

**TEMPLATE FOR  
4-YEAR BS DEGREE PROGRAMME**

<b>SR.</b>	<b>CATEGORIES</b>	<b>NO. OF COURSES MIN– MAX</b>	<b>CREDIT HOURS MIN – MAX</b>
1.	Compulsory Requirement (No Choice)	9 – 9	25 – 25
2.	General Courses to be chosen from other departments	7 – 8	21 – 24
3.	Discipline Specific Foundation Courses	9 – 10	30 – 33
4.	Major Courses including research project / Internship	11 – 13	36 – 42
5.	Electives within the major	4 – 4	12 – 12
	<b>Total</b>	<b>40 – 44</b>	<b>124 – 136</b>

- Total numbers of Credit hours      124-136
- Duration                                      4 years
- Semester duration                        16-18 weeks
- Semesters                                     8
- Course Load per Semester          12-18 Cr hr
- Number of courses per semester    4-6

**LAYOUT FOR BS BOTANY (4 – YEAR PROGRAMME)**

<b>9-Compulsory Courses (25 Cr. H)</b>		<b>7-8 General courses 21-24 Cr. H</b>	
<b>Subjects</b>	<b>Cr. Hr.</b>	<b>Subjects</b>	<b>Cr. Hr</b>
1. ENGLISH I (Functional English)	3	1. General Course-I ***	3
2. ENGLISH II(Communication Skill)	3	2. General Course-II***	3
3. ENGLISH III (Technical Report Writing & presentation skills)	3	3. General Course-III ***	3
4. ENGLISHVI*	2	4. General Course-IV ***	3
5. PAKISTAN STUDIES	3	5. General Course-V ***	3
6. ISLAMIC STUDIES / ETHICS	3	6. General Course-VI ***	3
7. MATHEMATICS	3	7. General Course-VII ***	3
8. BIostatistics		8. General Course-VIII***	3
9. INTRODUCTION TO COMPUTER			
	<b>25</b>		<b>24</b>

<b>Discipline Specific Foundation Courses 9-10 courses ( 30-33 Cr.H)</b>		<b>Major courses, 11-13 (36-42 Cr.H)</b>	
<b>Subjects</b>	<b>Cr. Hr</b>	<b>Subjects</b>	<b>Cr. Hr</b>
1. Diversity of Plants	4	1. Phycology & Bryology	3
2. Plant Systematics, Anatomy & Development	4	2. Mycology & Plant Pathology	3
3. Cell Biology, Genetics & Evolution	4	3. Plant Systematics	3
4. Plant Physiology & Ecology	3	4. Genetics-I	3
5. Biodiversity & Conservation	3	5. Plant Biochemistry-I	3
6. Bacteriology & Virology	3	6. Plant Physiology-I	3
7. Diversity of Vascular Plants	3	7. Molecular Biology	3
8. Plant Anatomy		8. Plant Biochemistry-II	3
9. Plant Ecology-I		9. Plant Ecology-II	3
		10. Plant Physiology-II	3
		11. Genetics II	3
		12. Environmental Biology	
	<b>32</b>		<b>36</b>

<b>4 Elective Courses within the major including research project/internship (12 Cr.H)</b>	
1. Elective-I / Research Project / Internship/ *Optional	3
2. Elective-II University Option	3
3. Elective-III Research Project / Internship/ *Optional	3
4. Elective-IV University Option	3
Total	12

\* University has the option to recommend any other course in lieu of English IV

\*\* University may recommend any other course in lieu of Mathematics

\*\*\* To be chosen from list of General Courses

**SCHEME OF STUDIES FOR BS 4 YEARS**

Semester	Course Codes	Course Titles	Course Nature	Theory	Lab	Cr. Hrs.
First	Bot-301	Diversity of Plants	Foundation-I	3	1	4
	Bot-303	Introduction To Environmental Sciences	General-II	2	1	3
	Bot-304	Principle Of Animal Life-1	General-I	2	1	3
	Bot-305	Mathematics-1 (Algebra)/(Statistical Packages)	Compulsory	3	0	3
	Bot-306	Pakistan Studies	Compulsory	2	0	2
	Bot-307	English-I (Functional English)	Compulsory	3	0	3
<b>Total Cr. H. of Semester</b>				<b>15</b>	<b>3</b>	<b>18</b>
Second	Bot-302	Plant Systematic, Anatomy and Development/ Embryology	Foundation-II	3	1	4
	Bot-308	Introduction to Geography of Pakistan	General-IV	2	1	3
	Bot-309	Principle Of Animal Life-II	General-III	2	1	3
	Bot-310	EnglishIV/ Univ option (Introduction to Statistics)	Compulsory	3	0	3
	Bot-311	Islamic Studies	Compulsory	2	0	2
	Bot-312	English-II (Communication Skills)	Compulsory	3	0	3
<b>Total Cr. H. of Semester</b>				<b>15</b>	<b>3</b>	<b>18</b>
Third	Bot-401	Cell Biology, Genetics and Evolution	Foundation-III	3	1	4
	Bot-404	Chemistry-I (Inorganic Chemistry)	General-VI	2	1	3
	Bot-405	Animal Diversity-I	General-V	2	1	3
	Bot-406	Introduction To Computer	Compulsory	2	1	3
	Bot-407	English-III (Technical Report Writing & Presentation Skill)	Compulsory	3	0	3
<b>Total Cr. H. of Semester</b>				<b>12</b>	<b>4</b>	<b>16</b>
Fourth	Bot-400	Biostatistics	Compulsory	3	0	3
	Bot-402	Plant Physiology and Ecology	Foundation-IV	3	1	4
	Bot-403	Biodiversity and Conservation	Foundation-V	3	1	4
	Bot-408	Animal Diversity-II	General-VII	2	1	3
	Bot-505	Plant Systematics	Major-III	2	1	3
<b>Total Cr. H. of Semester</b>				<b>12</b>	<b>5</b>	<b>17</b>
Fifth	Bot-409	Chemistry-II (Organic Chemistry)	General-VIII	2	1	3
	Bot-501	Bacteriology and Virology	Foundation-VI	2	1	3
	Bot-502	Phycology and Bryology	Major-I	2	1	3
	Bot-503	Mycology and Plant Pathology	Major-II	2	1	3
	Bot-504	Diversity of Vascular Plants	Foundation-VII	2	1	3
<b>Total Cr. H. of Semester</b>				<b>10</b>	<b>5</b>	<b>15</b>
Sixth	Bot-506	Plant Anatomy	Foundation-VIII	2	1	3
	-----	Research Methodology	Elective-II	2	1	3
	Bot-507	Genetics-I	Major-IV	2	1	3
	Bot-508	Plant Biochemistry-I	Major-V	2	1	3
	Bot-509	Plant Ecology-I	Foundation-IX	2	1	3
<b>Total Cr. H. of Semester</b>				<b>10</b>	<b>5</b>	<b>15</b>
Seventh	Bot-510	Plant Physiology-I	Major-VI	2	1	3
	Bot-601	Molecular Biology	Major-VII	2	1	3
	Bot-602	Plant Biochemistry-II	Major-VIII	2	1	3
	Bot-603	Plant Ecology-II	Major-IX	2	1	3
	-----	RESEARCH PROJECT/INTERNSHIP/ OPTIONAL PAPER	Elective-I	2	1	3
<b>Total Cr. H. of Semester</b>				<b>10</b>	<b>5</b>	<b>15</b>

Eight	<b>Bot-604</b>	<b>Plant Physiology-II</b>	Major-X	2	1	3
	<b>Bot-605</b>	<b>Genetics-II</b>	Major-XI	2	1	3
	<b>Bot-606</b>	<b>Environmental Biology</b>	Major-XII	2	1	3
		<b>RESEARCH PROJECT/INTERNSHIP/ OPTIONAL PAPER</b>	Elective-III	2	1	3
		<b>University Option</b>	Elective-IV	2	1	3
	<b>Total Cr. H. of Semester</b>				<b>10</b>	<b>5</b>
<b>Grand total of Cr. Hours</b>						<b>129</b>

- \* University has the option to recommend any other course in lieu of English IV
- \*\* To be chosen from list of General Courses

**Note: - Optional and elective papers to be framed by respective Board of Studies.**

**DETAIL OF COURSES  
FOR BS (4 – YEAR) IN BOTANY**

**1<sup>st</sup> Year**

**1<sup>st</sup> Semester**

**Title of the Course: Bot-301      Diversity of Plants**

**Credit Hours:      4 (3+1)**

**Course Nature: Foundation-I**

**Specific Objectives of course:**

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

**Course Outline:**

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

- a) Viruses (RNA and DNA types) with special reference to TMV;
- b) Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with reference to biofertilizers, pathogenicity and industrial importance;
- c) Algae (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)
- d) Fungi (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications.
- e) Lichens (Physcia)
- f) Bryophytes: Riccia, Anthoceros, Funaria
  
- g) Pteridophytes: Psilopsida (Psilotum), Lycopsida (Selaginella), Sphenopsida (Equisetum), Pteropsida (Marsilea)
- h) Gymnosperms
  - i. Cycas
  - ii. Pinus
  - iii. Ephedra
- i) Angiosperms: Monocot (Poaceae), Dicot Solanaceae)

**Lab Outline:**

Culturing, maintenance, preservation and staining of microorganisms. Study of morphology and reproductive structures of the types mentioned in theory.

Identification of various types mentioned from prepared slides and fresh collections.

**Recommended Books:**

1. Lee, R. E. 1999. Phycology. Cambridge University Press, UK
1. Prescott, L. M., Harley, J. P. and Klein, A. D. 2004. Microbiology, 3<sup>rd</sup> Ed. WM. C. Brown Publishers.
2. Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. Introductory Mycology. 4<sup>th</sup> Ed. John Wiley and Sons Publishers.
3. Agrios, G. N. 2004. Plant pathology. 8<sup>th</sup> Ed. Academic Press London.
4. Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
5. Andrew, H. N. 1961. Studies in Paleobotany. John Willey and Sons.
6. Ingrouille, M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.

7. Mauseth, J. D. 2003. Botany: An Introduction to Plant Biology 3<sup>rd</sup> Ed., Jones and Bartlett Pub. UK
8. Marti. J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP
9. Taylor, T. N. & Taylor, E. D. 2000. Biology and Evolution of Fossil Plants. Prentice Hall. N. Y.
10. Hussain, F. 2012. A Text Book of Botany and Biodiversity. Pak Book Empire.

**Journals / Periodicals:**

Pakistan Journal of Botany, American Journal of Botany, Canadian Journal of Botany, Annals of Botany.

**Student's Output:** To introduce the diversity of plants, their structures and significance.

**Title of the Course: Bot-303 Introduction to Environmental Sciences**

**Credit Hours: 3 (2-1)**

**Course Nature: General-II**

**Objectives**

To introduce the students with basic concepts and the history of development of Environmental Science as an academic discipline, its importance in human life, its interdisciplinary nature and provide students with an understanding of the relationships between different components of environment, current global, and national environmental challenges for sustainable development.

**Course Outlines**

Introduction: basic concepts, history, nature and scope of Environmental Science and its contribution to society. Different aspects of environment: physical, ecological, socio-economic, ethical, philosophical. Major components of environment: physico-chemical, biological and social, and their relationships with various environmental factors. Human environment and its problems: global, national, regional. Environmental challenges for sustainable development: current and future trends in population growth, environmental pollution, development in industry and agriculture, urbanization, poverty and resource depletion.

**Recommended Books:**

1. *Environmental Science: Earth as a Living Planet*, Botkin, D.B & Keller, E.A. 6<sup>th</sup> Ed. John Wiley & Sons, 2007.
2. *Environmental Science: systems and solutions*, McKinney, M.L., Schoch, R.M. & Yonavjak, L. 4<sup>th</sup> Ed. Jones & Bartlett Publishers, 2007
3. *Environmental Science: Toward a Sustainable Future*, Wright, R.T. & Nebel, B.J. 10<sup>th</sup> Ed. Pearson Educational, 2007.
4. *Environmental Science: working with the Earth*. Miller, G., Thomson Learning, 2002.

**Student's Output:**

To introduce the basic concepts and the history of development of Environmental Science as an academic discipline, its importance in human life, its interdisciplinary nature and provide an understanding of the relationships between different components of environment, current global, and national environmental challenges for sustainable development.



**Title of the course: Bot-304 PRINCIPLES OF ANIMAL LIFE – I**  
**Credit Hours: 3 (2+1)**  
**Course Nature: General-I**

### **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 organelle 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.

### **Course Contents**

#### **1. 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.

## Practicals

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, 12<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 6<sup>th</sup> Edition (International), 2005. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 5<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES, 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
7. Hickman, C.P. and Kats, H.L., LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
8. Molles, M.C. ECOLOGY: CONCEPTS AND APPLICATIONS. 6<sup>th</sup> Edition. 2005. McGraw Hill, New York, USA.
9. Odum, E. P. FUNDAMENTALS OF ECOLOGY. 3<sup>rd</sup> Edition. 1994. W.B. Saunders. Philadelphia.
10. Slingby, D. and Cook, C., PRACTICAL ECOLOGY. 1986. McMillan Education Ltd. UK.

