of petiole. Types of leaf bases. Types of leaf apices. Terms used for the presence/Absence of stipules and petiole.
Leaf Lamina: Simple, compound leaf. Special modification of leaf: Phylloclades, Cladodes, Scale leaf.
8. Stipules: Definition, types of stipules; stipulodes. Presence/absence of stipule.
9. Flower: Definition, typical parts of flower, Flower as modified shoot. Pedicel: Definition, sessile, sub-sessile, pedicellate. Bracts, types of bracts. Aestivation: Arrangement of floral leaves. Insertion of floral leaves. Symmetry of flower. Prefloration: Ptyxis and aestivation. General descriptive terms of flowers. Nectaries and its types. Descriptive terms of floral part: pedicel, bracts, sepals (Calyx), petals (Corolla), perianth, stamen (Androecium), carpel (Gynaecium), Ovary. Stigma: Types of stigma. Style and its types. Placentation: Definition, types of placentation; Ovule: structure and its types. Floral formula and floral diagram.
10. Inflorescence: Definition, types of inflorescence with examples.
11. Reproduction: Definition and types of vegetative and sexual reproduction.
12. Pollination: Definition, types of pollination:
13. Fertilization. Formation of embryo, seeds and fruits
14. Fruit: Definition, Classification, simple, Aggregate and composite forms
15. Dispersal: Definition, and types of dispersal.

Practical:

- Studying different representative plants, leaves, flowers, fruits and seeds in the lab.
- Collection of plants, leaves, inflorescence, fruits, seeds and mounting on the herbarium sheet with proper identification of species, type of information studied in the lab. One hundred leaves/flowers/bracts/fruits etc. be collectively presented to teacher.
- Section cutting of ovary to see placentation and insertion of ovule.
- Making of Floral diagram and Flora formulae of some representative examples.

Recommended Books:

1. Bokhari, M.H. and T.Z. Bokhari. 2007. Illustrated Glossary of General Taxonomic Terms. Institute of Applied Biology, B.Z. University, Multan.
2. Featherly, H.I. 1966. Terminology of the higher plants. Hafner Pub.Co.Ltd.
3. Harris, J.G. and M.W. Harris. Plant Identification Terminology- An Illustrated Glossary.
4. Rajput, M.T.M., S.S. Hassney and K.M. Khan. 1996. Plant Taxonomy. Naseem Book Depot, Hyderabad, Sindh.

Second Year

Semester-III				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
MGT 215	**Gen-Ed-10**	Entrepreneurship	3 (3+0)	100
QR 102	**Gen-Ed: 06**	Quantitative Reasoning-2 (Statistics)	3 (2+1)	100
LLB 124 / PSC 112 / SOC 116	**Gen-Ed-03**	Law /Introduction to Political Science / Introduction to Sociology	2 (2+0)	50
ZOOL 121	**Inter-Disp-03**	Principle of Animal Life-II	3 (2+1)	100
BOT 122	**Major-A-03**	Systematics Anatomy and Development	3 (2+1)	100
BOT 123	**Major-A-04**	Cell Biology, Genetics and Evolution	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	17	550

BOT 122	**Major-A-03**	Systematics Anatomy and Development	3 (2+1)	100

Theory:

a) Plant Systematics:

1. Introduction to Plant Systematics: aims, objectives and importance.
2. Classification: brief history of various systems of classification with emphasis on Takhtajan.
3. Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN). St. Luis code.
4. Morphology: a detailed account of various, morphological characters root, stem, leaf, inflorescence, flower, and placentation and fruit types.
5. Diagnostic characters, economic importance and distribution pattern of the following families:
    i) Ranunculaceae, Brassicaceae (Cruciferae), Fabaceae (Leguminosae), Rosaceae
    ii) Euphorbiaceae or Cucurbitaceae or Solanaceae
    iii) Lamiaceae (Labiatae), Apiaceaeor (Umbelliferae), Asteraceae (Compositae)
    iv) Liliaceae (Sen. Lato) or Poaceae (Graminae)

b) Anatomy:

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like:
    i. Parenchyma,
    ii. Collenchyma
    iii. Sclerenchyma
    iv. Epidermis (including stomata and trichomes)
    v. Xylem
    vi. Phloem
3. Meristem: types, stem and root apices
4. Vascular cambium
5. Structure and development of root, stem and leaf. Primary and secondary growth of dicot stem, periderm
6. Characteristics of wood: diffuse porous and ring –porous, sap and heart wood, soft and hard wood, annual rings.

c) Development / Embryology:

1. Early development of plant body: *Capsella bursa-pastoris*
2. Structure and development of Anther
    - Microsporogenesis
    - Microgametophyte
3. Structure of Ovule
    - Megasporogenesis
    - Megagametophyte

1. Endosperm formation or Parthenocarpy or Polyembryony

Practical:

Anatomy:

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

Taxonomy:

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

Books Recommended:

1- Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
2- Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
3- Lawrence, G.H.M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
4- Maheshwari, P.1971. Embryology of Angiosperms, McGraw Hill.New York.
5- Mauseth, J.D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK.
6- Moore, R.C., W.D. Clarke and Vodopich, D.S. 1998. Botany. McGraw Hill Company, U.S.A.
7- Panday, B.P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.

BOT 123	**Major-A-04**	Cell Biology, Genetics and Evolution	3 (2+1)	100

Theory:

a) Cell Biology:

1. Structures and Functions of Bio-molecules
    i. Carbohydrates
    ii. Lipids
    iii. Proteins
    iv. Nucleic Acids
2. Cell: Physico-chemical nature of plasma membrane and cytoplasm.
3. Ultrastructure of plant cell with a brief description and functions of the following organelles

i. Endoplasmic reticulum
ii. Plastids
iii. Mitochondria
iv. Ribosomes
v. Dictyosomes
vi. Vacuole
vii. Microbodies (Glyoxysomes and Peroxisomes)

4. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis
5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
6. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

b) Genetics:

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

Practical:

1. Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs
2. Measurement of cell size.
3. Study of mitosis and meiosis by smear/squash method and from prepared slides.
4. Study of chromosome morphology and variation in chromosome number.
5. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant source.
6. Genetical problems related to transmission and distribution of genetic material.
7. Identification of DNA in plant material. Carmine/Orcein staining.
8. Study of salivary gland chromosomes of Drosophila.

