

Scheme and Syllabi of
BS (4-Years) Botany for Affiliated Colleges & Department of
Botany University of Balochistan, Quetta



DEPARTMENT OF BOTANY
UNIVERSITY OF BALOCHISTAN,
QUETTA
(2017)

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UNIVERSITY OF BALOCHISTAN QUETTA**

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**DEPARTMENT OF BOTANY
UNIVERSITY OF BALOCHISTAN QUETTA**

ISO 9001: 2000 Certified

**Scheme and Syllabi of BS (4 Years) Botany Program for Affiliated Colleges &
Department of Botany University of Balochistan, Quetta**

Scheme of Studies for BS (4 Years) Botany Program

BS-four Years Botany program comprises of 8 semesters with 130 credit hours. Outline of the courses is as under.

Duration of the Program: The duration of BS Botany is four years (08 Semesters)

General Courses 02 Years (04 Semesters)

Specialized Courses 02 Years (04 Semesters)

Main Features of BS Botany Program/Credit Requirements

Major Subject: Botany

Eligibility Criteria: At least FSc with biology as an elective subject (as per university rules).

Elective Courses for Semester 7th: Courses to be adopted from the given list as per expertise available in Botany Department UoB Quetta and their affiliated Colleges.

Elective Courses for Semester 8th: Courses to be adopted from the given list as per expertise available in Botany Department UoB Quetta and their affiliated Colleges.

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

S.No	CATEGORIES	N. Of Courses	Credit Hours
1	Compulsory Requirement (No Choice)	9-9	25
2	General Courses to be chosen from other departments	7-8	24
3	Discipline Specific Foundation Courses	9-10	33
4	Major Courses including research project / Internship	11-13	36 – 42
5	Electives within the major	4-4	12
	Total	40-44	124-136

- 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 (not more than 3 Lab/Practical Courses per Semester)

**Scheme of Courses for BS (4 Years) for Botany Department and Affiliated Colleges of
University of Balochistan, Quetta**

Year 1 st		
Semester 1 st		
Code	Subject Title	Cr. Hrs.
ENG-601	Functional English	3(3-0)
PAKS- 601	Pakistan Studies	2(2-0)
BOT-601	Diversity of Plants	4(3-1)
CHEM-601	Physical Chemistry	4(3-1)
ZOOL-601	Principles of Animal life	4(3-1)
Total Cr. Hrs/Semester		17
Year 1 st		
Semester 2 nd		
Code	Subject Title	Cr. Hrs.
ENG-602	Communication Skills	3(3-0)
ISL- 601	Islamic studies	2(2-0)
BOT-602	Plant Systematics, Anatomy and Development/ Embryology	4(3-1)
CHEM-602	Organic Chemistry	4(3-1)
ZOOL-602	Diversity in Animals (Invertebrates)	4(3-1)
Total Cr. Hrs/Semester		17
Year 2 nd		
Semester 3 rd		
Code	Subject Title	Cr. Hrs.
ENG-603	Technical Report Writing & Presentation Skill	3(3-0)
COMP-601	Introduction to Computer	3(3-0)
CHEM-603	Inorganic Chemistry	4(3-1)
ZOOL-603	Principles of Animal Physiology	4(3-1)
BOT-603	Cell Biology, Genetics and Evolution	4(3-1)
Total Cr. Hrs/Semester		18
Year 2 nd		
Semester 4		
Code	Subject Title	Cr. Hrs.
MATH-601	Mathematics for Botany	3(2-1)
ZOOL-604	Diversity of Animal (Vertebrates)	4(3-1)
BOT-604	Plant Physiology and Ecology	4(3-1)
BOT-605	Biodiversity and Conservation	4(3-1)
BOT-606	Biostatistics	3(2-1)
Total Cr. Hrs/ Semester		18
Year 3 rd		
Semester 5 th		
Code	Subject Title	Cr. Hrs.
BOT-607	Bacteriology and Virology	3(2-1)
BOT-608	Phycology and Bryology	3(2-1)
BOT-609	Mycology and Plant Pathology	3(2-1)

BOT-610	Diversity of Vascular Plants	3(2-1)
BOT-611	Plant Systematics	3(2-1)
BOT-622	Environmental Biology	3(2-1)
Total Cr. Hrs/ Semester		18
Year 3rd		
Semester 6th		
Code	Subject Title	Cr. Hrs.
BOT-612	Plant Anatomy	3(2-1)
BOT-613	Genetics-I	3(2-1)
BOT-614	Plant Biochemistry-I	3(2-1)
BOT-615	Plant Ecology-I	3(2-1)
BOT-616	Plant Physiology-I	3(2-1)
Total Cr. Hrs/ Semester		15
Year 4		
Semester 7		
Code	Subject Title	Cr. Hrs.
BOT-617	Molecular Biology	3(2-1)
BOT-618	Plant Biochemistry-II	3(2-1)
	Elective course-1(Select one from the given list of optional papers for Semester 7)	3(2-1)
	Elective course- II (Select one from the given list of optional papers for Semester 7)	3(2-1)
	Elective course - III (Also select one from the given list of optional Papers for Semester 7)	3(3-0)
Total Cr. Hrs/ Semester		15
Year 4th		
Semester 8		
Code	Subject Title	Cr. Hrs.
BOT-619	Plant Physiology-II	3(2-1)
	Elective course-IV	3(2-1)
	Research project	6 (0-6)
Total Cr. Hrs/ Semester		12
Grand Total Cr. Hrs/All Semesters		130

List of Optional Papers for Semester 7th

Year 4th		
Semester 7		
Code	Subject Title	Cr. Hrs.
BOT-622	Plant Ecology-II	3(2-1)
BOT-623	Plant Tissue Culture (Advance course)	3(2-1)
BOT-624	Palynology	3(2-1)
BOT-625	Air pollution, its Impacts and control	3(3-0)
BOT-626	Laboratory Techniques	3(3-0)
BOT-627	Biohazards, Biosafety and Bioethics	3(3-0)

List of elective for Semester 8th

Year 4th		
Semester 8th		
Code	Course Title	Cr. Hrs.
BOT-628	Plant Nutrition and Soil Fertility	3 (2-1)
BOT-629	Biodegradation and Bioremediation	3 (2-1)
BOT-630	Microbes, Man and Environment	3 (2-1)
BOT-631	Water Pollution, its management and control	3 (2-1)
BOT-632	Challenges of a changing earth	3 (3-0)
BOT-621	Genetics-II	3 (3-0)

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Year 1st		Discipline	
Semester 1		Botany	
Code	Course Title		Cr. Hrs.
ENG-601	Functional English		3(3-0)

Objectives: To enhance language skills and develop critical thinking of students.

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

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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. Brian Tomlinson and Rod Ellis. Oxford
Supplementary Skills. Third Impression 1992. ISBN0 19 453402 2.

d) Speaking

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Year 1 st		Discipline
Semester 1		Botany
Code	Course Title	Cr. Hrs.
PAKS-601	Pakistan Studies	2(2-0)

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 Bangladesh*, 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.
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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.

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Year 1 st		Discipline
Semester 1		Botany
Code	Course Title	Cr. Hrs.
BOT-601	Diversity of Plants	04(3-1)

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 specific 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 (Phycia)**
- f) Bryophytes**
 - i. Riccia
 - ii. Anthoceros
 - iii. Funaria
- g) Pteridophytes.**
 - i. Psilopsida (Psilotum)
 - ii. Lycopsida (Selaginella)
 - iii. Sphenopsida (Equisetum)
 - iv. Pteropsida (Marsilea)
- h) Gymnosperms**
 - i. Cycas
 - ii. Pinus
 - iii. Ephedra
- i) Angiosperms
 - i. Monocot (Poaceae)
 - ii. 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, 3rd Ed. WM. C. Brown Publishers.
2. Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. Introductory

- Mycology. 4th Ed. John Wiley and Sons Publishers.
3. Agrios, G. N. 2004. Plant pathology. 8th 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 3rd 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.

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Year 1 st		Discipline	
Semester 1			
Code	Course Title		Cr. Hrs.
CHEM-601	Physical Chemistry		04(3-1)

Course Outline:

Elementary Mathematics: Logarithmic, exponential and trigonometric functions, differentiation of elementary functions, methods of differentiation & integration, significance of differentiation & integration.

Physical States of Matter: Gases (van der Waal's equation, critical Phenomena, Critical values of T, P & V., liquification of gases, molecular collisions, collision diameter, mean free path).

Liquids (viscosity, Parachor value, Refractive index, molar refraction and its applications.

Dipole moment, **Solids** (Unit cells. Bragg crystal analysis, crystal structure of NaCl, powder method of crystal structure analysis).

Atomic Structure: De Broglie equation. Schrodinger wave equation, solution for particle in 1D box, quantization concept, Heisenberg Uncertainty Principle, Puali Exclusion Principle, Hund's Rule.