**Student's Output:** 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 organelle 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.

**Title of the course: Bot-305 MATHEMATICS- I (ALGEBRA)**

**Credit Hours: 3 (3 + 0)**

**Course Nature: Compulsory**

**Specific Objectives of the Course:**

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression. *Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

**Recommended Books:**

1. Dolciani M. P, Wooton W, Beckenback E F, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,
2. Boston (suggested text)
3. Kaufmann J. E, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
4. Swokowski E. W., *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

**Student's Output:** To understand majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

**Title of the course: Bot-306**  
**Credit Hours: 2 (2+0)**  
**Course Nature: Compulsory**

## **Pakistan Studies**

### **Introduction/Objectives**

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

### **Course Outline**

#### **1. Historical Perspective**

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### **2. Government and Politics in Pakistan**

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### **3. Contemporary Pakistan**

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

### **Books Recommended**

1. Burki, Shahid Javed. *State & Society in Pakistan*, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Banglades.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.

12. Aziz, K. K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

**Student's Output:** To have a Developed vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

**English-I**  
**(Functional English), Bot-307 (Cr.3+0)**  
**Course Nature: Compulsory**

**Objectives:** To enhance language skills and develop critical thinking

**Course Contents:**

Basics of Grammar, Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling

**Comprehension**

Answers to questions on a given text

**Discussion**

General topics and every day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers)

**Translation skills**

Urdu to English

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

**Note: Extensive reading is required for vocabulary building**

**Recommended Books:**

**1. Functional English**

- a) Grammar
  - 1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third Edition. Oxford University Press. 1997. ISBN 0194313492
  - 2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
- b) Writing
  - 1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- c) Reading/Comprehension
  - 1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
- d) Speaking

**Student's Output:** To enhance language skills and critical thinking

**1<sup>st</sup> Year**

**2<sup>nd</sup> Semester**

**Title of the Course: Bot-302. Plant Systematics, Anatomy and Development/Embryology**

**Credit Hours: 4 (3+1)**

**Course Nature: Foundation-II**

**Specific Objectives of course:**

To understand: 1. various systems of classification, identification and nomenclature of Angiosperms, 2- Structures and functions of tissues and organs at embryonic level.

**Course Outline:**

**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).Vienna code.
4. Morphology: a detailed account of various morphological characters root, stem, leaf, inflorescence, flower, placentation and fruit types.
5. Diagnostic characters, economic importance and distribution pattern of the following families
  - i. Ranunculaceae
  - ii. Brassicaceae (Cruciferae)
  - iii. Fabaceae
  - iv. Rosaceae
  - v. Euphorbiaceae
  - vi. Cucurbitaceae
  - vii. Lamiaceae (Labiatae)
  - viii. Apiaceae (Umbelliferae)
  - ix. Asteraceae
  - X. Liliaceae (Sen. Lato)

**b) Anatomy**

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like: Parenchyma, Collenchyma, Epidermis (Stomata, Trichomes), Xylem, Phloem
3. Meristem: types, stem and root apices  
Vascular cambium  
Structure and development of root, stem and leaf. Primary and secondary growth of dicot stem, periderm  
Characteristics of wood: diffuse porous and ring porous, sap and heart wood, soft and hard wood, annual rings.
4. **Development/Embryology**
  - a. Structure of Ovule Megasporogenesis Megagametophyte
  - b. Endosperm formation
  - c. Parthenocarpy
  - d. Polyembryony

**Lab Outline:****Plant Systematics**

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.
4. Students shall submit 40 fully identified herbarium specimens.

**Anatomy and Embryology**

1. Study of stomata and 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.
5. Anatomy of germinating seeds
6. Study of pollens

**Recommended Books:**

1. Mauseth, J. D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R. C., W. D. Clarke and Vodopich, D. S. 1998. Botany. McGraw Hill Company, U.S.A.
3. Raven, P. H., Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants. W. H. Freeman and Company Worth Publishers.
5. Stuessy, T. F. 1990. Plant Taxonomy. Columbia University Press, USA.
6. Lawrence, G. H. M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
7. Panday, B. P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
8. Raymond E, S. E. Eichhorn. 2005. Esau's Plant Anatomy. Meristems cells and tissues of the plant body, 3<sup>rd</sup> Ed. John Wiley & Sons. Inc.
9. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
10. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
11. Maheshwari, P. 1971. Embryology of Angiosperms, McGraw-Hill. New York.
12. Eames A. J. and L. H Mac Daniels. 2002. An Introduction to Plant Anatomy. Tata-Mac Graw-Hill Publishing Company, Limited, New Delhi.
13. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3<sup>rd</sup> Edition, Regency Publications, New Delhi.
14. Naik, V. N. 2005 Taxonomy of Angiosperms. 20<sup>th</sup> Reprint. TataMacGraw-Hill Publishing Company, Limited New Delhi.
15. Rajput, M. T., S. S. Hassney and K. M. Khan. 1996. Plant Taxonomy. New Trends Computer Service, Hyderabad, Sindh, Pakistan.

**Journals / Periodicals:**

**Pakistan Journal of Botany, Taxon, Phytton.**

**Student's Output:** To understand: 1. various systems of classification, identification and nomenclature of Angiosperms, 2- Structures and functions of tissues and organs at embryonic level.



**Title of the course: Introduction to Geography of Pakistan**

**Course code: Bot-308**

**Cr. Hrs. 3(2+1)**

**Nature of Course:** General-IV

**Course objectives:** This course attempts to impart knowledge about the relationship between man and physical, socio-economic and cultural environment with special reference to Pakistan, including land, population, human settlements, resources and related human activities.

**Relief:** General structure and relief, physiographic regions, rainfall, soil of Pakistan

**Climate:** Geographic factors, temperature, pressure and winds, climatic regions

**Natural Vegetation:** Forests, grass lands, Desert and semi deserts

**Irrigation:** Means of irrigation, Principal canal systems, waterlogging and salinity

**Power and Development:** Hydroelectric projects, thermal projects, problems of power resource development

**Agriculture:** Chief crops and their distribution

**Mining:** Major minerals, their distribution and development

**Industries:** Major industries, their distribution and relation to raw materials and markets

**Communication:** Railways, road, airways and waterways, their distribution and problems

**Development:** Population, distribution, rural and urban, religion, languages, growth of population

**World relations:** Pakistan and her neighbors, Pakistan and Muslim world, Pakistan and the world

**Map work:** Scale types and their method of conservation, study and interpretation of ordnance survey maps of Pakistan, Map projections, General principles, classification and choices of projections, Construction of the following projections

**Practicals:** Scale types and their methods of construction, Study and interpretation of ordnance survey maps of Pakistan

**Map projections:** General principles, classification and choices of projections, Construction of following projections

a. Mercator projection

b. Zenithal projection

c. Conical projection with one standard parallel

d. Bonn projection

**Recommended Books:**

Ahmad, K. S. (1978) Geography of Pakistan, Oxford University Press, Oxford.

Burkey, J. S. (1991) Pakistan the continuing search for Nationhood, Western Press Oxford, UK.

Davidson, A. P. & Ahmad, M. (2003) Privatization and the Crisis of Agricultural Extension: The Case of Pakistan, King's Soas Studies in Development Geography, Ashgate Publishing, New Delhi.

Dichter, D. (1967) Geography of N-W.F.P, Oxford University Press, Oxford. Hameed, A. (1972) Study of the Middle Indus Basin, San Francisco State College, San Francisco.

Johnson, B.L.C (198).

Khan, F. K. (1991) Geography of Pakistan, Oxford University Press, Karachi Spate, O.  
H. K. (2004) India and Pakistan, Munshiram Mohoanlal Publications Pvt. Ltd., UK.  
Tayyeb, A. (1973) A Political Geography of Pakistan, Oxford University Press. Oxford.

**Student's Output:** To impart knowledge about the relationship between man and physical, socio-economic and cultural environment with special reference to Pakistan, including land, population, human settlements, resources and related human activities.

**Title of the course: Bot-309 PRINCIPLES OF ANIMAL LIFE-II**

**Course Credit Hr: 3 (2+1)**

**Nature of the course: General-III**

**Aims and Objectives:**

The course imparts knowledge and understanding of:

- a. cell division and its significance in cell cycle. concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
- b. animal behaviour and communication.
- c. theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

**Course Contents**

**1. Cell Division**

Mitosis, cytokinesis, and the cell cycle: an overview; control of the cell cycle; meiosis: the basis of sexual reproduction; gamete formation.

**2. Inheritance Patterns**

The birth of modern genetics; Mendelian inheritance patterns; other inheritance patterns; environmental effects and gene expression.

**3. Chromosomes and Gene Linkage**

Eukaryotic chromosomes; linkage relationships; changes in chromosome number and structure.

**4. Molecular Genetics: Ultimate Cellular Control**

DNA: the genetic material; DNA replication in eukaryotes; genes in action; control of gene expression in eukaryotes; mutations; applications of genetic technologies; recombinant DNA.

**5. Animal Behaviour**

Four approaches to animal behaviour; proximate and ultimate causes; anthropomorphism; development of behavior; learning; control of behavior; communication; behavioral ecology; social behavior.

**6. Evolution: A Historical Perspective**

Pre-Darwinian theories of change; Lamarck: an early proponent of evolution; early development of Darwin's ideas of evolution and evidences; the theory of evolution by natural selection; evolutionary thought after Darwin; biogeography.

**7. Evolution and Gene Frequencies**

The modern synthesis: a closer look; the Hardy-Weinberg theorem; evolutionary mechanisms: population size, genetic drift, natural selection, gene flow, mutation, and balanced polymorphism; species and speciation; rates of evolution; molecular evolution; mosaic evolution.

**Books Recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2000. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6<sup>th</sup> Edition. Menlo Park, California:

2002. Benjamin/Cummings Publishing Company, Inc.

## Practicals

1. Study of mitosis in onion root tip.
2. Study of meiosis in grasshopper testis (students should prepare the slide).

*Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).*

3. Problem based study of Mendelian ratio in animals.
4. Multiple alleles study in blood groups.
5. Survey study of a genetic factor in population and its frequency.
6. Study of karyotypes of *Drosophila*, mosquito.
7. Study of cytochemical detection of DNA in protozoa and avian blood cell.
8. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

## Books Recommended

1. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
2. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

### **Student's Output:** To Understand:

- a. cell division and its significance in cell cycle.  
concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
- b. animal behaviour and communication.
- c. theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

## INTRODUCTION TO STATISTICS

**Credit Hours:** 3 (3+0)

**Course objectives:** To equip the graduates with the knowledge of Introductory Statistics.

1. What is Statistics?  
Definition of Statistics, Population, sample Descriptive and inferential Statistics, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources, Editing of Data. Exercises.
2. Presentation of Data  
Introduction, basic principles of classification and Tabulation, Constructing of a frequency distribution, Relative and Cumulative frequency distribution, Diagrams, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Histogram, Ogive for Discrete Variable. Types of frequency curves. Exercises.
3. Measures of Central Tendency  
Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. Properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.
4. Measures of Dispersion  
Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.
5. Probability and Probability Distributions.  
Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises
6. Sampling and Sampling Distributions  
Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and nonprobability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions. Exercises.
7. Hypothesis Testing  
Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, acceptance and rejection regions, general procedure for testing of hypothesis. Exercises.

8. Testing of Hypothesis- Single Population

Introduction, testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

1. Testing of Hypotheses-Two or more Populations

Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples, Analysis of Variance and ANOVA Table. Exercises

2. Testing of Hypothesis-Independence of Attributes

Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

3. Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation.  $r$  and  $R^2$ .

Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

**Recommended Books**

1 Walpole, R. E. 1982. "Introduction to Statistics", 3<sup>rd</sup> Ed., Macmillan Publishing Co., Inc. New York.

2 Muhammad, F. 2005. "Statistical Methods and Data Analysis", Kitab Markaz, Bhawana Bazar Faisalabad.

**Student's Output:** To equip the graduates with the knowledge of Introductory Statistics.

**Course title: Bot-311. ISLAMIC STUDIES**

**Course Cr.Hr: 2 (2+0)**

**Course Nature: Compulsory**

**Objectives:**

This course is aimed at:

- 1 To provide Basic information about Islamic Studies
- 2 To enhance understanding of the students regarding Islamic Civilization
- 3 To improve Students skill to perform prayers and other worships
- 4 To enhance the skill of the students for understanding of issues related to faith and religious life.