Books Recommended:

1. Carroll, S.B., Grenier,J.K. and Welnerbee, S.d. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
2. Dyonsager, V.R. (1986). Cytology and Genetics. Tata and McGraw Hill Publication Co. Ltd,, New Delhi.
3. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
4. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
5. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
6. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
7. Strickberger, M.V. (1988), Genetics, MacMillan Press Ltd., London.

Second Year

Semester-IV				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 241	**Inter-Disp-04**	Biodiversity and Conservation	3 (2+1)	100
BOT 242	**Major**	Plant Systematics	3 (2+1)	100
BOT 243	**Major**	Phycology and Bryology	3 (2+1)	100
BOT 244	**Major**	Plant Physiology-1	3 (2+1)	100
BOT 245	**Major**	Diversity of Vascular Plants	3 (2+1)	100
BOT 246	**Major**	Autecology (Plants)	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**18**	**600**

BOT 241	**Inter-Disp-04**	Biodiversity and Conservation	3 (2+1)	100

Theory:

1. Introduction and importance of biodiversity: Species diversity, Ecological diversity, Genetic diversity, Social diversity

2.

i Causes and depletion of biodiversity: Habitat loss, Habitat fragmentation, Over-exploitation, Climatic changes, Invasive species, .Seawater intrusion
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 Implementation 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 area
Xv IUCN categories for threatened species
Xvi Criteria for recognizing different categories of threatened species
Xv Gene bank management and operation
Xvi Public awareness strategies.
Xvii Population explosion
Xviii Biodiversity action plan for Pakistan
Xix Role of herbaria and botanical gardens in conservation.

Practical:

1. Causes of local species extinction.
2. To study the hilly and plane area of Pakistan.
3. Data collection.
4. Preparation of an inventory of the flora of a given region.
5. To carry on base line study of any designated category.

Recommended Book:

1. Bush, M.B. 1997. Ecology of a Changing Planet. Prentice Hall.
2. Cotton, C.M. (1996). Ethnobotany Principle Application. John Wiley & Sons Chichester, UK.
3. Cunnighum, A.B. 2001. Applied ethnobotany: People, wild plant use and conservation. Earthspan Publications.
4. De Klemm, C. (1990) Wild plant conservation, IUCN, Gland.
5. Dyke, F.V. (2003). Conservation Biology. McGraw Hill, New York.
6. Grombridge, B. & Jenkins, M. D. (2002). World Atlas of Biodiversity: Earths Living Resources in the 21st. Century, University. California Press, Berkeley.
7. Heywood, V.H. 1995. Global Biodiversity Assessment. Cambridge University Press and UNEP.
8. Krishmamurthy, K.V. 2003. A Textbook of biodiversity Science publishers Inc. Enfield, NH, USA.
9. Levine, D.A. 2000. 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. Essentials of conservation Biology. Sinaur Association Pub. Mass. USA.
12. Virchow, D. (1998). Conservation of Genetic Resources. Springer-Verlag, Berlin

BOT 242	**Major-A-5**	Plant Systematics	3 (2+1)	100

Theory:

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. 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.
8. Brief introduction of Numerical taxonomy.
9. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:
    1. Arecaceae (Palmae)
    2. Asclepiadaceae
    3. Boraginaceae
    4. Cannaceae
    5. Capparidaceae
    6. Caryophyllaceae
    7. Casuarinaceae
    8. Chenopodiaceae
    9. Convolvulaceae
    10. Cyperaceae
    11. Juncaceae
    12. Magnoliaceae
    13. Malvaceae
    14. Myrtaceae
    15. Orchidaceae
    16. Papaveraceae
    17. Salicaceae
    18. Scrophulariaceae
    19. Trochodendraceae
    20. Winteraceae

Practical:

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.

RecommendedBooks:

1. Ali, S.I. and Nasir, Y. 1995. Flora of Pakistan. Karachi Univ. Press, Karachi
2. Davis, P.H. & Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London
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. &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. Levine, D.A. 2000. The Origin, Expansion and Demise of Plant Species. Oxford University Press.
5. Naik, V.N. 1988. Taxonomy of Angiosperms. Tata McGraw Hill Publishing Company, New Delhi.
6. Nasir, E. & Ali, S.I. 1994. Flora of Pakistan. Karachi Univ. Press, Karachi.
7. Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold..
8. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.

BOT 243	**Major-A-6**	Phycology and Bryology	3 (2+1)	100

Theory

a) Phycology

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

b) Bryology:

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

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.*

Books Recommended:

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

BOT 244	**Major-A-7**	Plant Physiology-1	3 (2+1)	100

Theory:

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

Practical:

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.

RecommendedBooks:

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. Epstein, E. and Bloom, A.J. 2004. Mineral Nutrition of Plants: Principles and Perspectives. 2nd Edition. Sinauer Associates, California, USA.
4. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
5. Heldt, H-W. 2004. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
6. IhsanIllahi, 1991. Plant Growth, UGC Press, Islamabad.
7. IhsanIllahi, 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
8. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.

BOT 245	**Major-A-8**	Diversity of Vascular Plants	3 (2+1)	100

Theory

a). Pteridophytes

Introduction, origin, history, features and a generalized life cycle.

Methods of fossilization, types of fossils, geological time scale and importance of paleobotany. First vascular plant - Rhyniophyta e.g. *Rhynia*.

General characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilophyta (*Psilotum*), Lycophyta (*Lycopodium, Selaginella*), Sphenophyta (*Equisetum*), Pterophyta (*Ophioglossum*, *Dryopteris*and *Azolla/Marsilea*).

b). Gymnosperms:

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

1. Origin of angiosperms
2. Evolution of fruit habit.

Practical

1. Morphological and reproductive features of available genera.
2. Study trips to different parts of Pakistan for the collection and identification of important pteridophytes and gymnosperms.

Books Recommended:

1. Beck, C.B. 1988. Origin and Evolution of Gymnosperms, Columbia University Press, New York,
2. Erdtman, G. 1954. An Introduction to Pollen analysis. 2nd. Ed. Ronald Press, New York.
3. Foster, A.S. and Gifford, E. M. Jr. 1998. Comparative Morphology of Vascular Plants. W. H. Freeman and Co.
4. Jones, D. 1983. Cycadales of the World, Washington, DC.
5. Mauseth, J.D. 1998. An Introduction to Plant Biology, Multimedia Enhanced, Jones and Bartlett Pub. UK.
6. Moore, R.c., W.d. Clarke and Vodopich, D.S. 1998. Botany McGraw Hill Company, USA
7. Raven, P.H. Evert, R.E. and Eichhorn, S.E. 1999. Biology of Plants, W.H. Freeman and Company Worth Publishers.
8. Ray, P.M. Steeves, T.A. and Fultz, T.A. 1998. Botany Saunders College Publishing, USA.
9. Sporne, K.R. 1967. The Morphology of Gymnosperms. Hutchinson Univ. Library.
10. Stewart, W. N. and Rothwell, G.W. 1993. Paleobotany and the Evolution of Plants, University Press, Cambridge.
11. Taylor, T.N. and Taylor, E.D. 1987. The Biology and Evolution of Fossil Plants, Prentice Hall.

BOT 246	**Major-A-9**	Autecology (Plants)	3 (2+1)	100

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. Soil erosion
3. Light and temperature: Nature of light, Factors affecting the variation in light and temperature, Responses of plants to light and temperature, Adaptation to temperature extremes,
4. Carbon dioxide: Stomatal responses, water loss and CO2-assimilation rates of plants in contrasting environments. Ecophysiological effects of changing atmospheric CO2 concentration. Functional significance of different pathways of CO2 fixation. Productivity: response of photosynthesis to environmental factors, C and N balance
5. Water: Water as an environmental factor, Role of water in the growth, adaptation and distribution of plants, Water status in soil. Water and stomatal regulation, Transpiration of leaves and canopies.
6. Oxygen deficiency: Energy metabolism of plants under oxygen deficiency, Morpho-anatomical changes during oxygen deficiency, Post-anoxic stress
7. Wind as an ecological factor.
8. Fire as an ecological factor.

Practical:

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

RecommendedBooks:

1. Bazzaz, F.A. 2004. Plants in Changing Environments: Linking Physiological, Population, and Community Ecology, Cambridge University Press
2. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
3. Lambers, H. et al. 2002. Plant Physiological Ecology, Springer-Verlag
4. Larcher, W. 2003., Physiological Plant Ecology: Ecophysiology and Stress Physiology of Function Groups - Springer-Verlag
5. Nobel, P.S 1999, Physico-chemical and Environmental Plant Physiology, Academic Press
6. Schultz et al. 2005. Plant Ecology, Springer-Verlag

Third Year

Designed for both BS (*4-Year*)/ BS (*4-Year Split*) from semester V-VIII: Effective from Fall-2023

Semester-V				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 351	**Major**	Comparative Morphology of Archegoniate	3 (2+1)	100
BOT 352	**Major**	Environmental Sciences-I	3 (2+1)	100
BOT 353	**Major**	Virology and Bacteriology	3 (2+1)	100
BOT 354	**Major**	Mycology and Plant Pathology	3 (2+1)	100
BOT 355	**Major**	Molecular Biology	3 (2+1)	100
BOT 356	**Major**	Plant Anatomy	3 (2+1)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**18**	**600**

BOT 351	**Major-A-10**	Comparative Morphology of Archegoniate	3 (2+1)	100

Theory:

A- Bryology:

a) General characters, classification (Major groups) distribution and Ecology with reference to some representative genera of Hipaticeae, Anthocerotae and Musci found in Pakistan.

b) Major evolutionary line in bryophyte including their origin.

B- Pteridophytes:

1. **Fossils:**
   Definition, types of Fossils and process of Fossilization and methods used for their study. Nomenclature and geological time scale.
2. **Psilopsida:**
   General characteristics of Psilotaceae, Rhyneaceae, Zoosterophyllaceae, Asteroxylaceae and their Phylogenetic importance.
3. **Lycopsida:**
   Classification and general characteristics of Aligulatae of both fossils and living members. Nature of stigmarian axes. Heterospory and origin of seed habit.
4. **Sphenopsida:**
   Affinities and Phylogenetic importance. Classification of living and fossils taxa.
5. **Pteropsida:**
   General characteristics, Classification and Phylogenetic importance of Sorus, Indusium, sporangial organization, sporangial evolution with reference to Eusporangiatae, Protolepto-Eusporangiatae, Leptosporangiatae.

c- Gymnosperms:

History, origin, distribution, ecology morphology, classification, affinities and anatomy of CycadofilicalesBenneuitales, GinkgoalesCycadales, Gnetales. Distribution of gymnosperms in Pakistan. Economic importance of gymnosperms.

d- Palynology:

An introduction to palynology, its application in Botany, Geology Archeology, medicines. Honey and oils and gas exploration.