Chemical Thermodynamics: First law of thermodynamics, state functions, isothermal and adiabatic processes in ideal gases, heat capacity, reversible and irreversible processes.

Spontaneous and non-spontaneous processes, second law of thermodynamics, change of entropy with change in T, P & V.

Chemical Equilibrium: Law of Mass Action, equilibrium constant, relationship between K_c , K_p , K_x and K_a and LeChaterlier's Principle.

Solutions: composition, ideal and non-ideal solutions. Raoult's law. Colligative properties, ebullioscopy, cryoscopy, osmotic pressure, distillation and concept of azeotrops.

Chemical Kinetics: Zero, first and second order reaction, Arrhenius equation, activation energy, Lindermmann's mechanism, collision theory and transition state theory.

Electrochemistry: Conductance, dependence of conductance on the nature of solvent and temperature, Kohlrausch's law and its applications, measurement of conductance strong and weak electrolytes, degree of dissociation.

Physical Chemistry Lab (Cr. 01)

1. Determination of surface tension and Parachor value by stalagmometer.
2. Determination of percent composition of liquid solutions from surface tension measurement.
3. Determination of viscosity and Rhechor value of liquids from viscosity measurement.
4. Determination of percent composition of liquid solutions viscometrically.
5. Determination of refractive index and molar refractivity by refractometer.
6. Determination of percent composition of liquid solutions by refractive index measurements.
7. Determination of heat of solution by solubility method.
8. Determination of heat of neutralization of an acid with a base.
9. A kinetic study of acid hydrolysis of ethyl acetate.
10. Kinetic study of saponification of ethyl acetate.

11. Determination of molecular weight of a compound by elevation in boiling point. (Ebullioscopic method).
12. Determination of molecular weight of a compound by lowering of freezing point (The Cryoscopic methods).
13. Determination of equilibrium constant of KI – I₂ KI₃.
14. Conductometric titration of strong acid and strong base.

Recommended Books (Physical Chemistry)

1. Chaudhry, G.R., Text Book of Physical Chemistry, 2nd Edition, New Kitab Markaz, Amin pur Bazar, Faisalabad, Pakistan, (2001).
2. Shaheen, M.A. Jilani Manual of Practical Chemistry, Vol.I, Jilani Notes, Lahore Pakistan
3. Maron S. H. and Jerome, B. “Fundamentals of Physical Chemistry” Macruthan Publishing co. Inc. New York, (1995).
4. Atkins P.W. and Clugston, M.J. “Principles of Physical Chemistry’ Pitam Publishing Company. NY (1998).
5. Moore, W.J., “Physical Chemistry”, 5th Ed. Longmans Publishers, NY (1972).
6. Jones, M., “Elements of Physical Chemistry” 3rd Ed. Benjamin Cummings Publishing Company Inc., NY (1993).
7. Adamson, A. W., “Understanding Physical Chemistry” 3rd Ed. Benjamin Cummings Publishing Company Inc. NY (1973).
8. Heald, C. and Smith, A.C.K. Applied Physical Chemistry. MacMillan UK (1973).
9. Akhtar, M.N. & Ghulam Nabi, “Text Book of Physical Chemistry” Ilmi Kitab Khawna, Lahore (2006).
10. Bhatti, H.N. and K. Hussain, “Principles of Physical Chemistry”; Carwan Book House, Lahore (2005).
11. Levitt, B.P., “Findlay’s Practical Physical Chemistry”. 9th Ed. Longman, London (1973).
12. Das, R.C. and B. Behera, “Experimental Physical Chemistry”, Tata McGraw Hill, Delhi (2003).
13. Crocleford, H.D., H.W. Biard, F.W. Getzen & J.W. Nowell, “Laboratory Manual of Physical Chemistry”, 2nd Ed., John Wiley & Sons, London (1975).

**BS (4 YEARS) FOR AFFILIATED COLLEGES & DEPARTMENT OF
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Year 1st		Discipline	
Semester 1		Botany, Zoology, Chemistry	
Code	Subject Title		Cr. Hrs.
ZOOL-601	Principles of Animal life		04(3-1)

Course Outline:

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.

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.

Lab Outline: Cr. 01 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, and columnar), connective tissue (adipose, cartilage, bone, and blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac).

Note: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.

3. Plasmolysis and deplasmolysis in blood.

4. Protein digestion by pepsin.

5. Ecological notes on animals of a few model habitats.

6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Books Recommended

1. Hickman, C.P., Roberts, L.S. And Larson, A. Integrated Principles of Zoology, 12th Edition (International), 2004. Singapore: McGraw-Hill.

2. Miller, S.A. And Harley, J.B. Zoology, 6th Edition (International), 2005. Singapore: McGraw-Hill.

3. Pechenik, J.A. Biology of Invertebrates, 5th 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, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

6. Miller, S.A. General Zoology Laboratory Manual. 5th 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. 6th edition. 2005. McGraw-Hill, New York, USA.

9. Odum, E. P. Fundamentals of Ecology. 3rd Edition. 1994. W.B. Saunders. Philadelphia.

10. Slingby, D. And Cook, C., Practical Ecology. 1986. McMillan Education Ltd. UK.

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Year 1 st		Discipline
Semester 2		Botany
Code	Subject Title	Cr. Hrs.
ENG-602	Communication Skills	03(3-0)

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 Francoise 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

1. 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 Riachard Yorke.

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Year 1 st		Discipline
Semester 2		Botany, Zoology, Chemistry
Code	Subject Title	Cr. Hrs.
ISL- 601	Islamic studies	2(2-0)

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 Jurisprudence 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)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

**BS (4 YEARS) FOR AFFILIATED COLLEGES & DEPARTMENT OF
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Year 1 st		Discipline
Semester 2		Botany
Code	Subject Title	Cr. Hrs.
BOT-602	Plant Systematics, Anatomy and Development/ Embryology	04(3-1)

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 (Leguminosae)
 - iv. Rosaceae
 - v. Euphorbiaceae
 - vi Cucurbitaceae
 - vii. Lamiaceae (Labiatae)
 - viii. Apiaceae (Umbelliferae)
 - ix. Asteraceae (Compositae)
 - x. Liliaceae (Sen. Lato)

b) Anatomy

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like:
 - i. Parenchyma
 - ii. Collenchyma
 - iii. Sclerenchyma
 - iv. Phloem Epidermis (including stomata and trichomes)
 - v. Xylem
3. Meristem: types, stem and root apices
4. Vascular cambium
5. Structure and development of root, stem and leaf. Primary and secondary

growth of dicot stem, periderm

6. Characteristics of wood: diffuse porous and ring porous, sap and heart wood, soft and hard wood, annual rings.

c) Development/Embryology

1. Early development of plant body:

2. *Capsella bursa-pastoris*

3. Structure and development of Anther Microsporogenesis, Microgametophyte

4. Structure of Ovule Megasporogenesis Megagametophyte

5. Endosperm formation

6. Parthenocarpy

7. 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, 3rd 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. 3rd Edition, Regency

Publications, New Delhi.

14. Naik, V. N. 2005 Taxonomy of Angiosperms. 20th 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.

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Year 1st		Discipline	
Semester 2		Botany	
Code	Subject Title		Cr. Hrs.
BOT-602	Organic Chemistry		04(3-1)

Course contents:

Basic Concepts: Atomic, molecular and hybrid orbitals: multiple localized and delocalized bonds; properties of bonds; inductive; effect dipole moment. The concept of resonance, rules for resonance; resonance energy; steric inhibition of resonance; hyper conjugation; resonance effect; hydrogen bonding; tautomerism. Introduction to resonance, rules for resonance, resonance energy, steric inhibition of resonance, Introduction to spectroscopy with special reference to ultraviolet / visible and infrared spectroscopy.

Hydrocarbons: Classification of hydrocarbons. Nomenclature, methods of preparations, physical characteristics and chemical reactions of alkanes, cycloalkanes, alkenes and alkynes. Source of aromatic hydrocarbons. Structure of benzene and the concept of aromatics hydrocarbons. Structure of benzene and the concept of aromaticity Aromatic electrophilic substitution.

Stereoisomerism: Conformational Analysis of ethane and butane. Optical Isomerism. Optical activity, chiral carbon atom and optical isomerism; relative and absolute configuration, creation of chiral carbon and racemization, optical isomerism in compounds containing two chiral carbon atoms; diastereoisomers; elements of symmetry; resolution of racemic mixture. Geometrical Isomerism, *cis/trans* isomerism, designation of configuration, Determination of configuration.

Alkyl Halides: Nomenclature, methods of preparation and chemical reactions with special reference to nucleophilic substitution and elimination reaction of alkyl halides. Preparations, structure and synthetic applications of Grignard's reagents.

The Hydroxyl group and Ethers: Nature of hydroxyl group in alcohols and phenols.