**DETAIL OF COURSES**

**Introduction to Quranic Studies**

- 1) Basic Concepts of Quran
- 2) History of Quran
- 3) Uloom-ul -Quran

**Study of Selected Text of Holly Quran**

- 1) Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
- 2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- 3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- 4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77) 5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

**Study of Selected Text of Holly Quran**

- 1) Verses of Surah Al-Ihزاب Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

**Seats of Holy Prophet (S.A.W) I**

- 1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
- 2) Life of Holy Prophet (S.A.W) in Makkah
- 3) Important Lessons Derived from the life of Holy Prophet in Makkah

**Seerat of Holy Prophet (S.A.W) II**

- 1) Life of Holy Prophet (S.A.W) in Madina
- 2) Important Events of Life Holy Prophet in Madina

### 3) Important Lessons Derived from the life of Holy Prophet in Madina

#### **Introduction To Sunnah**

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

#### **Selected Study from Text of Hadith**

##### **Introduction to Islamic Law & Jurisprudence**

- 1) Basic Concepts of Islamic Law & Jurisprudence
- 2) History & Importance of Islamic Law & Jurisprudence
- 3) Sources of Islamic Law & Jurisprudence
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

##### **Islamic Culture & Civilization**

- 1) Basic Concepts of Islamic Culture & Civilization
- 2) Historical Development of Islamic Culture & Civilization
- 3) Characteristics of Islamic Culture & Civilization
- 4) Islamic Culture & Civilization and Contemporary Issues

##### **Islam & Science**

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quranic & Science

##### **Islamic Economic System**

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

##### **Political System of Islam**

- 1) Basic Concepts of Islamic Political System
- 2) Islamic Concept of Sovereignty
- 3) Basic Institutions of Govt. in Islam

##### **Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids



### **Social System of Islam**

- 1) Basic Concepts Of Social System Of Islam
- 2) Elements Of Family
- 3) Ethical Values Of Islam

### **Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jrisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)  
Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

### **Students Output:**

- 1 To Provide Basic information about Islamic Studies
- 2 To understanding of the Islamic Civilization
- 3 To improve their skills to perform prayers and other worships

**Course title: ENGLISH-II (COMMUNICATION SKILLS)**

**Course code: 312**

**Course Cr.Hr:3(3+0)**

**Course Nature: Compulsory**

**Objectives:**

Enable the students to meet their real life communication needs.

**Course Contents**

**Paragraph writing**

Practice in writing a good, unified and coherent paragraph

**Essay writing**

Introduction

**CV and job application**

Translation skills

Urdu to English

**Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

**Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

**Presentation skills**

Personality development (emphasis on content, style and pronunciation)

**Note: documentaries to be shown for discussion and review**

**Recommended books:**

**Communication Skills**

- a) Grammar
  - 1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- b) Writing
  - 4. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
  - 5. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- c) Reading
  - Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0. 2. Reading and Study Skills by John Langan 6. Study Skills by Richard Yorky.

**Students Output:** To have improved communication skills

2<sup>nd</sup>Year

3<sup>rd</sup> Semester

Title of the course: Bot-401 Cell Biology, Genetics and Evolution

Credit hours: 4 (3+1)

Nature of the course: Foundation-III

**Specific objectives of course:** To understand:

1. Structure and function of cell.
2. Nature of genetic material and hereditary process
3. Familiarization with evolutionary processes.

**Course outline:**

**a) Cell Biology**

1. Structure and Function of Bio-molecules: Carbohydrates, Lipids, Proteins, Nucleic Acids
2. Cell: Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell.
3. Brief description of following cell organelles:
  - i. Cell wall, ii. Cell membrane
  - iii Nucleus
  - iv Endoplasmic reticulum
  - v Plastids
  - vi Mitochondria
  - vii Ribosomes
  - viii Dictyosomes
  - ix Vacuoles
4. Reproduction in somatic and embryonic cell, mitosis, meiosis and cell cycle

**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. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. *lac* operon).
3. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and Euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

**c) Evolution:** Introduction and theories.

**Lab Outline:**

**Cell Biology**

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 sources.

### **Genetics**

1. Genetical problems related to transmission and distribution of genetic material.
2. Identification of chromosomes in plant material. Carmine/orcein staining.
3. Determination of blood groups

### **Recommended Books:**

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V. R. (1986). Cytology and Genetics. Tata and McGraw-Hill Publication Co. Ltd., New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
5. Strickberger, M. V. (1988), Genetics, MacMillan Press Ltd., London.
6. 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.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Strickberger, M. W. 2000 Evolution. Jones & Bartlet Publishers Canada
9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press.
10. Bruce Albert et al. 2009. Essential cell biology. Garland Sciences Publishers.

### **Journals/Periodicals:**

Theoretical & Applied Genetics, the Cell, Heredity.

**Title of the Course: Inorganic  
Chemistry (Gen-VI)**  
**Credit Hours: 03 (2+1) C. code: Bot-404**

The program is aimed that the student should learn:

1. The Development of periodic law and properties of elements in a systematic way.
2. The principal of chemical bonding
3. Chemistry of acid and bases
4. Chemistry of p-block Elements

**1. The Periodic Law and Periodicity**

Development of Periodic Table; Classification of elements based on *s*, *p*, *d* and *f* orbitals, group trends and periodic properties in *s*, *p*, *d* and *f* block elements, i.e., atomic radii, ionic radii, ionization potential, electron affinities, electronegativities and redox potential.

**2. Principles of Chemical Bonding**

Types of chemical bonding; ionic bonding; the localized bond approach: VB theory, hybridization and resonance; the delocalized approach to bonding: molecular orbital theory as applied to diatomic and polyatomic molecules, three center bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding.

**3. Acids and Bases**

Concepts of acids and bases including SHAB concept, relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions. Theory of Indicators, solubility, solubility product, common ion effect and their industrial applications.

**4. Chemistry of p-block Elements**

Chemistry and structure of *p*-block elements; main emphasis on the chemistry and structure of noble gases and their compounds, chemistry and structure of interhalogens, pseudohalogens and polyhalides. Prediction of shapes of molecules using VSEPR model and hybridization.

**PRACTICAL (CHEM-151) (1-Cr. Hr.)**

**1. Laboratory Ethics and safety measures**

Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations

**2. Qualitative analysis**

Analysis of four ions (two anions and two cations) from mixture of salts

**3. Quantitative analysis**

Laboratory work illustrating topics covered in the lecture of **CHEM-151**

## Recommended Books

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001
2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
3. Clyde Day, M. & Selbin, J., "Theoretical Inorganic Chemistry", 2<sup>nd</sup> Ed., Van Nostrand Reinhold, 1969.
4. Lee, J.D., "Concise Inorganic Chemistry", Chapman and Hall, 5<sup>th</sup> Edition, 1996.
5. Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2<sup>nd</sup> Edition, 1994.
6. Bassette, J., Denney, G. H. and Mendham, J., "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4<sup>th</sup> Edition, 1981.
7. Vogel, A. I., "A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis" Longman Green & Co. 1995.

## Students Output: To learn:

1. The Development of periodic law and properties of elements in a systematic way.
2. The principal of chemical bonding
3. Chemistry of acid and bases
4. Chemistry of p-block Elements

## **Title of the course: ANIMAL DIVERSITY-I**

*(CLASSIFICATION, PHYLOGENY AND ORGANIZATION)*

**Course code: 405**

**Course Cr.Hr: 3 (2+1)**

**Course Nature: General-V**

### **Aims and Objectives:**

The course is designed to provide students with:

- a. concepts of evolutionary relationship of animal kingdom.
- b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

### **Course Contents**

#### **1. Introduction**

Classification of organisms; evolutionary relationships and tree diagrams; patterns of organization.

#### **2. Animal-Like Protists: The Protozoa**

Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations.

#### **3. Multicellular and Tissue Levels of Organization**

Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations.

#### **4. Triploblastics and Acoelomate Body Plan**

Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations.

#### **5. Pseudocoelomate Body Plan: Aschelminths**

Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations.

#### **6. Molluscan Success**

Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations.

#### **7. Annelida: The Metameric Body Form**

Evolutionary perspective: relationship to other animals, metamerism and tagmatization; classification up to class. External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory

functions, excretion, regeneration, reproduction and development, in polychaeta, oligochaeta and hirudinea; further phylogenetic considerations.

#### **8. Arthropods: Blueprint for Success**

Evolutionary perspective: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations.

#### **9. Hexapods and Myriapods: Terrestrial Triumphs**

Evolutionary perspective; classification up to class. External structure and locomotion, nutrition and the digestive system, gas exchange, circulation and temperature regulation, nervous and sensory functions, excretion, chemical regulation, reproduction and development in hexapoda; insect behavior; insects and humans; further phylogenetic considerations.

### **Books Recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

### **Practicals**

1. Study of *Euglena*, *Amoeba*, *Entamoeba*, *Plasmodium*, *Trypanosoma*, *Paramecium* as representative of animal like protists. (Prepared slides).
2. Study of sponges and their various body forms.
3. Study of principal representative classes of phylum Coelenterata.
4. Study of principal representative classes of phylum Platyhelminthes.
5. Study of representative of phylum Rotifera, phylum Nematoda.
6. Study of principal representative classes of phylum Mollusca.
7. Study of principal representative classes of phylum Annelida.
8. Study of principal representative classes of groups of phylum Arthropoda.
9. Brief notes on medical/economic importance of the following: *Plasmodium*, *Entamoeba histolitica*, *Leishmania*, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.
10. Preparation of permanent stained slides of the following: *Obelia*, *Daphnia*, Cestode, Parapodia of *Nereis*.

### **Books Recommended**

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
2. Miller, S.A., GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill

**Students Output:** To understand the:

- a. concepts of evolutionary relationship of animal kingdom.
- b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.



**Course Name: Introduction to Computers** (Information and Communication Technologies ICT) (**Compulsory**)

**Course Structure:** Lectures: 2 Labs: 1 **Credit Hours: 3**

**Course code: 406**

**Course Description:**

This is an introductory course on Computers (Information and Communication Technologies). Topics include ICT terminologies, hardware and software components, the internet and world wide web, and ICT based applications. Basic Knowledge of office software such as MS Word, Power Point and Excel sheets.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

**Course Contents:**

: Basic Definitions & Concepts

: Hardware: Computer Systems & Components

: Storage Devices , Number Systems

: Software: Operating Systems, Programming and Application Software

: Introduction to Programming, Databases and Information Systems

: Networks

: Data Communication

: The Internet, Browsers and Search Engines

: The Internet: Email, Collaborative Computing and Social Networking

: The Internet: E-Commerce

: IT Security and other issues

: Text Processing (MS Word)

: Presentation Tool(MS Power Point)

: Spreadsheets (MS Excel)

: Project Week

: Review Week

**Text Books/Reference Books:**

Introduction to Computers by Peter Norton, 6th International Edition (McGraw HILL)

Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition (McGraw HILL)

Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer

Fundamentals of Information Technology by Alexis Leon, Mathewsleon Leon press

**Title of the course: ENGLISH – III (TECHNICAL WRITING AND PRESENTATION SKILLS)**  
**Course code: 407**  
**Cr.Hr: 3(3+0)**  
**Course Nature: Compulsory**

**Objectives:**

Enhance language skills and develop critical thinking

**Course Contents**

**Presentation skills**

**Essay writing**

Descriptive, narrative, discursive, argumentative

**Academic writing**

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

**Technical Report writing**

**Progress report writing**

**Note: Extensive reading is required for vocabulary building**

**RECOMMENDED BOOKS:**

**Technical Writing and Presentation Skills**

- a) Essay Writing and Academic Writing
  1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
  2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
  3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
- d) Presentation Skills
- e) Reading

The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

**2<sup>nd</sup>Year**

**4<sup>th</sup> Semester**

**Title of the course: Bot-400. Biostatistics**

**Credit hours: 3 (3+0)**

**Course Nature: Compulsory**

**Course outline:**

1. Introduction objectives and scope:

Definition, Characteristics, Importance and limitations, Population and samples

2. Frequency distribution:

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

3. Measures of central tendencies and dispersion:

Arithmetic Mean, Median, Mode, Range, Variance, Standard deviation, Standard error of the mean, Mean deviation.

4. Organizing and describing data (Standard distributions).

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

5. Basic experimental design:

Concept and design, Principles of experiments, Observational studies, Planning of experiments, Replication and randomization, Field plot technique, Layout and analysis of completely randomized design, Randomized complete block design, Latin square design, Factorial design, Treatment comparison.

6. Tests of significance:

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

7. Introduction to comparing many means:

Unit organization, Basic one way ANOVA, Types of sums of squares, How ANOVA works, The ANOVA Table. Two-way ANOVA-Factorial designs: (two-way Factorial analysis, calculating and analyzing the two-way ANOVA, Linear combination, multiple comparisons.

8. Correlation and Regression.

**Lab outline:**

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

**Recommended Books:**

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

**Title of the course: Bot-402 Plant Physiology and Ecology**

**Credit hours: 4 (3+1)**

**Nature of the course: Foundation-IV**

**Specific objectives of course:**

1. To provide comprehensive knowledge of functioning of organs, organelles and biomolecules,
2. To enable the students to assess the effects of various environmental factors on plant growth and development.

**Course Outline:**

**a) Plant Physiology**

1. Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation.
2. Mineral nutrition: Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.
3. Photosynthesis: Introduction, Oxygenic and non-oxygenic photosynthesis  
Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C<sub>3</sub> and C<sub>4</sub> plants. Factors affecting this process, Products of photosynthesis.
4. Respiration: Definition and respiratory substrates. Mechanism-Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and anaerobic respiration, Respiratory quotients.