Practical:

1. Morphology of section cutting, staining, mounting of Adiantum, Asplenium, Dryopteris,.PterisMasilea, Equisitum. Male and female cone with twig of pinus, thuja, cycus,andTaxus.
2. Section cutting, identification and studies of stereo-sections of the woods of pinus, Cedrus, abies, cupressus, Juniperus and Thuja.

3. Morphological studies of the materials and prepared slides of; LunnariaConocephalum, Funaria, Polytrichum, Rhynia, Psilotum, LycopodiumSphenophyllum, Equisitium, Lapidocarpon, Pteris rhizome, Osmunda rhizome Ophioglossum, Osmundabotrychinum, Athyrium, polystichum.

Candidates are required to collect at least 25 Bryophytes, Pteridophytes and gymnosperms of Pakistan and to submit their collection properly mounted and identified at the time of examination.

Recommended Books:

1. Andrews, H.W. 1961. Studies in paleobotany. Johan Wiley and Sons.
2. Chamberlain, C.J. 1966. Gymnosperm, structures and evolution. Dover Publications inc.
3. Fames A.J. 1936. Morphology of Vascular plants (lower groups). McGraw Hill and Co.
4. Gangule, H.C. 1985. Handbook of Indian Mosses Amerind Publishing Co. New Delhi.
5. Kashyap, S.R. 1932. Liverworts of western Himalayas and the Punjab Plains Vol: I & II Punjab University.
6. Schofield, W.B. 1985. Introduction to bryology. MacMillan Publishing Company London.
7. Smith G.M. 1955. Cryptogamic botany Vol: II 2nd edition McGraw Hill.
8. Sporne, K.P. 1961. The Morphology of gymnosperm. Hutchinson, University Library.
9. Sporne, K.P. 1965. The Morphology of Pteridophytes. Hutchinson, University Library.

Chairman, Department of Botany University of Malakand

Assistant Registrar (Academics) University of Malakand 05-Dec-2023

BOT 352	**Major-A-11**	Environmental Sciences-I	3 (2+1)	100

Theory:

Introduction: Definitions, History, Environmental systems and factors: Atmosphere and its Layers, Lithosphere and its zones, hydrosphere and its classification and Biosphere and limits of life.

Ecosystem: Structure (Biotic and Abiotic factors) and Functions (Materials and Energy Flow) of ecosystem

Environmental sustainability: Ecosystem evolution (Hydroseres and Xeroseres)

Pollution: Definition, types (Material and non-material), sources, causes, effects.

- Air Pollution and its consequences (Global warming, Greenhouse effect, Acid rain, Ozone Layer depletion).
- Water Pollution: Sources and effects of water pollution on living organisms
- Soil Pollution: Sources and effects of Soil pollution on living organisms

Resources: Renewable and Non Renewable resources (Land, Agriculture, Fisheries, Forests and Energy resources)

Practical:

Testing water for different pollutants (Coliform bacteria, Chloride, Carbonate ions and Nitrate ions). Design for material recycling and reuse. Test for Ozone. Algae as Biofuel Wind, Solar and Hydal energy. Design to observe Effect of Pollutant on Plant GrowthPrimary, Secondary and Tertiary treatment of water.

Recommended Books:

1. Botkin, D. and Keller, E. Environmental Sciences; Earth as a Living Planet. 8th ed. John Wiley and Sons, Inc. (2000).
2. Cunningham, W.P, &Saigo, B.W. Environmental Sciences 6th ed. McGraw-Hill (2001).
3. Enger, E.D. and Smith, B.F. Environmental Science: A study of Interrelationship. McGraw-Hill, (1997).
4. Kupchella, C.E. and Hyland. M.C. Environmental Science; Living within the System of Nature. Prentice Hall, (1986).
5. Nebel, B.J. & Wright, R.T. Environmental Sciences, 6th ed. Prentice Hall. New Jersey, (1999).
6. Zia-ul-Haq, Calculas and Analytic Geometry, 1998. The Caravan Book House, Lahore.

BOT 353	Major-A-12	Virology and Bacteriology	3 (2+1)	100

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.

Practical:

a) Viruses:

Observation of symptoms of some viral infected plant specimens.

a) 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. Arora, D.R. 2004. Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
2. Black, J.G. 2005 Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
3. Hull R. Matthews, 2004, Plant Virology, Academic Press.
4. Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens, The Haworth Press, Inc.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2005. Microbiology McGraw Hill Companies, Inc.

BOT 354	Major-A-13	Mycology and Plant Pathology	3 (2+1)	100

Theory:

a) Mycology:

1. Introduction:General characters of fungi**,** Thallus, cell structure and ultrastructure of fungi
2. Reproduction: Asexual and sexual reproduction and reproduction structures, life cycle, haploid, heterokaryotic and diploid states.
3. Fungal Systematics**:** Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of 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, shisham dieback etc.

Practical:

a) Mycology:

General characters and morphology of fungi. Study of unicellular and mycelia 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 chemo-therapeutants.

RecommendedBooks:

1. Agrios, G.N., 2002. Plant Pathology, 5th ed. 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.

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6. Trigiano, R.N., Windham, M.T. and Windham, A.S., 2004. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

BOT 355	Major-A-14	Molecular Biology	3 (2+1)	100

Theory:

1. Nucleic Acids: DNA-circular and super helical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA
2. Proteins: Basic features of protein molecules. Folding of polypeptide chain, α-helical and β-secondary structures. Protein purification and sequencing.
3. Transcription: Enzymatic synthesis of RNA, transcriptional signals
4. Translation: The genetic code. The Wobbling, polycistronic and monocistronic RNA. Overlapping genes.
5. 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.
6. Plant Omics: Transcriptomics; DNA libraries, their construction, screening and application. Microarray of gene technology and its application in functional genomics.
7. Proteomics; structural and functional proteomics. Methods to study proteomics Metabolomics; methods to study metabolomics; importance and application of metabolomics.