Alcohols: Classification and nomenclature of alcohols; methods of preparation and chemical reactions of alcohols; distinction between primary, secondary and tertiary alcohols. Polyhydric alcohols.

Phenols: Methods of preparation of phenols; acidity of phenols; chemical reactions of phenols. Ethers: Methods of preparation and reactions of ethers.

The Carbonyl Group: Nature of carbonyl group and its reactivity; nomenclature of aldehydes and ketones; methods of preparation of aldehydes and ketones; chemical reactions of aldehydes and ketones; distinction between aldehydes and ketones.

Carboxylic Acids and their Derivatives: Nomenclature of carboxylic acids; methods of preparation and chemical reactions of carboxylic acids, strength of carboxylic acids and the factors affecting it. Formation and hydrolysis of acid anhydrides, acid amides, acid halides and esters including glycerides. Introduction to amino acids.

Nitrogen Compounds: Amines: Classification and nomenclature of amines; methods of preparation and chemical reactions of amines; distinction between primary, secondary

and tertiary amines. Preparation and reactions of aniline. Basicity of aliphatic and aromatic amines and factors affecting it. Diazonium Salts and their synthetic applications.

Recommended Books (Organic Chemistry)

1. Younas, M., Text Book of Organic Chemistry, Ilmi Kutab Khana, Lahore. (2006).
2. Rehman, A., Text Book of Organic Chemistry, Caravan Book House, Lahore. (2006).
3. Shaheen, M.A. Jilani Manual of Practical Chemistry, Vol. III, Jilani Notes, Lahore Pakistan (2015).
4. March, J., Advanced Organic Chemistry, Wiley, New York. (1992).
5. Pine, S. H., Organic Chemistry, McGraw-Hill, New York. (1987).
6. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, Prentice Hall. (1999).
7. Younas, M., Organic Spectroscopy, A. H. Publisher, Lahore. (2006).
8. Solomons, T. W. G., Fundamentals of Organic Chemistry, Wiley, New York. (1999).
9. Kemp, W., Organic Spectroscopy, Macmillan, London. (1990).
10. Chughtai, F. A., Organic Reactions, Majid Book Depot, Lahore/Faisalabad. (1995).
11. Vogel, A. I., A Text Book of Practical Organic Chemistry, Prentice Hall. (1996).
12. Clarke, H. T. and D. Haynes. A Hand Book of Organic Analysis, Edward Arnold, London. (1947).
13. Mann, F. G and B. C. Saunders. Practical Organic Chemistry, Longman, London. (1978).
14. Shriner, R. L., D.Y. Curtin, R.C. Fuson, and T.C. Morrill, The Systematic Identification of Organic Compounds, Wiley, New York. (1997).
15. Rehman, A., Experimental Organic Chemistry, The Caravan Book House, Lahore. (2006).
16. Morrison R. T. and R.N. Boyd, Organic Chemistry, Allyn and Bacon, London. (1987).

Organic Chemistry Lab (Cr. 01)

1. Qualitative Organic Analysis: Systematic identification of organic compounds containing groups containing groups like COOH, OH, NH₂ and C=O.
2. Purification techniques viz solvent extraction distillation and Recrystallization, etc.
3. Preparation of simple organic compounds viz, Ethyl benzoate, benzoic acid, tribromophenol, aspirin and nitrobenzene.

Recommended Books Lab (Organic Chemistry)

1. Younas, M. Text Book of Organic Chemistry, Ilmi Kutab Khana, Lahore (2006).
2. Rehman, A. Text Book of Organic Chemistry, Caravan Book House Lahore (2006).
3. Smith M.B. and March, J. March's Advanced Organic Chemistry, 5th Edition, John Wiley, NY. (2001).
4. Pine, S. H. Organic Chemistry, (5th Edition) McGraw-Hill, NY. (1987).
5. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, Longman, London (1999).
6. Younas, M. Organic Spectroscopy, A. H. Publisher, Lahore (2006).
7. Solomons, T.W.G., Fundamentals of Organic Chemistry, Wiley, NY (2003).
8. Kemp, W., Organic Spectroscopy, Macmillan, London (1990).
9. Vogel, A.I. A Text Book of Practical Organic Chemistry, Longman, London (1968).
10. Mann, F.G and Saunders B.C. Practical Organic Chemistry, Longman, London (1978).

11. Shriner, R.L., Curtin, D.Y. Fuson, R.C. and Morrill, T.C. The Systematic Identification of Organic Compounds, Wiley, NY (1997).
12. Rehman, A. Experimental Organic Chemistry, The Caravan Book House, Lahore (2006).
13. Morrison, R.T. and Boyd, R.N. Organic Chemistry, Allyn & Bacon, Boston (1987).

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Year 1st		Discipline	
Semester 2		Botany	
Code	Subject Title		Cr. Hrs.
BOT-602	Diversity in Animals (Invertebrates)		04 (3-1)

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.

Lab Outline Cr. 01

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, and 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, Entamoebahistolitica, 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. 5th edition (International), 2002. Singapore: McGraw Hill.

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Year 2st		Discipline	
Semester 3rd		Botany	
Code	Subject Title		Cr. Hrs.
BOT-602	English-III (Technical Report Writing & Presentation Skill)		3(3-0)

Objectives:

To enable the students to write a research paper / technical report in a succinct manner according to a specified format.

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

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 reportwriting).

2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.

3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by northern 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).

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Year 2st		Discipline	
Semester 3rd		Botany	
Code	Subject Title		Cr. Hrs.
COMP-601	Introduction to Computer		03(2-1)

Course Outlines

- 1. Introductions to Computers:** Data and Information, Information Processing Cycle, The Components of Computer, Advantages and Disadvantages of using Computers, Networks and the Internet. Computer Software, Categories of Computers, Elements of an Information System, Examples of Compute Usage, Computer Applications in Society.
- 2. The Internet and World Wide Web:** Key Concept of the Internet, Evolution of Internet, The World Wide Web, E -commerce, Other Internet Services, Netiquettes
- 3. Application Software,** Business Software, graphics and Multimedia Soft Ware, Software for Home, Personal and Educational Use, Web Applications, Application Software for Communications
- 4. The system unit:** Processor, Data Representation, Memory, Expansion Slots and Adapter cards, Ports and Connectors, Busses, Bays, Power Supply
- 5. Input devices:** What is Input, What are Input Devices, The Key Board, Pointing Devices, Mouse, Other Pointing Devices, Touch Screens, and Touch Sensitive Pads, Pen Input, Other Inputs for Smart Phones, Game Controllers, Digital Cameras, Voice Input, Video Input, Scanners and Reading Devices , Biometric Input, Terminals , Putting it all together, Input Devices for Physically Challenged Users
- 6. Output Devices:** What is Output, Display Devices, Printers, Speakers, Headphones, and Ear Buds, Other Output Devices.
- 7. Storage:** Hard Disk, Flash Memory Storage, Cloud Storage, Optical Discs, Other Types of Storage,
- 8. System Software:** Operating Systems, Operating System Functions, Types of Operating Systems, Stand Alone Operating Systems, Server Operating Systems, Embedded Operating Systems, Utility Programmes.
- 9. Communications:** Use Of Computer Communications, Networks, Network Communications Standards Communications Software, Communications Over the Telephone Network, Communications Devices, Home Networks, Communications Channels,, Physical Transmission Media, Wireless Transmission Media.
- 10. Databases:** Data and Information, The Hierarchy of Data, Maintaining Data, File Processing Verses Database, Database Management System, Relational, Object Oriented and Multidimensional Databases, Web Databases and Database Administration.
- 11. Computer Security and Safety Ethics And Privacy:** Computer Security Risks, Internet and Network Attacks, Unauthorized Access and Use, Hardware Theft and Vandalism, Software Theft, Information Theft, System Failure, Backing Up, Wireless Security, Health Concerns of Computer Use, Ethics and Society

Labs: Cr. 01

Lab work should be carried out to develop students Computer Skills, Operating Systems, and Utility Software Skills, E-Mail Skills, Word Processing Skills, Spreadsheet Skills, Electronic Presentations Skills, Web Surfing Skills

Recommended books:

Discovering Computers by Gary B Shelly & Emisty E Vermaat, Course Technology; 1st Edition (January 25, 2011)

Computing Essentials 2012 by Timothy J.O, Leary and Linda I.O, Leary, McGraw Hill Higher Education; 22 Revised Edition (February, 1 2011)

Computers Understanding Technology by Fuller, Floyed; Larson, Brain, Fourth Edition. ISBN 978-076383-927-7.

Concepts of Information Technology By Imran Saeed, Afsan Raza, Tariq Mahmood And Zafar Hussain, 6th Edition, IT Seris Publications.

The Essential Guide to Computing; The Story of Information Technology by E.Garrison Walters, Prentice Hall PTC (August 11, 2000) ISBN-10; 0130194697

Computer Applications by Tasleem Mustafa, Tariq Mahmood, Imran Saeed, and Zahid Javed, IT Publication Series.