**b) Ecology**

1. Introduction, aims and applications of ecology.
2. Soil: Physical and Chemical properties of soil (soil formation, texture, pH, EC, organism and organic matter etc) and their relationships to plants.
3. Light and Temperature. Quality of light, diurnal and seasonal variations. Ecophysiological responses.
4. Water: Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants.
5. Wind: Wind as an ecological factor and its importance.
6. Population Ecology: Introduction. A brief description of seed dispersal and seed bank.
7. Community Ecology
  - i. Ecological characteristics of plant community
  - ii. Methods of sampling vegetation (Quadrat and line intercept)
  - iii. Major vegetation types of the local area.
8. Ecosystem Ecology
  - i. Definition, types and components of ecosystem.

ii. Food chain and Food web.

9. Applied Ecology: Causes, effects and control of water logging and salinity with respect to Pakistan

**Lab Outline:**

**a) Plant Physiology**

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

**b) Ecology**

1. Determination of physical and chemical characteristics of soil.
2. Measurements of various population variables
3. Measurement of vegetation by Quadrat and line intercept methods.
4. Field trips to ecologically diverse habitats.
5. Measurements of wind velocity.
6. Measurement of light and temperature.
7. Effect of light and temperature on seed germination.

**Recommended Books:**

1. Ihsan, I. 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
2. Witham and Devlin. 1986 Exercises in Plant Physiology, AWS Publishers, Boston.
3. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4<sup>th</sup>. Ed. Sinauers Publ. Co. Inc. Calif.
4. Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5<sup>th</sup> Edition. Wadsworth Publishing Co. Belmont CA.
5. Hopkins, W. B. 1999. Introduction to Plant Physiology. 2<sup>nd</sup> Ed. John Wiley and Sons. New York
6. Schultz, J. C. 2005. Plant Ecology. Springer-Verlag, Berlin.
7. Ricklefs, R. E. 2000. Ecology. W. H. Freeman and Co., UK.
8. Ricklefs, R. E. 2001. The Economy of Nature. W. H. Freeman and Co., UK.
9. Barbour, M. G., J. H. Burke and W. D. Pitts. 1999. Terrestrial Plant Ecology, The Benjamin, Cumming Publishing Co. Palo Alto, California, USA.
10. Chapman, J. L. and Reiss, M. J. 1995. Ecology: Principles and Applications. Cambridge University Press.
11. Hussain F. 1989. Field and Laboratory Manual of Plant Ecology. National Academy of Higher Education, Islamabad.
12. Hussain, S. S. 1989. Pakistan Manual of Plant Ecology; National Book Foundation, Islamabad.

13. Larcher, W. 2003 Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functions Groups – Springer Verlag.
14. Krebs, C. J. 1997. Ecology. Harper and Row Publishers.
15. Smith, R. L. 1996. Ecology and Field Biology. Addison Wesley Longman, Inc., New York.
16. Smith, R. L. 1998. Elements of Ecology. Harper and Row Publishers, New York.
17. Smith, R. L. 2004. Ecology and field biology. Addison Wesley Longman, Inc., New York.
18. Subrahmanyam, N. S. and Sambamurthy, A. V. S. S. 2000. Ecology. Narosa Publishing House, New Delhi.
19. Townsend, C. R., Harper, J. L. and Begon, M. E. 2002. Essentials of Ecology. Blackwell Scientific Publications, UK.
20. Odum, E. P. 1985. Basic Ecology. W. B. Saunders.

**Journals/Periodicals:** Plant  
Physiology, Journal of Ecology

**Students Output:** To provide comprehensive knowledge of functioning of organs, organelles and biomolecules and enable to assess the effects of various environmental factors on plant growth and development.



**Title of the Course: Bot-403. Biodiversity and Conservation**

**Credit Hours:** 4 (3+1)

**Course Nature: Foundation-V**

**Specific objectives of course:**

To familiarize the students with the diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystems.

**Course Outline:**

1. Biodiversity : Definition, types and threats
2. Threats to Biodiversity; deforestation, over grazing, erosion, desertification, ecosystem degradation, bio invasion, pollution and climate change
3. Biodiversity of Pakistan
4. Measuring biodiversity: Alpha, Beta and Gamma diversity; Systematic and functional diversity.
5. Ecological services, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of Bio resources)
6. Sustainable and unsustainable use of biological resources
7. Biodiversity Hot spots of Pakistan and the world.
8. International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar
- 9 Conservation strategies; *in situ*, *ex situ*, *in vitro* conservation
10. Conservation vs preservation
11. IUCN categorized protected areas in Pakistan; red listing
12. Environmental Impact Assessment.
13. Use of herbarium and Botanical Garden in biodiversity and conservation.
14. Concept of pastures and wild life management
15. Global Biodiversity Information Facility (GBIF)

**Lab outline:**

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

**Recommended Books:**

1. Abbasi, A. M., Khan, M. A., M. Ahmad and M. Zafar. 2012. Medicinal plant biodiversity of Lesser Himalaya Pakistan. Springer Publishers USA.
2. Hussain, F., 1991. Vegetation and ecology of lesser Himalaya. Department of Botany, Peshawar
3. Shinwari, M. I. and M. A. Khan. 1998. Ethnobotany of Margalla Hills. Department of Biological Sciences, Quaid-i-Azam University Islamabad Pakistan.
4. Shinwari, M. I., M. I. Shinwari and Shah, M. 2007. Medicinal Plants of Margalla Hills National Park Islamabad. Higher Education Commission Islamabad. Pp.218.
5. Provincial conservation strategies
6. Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.
7. Falk, D. A. & Holsinger, K. E. 1991. Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, Oxford, UK.

8. Frankel, O. H., Brown, A. H. D. & Burdon, J. J. 1995. *The Conservation of Plant Biodiversity*. Cambridge University Press, Cambridge, UK.
9. IUCN. 1994. *IUCN Red List Categories*. As Approved by the IUCN Council. IUCN.
10. Leadley, E. and Jury, S. 2006 *Taxonomy and Plant Conservation*. CUP.
11. Bush, M. B. 1997 *Ecology of a changing Planet*. Prentice hall. New Jersey.
12. French, H. 2000 *Vanishing Borders- protecting the Planet in the age of globalization*. W. W. Norton & Co.
13. Swanson, T. 2005 *Global Action for Biodiversity*. Earth Scan Publication Ltd.
14. Taylor, P. 2005 *Beyond Conservation*. Earth Scan Publication Ltd.

**Journals /Periodicals**

Systematics and Biodiversity, Biological Conservation.

**Students Output:** To have the knowledge of diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystems.

**Title of the course: ANIMAL DIVERSITY-II** (CLASSIFICATION, PHYLOGENY AND ORGANIZATION)

**Course code: 408**

**Course Cr.Hr: 3(2+1)**

**Course Nature: General-VII**

### **Aims and Objectives:**

The course provides knowledge and understanding about the different animal groups, emphasizing their phylogenetic relationships.

### **Course Contents**

#### **1. Echinoderms**

Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cyclophores, and chaetognaths.

#### **2. Hemichordates and Invertebrate Chordates**

Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations.

#### **3. Fishes: Vertebrate Success in Water**

Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

#### **4. Amphibians: The First Terrestrial Vertebrates**

Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations.

#### **5. Reptiles: The First Amniotes**

Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhychocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

#### **6. Birds: Feathers, Flight, and Endothermy**

Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation.

**7. Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity** Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange,

and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

### **Books Recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International) 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

### **Practicals**

1. Study of a representative of Hemichordate and Invertebrate Chordate.
2. Study of representative groups of class Fishes.
3. Study of representative groups of class Amphibia.
4. Study of representative groups of class Reptilia.
5. Study of representative groups of class Aves.
6. Study of representative groups of class Mammalia.
7. Field trips to study animal diversity in an ecosystem.

*Note: Preserved specimen and/or colored projection slide and/or CD ROM projection of computer must be used.*

### **Books Recommended**

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
2. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

**Title of the Course: Bot-409      Organic Chemistry**

**Credit Hours: 03 (2+1)**

**Course Nature: General-VIII**

### **Introduction to Organic Chemistry**

Organic chemistry-the chemistry of carbon compounds; the nature of organic chemistry-a historical perspective.

### **Chemical Bonding and Properties of Organic Molecules**

Localized and delocalized chemical bonding; concept of hybridization leading to bond angles, bond lengths, bond energies and shape of organic molecules; dipole moment; inductive and field effects; resonance; aromaticity; tautomerism; hyperconjugation; hydrogen bonding; acids and bases; factors affecting the strengths of acids and bases.

### **Classes and Nomenclature of Organic Compounds**

Classification of organic compounds; development of systematic nomenclature of organic compounds; IUPAC nomenclature of hydrocarbons and heteroatom functional groups.

### **Functional Group Chemistry**

A brief introduction to the chemistry of hydrocarbons, alkyl halides, alcohols, phenols, ethers, aldehydes, ketones, amines, and carboxylic acids and their derivatives.

### **Recommended Literature**

(Latest available editions of the following books)

1. Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University Press, New York.
2. Loudon, G. M., "Organic Chemistry", Oxford University Press, New York
3. Sorrell, T. N., "Organic Chemistry", Viva Books Private Ltd., New Delhi.
4. Finar, I. L., "Organic Chemistry", Vol. 1, Pearson Education, Delhi.
5. Carey, F. A., "Organic Chemistry", McGraw-Hill, New York.
6. Ahluwalia, V. K. and Goyal, M., "A Text Book of Organic Chemistry", Narosa Publishing House, New Delhi
7. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
8. Bansal, R. K., "Organic Reaction Mechanisms", Tata McGrawHill Publishing Company Ltd., New Delhi.
9. Pine, S. H., "Organic Chemistry", National Book Foundation, Islamabad.
10. Bailey Jr., P. S. and Bailey, C. A., "Organic Chemistry-A Brief Survey of Concepts and Applications", Prentice-Hall, New Jersey.

### **3rd Year**

#### **Semester 5<sup>th</sup>**

**Title of the Course: BOT-501      Bacteriology and Virology      Credit Hours: 3(2+1)**

**Course Nature: Foundation-VI**

**Specific objectives of course:** To understand the morphology, structure and economic importance of Viruses and Bacteria

#### **Course outline:**

##### **a) Viruses**

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

##### **b) Bacteria**

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

##### **c)      Plant microbe interaction**

#### **Lab outline:**

##### **a) Viruses**

Observation of symptoms of some viral infected plant specimens.

##### **b) Bacteria, Actinomycetes and Cyanobacteria**

**1.** Methods of sterilization of glassware and media etc.; **2.** Preparation of nutrient medium and inoculation; **3.** Preparation of slides for the study of various forms, capsule/slime layer, spores, flagella and Gram-staining; **4.** Growth of bacteria, subculturing and identification of bacteria on morphological and biochemical basis (using available techniques); **5.** Microscopic study of representative genera of Actinomycetes and Cyanobacteria from fresh collections and prepared slides.

#### **Recommended Books:**

1. Black, J.G. 2005 Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
2. Prescott, L.M., Harley, J.P. and Klein, D.A. 2005. Microbiology McGraw Hill Companies, Inc.
3. Arora, D.R. 2004. Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.

4. Ross F.C. 1995. Fundamentals of Microbiology. John Willey Co. New York.
5. Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens, The Haworth Press, Inc.
6. Hull R. Matthews, 2004, Plant Virology, Academic Press.
7. Tortora, G.J. ; Funke, B.R. and Case C.L. , 2004, Microbiology. Pearson Education.
8. Molecular Plant-Microbe Interactions, Kamal Bouarab, Normand Brisson, Fouad Daayf (eds), 2009 MPG Books Group, Bodmin, UK.
9. Plant-Microbe Interactions Gary Stacey, Noel T. Keen (Eds) 2011, springer London.

**Journals/Periodicals:**

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

**Students Outcome:** To understand the morphology, structure and economic importance of Viruses and Bacteria

**Title of the Course: BOT-502 Phycology and Bryology Credit Hours: 3(2+1)**

**Course Nature: Major-I**

**Specific objectives of course:** To understand the classification, morphology and economic importance of Algae and Bryophytes

**Course outline:**

**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.

**Lab Outline:**

**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: Peltia, Porella, Anthoceros and Polytrichum.

**Recommended Books:**

1. Bold, H. C. and M.J. Wynne 1985. Introduction to Algae: structure and reproduction. Prentice Hall Inc. Engle Wood Cliffs
2. Lee. R.E. 1999. Phycology. Cambridge University Press, U.K.
3. Dawson, E.Y., Halt. 1966. Marine Botany. Reinhart and Winstan, New York.
4. Chapman, V.J. and D.J. Chapman. 1983. Sea weed and their uses. McMillan and Co. Ltd. London.
5. Vashishta. B. R. 1991. Botany for degree students. Bryophytes 8th ed. S. Chand and Co. Ltd. Delhi.
6. Schofield, W.B. 1985. Introduction to Bryology. Macmillan Publishing Co. London.
7. Hussain, F. and I. Ilahi. 2004. A text book of Botany. Department of Botany, Uni. of Peshawar.
8. Barsanti, L. and P. G. Gualtieri. 2006. Algae, anatomy, biochemistry, biotechnology. Taylor and Francis, New York.
9. Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Algae. S. Chand & Co.
10. Bellinger, E. G. and D. C. Sigeo. 2010. Fresh water algae (Identification and use as bioindicators). John Wiley & Sons.
11. Hussain, F. 2013. Phycology. A text book of Algae. Pak Book Empire Lahore.
12. Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Bryophytes. S. Chand & Co. New Delhi.