RecommendedBooks:

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. Ignacimuthu, S. 2005. Basic bioinformatics. Narosa Publishing House, India.
5. Lodish, H. et al., 2004. Molecular Cell Biology. 5th Edition. W.H. Freeman & Co., New York.
6. Malacinski, G. M. 2003. Essentials of Molecular Biology, 4th edition. Jones and Bartlett Publishers, Massachusetts.
7. Watson, J.D. et al. 2004. Molecular Biology of the Gene. Peason Education, Singapore.
8. Weaver, R.F. 2005. Molecular Biology. Mc|Graw Hill, St. Louis.

BOT 356	Major-A-15	Plant Anatomy	3 (2+1)	100

Theory:

1. The plant body and its development: fundamental parts of the plant body, internal organization, and different tissue systems of primary and secondary body.
2. Meristematic tissues: classification, Cyto-histological characteristics, initials and their derivatives.
3. Apical meristem: Delimitation, different growth zones, and 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, and 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.

Practical:

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

Books Recommended:

1. Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.
2. Dickison, W.C. 2000. Integrative plant anatomy. Academic Press, U.K.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.

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5. Metcalf, C.R. and Chalk, L. 1950. Anatomy of the Dicotyledons. Clerondon Press. Oxford.

Third Year

Semester-VI				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 361	**Major**	Genetics-I	3 (2+1)	100
BOT 362	**Major**	Synecology (Plants)	3 (2+1)	100
BOT 363	**Major**	Research Methodology	3 (2+1)	100
BOT 364	**Major**	Plant Biochemistry-I	3 (2+1)	100
BOT 365	**Major**	Dendrochronology/Optional Paper	3 (3+0)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**15**	**500**

BOT 361	**Major-A-16**	Genetics-I	3 (2+1)	100

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. 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.
5. Recombination in Bacteria and their Viruses : Bacterial chromosome, bacterial conjugation, bacterial recombination and mapping the *E. coli* 34
1. Chromosome, bacterial transformation, Bacteriophages genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer.
6. The Structure of DNA: DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene.
7. 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, universality of genetic information transfer, eukaryotic RNA.
9. The Extranuclear Genome: Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extra-nuclear genes in chlamydomonas, mitochondrial genes in yeast, extra-genomic 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.

Practical:

A. Numerical problems:

i. Arrangement of genetic material:

a. Linkage and recombination.
b. Gene mapping in diploid.
c. Recombination in Fungi.
d. Recombination in bacteria.
e. Recombination in viruses.

ii. Population Genetics:

a. Gene frequencies and equilibrium.
b. Changes in gene frequencies,

2. Blood group and Rh-factor:

3. Drosophila:

a. Culture technique
b. 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:

a. Bacterial cultural techniques, Gram staining (*E. coli*, *B. subtilis*)
b. Transformation.
c. Conjugation.

Recommended Books:

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

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BOT 362	**Major-A-17**	Synecology (Plants)	3 (2+1)	100

Theory:

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

Practical:

1- Determination of seed bank in various populations. Seed dispersal pattern of local populations.

2- Demography and life history of local annual population. Study of community attributes. Sampling of vegetation including Quadrat, plotless, transect and Braun-Blanqut. Correlate soil properties with vegetation type.

3- Field trip to study different communities located in different ecological regions of Pakistan.

4- Slide show of the vegetation of Pakistan. Slide show of the major formations of the world. Soil physical and chemical properties

RecommendedBooks:

1. Barbour M. G. et al., 1999, Terrestrial Plant Ecology, The Benjamin-Cumming Publishing Co.
2. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
3. Gurevitch, et al., 2002.The Ecology of Plants, Sinauer Associates, Inc.
4. Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education. Islamabad
5. Hussain, S. Pakistan Manual of Plant Ecology,
6. Lambers, H. et al., 2002. Plant Physiological Ecology, Springer-Verlag
7. Moore P.D. and Chapman S. B. 1986. Methods in Plant Ecology, Blackwell Scientific Publication, Oxford.
8. Schultz et al. 2005. Plant Ecology, Springer-Verlag .
9. Smith, R. L. 1998. Elements of Ecology by Harper & Row Publishers,
10. Townsend et al. (2003). Essentials of Ecology, Blackwell Publishing,

BOT 364	**Inter-Disp-2** Research Methodology	3 (2+1)

Theory:

Prerequisites: Specific objectives of course: To enable the students to know the theoretical aspects of planning research, handling, presentation of data, writing and submission of research papers and thesis Course Outline: What is science, philosophy and theory, how to do science. Questions, hypothesis, their types, experimentation, validation, theories and laws. Research Methods (planning research, various methods, analyzing 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.

Recommended Books:

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, MA: Harvard Educational Review

3. Shank, G. D. 2001, Qualitative Research: A Personal Skills Approach

BOT 365	**Inter-Disp-3** Plant Biochemistry-I	3 (2+1)

Theory:

Carbohydrates:

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

Lipids:

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

Proteins:

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

Nucleic Acids:

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

Enzymes:

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

Practical:

1. Solutions, acids and bases. Electrolytes, non-electrolytes, buffers, pH. Chemical bonds.
2. To 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 extracted from a plant source.
12. To determine the PKa and isoelectric point of an amino acid.

RecommendedBooks:

1. Abdes, R.H. Frey, P.A. and Jencks W.P. 2004, Biochemistry, Jones and Bartlet, London.
2. Conn E E. and Stumpf P.K., 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
3. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
4. Goodwin T.W. and Mercer, E.I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.
5. Heldt, H-W. 2004. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
6. Lea, P.J... andLeegood, R.C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
7. Lehninger, A L. 1998. Principles of Biochemistry. Worth Publishers Inc.
8. Mckee, T. and Mckee, J.R. 1999. Biochemistry – An Introduction. WCB/McGraw-Hill, New York, Boston, USA.
9. 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.