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Year 2nd		Discipline	
Semester 3rd		Botany	
Code	Subject Title		Cr. Hrs.
CHEM-603	Inorganic Chemistry		04(3-1)

Course Contents:

Periodic Table and Periodicity of Properties: Modern Periodic Table, Group trends and periodic properties, Atomic & ionic radii, ionization potentials, electron affinities and electronegativities; Redox potential, electrochemical series and its applications. Corrosion and electroplating.

Acid Base Equilibria: Acids and bases, relative strengths of acids, pH, pKa, pKb. Hard and soft acid & Bases. SHAB Principle & its application. Buffers, types buffer, Preparation, Buffer capacity and applications of buffers. Indicators: (Acid-base, Redox, Adsorption), Solubility product, Common ion effect and its applications.

Chemical Bonding: Nature of a bond, hybridization, Valence Bond Theory (VBT), The Concept of Resonance, Molecular Orbital Theory (MOT), Valence Shell Electron Pair Repulsion (VSEPR) theory. Special types of bonds such as Metallic bonds, Hydrogen Bonding, Bent bond, Ion-dipole-dipole bond, ion induced-dipole bond.

Chemistry of p-Block Elements: Introduction to p-block elements (Group trends in p-block elements with reference to, atomic sizes & chemical reactivities). Boranes & Boride; aluminium halides, hydrides & Alums; Silicates (Structural aspects, classifications and applications); silicones (Structural aspects, classifications and applications), Germanes; phosphazenes, Phosphides, Oxoacids of Phosphorous; Oxoacids & salts of sulphur; Noble gases (compounds of Xe, Kr, Ra; bonding and applications). Production of pure silicon chips for solar energy cells.

Chemistry of d-Block Elements: Electronic configuration. Characteristics. Nomenclature. Nature of bonding in coordination compounds: Werner's theory, VBT, MOT and CFT for coordination compounds. Isomerism in coordination compounds. Chelates: Classification and applications. Applications of coordination compounds (Medicinal, Industrial, Agricultural).

Separation Techniques: General introduction and Applications (Solvent extraction and Chromatographic techniques such as paper, Ion exchange and Column).

Introduction to Analytical Techniques in Inorganic Chemistry: Introduction to spectroscopic Techniques: Principle, brief instrumentation, sample handling and applications (Flame emission, Atomic Absorption, IR & UV/Vis).

Chemical Industries: Metallurgy of Al, Cr and U, fertilizers (Urea & Phosphate fertilizers) Cement and Sugar.

Inorganic Chemistry Lab (Cr. 01)

1. Qualitative Analysis; four radicals (cations and anions) for salt mixture.
2. Chromatographic separation of cations.
3. Determination of total hardness of water using EDTA.
4. Estimation of manganese (II) using EDTA.

5. Estimation of copper (iodometrically).
6. Determination of thiosulphate ion (iodometrically).
7. Determination of ferricyanide using KI solution.
8. Determination of chloride by Volhard's and Mohr's methods.
9. Estimation of chloride ions using adsorption (Fluorescein) indicator.
10. Estimation of bromide ions using adsorption (Eosin) indicator.
11. Estimation of percentage of ferrous ions in the Mohr's salt using KMnO_4 .
12. Percentage determination of ferric ions in ferric alum using KMnO_4 solution.
13. Determination of purity of commercial potassium oxalate using KMnO_4 solution.
14. Estimation of ferrous ions using $\text{K}_2\text{Cr}_2\text{O}_7$ solution.

Recommended Books (Inorganic Chemistry)

1. Iqbal, M.Z., 'Text Book of Inorganic Chemistry', IlmiKitabKhana, Revised Edition (1998).
2. Chaudhry, G. R., 'Text Book of Inorganic Chemistry, 2nd Edition; New KitabMarkaz, Faisalabad, Pakistan (2001).
3. Shaheen, M.A. Jilani Manual of Practical Chemistry, Vol. I, Jilani Notes, Lahore Pakistan (2014).
4. Shaheen, M.A. Jilani's Concise Text Book of Inorganic Chemistry, Jilani Notes, Lahore (2015)
5. Albert, C.F., Wilkinson G. and Gaus, P.L. Basic Inorganic Chemistry, 3rd Edition, John Wiley & Sons, Inc. NY (1995).
6. Lee, J.D., 'Concise Inorganic Chemistry'. 5th Edition, Chapman & Hall, UK (1996).
7. Jolly, W.L., 'Modern Inorganic Chemistry', Chemistry', 2nd Edition McGraw Hill, NY (1991).
8. Shriver, D.F., Atkins P.W. and Langford, C.H. 'Inorganic Chemistry', 2nd Edition, Oxford Press, UK (1994).
9. Housecroft, C.E. and Sharpe, A.G., 'Inorganic Chemistry', 3rd Edition, Longman, NY (1992).
10. Rayner-Canham, G. 'Descriptive Inorganic Chemistry', W.H. Freeman & Co. UK (1995).
11. Jeffery, G.H., Bassett, J., Mendham, J. and Denney, R.C. 'Vogel's Textbooks of Quantitative Chemical Analysis', 5th Edition, Benjamin-Cummings, NY (1989).
12. Vogel, A.I., 'A Text Book of Macro and Semi micro Qualitative Inorganic Analysis', Longman Green & Co. NY (1995).
13. Skoog, D.A., West, D.M and Holler, F.J. Analytical Chemistry, 6th Edition Saunders College Publications, UK (1994).
14. Graham, H and Man, H. Chemistry in Context 5th Edition, Thomas Nelson Ltd. U.K. (2000).
15. Philp M. Advance Chemistry, Cambridge Low Price Edition, U.K. (1996).
16. David H. Modern Analytical Chemistry, McGraw Hill, NY (2000).

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Year 2st		Discipline	
Semester 3rd		Botany	
Code	Subject Title		Cr. Hrs.
ZOOL-603	Principles of Animal Physiology		04(3-1)

Course Contents:

1. Protection, Support, and Movement

Protection: the integumentary system of invertebrates and vertebrates; movement and support: the skeletal system of invertebrates and vertebrates; movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates.

2. Communication I: Nerves

Neurons: structure and function; neuron communication: introductory accounts of resting membrane potential, action potential (nerve impulse) and transmission of the action potential between cells; invertebrate and vertebrate nervous systems: the spinal cord, spinal nerves, the brain, cranial nerves and the autonomic nervous system.

3. Communication II: Senses

Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygrometers, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates; lateral-line system and electrical sensing, lateral-line system and mechanoreceptor, hearing and equilibrium in air, hearing and equilibrium in water, skin sensors of damaging stimuli, skin sensors of heat and cold, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

4. Communication III: The Endocrine System and Chemical Messengers

Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action; some hormones of porifera, cnidarians, platyhelminthes, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals.

5. Circulation, Immunity, and Gas Exchange

Internal transport and circulatory systems in invertebrates: characteristics of invertebrate coelomic fluid, hemolymph, and blood cells; transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response; gas exchange: respiratory surfaces; invertebrate and vertebrate respiratory systems: cutaneous exchange, gills, lungs, and lung ventilation; human respiratory system: gas transport.

Books Recommended

1. Hickman, C.P., Roberts, L.S. And Larson, A. Integrated Principles of Zoology, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 5th Edition (International), 2002. Singapore: McGraw Hill.

3. Pechenik, J.A. Biology of Invertebrates, 4th 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, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Lab Outline: Cr. 01

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of Labeo, Ranatigrina, Varanus, fowl and rabbit.
Note: Exercises of notes on the adaptations of skeletons to their function must be done.
3. Earthworm or leech; cockroach, freshwater mussel, Channa or *Catlacatla* or Labeo or any other local fish, frog, pigeon and rator mouse and rabbits are representative animals for study in dissections.
4. Study of models or preserved brains of representative animals and notes on adaptations.
5. Study of nervous system of earthworm and a fish.
6. Study of endocrine system in an insect and a rabbit.
7. Study of different types of blood cells in blood smear of rabbit.
8. Study of heart, principal arteries and veins in a representative\ vertebrate (dissection of representative fish/mammals).
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

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.5thedition (International), 2002. Singapore: McGraw Hill.

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Year 2nd		Discipline	
Semester 3rd		Botany	
Code	Subject Title		Cr. Hrs.
ZOOL-603	Cell Biology, Genetics and Evolution		04 (3-1)

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
 - i. Carbohydrates
 - ii. Lipids
 - iii. Proteins
 - iv. 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 embryogenic 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.