13. Fida Hussain, Habib Ahmad and Syed Zahir Shah. 2012. The unicellular algae of District Peshawar, Pakistan. Lambert Publication, Germany.

**Journals / Periodicals:**

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

**Students Outcome:** To understand the classification, morphology and economic importance of Algae and Bryophytes

**Title of the Course:** BOT-503      **Mycology and Plant Pathology**

**Credit Hours:** 3(2+1)

**Specific objectives of course:** To introduce the students to Mycology and Diseases caused by Fungi.

**Course outline:**

**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; 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, red rot of sugarcane etc.
6. Systemic resistance: Induced systematic resistance (ISR), Acquired Systematic resistance (ASR).

**Lab Outline:**

**a. Mycology**

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

**b. Pathology**

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

**Recommended Books:**

1. Agrios, G.N., 2005. Plant Pathology, Academic Press, London.
2. Ahmad, I. and Bhutta, A.R., 2004. Textbook of Introductory Plant Pathol. Book Foundation, Pak.

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., India.
6. Moore-Landecker, E., 1996. Fundamentals of Fungi. 4th edn. Prentice Hall Inc., New Jersey, USA.
7. Trigliano, R.N., Windham, M.T. and Windham, A.S., 2004. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

**Journals / Periodicals:**

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

**Students Outcome:** To introduce the students to Mycology and Diseases caused by Fungi.



**Title of the Course:** BOT-504      **Diversity of Vascular Plants**      **Credit Hours:** 3(2+1)

**Specific objectives of course:** To enable the students to understand and appreciate the biology and evolution of plant architecture

**Course outline:**

**a) Pteridophytes:** Introduction, origin, history, features and a generalized life cycle. Methods of fossilization, types of fossils, geological time scale and importance of paleobotany. First vascular plant - Rhyniophyta e.g. Cooksonia

General characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilopsida (Psilotum), Lycopsidea (Lycopodium, Selaginella), Sphenopsida (Equisetum), Pteropsida (Ophioglossum, Dryopteris and Azolla/Marsilea).

**b) Origin and Evolution of seed habit.**

**c) Gymnosperms:** Geological history, origin, distribution, morphology, anatomy, classification and affinities of Cycadofilicales, Bennettitales, Ginkgoales, Cycadales and Gnetales. Distribution of gymnosperms in Pakistan. Economic importance of gymnosperms. An introduction to the Gondwana flora of world.

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

**e) Palynology:**

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

**Lab Outline:**

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

**Recommended Books:**

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

**Journals / Periodicals:** Pakistan Journal of Botany, New Phytologist, Review of Palaeobotany & Palynology, Palaeontographica, Palaeobotanist.

**Students Outcome:** To enable the students to understand and appreciate the biology and evolution of plant architecture

**Title of the Course:** BOT-505      **Plant Systematics**      **Credit Hours:** 3(2+1)

**Specific objectives of course:** To know floral composition/system of classification focusing on identification, classification, description nomenclature and flora writings, monographs.

**Course outline:**

1. **Introduction:** Importance and relationship with other sciences, Phases of plant taxonomy. Origin and radiation of angiosperm, their probable ancestors, when, where and how did the angiosperms evolve; the earliest fossil records of angiosperms.
2. **Concept of Species:** What is a species? Taxonomic species, Biological species, Micro and macro species, Species aggregate. Infra specific categories.
3. **Speciation:** Mechanism of speciation, Mutation and hybridization Geographical isolation, Reproductive isolation, Gradual and abrupt.
4. **Variation:** Types of variation, Continuous and discontinuous variation, Clinal variation.
5. **Systematics and Genecology/Biosystematics:** Introduction and importance, Methodology of conducting biosystematics studies, various biosystematics categories such as ecophene, ecotype, ecospecies, coenospecies and comparium.
6. **Taxonomic Evidence:** Importance and types of taxonomic evidences: anatomical, cytological, chemical, molecular, palynological, geographical and embryological.
7. **Nomenclature:** Important rules of botanical nomenclature including effective and valid publication, typification, principles of priority and its limitations, author citation, rank of main taxonomic categories, conditions for rejecting names.
8. **Classification:** Why classification is necessary? Importance of predictive value. Brief history, Different systems of classification with at least one example of each (Linnaeus, Bentham and Hooker, Engler and Prantl, Bessey, Cronquist, Takhtajan, and Dahlgren. 9. Brief introduction of Numerical taxonomy.
9. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:
  1. Apiaceae (Umbelliferae); 2. Arecaceae (Palmae); 3. Asclepiadaceae; 4. Asteraceae (Compositae); 5. Boraginaceae; 6. Brassicaceae (Cruciferae); 7. Capparidaceae 8. Caryophyllaceae; 9. Chenopodiaceae; 10. Convolvulaceae; 11. Cucurbitaceae; 12. Cyperaceae 13. Euphorbiaceae; 14. Fabaceae (Leguminosae); 15. Lamiaceae (Labiatae); 16. Liliaceae 17. Magnoliaceae; 18. Malvaceae; 19. Myrtaceae; 20. Orchidaceae; 21. Papaveraceae; 22. Poaceae (Gramineae); 23. Ranunculaceae; 24. Rosaceae; 25. Salicaceae; 26. Scrophulariaceae; 27. Solanaceae.

**Lab Outline:**

1. Technical description of plants of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan.
2. Preparation of indented and bracketed types of keys.
3. Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.
4. Study of variation pattern in different taxa.
5. Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination.
6. Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

**Recommended Books:**

1. Ali, S.I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi.
2. Ali, S.I. and Qaiser, M. 1993-2007. Flora of Pakistan. Karachi Univ. Press, Karachi.

3. Greuter, W., McNeill, J., Barrie, F.R., Burdet, H. M., Demoulin, V., Filguerras, T.S., Nicolson, D.H. Silva, P.C., Skog, J.E., Trehane, P., Turland, N.J. & Hawksworth, D.L., (eds.) 2000. International code of botanical nomenclature (Saint Louis Code) adopted by the 16<sup>th</sup> International botanical congress St. Louis Missouri, July –August 1999. Koeltz, Königstein. (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.
18. Leadlay, E. and Stephen 2006. Taxonomy and Plant Conservation.
19. Rajput, M. T., S. Saliha and K. M. Khan. 1996 Plant Taxonomy. Nasim Book Depot Hyderabad.
20. Heywood V.H. 1978. Flowering Plants of the World. Oxford University Press.
21. Simpson, M.G. 2006. Plant Systematics. Elsevier Academic Press.
22. Soltis, D.E. P.S. Soltis, P.K Endress, and M.W. Chase, 2005. Phylogeny & evolution of angiosperms. Sinauers associates, Inc. Publishers.
23. Pullaiah, T. 2007 Taxonomy of Angiosperms 3rd Ed. Regency Publication, New Delhi.

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

**Students Outcome:** To know floral composition/system of classification focusing on identification, classification, description nomenclature and flora writings, monographs.



**Title of the Course:** BOT-506

**Plant Anatomy**

**Credit Hours:** 3(2+1)

**Specific objectives of course:** To provide the students understanding about anatomical features of vascular plants.

**Course outline:**

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

**Lab outline:**

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

**Recommended Books:**

1. Dickison, W.C. 2000. Integrative plant anatomy. Academic Press, U.K.
2. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Metcalf, C.R. and Chalk, L. 1950. Anatomy of the Dicotyledons. Clarendon Press. Oxford.
5. Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.
6. Vaughan, J.G. 1990. The structure and Utilization of Oil Seeds. Chapman and Hall Ltd. London.
7. Metcalfe, C.R. 1960. Anatomy of the Monocotyledons. Gramineae. Clarendon Press, Oxford.
8. Metcalfe, C.R. 1971. Anatomy of the Monocotyledons.V. Cyperaceae. Clarendon Press, Oxford.
9. Cutler, D.F. 1969. Anatomy of the Monocotyledons. IV. Juncales. Clarendon Press, Oxford.
10. Cutler, D.F. 1978. Applied Plant Anatomy. Longman Group Ltd. England
11. Raymond, E.S. and E. Eichhorn. 2005. Esau's Plant Anatomy; Meristematic cells and tissues of plant body. John Willey Sons.
12. Eames, A.J. and L.H. Mac Daniels. 2002. An introduction to Plant Anatomy. Tat Mac-Graw Hill Publishing Company Limited, New Delhi.

**Journals/Periodicals:** Pakistan Journal of Botany.

**Students Outcome:** To provide the students understanding about anatomical features of vascular plants.

**Title of the Course:** Bot-507

**Genetics-I**

**Credit Hours:** 3 (2+1)

**Specific Objectives of course:** To understand the nature and function of genetic material.

**Course Outline:**

1. **Extensions of Mendelian Analysis:** Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity.
2. **Linkage I:** Basic Eukaryotic Chromosome Mapping: The discovery of linkage, recombination, linkage symbolism, linkage of genes on the X chromosome, linkage maps, three-point testcross, interference, linkage mapping by recombination in humans.
3. **Linkage II:** Special Eukaryotic Chromosome Mapping Techniques: Accurate calculation of large map distances, analysis of single meiosis, mitotic segregation and recombination, mapping human chromosomes.
4. **Recombination in Bacteria and their Viruses:** Bacterial chromosome, bacterial conjugation, bacterial recombination and mapping the E.coli chromosome, bacterial transformation, bacteriophage genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer.
5. **The Structure of DNA:** DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene.
6. **The Nature of the Gene:** How genes work, gene- protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites, complementation.
7. **DNA Function:** Transcription, translation, the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA.
8. **The Extranuclear Genome:** Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochondrial genes in yeast, extragenomic plasmids in eukaryotes.
9. **Developmental Genetics:** Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease.
10. **Population Genetics:** Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

**Lab Outline:**

**1. Numerical problems**

**a) Arrangement of genetic material:**

**i.** Linkage and recombination. **ii.** Gene mapping in diploid. **iii.** Recombination in Fungi. **iv.** Recombination in bacteria. **v.** Recombination in viruses.

**b) Population Genetics:**

**i.** Gene frequencies and equilibrium. **ii.** Changes in gene frequencies.

**2. Blood group and Rh-factor**

**3. Drosophila:** **i.** Culture technique, **ii.** Salivary gland chromosome

**4. Fungal Genetics:** Sacchromyces culture techniques and study.

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

**6. Bacterial Genetics:** **i.** Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)

**ii.** Transformation. **iii.** Conjugation.

**Recommended Books:**

1. Gelvin, S, B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.
2. Pierca, B. A. 2005. Genetics. A conceptual approach, W. H. Freeman and Company, New York.

3. Synder, L, and Champness, W. 2004. Molecular Genetics of Bacteria. ASM Press, Washington D.C.
  4. Klug, W. S. and Cummings, M. R. 1997. Concepts of Genetics, Prentice Hall International Inc.
  5. Roth Well, N. V. 1997. Understanding Genetics, 2 nd Edition, Oxford University Press Inc. 10.
  6. Gardner, E. J., 2004. Principles of Genetics, John Willey and Sons, New York.
  7. Ringo J, 2004. Fundamental Genetics, Cambridge University Press.
  8. Griffiths A. J. F; Wessler, S. R; Lewontin, R. C, Gelbart, W. M; Suzuki, D. T. and Miller, J. H., 2005, Introduction to Genetic Analysis, W. H. Freeman and Company.
  9. Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.
  10. Hartl, D. L. and Jones, E. W. 2005, Genetics - Analysis of Genes and Genomes, Jones and Bartlett Publishers. Sudbry, USA.
  11. Hedrick, P. W. 2005. Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.
  12. Mahmut Caliskan. 2012. The Molecular basis of plant genetic diversity. In Tech Publishers.
  13. Ram J. Singh. 2011. Genetic resources, chromosome engineering and crop improvement. Medicinal plants. Vol. 6. CRC Press.
  14. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino. 2011. Concepts of genetics. Pearson Educations.
  15. Daniel Hartl. 2011. Genetics Johns and Bartlett Publishers.
  16. David Hyde. 2008. Introduction to Genetic principles. McGraw-Hill.
  17. Daniel, L. Hart, Elizabeth W. Jones. 2009. Analysis of genes and genomes. John and Barlett.
  18. Nouredine Benkeblia. 2011. Sustainable agriculture and new biotechnologies. CRC Press.
- Journals/Periodicals:** J. Genetics, Theoretical and Applied Genetics, Cytologia, Chromosoma, Genome.