BOT 366	**Field Experience/Internship**	2 (0+2)

The student concern will submit Field report (also will collect 100 identified plants) about the task designed for him by the supervisor. The supervisor will check the plagiarism (minim 19% as described by HEC) before submission to the office of Chairman for onward processing.

Semester 7		
Code	**Title**	**Cred. Hrs.**
BOT 471	**Major-A-22** Genetics-II	3 (2+1)
BOT 472	**Major-A-23** Plant Physiology-II	3 (2+1)
BOT 473	**Major-A-24** Medicinal Plants (Pharmacognosy)	3 (2+1)
BOT 474	**Major-A-25** Plant Biochemistry-II	3 (2+1)
BOT 475	Capstone Project / Optional Paper	3 (0+3)
		Total Credit Hours:15

Fourth Year

Semester-VII				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 471	**Major**	Genetics-II	3 (2+1)	100
BOT 472	**Major**	Plant Physiology-II	3 (2+1)	100
BOT 473	**Major**	Medicinal Plants (Pharmacognosy)	3 (2+1)	100
BOT 474	**Major**	Plant Biochemistry-II	3 (2+1)	100
BOT 475	**Major**	Field Experience/ 100 Plants Collection/ Internship	3 (0+3)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**15**	**500**

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Code	Title	Cred. Hrs.
BOT 471	**Major-A-22** Genetics-II	3 (2+1)

Theory:

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, recombinant DNA and social responsibility, 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.
3. Control of Gene Expression: Discovery of the *lac* system: negative control, catabolite repression of the *lac* operon: positive control, transcription: gene regulation in eukaryotes - an overview.
4. 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. Plant Genome Projects: Arabidopsis, achievement and future prospects. Other plant genome projects
8. Bioinformatics : Application of computational tests to the analysis of genome and their gene products
9. Bioethics : Moral, Religious and ethical concerns

Practical:

1. Problems relating to the theory
2. Isolation and separation of DNA and protein on Gel electrophoresis.
    i) Plant DNA Extraction
    ii) Protein (SDS-PAGE)
3. DNA Amplification by PCR

RecommendedBooks:

1. Beaycgamp T.L. and Walters L., Contemporary Issues in Bioethics, Wadsworth Publishing Company.
2. Brown, T.A., 2002 Genomes, Bios Scientific Publishers Ltd.
3. Gelvin, S, B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
4. Hartt, D. L, and Jones, E.W. 2005. Genetics, Analysis of Gene and Genomes. Jones and Bartlett Publishers, Sudbury, USA
5. Ignacimuthu, S. 2005, Basic Bioinformatics, Narosa Publishing House, India.
6. Miglani, 2003, Advanced Genetics, Narosa Publishing House, India,.
7. Primrose, S.B., Twyman, R. M. and Old R.W. 2004. Principles of Gene Manipulation, an Introduction to Genetic engineering (6th edition), Blackwell Scientific Publications.

BOT 472	**Major-A-23** Plant Physiology-II	3 (2+1)

Theory:

1. Plant Growth Regulators: Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action, transport, physiological effects of Auxins , Gibberellins, Cytokinins, Abscisic acid, Ethylene, Polyamines, 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. Hofler diagram - 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. 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.
6. Gene Regulation and Signal Transduction: Genome size and organization. Gene regulation in prokaryotes and eukaryotes. Signal transduction in prokaryotes and eukaryotes.

Practical:

1. To investigate the preferential absorption of ions by corn seedlings and potato slices.
2. To determine osmotic potential of massive tissue by freezing point depression method or by an Osmometer.
3. 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.
2. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
3. Epstein, E. and Bloom, A.J. 2004. Mineral Nutrition of Plants: Principles and Perspectives. 2nd Edition. Sinauer Associates, California, USA.
4. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.

BOT 473	**Major-A-24** Medicinal Plants (Pharmacognosy)	3 (2+1)

Theory:

Definition of Pharmacognosy, drug, crude drug, official and unofficial drugs. Cultivation, collection, drying, preservation, evaluation and classification of drugs. Therapeutic classes of drugs.

Detail study of the following medicinal plants giving them synonyms botanical origin, local names, distribution of plants, method of cultivation, macroscopic characteristics and microscopic characteristics of drugs (histology and powdered drug of the part used).

Chemical constituents, uses and adulterants with special reference to species growing in Pakistan. Ethnopharnacognosy of the medicinal plants.

Gymnosperm:

Ephedra (Ephedra spp:) Ephedraceae

Angiosperms:

(a) Dicotyledons;

I. Aconite (Root) *Acoittumnapellus*, Family Ranunculaccae)
II. Mandrake (Rhizome) (*Podopyllumpeltatum*, Family podophyllaceae
III. Opium (*Papaversomniferum*, Family papaveraceae)
IV. Liquorice (Rhizome) (*Glycyrrhizaglabra*, Family Leguminosae/ Fabaceae).
V. Gum acacia (Gum) (*Acacia senegal*, Family Mimosaseae).
VI. Senna (Leaflet) (*Cassia angustifolia*, Family Caesalpinaceae)
VII. Linseed (Seed) (*Liniunusitatissimum*, Family Linaceae)
VIII. Fennel (Fruit) (*Foeniculumvalgare*, Family Apiaceae)
IX. Rauwolfia (Rhizome) (*Rauwolfiaserpentina*, Family Apocynaceae)
X. Atropa (Root & Leaf) (*Atropa belladonna*, Family Solanaceae)
XI. Mentha (Leaf) peppermint (*Menthapiperita*, Family Lamiaceae)
XII. Stamonium (Leaf) (*Daturastramonium*, Family Solanaceae)
XIII. Henbane (Leaf) (*Hyocyamusniger*, Family Solanaceae)
XIV. Foxglove (Leaf) (*Digitalis purpuroa*, Family Scrophulariaceae)
XV. Valerian (Rhizome) (*Valerianaofficinalis*, Family valcrianaceae/ Caprifoliaceae)

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XVI. Chincona (bark) (*Cinchona succirubra*, Family Rubiaceae)
XVII. Santonica (Florets) (*Artemisia kurramensis*, Family Asteraceae)

(b) Monocotyledon:

I. Colchicum (corn) (*Colchicum automnale*, Family Liliaceae)
II. Zingiber (rhizome) (*Zingiberofficinale*, Family Zingiberaceae)

(c) Economic Botany:

Classification of Economic Botany, Agronomy, Variety development with reference to Pakistan. Release and development procedures of Wheat, Maize, Tobacco, Sugarcane, Rice and Cotton variety development and different centers across the globe for his commercialization.