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Year 2nd		Discipline	
Semester 4th		Botany, Zoology, Chemistry	
Code	Subject Title		Cr. Hrs.
MATH-601	Mathematics For Botany		03(02-1)

Specific Objectives of Course:

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

Course Outline:

Preliminaries: Real Numbers and the Real Line, *Functions and their graphs:* Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals:* Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, John Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4th edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

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Year 2nd		Discipline	
Semester 4th		Botany, Zoology, Chemistry	
Code	Subject Title		Cr. Hrs.
ZOOL-604	Diversity of Animal (Vertebrates)		04(03-1)

Course Contents:

1. Echinoderms

Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asterozoa, ophiurozoa, echinozoa, holothurozoa and crinozoa; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, 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 chelonina, 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, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. And Harley, J.B. Zoology, 5th Edition (International) 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 4th 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, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Lab Outline: Cr. 01

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. 5th Edition (International), 2002. Singapore: McGraw Hill.

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Year 2nd		Discipline	
Semester 4th		Botany, Zoology, Chemistry	
Code	Subject Title		Cr. Hrs.
BOT-604	Plant Physiology and Ecology		04(03-1)

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 C3 and C4 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.

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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.
8. Measurement of light and temperature.
9. 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. 4th. Ed. Sinauers Publ. Co. Inc. Calif.
4. Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
5. Hopkins, W. B. 1999. Introduction to Plant Physiology. 2nd 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

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Year 2nd		Discipline	
Semester 4th		Botany, Zoology, Chemistry	
Code	Subject Title		Cr. Hrs.
BOT-604	Biodiversity and Conservation		04(03-1)

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. Leadlay, 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.

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Year 2nd		Discipline	
Semester 4th		Botany, Zoology, Chemistry	
Code	Subject Title		Cr. Hrs.
BOT-606	Biostatistics		03 (02-1)

Course outline:

1. Introduction objectives and scope:

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

2. Measures of central tendencies and dispersion:

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

3. Standard distributions:

- i. Binomial distributions.
- ii. Poisson and normal distributions.

4. Basic experimental design:

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

5. Tests of significance:

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

6. Introduction to comparing of means:

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

7. Correlation and Regression.

Lab outline: Cr.01

- 1. Data collection, arrangement of data in frequency table, calculating frequent cumulative frequency and preparation of curve.
- 2. Calculating different measure of central tendency such as arithmetic means, harmonic mean, geometric mean, median and mode.

3. Calculation of mean from grouped and ungrouped data.
4. Calculation of variance and standard deviation from grouped and ungrouped data.
5. Calculating dispersion, relative dispersion, standard deviation, standard error, standard score and co-efficient variation by hand and machine method.
6. Problems concerning probability, binomial distribution, T-test
7. Chi square test.
8. Analysis of variance - one factor design.
9. Multiple Analyses of Variance.
10. Determination of correlation by constructing different types of graphs such as scatter diagram, linear positive correlation, linear perfect negative correlation, no correlation and curvilinear correlation (second degree polynomial, third degree polynomial).
11. Linear Regression and multiple regression models.
12. MS Excel, MSTAT or relevant statistical software packages.

Recommended Books:

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

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Year 3rd		Discipline	
Semester 5th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-607	Bacteriology and Virology		03(02-1)

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 & Sons, New York.
5. Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens. The Haworth Press, Inc.
6. Hull R. Matthews, 2004, Plant Virology, Academic Press.
7. Tortora, G. J: Funke, B. R. and Case C. L., 2004, Microbiology. Pearson Education.
8. Molecular Plant-Microbe Interactions, Kamal Bouarab, Normand Brisson, Fouad Daayf (eds), 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

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Year 3rd		Discipline	
Semester 5th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-608	Phycology and Bryology		03(02-1)

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, Anthocerosida 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:

Pellia, 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. MacMillan 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. 2012. A text book of Botany. Department of Botany, University 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.

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Year 3rd		Discipline	
Semester 5th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-609	Mycology and Plant Pathology		03(02-1)

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 and mycorrhiza) and their significance.
5. Importance of fungi in human affairs with special reference to Industry and Agriculture

b) Pathology

1. Introduction and classification of plant diseases.
2. Symptoms, causes and development of plant diseases
3. Loss assessment and disease control
4. Epidemiology and disease forecast
5. Important diseases of crop plants and fruit trees in Pakistan caused by fungi, e.g. damping off, mildews, rusts, smuts, dieback, red rot of sugarcane etc.
6. Systemic resistance: Induced systematic resistance (ISR), Acquired Systematic resistance (ASR).

Lab Outline:

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

Journals / Periodicals:

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

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Year 3rd		Discipline	
Semester 5th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-609	Diversity of Vascular Plants		03(02-1)

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-1&II, Columbia University Press, New York,
2. Foster, A. S. and Gifford, E. M. Jr. 1998. Comparative Morphology of Vascular Plants. W. H. Freeman and Co.
3. Jones, D. 1983. Cycadales of the World, Washington, DC.

4. Mauseth, J. D. 1998. An Introduction to Plant Biology, Multimedia Enhanced, Jones and Bartlett Pub. UK.
5. Moore, R. C., W.d. Clarke and Vodopich, D. S. 1998. Botany McGraw-Hill Company, USA
6. Raven, P. H. Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants, W. H. Freeman and Company Worth Publishers.
7. Ray, P.M. Steeves, T. A. and Fultz, T. A. 1998. Botany Saunders College Publishing, USA.
8. Taylor, T. N. and Taylor, E. D. 2000. The Biology and Evolution of Fossil Plants, Prentice Hall.
9. Stewart, W. N. and Rothwell, G. W. 1993. Paleobotany and the Evolution of Plants, University Press, Cambridge.
10. Faegri, K., P. E. Kaland & K. Krzywinski 1989. Text Book of Pollen Analysis, John 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. 7th 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

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Year 3rd		Discipline	
Semester 5th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-611	Plant Systematics		03(02-1)

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.
10. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:
 1. Apiaceae (Umbelliferae)
 2. Arecaceae (Palmae)
 3. Asclepiadaceae
 4. Asteraceae (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. 1992-2007 -todate. Flora of Pakistan. Karachi Univ. Press, Karachi.
3. Greuter, W., McNeill, J., Barrie, F. R., Burdet, H. M., Demoulin, V., Filguerras, T. S., Nicolson, D. H. Silva, P. C., Skog, J. E., Trehane, P., Turland, N. J. & Hawksworth, D.L.,(eds.) 2000. International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International botanical congress St. Louis Missouri, July –August 1999. Koeltz, Konigstein. (Regnum Veg.138.)
4. Davis, P. H. & Heywood, V. H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London
5. Ingrouille, M. 1992. Diversity and Evolution of Land Plants, Chapman & Hall. London

6. Nasir, E. & Ali, S. I. 1970-89. Flora of Pakistan. Karachi Univ. Press, Karachi.
7. Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.
8. Takhtajan, A. (1986). Flowering Plant: Origin and Dispersal, Oliver and Boyd, Edinburgh
9. Jones, S. B. and Luchsinger, A. E. 1987. Plant 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.
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 Linnaean Society.

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Year 3rd		Discipline	
Semester 6th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-612	Plant Anatomy		03(02-1)

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, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
5. Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions: additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth.
6. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.
7. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
8. Anatomy of reproductive parts:
 - 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. Pergamum Press, Oxford.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Metcalf, C. R. and Chalk, L. 1950. Anatomy of the Dicotyledons. 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 McGraw-Hill Publishing Company Limited, New Delhi.

Journals / Periodicals:

Pakistan Journal of Botan

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Year 3rd		Discipline	
Semester 6th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-613	Genetics-I		03(02-1)

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 meioses, mitotic segregation and recombination, mapping human chromosomes.
4. Recombination in Bacteria and their Viruses: Bacterial chromosome, bacterial conjugation, bacterial recombination and mapping the *E.coli* chromosome, bacterial transformation, bacteriophage genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer.
5. The Structure of DNA: DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene.
6. The Nature of the Gene: How genes work, gene- protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites, complementation.
8. DNA Function: Transcription, translation, the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA.
9. 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.
10. Developmental Genetics: Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease.
11. Population Genetics: Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Lab Outline:

1. Numerical problems

a) Arrangement of genetic material:

- i. Linkage and recombination.
- ii. Gene mapping in diploid.

iii. Recombination in Fungi.

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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.

ii. Conjugation.

Recommended Books:

1. Gelvin, S, B. 2000. Plant Molecular Biology Manual. Kluwer Academic Publishers.

2. Pierca, B. A. 2005. Genetics. A conceptual approach, W. H. Freeman and Company, New York.

3. Synder, L, and Champness, W. 2004. Molecular Genetics of Bacteria. ASM Press, Washington D. C.

4. Klug, W. S. and Cummings, M. R. 1997. Concepts of Genetics, Prentice Hall International Inc.

5. Roth Well, N. V. 1997. Understanding Genetics, 2nd Edition, Oxford University Press Inc.

10. Gardner, E. J., 2004. Principles of Genetics, John Willey and Sons, New York.

6. Ringo J, 2004. Fundamental Genetics, Cambridge University Press.

7. 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.