**Students Outcome:** To understand the nature and function of genetic material

**Title of the Course:** Bot-508

**Plant Biochemistry-I**

**Credit Hours:** 3 (2+1)

**Specific Objectives of course:** To elucidate the structure and role of primary metabolites in plants

**Course Outline:**

1. **Introduction to photosynthetic organisms:** Bioenergetics and overview of photosynthesis, Photosynthesis: The Light Reaction Photosystems, ATP Synthesis, CO<sub>2</sub> Fixation, RuBisCo and enzyme kinetic, C-3 Cycle, C-4 Cycle, Regulation of photosynthesis.
2. **Introduction to carbohydrates:** Occurrence and classification, Sugar structures, synthesis of polysaccharides, Carbon metabolism in the chloroplast, Starch synthesis Pentose phosphate pathway, Carbon export, Sucrose synthesis and transport in vascular plants, Cellulose synthesis and composition of primary cell walls.
3. **Introduction to lipids:** Occurrence, classification. Structure and chemical properties of fatty acids, Fatty acid biosynthesis in plants, di and triglycerides, phospholipids, glycolipids, sulpholipids, waxes and sterols.
4. **Introduction to 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. Plant defense proteins and peptides, Defensins and related proteins, Synthesis and functions of non-ribosomal peptides.
5. **Introduction to Nucleic Acids:** General introduction. Purine and pyrimidine bases, nucleosides, nucleotides. Structure and properties of DNA and RNA. Types and functions of RNA. Nucleic Acid Metabolism.
6. **Introduction to Enzymes:** Nature and functions, I.U.E. classification with examples of typical groups. Isozymes, ribozymes, abzymes. Enzyme specificity. Enzyme kinetics. Nature of active site and mode of action. Allosteric enzymes and feedback mechanism. Enzymes with multiple functions - mechanisms and evolution. Isoprenoid metabolism, Biosynthetic pathways, Monoterpenes, sesquiterpenes, phytosterols, diterpenes, Enzymes with multiple functions - mechanisms and evolution.

**Lab Outline:**

1. Solutions, acids and bases. Electrolytes, non-electrolytes, buffers, pH. Chemical bonds.
2. To determine the R<sub>f</sub> 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 R<sub>f</sub> 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 PK<sub>a</sub> and isoelectric point of an amino acid.

**Recommended Books:**

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

**Journals / Periodicals:**

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

**Students Outcome:** To elucidate the structure and role of primary metabolites in plants

**Title of the Course:** Bot-509

**Plant Ecology-I**

**Credit Hours:** 3 (2+1)

**Specific Objectives of course:** To understand the role and interaction of plants with their environment

**Course Outline:**

**Introduction:** History and recent developments in ecology.

1. **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.
2. **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.
3. **Carbon dioxide:** Stomatal responses, water loss and CO<sub>2</sub>-assimilation rates of plants in contrasting environments. Ecophysiological effects of changing atmospheric CO<sub>2</sub> concentration. Functional significance of different pathways of CO<sub>2</sub> fixation. Productivity: response of photosynthesis to environmental factors, C and N balance.
4. **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.
5. **Oxygen deficiency:** Energy metabolism of plants under oxygen deficiency, Morpho-anatomical changes during oxygen deficiency, Post-anoxic stress.
6. **Wind** as an ecological factor.
7. **Fire** as an ecological factor.

**Lab Outline:**

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 CO<sub>2</sub> and O<sub>2</sub> 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 CO<sub>2</sub> exchange in plants in relation to various environmental conditions.

**Recommended Books:**

1. M. Ahmad and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons New Urdu Bazar Karachi.
2. Schultz, J. C. 2005. Plant Ecology, Springer-Verlag.
3. Bazzaz, F. A. 2004. Plants in Changing Environments: Linking Physiological, Population, and Community Ecology, Cambridge University Press.
4. Chapin, F. S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag.
5. Lambers, H. et al. 2002. Plant Physiological Ecology, Springer-Verlag.
6. Larcher, W. 2003., Physiological Plant Ecology: Ecophysiology and Stress Physiology of Function Groups-Springer-Verlag.
7. Nobel, P. S 1999, Physico-chemical and Environmental Plant Physiology, Academic Press.
8. Lambers, H. T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.
9. Smith, R. L. 2004. Ecology and field Biology. Addison Wesley Longman, Inc., New York.
10. Barbour, M. G., Burke, J. H and Pitts, W. D. 2004 Terrestrial Plant Ecology, The Benjamin, Cummings Publishing Co. Red, Alta, California, USA

11. Smith R. L. 1998 Elements of Ecology. Harper & Row Publishing.
12. Townsend. C. R. Begon. M and J. L Harper. 2002 Essentials of ecology. Blackwell Publishing.
13. Gurevitch. J. Scheiner, S. M. and G. A Fox. 2006 The Ecology of Plants\ . Sinaur Associate Inc.
14. Hussain. F. 1989. Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education, Islamabad.
15. Hussain. S. S. 1989. Pakistan Manual of Plant Ecology. National Book Foundation Islamabad.
16. More. P. D. and Chapman S. B. 1986 Methods in Plant Ecology, Blackwell Scientific Publication Oxford.
17. Rashid, A. 2005. Soil Science. National Book Foundation, Islamabad.

**Journals / Periodicals:**

Pakistan Journal of Botany, Journal of Ecology, Journal of Applied Ecology, Ecology, Journal of Arid Environment.

**Students Outcome:** To understand the role and interaction of plants with their environment

**Title of the Course:** Bot-510      **Plant Physiology-I**      **Credit Hours:** 3 (2+1)

**Specific Objectives of course:** To provide comprehensive knowledge on some vital functions and mechanisms of plants.

**Course Outline:**

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. CO<sub>2</sub> reduction (dark reactions) - C<sub>3</sub> pathway and Photorespiration, Regulation of C<sub>3</sub> pathway, C<sub>4</sub> pathway and its different forms, C<sub>3</sub>-C<sub>4</sub> intermediates, CAM pathway. Methods of measurement of photosynthesis.
2. **Respiration:** Synthesis of hexose sugars from reserve carbohydrates. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respiration.
3. **Translocation of Food:** Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.
4. **Leaves and Atmosphere:** Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.
5. **Assimilation of Nitrogen, Sulphur and Phosphorus:** The nitrogen cycle. Nitrogen fixation. Pathways of assimilation of nitrate and ammonium ions. Assimilation of sulphur and phosphorus.

**Lab Outline:**

1. To determine the volume of CO<sub>2</sub> evolved during respiration by plant material.
2. To determine the amount of O<sub>2</sub> 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 C<sub>3</sub> and C<sub>4</sub> plants through their anatomical and physiological characters.
6. To regulate stomatal opening by light of different colours and pH.

**Recommended Books:**

1. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
2. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
3. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
4. Heldt, H-W. 2004. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
5. Ihsan Illahi, 1991. Plant Growth, UGC Press, Islamabad.
6. Ihsan Illahi. 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
7. Nobel, P.S. 1999. Physicochemical and Environmental Plant Physiology. Academic Press, UK.
8. Press, M.C., Barker, M.G., and Scholes, J.D. 2000. Physiological Plant Ecology, British Ecological Society Symposium, Volume 39, Blackwell Science, UK.



9. Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
10. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinauer Publ. Co. Inc. Calif.
11. W.B. Hopkins. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
12. Epstein, E. and Bloom, A.J. 2004. Mineral Nutrition of Plants: Principles and Perspectives. 2nd Edition. Sinauer Associates, California, USA.
13. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
14. Barton, W. 2007. Recent Advances in Plant Physiology.

**Journals/Periodicals:**

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

**Students Outcome:** To provide comprehensive knowledge on some vital functions and mechanisms of plants.

4<sup>th</sup> year

Semester 7th

**Title of the Course:** Bot-601      **Molecular Biology**      **Credit Hours:** 3 (2+1)

**Specific Objectives of course:** To disseminate the knowledge of molecular basis of life

**Course Outline:**

1. **Nucleic Acids:** DNA-circular and superhelical DNA. Renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA, Central Dogma.
2. **Proteins:** Basic features of protein molecules. Folding of polypeptide chain,  $\alpha$ helical and  $\beta$ -secondary structures. Protein purification and sequencing.
3. **Transcription:** Enzymatic synthesis of RNA, transcriptional signals Translation: The genetic code. The Wobbling, polycistronic and monocistronic RNA. Overlapping genes.
4. **Gene regulation in Eukaryotes:** Differences in genetic organization and prokaryotes and eukaryotes. Regulation of transcription, initiation, regulation of RNA processing, regulation of nucleocytoplasmic mRNA transport, regulation of mRNA stability, regulation of translation, regulation of protein activity.
5. **Plant Omics:** Transcriptomics; DNA libraries, their construction, screening and application. Microarray of gene technology and its application in functional genomics.
6. **Proteomics:** structural and functional proteomics. Methods to study proteomics. Metabolomics; methods to study metabolomics; importance and application of metabolomics.
7. Bioinformatics and computational biology. Levels, scope, potential and industrial application of bioinformatics and computational biology, docking.

**Lab Outline:**

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

**Recommended Books:**

1. Cullis, C. A. 2004. Plant Genomics and Proteomics. Wiley-Liss, New York.
2. Gibson, G. and S. V. Muse, 2002. A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
3. Gilmartin, P. M. and C. Bowler. 2002. Molecular Plant Biology. Vol. 1 & 2. Oxford University Press, UK.
4. Lodish, H. et al., 2004. Molecular Cell Biology. 5th Edition. W. H. Freeman & Co., New York.
5. Malacinski, G. M. 2003. Essentials of Molecular Biology, 4th Edition. Jones and Bartlett Publishers, Massachusetts.
6. Watson, J. D. et al. 2004. Molecular Biology of the Gene. Peason Education, Singapore.
7. Ignacimuthu, S. 2005. Basic bioinformatics. Narosa Publishing House, India.
8. Weaver, R. F. 2005. Molecular Biology. McGraw-Hill, St. Louis.
9. Lehninger, A. L. 2004. Principles of Biochemistry. Worth Publishers Inc.
10. David Figurski. 2013. Genetic manipulation of DNA and protein, example from current research. In Tech Publishers.
11. Bruce Alberts et al. 2007. Molecular biology of the cell. 5th Edition. Garland and Sons.
12. M. Madan Babu. 2013. Bacterial gene regulations and transcription network. Caister Publishers. Academic Publishers.

**Title of the Course: Bot-602 Plant Biochemistry-II Credit Hours: 3(2+1)**

**Specific Objectives of course:** To explicit the fundamentals of metabolic energy, Metabolism and Plant constituents.

**Course Outline:**

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 betaoxidation and its energy balance. Biosynthesis of fats.
  - ii. Replication of DNA. Reverse transcription. Biosynthesis of DNA and RNA.
  - iii. Components of protein synthesis. Genetic code, protein synthesis: initiation, elongation and termination.
3. Alkaloids: Occurrence, physiological effects, chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role.
4. Terpenoids: Classification: monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis.
5. Vitamins: General properties and role in metabolism.

**Lab Outline:**

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.

**Recommended Books:**

1. Conn E. E. and Stumpf, P.K. 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
2. Albert L. Lehninger, 1998. Principles of Biochemistry. Worth Publishers Inc.
3. Voet, D. Voet J.G. and Pratt, C.W. 1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
4. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
5. Smith; E L. Hill; R. L. Lehman; R. I. Lefkowitz, R J. and Abraham. H. Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
6. Zubay. G. 2003, Biochemistry, MacMillan Publishing Co., New York.
7. Chesworth, J.M. Strichbury T. and Scaife, J. R. 1998. An introduction to agricultural biochemistry. Chapman and Hall, London.
8. Mckee, T. and Mckee, J.R. 1999. Biochemistry – An Introduction. WCB / McGraw-Hill, New York, Boston, USA.
9. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinauers Publ. Co. Inc. Calif.
10. Lea, P.J. and Leegood, R.C. 1993. Plant Biochemistry and Molecular Biology. Wiley and Sons, New York.
11. Abides, R.H., Frey P.A. and Jencks, W.P. 1992. Biochemistry, Jones and Bartlet, London.
12. Goodwin T.W. and Mercer, E.I. 1997. Introduction to Plant Biochemistry. Pergamon Press, Oxford.
13. Heldt, H-W. 2008. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
14. Campbell, M.K. and F. Shawn. 2008. Biochemistry 6th Edition.

**Journals / Periodicals:**

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

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

**Course Outline:****A. Population Ecology**

1. Population structure and plant demography: Seed dispersal, Dormancy, Seed Bank, Seed dormancy, Recruitment, Demography
2. Life history pattern and resource allocation: Density dependent and density independent factors, Resource allocation, Reproductive effort, Seed size vs seed weight, Population genetics, Evolution.

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

**C. Ecosystem Ecology:** Ecological concepts of ecosystem, Boundaries of ecosystem? Compartmentalization and system concepts, Energy flow in ecosystem, biogeochemical cycles: water carbon and nitrogen; Case studies: any example

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

**Recommended Books:**

1. Ahmad, M. and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons, New Urdu Bazar, Karachi.
2. Schultz J.C. 2005. Plant Ecology, Springer-Verlag
3. Townsend C.R. Begon. M and J.L. Harper 2002. Essentials of Ecology, Blackwell Publishing,
4. Chapin, F.S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag,
5. Gurevitch, et al., 2002. The Ecology of Plants, Sinauer Associates, Inc.
6. Barbour M. G. et al., 1999, Terrestrial Plant Ecology, The Benjamin-Cumming Publishing Co.
7. Smith, R. L. 1998. Elements of Ecology by Harper & Row Publishers.
8. Moore P.D. and Chapman S. B. 1986. Methods in Plant Ecology, Blackwell Scientific Publication, Oxford.
9. Hussain, S. Pakistan Manual of Plant Ecology.
10. Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education. Islamabad.
11. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.
12. Larcher. W. 2003 Physiological Plant Ecology. Ecophysiology and Stress Physiology of Function Groups. Springer- Verlag.