Practical:

1. Microscopical characters of the drugs.
2. microscopicalcharactersof the drugs (T.S of the plant part used powdered drugs.)
3. Properties of gums.
4. Properties of different oils.
5. Identification test for starch, Calcium Oxalate etc.
6. Volatile and fixed oils, tannin, mucilage etc.

Note: The student should are required to submit collection of 30 medicinal plants.

Recommended Books:

1. Tyler, V.L.E.R. Brady & and E.F. Clayse. 1970. Pharmacognocy. Sixth Ed. Leimptionlondon.
2. Trease G.D & W.C Evans.1985. Pharmacognacy 12th Ed, English, Language. Soc. BaillereTindall.
3 Wallism, T.E.19981. Text book of pharmacognosy. J. & A. Churchill, Ltd. Glousester Palace, W.I. London.
4 Jain, S.K. 1991. Contribution of Enthobotany. Scientific Publisher,Johpur, India.

BOT 474	**Major-A-25** Plant Biochemistry-II	3 (2+1)

Theory:

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.

Practical:

1. Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.

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

RecommendedBooks:

1. Abides, R.H., Frey P.A. and Jencks, W.P. 1992. Biochemistry, Jones and Bartlet, London.
2. Albert L. Lehninger, 1998. Principles of Biochemistry. Worth Publishers Inc.
3. Chesworth,. J.M., Strichbury T. and Scaife, J. R. 1998. An introduction to agricultural biochemistry. Chapman and Hall, London.
4. Conn E. E. and Stumpf, P.K. 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
5. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
6. Goodwin T.W. and Mercer, E.I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.

BOT 475	**Capstone Project/ Thesis/ Optional Paper**	3 (0+3)

In semester 7th the students will start research work and will submit thesis in 8th semester to the supervisor. The supervisor will check the plagiarism (minim 19% as described by HEC) before submission to the office of Chairman for onward processing.

Semester 8		
Code	**Title**	**Cred. Hrs.**
BOT 481	**Major-A-26** Environmental Biology-II	3 (2+1)
BOT 482	**Major-A-27** Plant Tissue Culture	3 (2+1)
BOT 483	**Major-A-28** Plant Taxonomy	3 (2+1)
BOT 484	**Major-A-29** Plant Breeding	3 (2+1)
BOT 485	**Capstone Project/ Thesis/ Optional Papers**	3 (0+3)
		Total Credit Hours: 15

Fourth Year

Semester-VIII				
Code	**Category**	**Title**	**Cred. Hrs.**	**Marks**
BOT 481	**Major**	Environmental Biology-II	3 (2+1)	100
BOT 482	**Major**	Plant Tissue Culture	3 (2+1)	100
BOT 483	**Major**	Plant Taxonomy	3 (2+1)	100
BOT 484	**Major**	Plant Breeding/ Optional Paper	3 (2+1)	100
BOT 500	**Major**	Capstone Project/ Thesis	3 (0+3)	100
		Teaching of Holy Quran with translation		Non-Credit
		Total Credit Hours:	**15**	**500**

Chairman, Department of Botany, University of Malakand

Assistant Registrar (Academics), University of Malakand, 05-Dec-2023

BOT 481	**Major-A-26** Environmental Biology-II	3 (2+1)

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. Acid rain: 1. Theory of acid rain, 2. adverse effect 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 and Heavy metal pollution. Tanneries and 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: 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.

Practical:

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. Bazzaz, F.A. 1996. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
2. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
3. Eugene, E.D. and Smith, B.F. 2000. Environmental Science: A study of interrelationships. McGraw Hill. USA.

BOT 482	**Major-A-27** Plant Tissue Culture	3 (2+1)

Theory:

Introduction to plant cell and tissue culture. Plant tissue culture, plant genetic engineering and crop improvement. Tissue culture in agriculture, forestry, Botany and industry.

Explant Preparation and Selection Strategies:

Type of explant, size, age, quality, location and season. Surface Sterilization of explant

Culture Facilities and Sterile Techniques:

The basic laboratory layout and equipment. Sterilization of glassware, equipment and working area.

Media Components and Preparation:

Inorganic nutrients, organic nutrients, vitamins, amino acids, carbohydrates, gelling agents, antibiotic, plant hormones, complex organic supplements. Preparation of MS media from commercial packages and from stock solution. Contamination and its disposing. Safety in the laboratory.

Initiation and Maintenance of Callus:

Origin and types of callus, Role of callus in embryogenesis, organogenesis and cell culture. Initiation and propagation of callus cultures. Monitoring the growth of callus. Genetic transformation of callus. Sub-culturing of callus. Organogenesis (Rooting and Shooting). Deflasking or Acclimatization.

Production of Virus Free Plants:

Disease elimination by tissue culture. Disease elimination by chemotherapy. Disease elimination by thermotherapy. Virus Eradication.