8. 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

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Year 3rd		Discipline	
Semester 6th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-614	Plant Biochemistry-I		03(02-1)

Specific Objectives of course:

To elucidate the structure and role of primary metabolites in plants

Course Outline:

Introduction to photosynthetic organisms, Bioenergetics and overview of photosynthesis, Photosynthesis: The Light Reaction Photosystems, ATP Synthesis, CO₂ Fixation, RuBisCo and enzyme kinetic, C-3 Cycle, C-4 Cycle, Regulation of photosynthesis

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

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

Introduction to Proteins: Amino acids and their structure. 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

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.

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_f value of monosaccharides on a paper Chromatogram.
3. To estimate the amount of reducing and non-reducing sugars in plant material

titrimetrically/spectrophotometrically.

4. To determine the saponification number of fats.
5. To extract and estimate oil from plant material using Soxhlet apparatus.
6. Analysis of various lipids by TLC methods.
7. To estimate soluble proteins by Biuret or Lowry or Dye-binding method.
8. To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
9. To determine the R_f 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_a 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

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Year 3rd		Discipline	
Semester 6th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-615	Plant Ecology-I		03(02-1)

Specific Objectives of course:

To understand the role and interaction of plants with their environment

Course Outline:

1. Introduction: history and recent developments in ecology
2. Soil: Nature and properties of soil (Physical and Chemical). Water in the soil-plant-atmosphere continuum. The ionic environment and plant ionic relations, Nutrient cycling. Physiology and ecology of N, S, P and K nutrition. Heavy metals (brief description), Salt and drought stress and osmoregulation. Soil erosion
3. Light and temperature: Nature of light, Factors affecting the variation in light and temperature, Responses of plants to light and temperature, Adaptation to temperature extremes,
4. Carbon dioxide: Stomatal responses, water loss and CO₂-assimilation rates of plants in contrasting environments. Ecophysiological effects of changing atmospheric CO₂ concentration. Functional significance of different pathways of CO₂ fixation. Productivity: response of photosynthesis to environmental factors, C and N balance
5. Water: Water as an environmental factor, Role of water in the growth, adaptation and distribution of plants, Water status in soil, Water and stomatal regulation, Transpiration of leaves and canopies.
6. Oxygen deficiency: Energy metabolism of plants under oxygen deficiency, Morpho-anatomical changes during oxygen deficiency, Post-anoxic stress
7. Wind as an ecological factor.
8. Fire as an ecological factor.

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 CO₂ and O₂ concentration of air and water.
5. Effect of light, temperature, moisture, salinity and soil type on germination and growth of plants.
6. Measurement of ions, stomatal conductance, osmotic potential, water potential, xylem. pressure potential, leaf area and rate of CO₂ exchange in plants in relation to various environmental conditions.

Recommended Books:

1. M. Ahmad and S. S. Shaukat. 2012. A test book of vegetation ecology.

Publisher Abrar Sons New Urdu Bazar Karachi.

2. Schultz, J. C. 2005. Plant Ecology, Springer-Verlag
3. Bazzaz, F. A. 2004. Plants in Changing Environments: Linking Physiological, Population, and Community Ecology, Cambridge University Press
4. Chapin, F. S. et al. 2002. Principle of Terrestrial Plant Ecology, Springer-Verlag
5. Lambers, H. et al. 2002. Plant Physiological Ecology, Springer-Verlag
6. Larcher, W. 2003., Physiological Plant Ecology: 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, Cumming Publishing C. Palo Alto, California, USA.
11. Smith R. L. 1998 Elements of Ecology. Harper & Row Publishing.
12. Townsend. C. R. Begon. M and J. L Harper. 2002 Essentials of ecology. Blackwell Publishing.
13. Gurevitch. J. Scheiner, S. M. and G. A Fox. 2006 The Ecology of Plants\.. Sinaur Associate Inc.
14. Hussain. F. 1989 Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education, Islamabad.
15. Hussain. S. S. 1989 Pakistan Manual of Plant Ecology. National Book Foundation Islamabad.
16. More. P. D. and Chapman S. B. 1986 Methods in Plant Ecology, Blackwell Scientific Publication Oxford.
17. Rashid, A. 2005. Soil Science. National Book Foundation, Islamabad.

Journals / Periodicals:

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

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Year 3rd		Discipline	
Semester 6th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-616	Plant Physiology-I		03(02-1)

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. CO₂ reduction (dark reactions) - C₃ pathway and Photorespiration, Regulation of C₃ pathway, C₄ pathway and its different forms, C₃-C₄ intermediates, CAM pathway. Methods of measurement of photosynthesis.
- 2. Respiration:** Synthesis of hexose sugars from reserve carbohydrates. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respiration.
- 3. Translocation of Food:** Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.
- 4. Leaves and Atmosphere:** Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.
- 5. Assimilation of Nitrogen, Sulphur and Phosphorus:** The nitrogen cycle. Nitrogen fixation. Pathways of assimilation of nitrate and ammonium ions. Assimilation of sulphur and phosphorus.

Lab Outline:

1. To determine the volume of CO₂ evolved during respiration by plant material.
2. To determine the amount of O₂ used by respiring water plant by Winkler Method.
3. Separation of chloroplast pigments on column chromatogram and their quantification by spectrophotometer.
4. To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
5. To categorize C₃ and C₄ plants through their anatomical and physiological

characters.

6. To regulate stomatal opening by light of different colours and pH.

Recommended Books:

1. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
2. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
3. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
4. Heldt, H-W. 2004. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
5. 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's 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, Ianta, Annual Review of Plant Biology, Journal of Plant Physiology

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Year 4th		Discipline	
Semester 7th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-617	Molecular Biology		03(02-1)

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, α -helical and β -secondary structures. Protein purification and sequencing.
3. Transcription: Enzymatic synthesis of RNA, transcriptional signals Translation: The genetic code. The Wobbling, polycistronic and monocistronic RNA. Overlapping genes.
4. Gene regulation in Eukaryotes: Differences in genetic organization and prokaryotes and eukaryotes. Regulation of transcription, initiation, regulation of RNA processing, regulation of nucleocytoplasmic mRNA transport, regulation of mRNA stability, regulation of translation, regulation of protein activity.
5. Plant 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:

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

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

Recommended Books:

1. Cullis, C. A. 2004. Plant Genomics and Proteomics. Wiley-Liss, New York.
2. Gibson, G. and S. V. Muse, 2002. A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
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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.

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Year 4th		Discipline	
Semester 7th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-618	Plant Biochemistry-II		03(02-1)

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

Lab Outline:

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, 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. 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

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Year 4th		Discipline	
Semester 7th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-622	Plant Ecology-II		03(02-1)

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

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Year 4 th		Discipline
Semester 7 th		Botany
Code	Subject Title	Cr. Hrs.
BOT-623	Plant Tissue Culture (Advance course) (Optional)	03(02-1)

Syllabus Outline: Study of different Techniques used in Plant Tissue Culture

Course Outline:

- Introduction to Plant Tissue Culture
- A Plant Tissue Culture Laboratory
- Aseptic Technique
- Tissue Culture Media,
- Cellular Totipotency
- Callus Cultures
- Cell Suspension Cultures
- Protoplast Cultures
- Anther and Pollen Culture
- Production of Pathogen –free Plants.

Course Outline for Lab:

1. Acquaintance with a Plant Tissue Culture Laboratory.
2. Concepts and Demonstration of Equipment used in a Plant Tissue Culture Laboratory.
3. Aseptic Techniques.
4. Preparation of Plant Tissue Culture Media.
5. Culture of various Explants, Observation and Growth Studies of Callus Cultures.

Module Aims: The subject is offered with the aim of understanding the basic principles of Plant Tissue Culture Technology and its Applications.

The laboratory exercise is based on concepts and research proposals used in

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Learning Outcome: At the end of the course the students should be able to understand the different techniques used in Plant Tissue Culture including Plant Micropropagation, Callus and Suspension Culture and their Applications.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

Books Recommended:

1. **Dixon, R.A. and Gonzales, R.A. (2003).** *Plant Cell Culture. A Practical Approach.* Oxford University Press, Oxford, New York.
2. **Bhojwani, S.S. and Razdan, M.K. (2001).** *Plant Tissue Culture: Theory and Practice.* Elsevier, Amsterdam, Oxford, New York.
3. **Dodds, J.H. and Roberts, L.W. (2000).** *Experiments in Plant Tissue Culture.* Cambridge University Press. Cambridge, London, New York.

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Year 4th		Discipline	
Semester 7th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-624	Palynology (Optional)		03(02-1)

Syllabus Outline: Palynology; its Scope and Importance, Neopalynology and Palaeopalynology, Structure, Morphology, Ornamentation Pattern of Spores and their Technical Description, Branches of Neopalynology, Chemical Composition of Exine and Organic Thermal Maturity, Maceration Techniques to Isolate Palynomorphs and Field Work.