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

4<sup>th</sup> year

Semester 8<sup>th</sup>

**Title of the Course:** Bot-604      **Plant Physiology-II**      **Credit Hours:** 3 (2+1)

**Specific Objectives of course:** To give it comprehensive and advance knowledge of growth regulators, mechanism of water uptake and role of essential nutrients in plant metabolism.

**Course Outline:**

1. **Plant Growth Regulators:** Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal trasduction and mode of action, transport, physiological effects of Auxins, Gibberellins, Cytokinins, Absciscic acid, Ethylene, Polyamines, Brassinosteroids, 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 energetics. Essential and beneficial elements-their functions and deficiency symptoms in plants. Fertilizers and their significance in Agriculture.
4. **Phytochromes:** Discovery of phytochromes and cryptochromes. Physical and chemical properties of phytochromes. Distribution of phytochromes among species, cells and tissues and their role in biological processes. Phytochromes and gene expression.
5. **Control of Flowering:** Autonomous versus environmental regulation. Circadien rhythms. Classification of plants according to photoperiodic reaction, photoperiodic induction, locus of photoperiodic reaction and dark periods in photoperiodism. Role of photoperiodism in flowering. Biochemical 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. **Signal transduction** and gene regulation in prokaryotes and eukaryotes.
7. **Dormancy:** definition and causes of seed dormancy; methods of breaking seed dormancy; types and physiological process of seed germination.
8. **Plant Movements:** Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements.

**Lab Outline:**

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

**Recommended Books:**

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

**Title of the Course:** Bot-605

**Genetics-II**

**Credit Hours:** 3 (2+1)

**Specific Objectives of Course:** To introduce students recombination of genetic material at molecular levels with emphasis on introduction to biotechnology and genomics.

**Course Outline:**

1. **Recombinant DNA:** Recombinant DNA Technology Introduction, Basic Techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA methodology, Site directed Mutagenesis, DNA sequencing.
2. **Application of Recombinant DNA:** Applications of recombinant DNA technology using prokaryotes, recombinant DNA technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions.
3. **Mechanisms of Genetic Change I:** Gene Mutation: The molecular basis of gene mutations, spontaneous mutations, induced mutations, reversion analysis mutagens and carcinogens, biological repair mechanisms.
4. **Mechanisms of Genetic Change II:** Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.
5. **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.
6. **Human Genome Project:** Strategies and application, achievement and future prospects.
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.

**Lab Outline:**

Problems relating to the theory.

1. Isolation and separation of DNA and protein on Gel electrophoresis.  
**i.** Bacterial chromosome; **ii.** Plasmid DNA (minipreps); **iii.** Plant DNA; **iv.** Protein.
2. DNA Amplification by PCR.

**Recommended Books:**

1. Trun, N and Trempy J. 2004, Fundamental Bacterial Genetics, Blackwell Publishing House.
2. Winnacker, E. L. 2003, From Gene to Clones Introduction to Gene Technology, Panima Publishing Corporation, New Delhi.
3. Beaycgamp T. L. and Walters L., Contemporary Issues in Bioethics, Wadsworth Publishing Company.
4. Brown, T. A. 2002 Genomes, Bios Scientific Publishers Ltd.
5. The Genome of Homo Sapiens, 2003, Cold Spring Harbor Laboratory Press.
6. Ignacimuthu, S. 2005, Basic Bioinformatics, Narosa Publishing House, India.
7. Lwein, B. 2004, Gene VIII, Pearson Education Int.
8. Miglani, 2003, Advanced Genetics, Narosa Publishing House, India.
9. Hartt, D. L, and Jones, E. W. 2005. Genetics, Analysis of Gene and Genomes. Jones and Bartlett Publishers, Sudbury, USA.
10. Gelvin S. B. 2000 Plant Molecular Biology Manual Kluwer Academic Publishers

11. Primrose, S. B., Twyman, R. M. and Old R. W. 2004. Principles of Gene Manipulation, an Introduction to Genetic Engineering (6th Edition), Blackwell Scientific Publications.
12. Snyder, L and Champness W, 2003, Molecular Genetics of Bacteria, ASM Press.
13. Wilson, J. and Hunt, T. 2004. Molecular Biology of the cell – the problems book, Garland publishing Inc.
14. Anthony J. F Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart. W. H. 2009. An Introduction to Genetic Analysis, 7th Edition. Freeman and Company.
15. Hedrick, P. W. 2005. Genetics of Population. Jones and Bartlett Publisher, Sudbury, USA.
16. Mahmut Caliskan. 2012. The Molecular basis of plant genetic diversity. In Tech Publishers.
17. Ram J. Singh. 2011. Genetic resources, chromosome engineering and crop improvement. Medicinal plants. Vol. 6. CRC Press.
18. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino. 2011. Concepts of Genetics. Pearson Educations.
19. Daniel Hartl. 2011. Genetics Johns and Bartlett Publishers.
20. David Hyde. 2008. Introduction to Genetic principles. McGraw-Hill.
21. Daniel, L. Hart, Elizabeth W. Jones. 2009. Analysis of genes and genomes. John and Barlett.
22. Noureddine Benkeblia. 2011. Sustainable agriculture and new biotechnologies. CRC Press.

**Journals / Periodicals:**

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



**Title of the Course:** Bot-606      **Environmental Biology**      **Credit Hours:** 3 (2+1)

**Specific Objectives of Course:** To provide updated knowledge of environmental problems and sustainable environmental management.

**Course Outline:**

1. Environment: Introduction, scope, pressure.
2. Pollution: definition, classification and impact on habitats
  - i. **Air pollution:** Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, remediation. Photochemical smog. Smog. Acid rain: **1.** Theory of acid rain, **2.** Adverse effects of acid rains. Chlorofluorocarbons and its effects.
  - ii. **Water pollution:** Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal pollution.
  - iii. **Sediments pollution:** fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control remediation. Heavy metal pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and polluted waters.
  - iv. **Noise pollution**
  - v. **Radiation pollution** (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal.
3. Forest: importance, deforestation, desertification and conservation.
4. Ozone layer: **i.** Formation **ii.** Mechanism of depletion **iii.** Effects of ozone depletion.
5. Greenhouse effect and global warming: causes, impacts.
6. Human population explosion: impact on environment.
7. Impact assessment: Industrial urban, civil developments.
8. National conservation strategy: Brief review of major problems of Pakistan and their solutions.
9. Sustainable Environmental management.
10. Wetlands and sanctuaries protection: The pressures, problems and solutions.
11. Range management: Types of rangelands, potential threats, sustainable management.
12. Aerobiology (Pollen allergy & dust allergy).

**Lab Outline:**

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

**Recommended Books:**

1. Newman, E. I. 2001. Applied Ecology. Blackwell Science. UK.
2. Mooney, H. A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
3. Eugene, E. D. and Smith, B. F. 2000. Environmental Science: A study of interrelationships. McGraw-Hill. USA.
4. French, H. 2000. Vanishing Borders: Protecting the Planet in the Age of Globalization. W. W. Norton and Company, NY.
5. Hill, C. A. S. and Davis, C. J. 2000. Quantifying Sustainable Development. Academic Press, UK.

6. Bazzaz, F. A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
7. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
8. Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.
9. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.
10. Mohamamd Ashfaq and Mushtaq A. Saleem. Environmental Pollution and Agriculture.
11. Shah Faisal Muhamamd and Sultan Mehmood. 2012. Lambert Publishers Germany.
12. Advanced Air and Noise Pollution Control, L. K. Wang, N. C. Pereira and Y. T. Hung, Humana Press, 2005.
13. Air Pollution Control Technology Handbook, K. B. Schnelle and C. A. Brown, CRC Press, 2002. Handbook of Solid Waste Management and Waste Minimization Technologies, N. P. Cheremisinoff, Butterworth-Heinemann, 2003.
14. Pollution Control In Process Industries, S. P. Mahajan, Tata McGraw-Hill, 1985.
15. Industrial Pollution control: issues and techniques, N. J. Sell, Van Nostrand Reinhold, 1992.
16. Environmental Biotechnology: Basic Concepts and Applications, I. S. Thakur, I.K. International Publishing House Pvt. Limited, 2006.
17. Vandermeer, John H. 2011. The ecology of agro-ecosystems - Jones and Bartlett Publishers; Sudbury, Mass; 2011 - xv, 387 p.
18. Greipsson, Sigurdur. 2011. Restoration ecology - Jones and Bartlett Publishers; Sudbury, MA; 2011 - xvi, 408 p.
19. Santra, S. C. 2010. Fundamentals of ecology and environmental biology - New Central Book Agency; London; 2010 - 353p.
20. Singh, M.P. 2007 Forest environment and biodiversity Daya; New Delhi; 2007 - 556p.

**Journals/Periodicals:** Environmental Biology, Environment, Bioremediation.

### Elective Courses offered by the University for BS-Botany integrated 4-year Program

Course Nature	Course title	Credit hours
ELECTIVE-I	i. Plant pathology (Bot-608)	2+1 (3)
	ii. Palynology (Bot-612)	2+1 (3)
ELECTIVE-II	i. Research methodology (Bot-609)	2+1 (3)
ELECTIVE-III	i. Advanced Molecular Biology (Bot-610)	2+1 (3)
	ii. Advanced Plant Systematics (Bot-614)	2+1 (3)
ELECTIVE-IV	i. Plant Breeding (Bot-615)	2+1 (3)
	ii. Applied mycology (Bot-616)	2+1 (3)

## ELECTIVE COURSES

Elective/Optional paper for BS/ M.Sc

**Title of the Course: Advanced Plant Systematics**

**Course Code: Bot-614**

**Credit Hours: 3 (2+1)**

**Specific Objectives of the course:**

1. This course will explore the theory and procedures of modern systematic analysis
2. Students will be expected to gain a working knowledge of techniques and approaches to Systematics (including phylogenetics and evolutionary processes)
3. Survey the sources and interpretation of systematic data

**Course Outlines:**

1. **Taxonomy in practice:** Roles of characters and states, criteria for selection of characters and states, kinds of characters and networks, good and bad characters, evolutionary patterns, choosing evolutionary trees.
2. **Concepts of categories:** the taxonomic hierarchy, Species, reality of species, naturalness of species, current species concepts, the subspecies, variety and form, biosystematic infraspecific categories, the Genus, the Families and higher categories.
3. **Taxonomic information and data:** Chemotaxonomy, cytology and cytogenetics, information from breeding systems, isolating mechanisms, information from plant geography and ecology, patterns of geographic distribution, disjunction and vicariance, vicariance biogeography, endemism, centres of diversity, alien plants.
4. **Molecular phylogeny:** Generating molecular data, analysis of molecular data, alignment of sequences, homoplasy and long branches, methods of phylogeny reconstruction, gene trees vs species trees, Maximum parsimony analysis, Minimum evolution/Neighbour-joining trees, The Neighbour-Joining algorithm, Maximum likelihood phylogenies, Markov Chain Monte Carlo Bayesian analysis.
5. **The gathering and storage of Data:** Botanical garden, Herbaria and Taxonomic experts, Floras and Monographs, Data information system, Botanical illustrations.

**Laboratory/Practical**

1. Students will choose a taxon at the level of genus or above that they will use as a case study to explore the various concepts introduced in the course. These will include the applications of molecular phylogenetics to the taxon.
2. Exploration of library and internet resources relevant to systematics or phylogenetics. In particular, the students shall learn the basics of the NCBI Taxonomy database and *BLAST* search algorithms.
3. Constructing phylogenetic trees using PAUP and MEGA from the NCBI sequences.
4. DNA extraction, purification, PCR, sequencing methods.

### **Recommended Books**

1. Tod F. Stuessy (2009). *Plant Taxonomy, 'the Systematic Evaluation of Comparative data'* Second Edition, Columbia University Press, New York.
2. Clive A. Stace (1989). *Plant Taxonomy and Biosystematics*. 2<sup>nd</sup> Edition.
3. Schuh, R.T. 2000. *Biological Systematics. Principles and Applications*. Cornell University Press, Ithaca, NY
4. Winston, J.E. 1999. *Describing Species. Practical Taxonomic Procedure for Biologists*. Columbia University Press, New York, NY
5. Michael G. Simpson (2010). *Plant Systematics*, 2<sup>nd</sup> Edition. Elsevier Academic Press, NY.
6. Hall, B.G. (2011). *Phylogenetic Trees Made Easy - A How-To Manual*. Fourth Edition. Sinauer, Sunderland M.A.
7. Hillis et al. (eds) (1996) *Molecular Systematics*, 2nd edition, Sinauer, Sunderland M.A.
8. Nei, M. & Kumar, S. (2000) *Molecular Evolution and Phylogenetics*. Oxford University Press.
9. Li, W.-H. (1997). *Molecular evolution*. Sinauer Associates, Sunderland, MA, USA.