Types of Culture:

Initiation, maintenance, growth characters and uses of cell suspension culture. Isolation, purification, culturing and uses of protoplast culture. Introduction of anther and microspore culture. Pollen culture. Haploid for plant breeding and genetics. Factors affecting the success of another culture. Organ and embryo culture. Culturing of Hairy roots, Minitubers and Microtubers. Callus culture, Meristem culture, and fern spore culture.

Soma-clonal Variation:
Origin, mechanism and uses of somaclonal variation. Somaclonal variations for salt, herbicide, drought, nematodes and disease tolerance. Somaclonal variations in major crops.

Somatic Hybridization and Germplasm Conservation:
Protoplast fusion and hybridization. Somatic hybrids plants and their regeneration. Germplasm conservation, methods for germplasm conservation. Cryopreservation. Artificial seeds.

Plant Hormones:
Uses of plant hormones in tissue cultures. Auxins, Cytokinins, Gibberellins, Florigen and Abscisic acid.

Recommended Books:

1. Attege, C.R and B. Kristiansen.2001. Basic Biotechnology, CambridgeUniversity, PressUK.
2. Chopra V. L., V. S. Malik and S.R. Bhat. Plant Biotechnology. Oxford IBHPublishers New Delhi.
3. Evans, D.E. J.O.D. Coleman and A. Kearns. Plant Cell Culture. BIOS Scientific Publishers London.

BOT 483	**Major-A-28** Plant Taxonomy	3 (2+1)

Theory:

1- Introduction to systematics and Taxonomy introduction, Taxonomy and its significance, Basic Terms used in taxonomy, the Taxonomic hierarchy.
2- Plant Classification. History, Need, Various systems of classification.
3- Methods of describing a plant specimen. Technical recording of characters, drawing of scientific illustration, floral diagram, floral formula.
4- Plant Nomenclature, Introduction, purposes, Principles, Typification, Terminology of type materials, Authority citation, Rules for author citations, effective & valid publication, principle of priority, synonyms &its related terms, Names for plant hybrids.
5- Phytography. Introduction, plant duration, Habit, plant organs, vegetative morphology, Reproductive morphology, inflorescence, Fruit, ovules & seed.
6- Terminology used for types of leaves, arrangement of stem and branches, margins, types of pubescence, inflorescence.
7- Study of selected Dicot families
8- Study of selected Monocot families.

Practical:

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

Recommended Books:

1. Ali, S. I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi
2. 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. 3. 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 University Press.UK
13. Levin, D. A. 2000. The Origin, Expansion and Demise of Plant Species. Oxford University Press.
14. Shinwari, M. I. and M. A. Khan. 1998. Ethnobotany of Margalla Hills. Department of Biological Sciences, Quaid-i-Azam University Islamabad Pakistan.
15. Shinwari, M. I., M. I. Shinwari and Shah, M. 2007. Medicinal Plants of Margalla Hills National Park Islamabad. Higher Education Commission Islamabad. Pp.218.
16. Sivarajan V. V and N. K. P Robson 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.

BOT 484	**Major-A-29** Plant Breeding	3 (2+1)

Theory:

1. **Plant Breeding and its scope**. Definition, concept, Goals of plant breeding, contribution of plant breeding.
2. **Genetic Basis for plant Breeding.** Genetic consequences of hybridization, Quantitative inheritance, Population structure, Hardy-Weinberg Law, combining ability, Habitability, Genetic advance, Genetic base, choice of breeding methods.
3. **Nature of crops and Method of Breeding.** Mode of reproduction, Incompatibility, Male sterility, Methods of breeding and mode of reproduction.
4. **Origin, Domestication and Introduction of Crop Plants.** Centers of origin, centers of origin, centers of Diversity and origin, Domestication, Domestication of some crop plants, Introduction, procedure of introduction, Achievements and uses of introduction, Disadvantages.
5. **Breeding for Disease and insect Resistance.** Definition and history, loss of resistance, Race and its identification, classification, classification of resistance, Genetics of host-parasite interaction, Breeding for disease resistance, introduction, selection and hybridization, Back cross method, Mutation Breeding, Breeding for insect resistance, Breeding for Multiple resistance, Exploitation of resistance genes, advantages & Limitations of resistance breeding.

6. **Organization and Achievements of plant breeding in some crops**. Rice, Maize, wheat, Bajra, cotton, sugar cane.
7. **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.

Practical:

1. Crossing, F1 generation, F2 generation
2. Male sterility in plants
3. Vegetative reproduction: cutting, grafting, layering, budding
4. To study detrimental soil and air fungus.
5. Check horizontal and vertical resistance in wheat varieties.

Recommended Books:

1. Al-Khayri, J. M., Jain, S. M., & Johnson, D. V. (Eds.). (2015). *Advances in plant breeding strategies: Breeding, biotechnology and molecular tools*. Springer International Publishing.
2. Acquaah, G. (2009). *Principles of plant genetics and breeding*. John Wiley & Sons.
3. Allard, R. W., & Allard, R. W. (1999). *Principles of plant breeding (2nd edition)*. John Wiley & Sons.
4. Miglani, 2003, Advanced Genetics, Narosa Publishing House, India,.
5. Primrose, S.B., Twyman, R. M. and Old R.W. 2004. Principles of Gene Manipulation, an Introduction to Genetic engineering (6th edition), Blackwell Scientific Publications.

BOT 485	**Capstone Project/ Thesis/ Optional Papers**	3 (0+3)

In 8th semester the student will submit thesis to the research supervisor. The supervisor will check the plagiarism (minim 19% as described by HEC) before submission to the office of Chairman for onward processing.

Note:

Courses included in the General Education Category are designed by the respective departments including their course codes, credit hours and titles (reflected in the scheme of studies). All such courses approved by the Syndicate are available on the university website (www.uom.edu.pk). For any query the office of the Registrar Academics may be approached for clarification/guidance.

Chairman, Department of Botany, University of Malakand

Assistant Registrar (Academics), University of Malakand, 05-Dec-2023