Course Outline:

Neopalynology:

Production and Dispersal of Spores and Pollen

Ultra-structure and Stratification of Exine.

Spore and Pollen Diversity, Morphology and Ornamentational Pattern, Technical Description.

Environmental Palynology, Occurrence and Significance of Airborne Pollen with respect to Allergies and Asthma, Control Measures.

Mellitopalynology, Aeropalynology and Archaeopalynology. Palynology in Medicine and Criminology.

Palaeopalynology:

Ultra-structure and Chemical composition of Fossil Exine.

Palynomorphs as Sedimentary Particles, Preservation in Sediment, Post Depositional Hazards.

Palynomorphs in Oil and Gas Exploration, Geochronology, Stratigraphic Correlation, Reconstruction of Past Plant communities, Index Palynomorphs, Organic Thermal Maturity.

Technical Description of Palynomorphs.

Maceration Techniques and Field Work.

Course Outline for Lab:

1. Extraction of pollen and spores from Anther/Strobili/Sori, their Identification and Technical Description.
2. Palynological Analysis of Paleozoic, Mesozoic and Cenozoic Rock samples through Standard Procedures.
3. Preparation of Strew Mount Slides and Single Grain Manipulation(s).
4. Field Tour to the Salt Range, Pakistan to study Paleozoic, Mesozoic and Cenozoic Outcrops including Sample Collecting Techniques. Each student shall be required to submit a comprehensive Field Tour Report at the time of Practical Examination. Specific marks shall also be allocated for such a report.

Module Aims: This course is designed to understand the Importance, Scope and Applications of Palynology in other Fields, Techniques used to Isolate

Palynomorphs, their Technical Description and Evaluation of Palynological Data.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Learning Outcome: After getting through this course students would be able to know about Palynology, its Branches and their Importance, they would be able to Isolate Palynomorphs from Sedimentary Rock samples through different Maceration Techniques. Field Study Tour would enhance their knowledge of theory and better understanding of the subject.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

Books Recommended:

1. **Brooks, J. (2010).** *Organic Maturation Studies and Fossil Fuel Exploration.* Academic Press, London.
2. **Agashe, S.N. and Caulton, E. (2009).** *Pollen and Spores: Applications with Special Emphasis on Aerobiology and Allergy.* Science Publishers. 412pp. **ISBN-13: 978-1578085323.**
3. **Scott, A.C. (2009).** *Coal and Coal-bearing strata; recent advances.* Blackwell Scientific Publishers, Oxford.
4. **Erdtman, G. (reprinted 2008).** *An Introduction to Pollen Analysis.* Morison Press. 260pp. **ISBN-13: 978-1443723077.**
5. **Traverse, A. (2007).** *Paleopalynology: Topics in Geobiology.* (2nd Ed.), Springer Link Publishers. 813 pp. **ISBN-13: 978-1402066849.**
6. **Harley, M., Morton, C.M. and Blackmore, S. (2000).** *Pollen and Spores: Morphology and Biology,* Royal Botanic Gardens, Kew. 530pp.
7. **Kapp, R.O., Davis, O.K. and King, J.E.** [Illustrated by Hall, R.C.] (2000). *Ronald O. Kapp's Pollen and Spores.* (2nd ed.), AASP Found. 279 pp. **ISBN 931871-05-0.**
8. **Kurmann, M.H. and Doyle, E. (1994).** *Ultrastructure of Fossil Spores and Pollen.* Royal Botanic Gardens, Kew. 227pp. **ISBN-13: 978-0947643607.**
9. **Collinvaux, P.A., De Oliveira, P.E. and Moreno, E. (1999).** *Amazon: Pollen Manual and Atlas.* Harwood Academic Publishers. 344pp. **ISBN-13: 978-9057025877.**
10. **Traverse, A. (1996).** Nomenclature and Taxonomy: Systematics. *In: Jansonius, J. and McGregor, D.C. Eds., Palynology: Principles and Applications, American Association of Stratigraphic Palynologists Foundations,* 11-28, Publishers Press.
11. **Jones, G.D., (1995).** *Pollen of the Southeastern United States: with Emphasis on Melissopalynology and Entomopalynology.* AASP Foundation Contribution Series No. 30: 76 pp., 104 photographic plates. **ISSN 0160-8843.**
12. **Punt, W., Blackmore, S., Nilsson, S. and Thomas, A.L. (1994).** *Glossary of Pollen and Spore Terminology.* LPP Contributions Series No. 1: 71pp. LPP Foundation,

Laboratory of Palaeobotany and Palynology, University of Utrecht, Utrecht, The Netherlands. **ISBN 90-393-0230-8.**

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Year 4th		Discipline	
Semester 7th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-625	Air pollution, its Impacts and control (Optional)		03(03-0)

Syllabus Outline: Nature of Atmosphere, Air Pollution causing Factors and Measurements for their Remedies.

Course Outline:

Atmosphere Introduction: Nature and Scope.

Chemistry of Troposphere and Stratosphere, Primary Pollutants, Troposphere Ozone and its Impacts, Stratospheric Ozone and its Destruction, Atmospheric Aerosols; Origin, Types, Functions and Impacts, Acid Rain and its Adverse Effects.

Trace Gases and Global Warming, The Greenhouse Theory, The Culprit Gases and their Warming Potential, Estimates of Greenhouse Impacts.

Air Quality in Urban Atmosphere; Introduction. Exhaust Emissions from Motor Vehicles, Waste Heat, Primary and Photochemical Pollutants, Urban Pollution Rankings in Pakistan and other Countries, Catalyst System for Emission Control from Motor Vehicles, Organ Metallic Compounds in the Environment, (Organ Lead and Organ Mercury). The Health Effects of Environmental Pollutants, Effects on Inert Materials and General Adverse Effects.

Radiation and Nuclear Explosion: Background Information, Radiation Impact at Ecosystem Level and Comparative Sensitivity of Organisms, Fate of Radionuclides and Fall Out Problem, Disposal of Radioactive Wastes, the Lessons of Chernobyl, Nuclear Winter, Environmental Consequences of Nuclear War, Uncertainties and Recent Developments.

Control of Air Pollution; Air Quality Standards, International Air Quality Programmes, Control of Atmospheric Pollution at Source.

Module Aims: The objective of this course is to develop skills in formulating and solving problems arising from Emerging Technologies for the Energy and Industrial Waste. The course

is designed to know the Effects of Air Pollution as motivation for control of Anthropogenic Omissions to the Atmosphere.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Learning Outcome: To make the student capable to design a System Component and Process for

Controlling Pollution/Environmental Hazards. On completion of the course, the students are able to discuss and explain Fundamental reasons of Air Pollution, to create awareness on Pollution generated at different stage of Industries Outcome Procession.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

Books Recommended:

1. **Bridgeman, H.A (2009).** *Global Air Pollution*. Belhaven Press, London.
2. **Southwick, C.H. (2007).** *Global Ecology*. Sinauer Associates, Inc. Sunderland, Massachusetts.
3. **Crawley, M.J. (2007).** *Plant Ecology* (3rd Ed.). Blackwell Science Ltd. (U.K).
4. **National Research Council, USA, (2007).** Committee on Medical and Biological Effects of Environmental Pollutants; Ozone and other Photochemical Oxidants. National Academy of Sciences, Washington, D.C.
5. **Schneider, S.H. (2005).** *Global Warming*. Sierra Club Books. San Francisco.

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Year 4 th		Discipline
Semester 7 th		Botany
Code	Subject Title	Cr. Hrs.
BOT-626	Laboratory Techniques (Optional)	03 (03-0)

Syllabus Outline: Visit of different laboratories of the department to learn different Techniques being used along with the working of different Instruments.

Course Outline:

Students shall be required to visit all Research Laboratories in the Department on a Regular Basis to learn Advanced Techniques. They will submit Report about each Laboratory at the end of the Semester, which should elaborate and highlight details of all Advanced Techniques/Instrumentation in the written form. Each student will appear for Viva Voce Examination pertaining to that report during which time he/she shall be asked various questions pertaining to the said techniques. Total marks for this course would be divided into two parts viz.; Written Report and Viva Voce Examination. Students shall consult Books available in the Library for each the discipline as directed by the respective Teacher/Faculty Member.

Module Aims: The aim of this course is to acquaint the student with the working of various Instruments and Techniques used in different laboratories.

Learning Strategies:

1. Group Discussions
2. Laboratory Work

Learning Outcome: The students are expected to learn about the basic concepts of different Instruments and experiments being performed in different laboratories.

Assessment Strategies:

1. Written Reports
2. Class Discussion
3. Oral Presentation

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Year 4th		Discipline	
Semester 7th		Botany	
Code	Subject Title	Cr. Hrs.	
BOT-627	Biohazards, Biosafety and Bioethics (Optional)	03 (03-0)	

Syllabus Outline: Hazardous role of Microbes Ethical Manipulation of Gene and Safety Measures to Overcome Environmental Pollution.