### **Journals/ Periodicals**

Plant Systematics, Cladistics, BMC Evolutionary Biology, Journal of Evolutionary Biology, Molecular Phylogenetics and Evolution, Systematic Biology, Taxon, Botanical Journal of the Linnean Society, Journal of the Missouri Botanical Garden, Trends in Ecology & Evolution .

**Title of the Course:** **Applied mycology**

**Course code:** Bot-616

**Credit Hours:** 03(2+1)

**Nature of the Course:** Elective

**Specific objectives:** To understand applied aspects of fungi and modern trends in mycology

**Course Outline:**

1. Introduction: Mycodiversity of kingdom Fungi and fungi like organisms, application of mycology in field of medicine, agriculture, forestry, food and pharmaceutical industries.
2. Pharmaceutical and Chemical Commodities from Fungi: secondary metabolites of fungi, fungi as source of antibiotics, antioxidants, alcohols, alkaloids, vitamins and organic acids, commercial production of penicillins and cyclosporins
3. Food mycology, edible, poisonous and hallucinogenic mushrooms, mushroom farming; button, oyster and shiitake mushroom cultivation, food spoilage, cheeses, beer and wine production through fungi. Fungal toxicity; classes of mycotoxins and mycotoxicoses
4. Fungal ecology: Monitoring and inventorying of fungi, Sampling and collection techniques used for different group of fungi, Isolation of fungi from different substrates such soil, dung, air, water, from animal and plant tissues
5. Mycorrhizal association and type of mycorrhizal fungi, and their role in agriculture and forestry, endophytic fungi
6. Wood rotting fungi, Fungi as efficient decomposing agents, composting and role of fungi in soil formation
7. Mycoremediation: using fungi in controlling water pollutants and toxic industrial and domestic wastes, fungi as biopesticides
8. Myconanotechnology: Syntheses of myco-nanoparticles and their applications
9. Recent advances in fungal systematics and phlogeny: Molecular identification of fungi
10. Fungal genomics and proteomics
11. Fungal media types, preparation, preservation and maintenance

**Lab outline:**

Basic techniques applied in mycological laboratory (media, equipment, reagents).

Isolation and culturing techniques

Identification of fungi by using mycological keys.

Staining and microscopic techniques of fungal materials

Molecular techniques for identification of macro and microfungi

**Recommended Books:**

1. Deacon J.W., 2005. Fungal biology. Wiley-Blackwell, 4th ed.
2. Dijksterhuis J., Samson R. A., 2007. Food Mycology: A Multifaceted Approach to Fungi and Food. CRC Press.
3. Burgess Galloway L.D., 1937. Applied Mycology and Bacteriology
4. Arora D., Arora K., Bharat R., 1991. Handbook of Applied Mycology: Volume 1: Soil and Plants.
5. Randy B., 2006. Genes and Genomics, Volume 5 (Applied mycology and Biotechnology)
6. Khachatourians G.G., Arora D.K., 2001. Applied Mycology and Biotechnology: Agriculture and Food Production. Elsevier Science Pub Co., 1st ed.
7. Carlile M., Watkinson S., Graham G., 2001. The Fungi, 2nd ed. Academic Press.
8. Webster I., Weber D., 2007. Introduction to Fungi. Cambridge University Press, 2nd ed.

**Title of the Course: Palynology**

**Course Code: Bot-612**

**Credit Hours: 3 (2+1)**

**Specific Objectives of course:**

1. To provide instructions on basic pollen taxonomy as an aid in identifying and classifying various palynoflora
2. To provide a general background of the enormous diversity of pollens
3. To understand the various applications of Palynology

**Course Outline:**

1. **Palynology:** Aeropalynology, Melissopalynology, Yellow rain, Pollen Allergy; History of Palynology, Palynology as a multidisciplinary field, Applications of Palynology, Palynology in relation to Plant Taxonomy.
2. **Pollen Morphology:** Polarity and Symmetry, Apertures, Pollen Wall, Structure and Sculpture, Harmomegathy and details of terminology involved in pollen description.
3. **Methods:** Acetolysis and Light Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, New and improved methods in Palynology.
4. Status of Palynology in Pakistan.

**Lab Outlines:**

1. Preparation of glycerine gelly for pollen preparation
2. Pollen preparations of the local flora through acetolysis methods
3. Acetocarmine staining for light microscopy
4. Pollen fertility estimation
5. Microscopic studies of the quantitative and qualitative features of pollen grains

**Recommended Books:**

1. **Blackmore, S.** (2000) The palynological compass: the contribution of palynology to systematics. In: Nordenstam B, El-Ghazaly G, Kassar M (eds) Plant Systematics for the 21st Century. Portland Press, London.
2. **Erdtman, G.** (1952) Pollen Morphology and Plant Taxonomy. Angiosperms. Almqvist & Wiksell, Stockholm.
3. **Erdtman, G.** (1969) Handbook of Palynology. An Introduction to the Study of Pollen Grains and Spores. Munksgaard, Copenhagen.

4. **Faegri, K and Iversen, J.** (1989) Textbook of Pollen analysis. 4th ed. John Wiley & Sons, Chichester.
5. **Hesse, M., Halbritter, H., Weber, M., Buchner, R., Frosch-Radivo, A., and Ulrich, S.** (2008). Pollen terminology: an illustrated handbook (Springer).
6. **Moore, P.D., and Webb, J.A.** (1978). An illustrated guide to pollen analysis. London, etc: Hodder & Stoughton.
7. **Punt, W., Hoen, P., Blackmore, S., and Le Thomas, A.** (2007). Glossary of pollen and spore terminology. Review of Palaeobotany and Palynology *143*, 1-81.
8. **Huang, T.C.** (1972). Pollen Flora of Taiwan (National Taiwan University: Botany. Dept. Press).
9. **Traverse, A** (2007) Paleopalynology. 2nd ed., Springer, Dordrecht.

### **Journals / Periodicals:**

Grana, Palynology Journal, Palynology and Paleobotany, Pakistan Journal of Botany, Turkish Journal of Botany, Canadian Journal of Botany, Nordic Journal of Botany, Botanical Journal of the Linnean Society, South African Journal of Botan.



**Title of the Course: Plant Pathology**

**Course code:** Bot-608

**Credit Hours:** 3(2+1)

**Nature of the Course:** Optional

**Specific objectives:** To understand causes, mechanisms classification and economic importance of plant diseases

**Course Outline:**

12. Introduction to pathology and plant diseases, history, scope of phytopathology, economic importance of plant disease.
13. Nature, classification of plant diseases.
14. Symptoms of plant diseases, nature and types
15. Nature, classification, growth and reproduction of plant pathogens.
16. Pathogenesis and parasitism: phenomenon of infection, disease development, host parasite relationship, resistance and susceptibility, plant defensive system, the effects of environments and nutrition on disease development
17. Production and liberation of inoculums, Transmission and dissemination of plant pathogens/inoculum
18. Disease detection and diagnosis
19. The principles of disease management: cultural, chemical, biological control of plant diseases, eradication, plant protection and sanitation , quarantines , disease resistant varieties
20. Epidemiology, disease forecast and loss assessment
21. Molecular mechanism of pathogen infection, disease development and transmission
22. Plant diseases: black rot of crucifers, loose smut of barley, black stem rust of wheat, white heart rot of deciduous trees, tobacco mosaic disease, white rust of crucifers, streak smut of wheat, powdery mildews of grasses and ornamental plants, white rust of crucifers, red rot of sugarcane, downy mildews of seedlings, late blight and early blight of potato, damping off caused by phythium spp. shisham dieback, citrus canker of citrus, apple scab, leaf curl of peaches, diseases of transect and storage.

**Lab Outline:**

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 pathogenicity. Isolation, sterilization and culturing techniques of plant pathogens. Collection and studying diseased plant specimens.

**Recommended Books:**

1. Agrios, G.N., 2005. Plant Pathology, Academic Press, London.
2. Gail L. Schumann and Cleora J. D'Arcy, 2009. Essential Plant Pathology, Second Edition
3. Robert N. Trigiano 2007. Plant Pathology Concepts and Laboratory Exercises, Second Edition
4. Ahmad, I. and Bhutta, A.R., 2004. Textbook of Introductory Plant Pathology. Book Foundation, Pakistan.
5. Trigiano, R.N., Windham, M.T. and Windham, A.S., 2004. Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

**Course Outline:**

1. **Plant breeding and its Scope:** Definition, Plant breeding as an art and Science, Concept and Goals of Plant breeding.
2. **Genetic basis for Plant breeding:** Genetic consequences of hybridization, Quantitative inheritance, Population structure, Hardy-Weinberg Law, Combining ability, Heritability, Choice of breeding methods.
3. **Nature of Crops and Methods of breeding:** Mode of Reproduction, Incompatibility, Male sterility, Hybridization.
4. **Domestication and Introduction of Crop Plants:** Centers of Origin, Centers of diversity, Domestication of Crop plants, Introduction of Crop Plants.
5. **Mutation breeding:** Definition and history, Classification of mutation, Mutagens and their classification.
6. **Ploidy breeding:** Classification of Ploidy, Aneuploidy, Euploidy, Ploidy in Crop improvement.
7. **Breeding for Disease and Insects resistance:** Definition, Classification of resistance, Genetics of host parasite interaction, breeding for disease resistance.
8. **Achievements in Crop plants:**
  - Wheat
  - Rice
  - Maize
  - Cotton

**Practicals**

1. Field study of Crop plants to observe pathogens causing diseases
2. Study of soil texture suitable for crop plants
3. Identification of the domesticated and introduced plants
4. Selection of elite genotypes for future breeding strategies
5. The construction of morphological data recording descriptors

**Recommended books**

1. Coors, J.G. and Pandey, S. (eds) (1999) *The Genetics and Exploitation of Heterosis in Crops*. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America,
2. Falconer, D.S. (1960) *Introduction to Quantitative Genetics*. Oliver and Boyd, London.
3. Gowen, J.W. (ed.) (1952) *Heterosis*. Iowa State University Press, Ames, Iowa.
4. Hanson, W.D. and Robinson, H.F. (eds) (1963) *Statistical Genetics and Plant Breeding*. Publication 982, National Academy of Sciences – National Research Council, Washington, DC.
5. Mather, K. (1949) *Biometrical Genetics*, 1st edn. Methuen, London.
6. Pollak, E., Kempthorne, O. and Bailey, T.B., Jr (eds) (1977) *Proceedings of International Conference on Quantitative Genetics*. Iowa State University Press, Ames, Iowa.

7. Schuler, J. (1988) Inserting genes affecting quantitative traits. In: Weir, B.S., Eisen, E.J., Goodman, M.M. and Namkoong, G. (eds) *Proceedings of the Second International Conference on Quantitative Genetics*. Sinauer Associates, Sunderland, Massachusetts, pp. 198–199.
8. Chahal, G.S. and S.S. Gosal. 2003. Principles and Procedures of Plant Breeding. Narosa Publishing House, New Delhi, India.
9. Singh, B. D. 2003. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi, India.

**Course Outline**

- Definition of pharmacology, drugs, crude drugs, official and unofficial drugs, cultivation, collection, curing, drying, preservation, evaluation and classification of drugs, therapeutic classes of drugs.
- Detail study of the following medicinal plants (Angiosperms), giving those synonyms, botanical origin, local names, distribution of plants, methods of cultivation, macroscopical characteristics of drugs. microscopical characteristics of drugs, chemical constituents, uses and adulterants with special reference to species growing in Pakistan.
  1. Opium (Family Papaveraceae)
  2. Berberis (Family Berbaridaceae)
  3. Liquorice (Family Papaveraceae)
  4. Acacia (Family Mimosaceae)
  5. Cassia (Family Caesalpinaceae)
  6. Colchicum (Family liliaceae)
  7. Zingiber (Family Zingiberaceae)
  8. Mentha ( Family Lamiaceae)
  9. Foeniculum (Family Apiaceae)
  10. Coriandrum (Family Apiaceae)

**Practicals**

1. Microscopical characters of the drugs using sectioning and powdered drugs
2. Macroscopic study of different gums and oils
3. Identification test for starch, Ca-oxalate
4. Identification tests for volatile and fixed oil, tannin and mucilage etc.

**Books recommended**

1. Tyler, V.L.E.R. Brady & E.F. Clayse. 1970. Pharmacognosy 6<sup>th</sup> Ed. Leimption London.
2. Trease G.D & W.C Evans.1985. Pharmacognosy 12<sup>th</sup> Ed, English Language. Soc. Bailere Tindall.
3. Jain, S.K. 1987. A manual of Ethnobotany. Scientific Publisher Johpur, India.
4. Willism, T.E.1998. Text book of Pharmacognosy. Churchill Ltd. Glouester Palace, W.I. London.
5. R S Satorkar and S D Bhandarkar, Pharmacology and Pharmacotherapeutics, Popular Prakashan, Bomby, 1993.
6. G E Trease and W C Evans, Pharmacognosy, W B Saunders, Philadelphia, Toronto, 2002.