Course Outline:

Hazardous Roles of Microbes in the Environment, Microorganisms as a Source of Disease and other Nuisances, Solution to various Hazards, new trends in Monitoring of toxic Environmental Hazards by Microbes.

Safety and the Genetic Manipulation of Organisms, Risk Assessment in Genetic Manipulation, Deliberate Release of Genetically Modified Microorganisms (GMOs), Role of Genetic Modification Safety Committee, Hazard Groups of Organisms, Guidelines for Microbial and Animal Cell Culture.

Cloning of Animal and Human Beings; Moral, Ethical, Legal and Patent Issues, Trade Secrets. International Regulations and contained Use of Genetically Modified Organisms (GMOs).

Radiation, Health and Safety; Sources and Laboratory use of Radiation, Radiation Protection, disposal of Radioactive Materials from Laboratories, Protection of Workers and Public. Environmental Pollution and Law.

Module Aims: The course is designed to provide essential knowledge about various Agents causing Biohazards. Highlighting the Reasons for Unethical use of Biodiversity and Guidance about Measurements leads to Biosafety.

Learning Outcome: Students are expected to have knowledge about the Measurements of Environmental Sustainability. They will have idea for how to utilize the Biological Resources which are friendly to Environment.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

Books Recommended:

1. **S.I. Cutter, (2003).** *Environmental Risks and Hazards.* Publishers Prentice Hall.
2. **Donnellan, C. (2002).** *Cloning.* Independent Educational Publication.
3. **Donnellan, C. (2001).** *The Ethics of Genetic Engineering.* Independent Educational Publication.
4. **O'Mahony, P.J. (2000).** *Nature, Risk, and Responsibility: Discourses of Biotechnology.* Routhedge Routhedge Publisher.
5. **Hansen, D.J. (2000).** *The Work Environment; Healthcare, Laboratories and Biosafety.* Lewi Publishers.
6. **Torrance, I. (2000).** *Bio-Ethics for new Millennium,* Saint Andrew Press.

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-619	Plant Physiology-II		03(02-1)

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 transduction and mode of action, transport, physiological effects of Auxins, Gibberellins, Cytokinins, Abscisic 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. Circadian rhythms. Classification of plants according to photoperiodic reaction, photoperiodic induction, locus of photoperiodic reaction and dark periods in photoperiodism. Role of photoperiodism in flowering. Biochemical signaling involved in flowering. Vernalization and its effect on flowering. Floral meristem and floral organ development. Floral organ identity genes and the ABC model.
6. Signal transduction in prokaryotes and eukaryotes.
7. Dormancy; definition and causes of seed dormancy; methods of breaking seed

dormancy; types and physiological process of seed germination.

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

Lab Outline:

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.
14. Barton, W. 2007. Recent Advances in Plant Physiology.
15. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinauer's Publ. Co. Inc. Calif.

Journals / Periodicals:

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

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-621	Genetics-II		03(02-1)

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.
5. Mechanisms of Genetic Change II: Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.
6. Mechanisms of Genetic Change III: Transposable Genetic Elements: Insertion sequences, transposons, rearrangements mediated by transposable elements, review of transposable elements in prokaryotes, controlling elements in maize.
7. Human Genome Project: Strategies and application, achievement and future prospects.
8. Plant Genome Projects: Arabidopsis, achievement and future prospects. Other plant genome projects
9. Bioinformatics: Application of computational tests to the analysis of genome and their gene products
10. Bioethics: Moral, Religious and ethical concerns

Lab Outline:

Problems relating to the theory

1 Isolation and separation of DNA and protein on Gel electrophoresis.

- i. Bacterial chromosome
- ii. Plasmid DNA (minipreps)
- iii. Plant DNA
- iv. Protein

2 DNA Amplification by PCR

Recommended Books:

1. Trun, N and Trempey 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

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-622	Environmental Biology		03(02-1)

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

Recommended Books:

1. Newman, E. I. 2001. Applied Ecology. Blackwell Science. UK
2. Mooney, H. A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.
3. Eugene, E. D. and Smith, B. F. 2000. Environmental Science: A study of 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. Hall, C. A. S. and Perez, C. L. 2000. Quantifying Sustainable Development. Academic Press, UK.
6. Bazzaz, F. A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
7. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
8. Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.
9. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.
10. 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

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-628	Plant Nutrition and Soil Fertility (Optional)		03(02-1)

Syllabus Outline: To study composition of different nutrients, absorption, translocation and assimilation of various nutrients, Nitrogen fixation.

Course Outline:

Introduction, Scope and History of Mineral Plant Nutrition.
 The Inorganic Components of Plants, Water, Dry Matter, Mineral Competition, Essential and other Mineral Elements, Macronutrient and Micronutrient Elements, Comparative Macronutrient and Micronutrient Elements; Comparative Elemental Requirements of Higher Plants; Deficiencies and Tissue Analysis, Deficiency Symptoms of Individual Elements.
 The Media of Plant Nutrition, The Variety of Nutrient Media: Soil; Solution Culture; Chemical Composition of Nutrient Solutions; Modified Solution Culture, Culture Solutions compared with Soil Solutions.

Soil Fertility Evaluation.

Soil and Fertilizer N, P, K, Ca, Mg, S, Fe and Trace Elements.

Liming and Use of Gypsum.

Fertilizers and Efficient Use of Water.

LAB COURS

Course Outline:

1. Sand and Water Culture Methods.
2. Study of Deficiency Symptoms of Macro and Micronutrient Elements.
3. Phenotypic Adaptations of plants to Nutrients, Deficiency and Methods of Growth Analysis.
4. Plant Tissue Analysis for Principle Inorganic Ions.
5. Determination of P, Ca and Mg Content of Soil.
6. Preparation of Fertilizer Mixtures.
7. Determination of total Water Requirements of a Crop by using Climatic Data (Blaney and Criddle Formula will be used).
8. Preparation of Standard Acid, Alkali and Indicator Solutions.

Module Aims: The students will be able to get an update on issues related to Plant Nutrition and Soil Fertility Integrated on Sustainable Land Use and Natural Resource Management.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory Work
4. Seminar/ Workshop

Learning Outcome: The students will develop an insight into the Mineral Requirements, Media Preparations and Mineral Metabolism. All Agriculture Practices based on fertilization will be analyzed.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class Discussion
4. Quiz
5. Tests

Books Recommended:

1. **Taiz, L.D. and Zeiger, E. (2010).** *Plant Physiology*. (5th Ed.), Sierauer Associates.
2. **Barker, A.V. and Pilbeam, D.J. (2007).** *Hand Book of Plant Nutrition*. CRC Press Washington D.C.
3. **Epstein, E. and Bloom, J.A. (2005)** *Mineral Nutrition of Plants: Principles and Perspectives*. (2nd Ed.), Sierauer Associates.
4. **Tisdale, S. and Nelson, W. (2005).** *Soil Fertility and Fertilizers*. (3rd Ed.), Mchillans.
5. **Wallace, T. (2005).** *The Diagnosis of Mineral Deficiencies in Plants*. Her Majesty's Stationery Office, London.

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title		Cr. Hrs.
BOT-629	Biodegradation and Bioremediation (Optional)		03(02-1)

Syllabus Outline: Environmental Pollutants, Biodegradation and Microbial Technologies, Strategies for Bioremediation.

Course Outline:

The Environment and Pollution: Introduction, Environmental Law.

Treatment Technologies.

Traditional Approaches to Pollution Control.

- a. Biotreatment Technologies for Pollution Control.
- b. Biocatalyst Selection and Genetic Modification.
- c. Enrichment and Screening Strategies.
- d. Design of enrichment strategies relating to the Environmental Source.
- e. Microbiological Techniques for Enrichment and Selection.
- f. Genetical Approach.

The Carbon Cycle and Xenobiotic Compounds:

Biodegradation and Microbial Technologies by Microorganisms.

- a. Acclimation
- b. Detoxification
- c. Activation
- d. Sorption
- e. Bioavailability: Sequestering and Complexing.
- f. Co-metabolism
- g. Environmental Effects.

LAB COURSE

Course Outline:

1. Isolation of Bacteria from Oil Wastes, Polluted Water from Industries and Sewage.
2. Spray Plate Technique for Testing the Degradation Ability of Bacteria for different Aromatic Hydrocarbons.
3. Bioremediation from Culture by Metal Resistant Bacteria.

Module Aims: The course is designed to provide the students the knowledge of Biodegradation of Pollutants and its Application in Biodegradation Studies.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory work
4. Seminar/ Workshop

Learning Outcome: After studying this course students will be able to understand the Chemistry of Biodegradation and its Application in Biodegradation Studies.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class discussion
4. Quiz
5. Tests

Books Recommended:

1. **Tortora, G.J., Christine L., Case, C.L., Funke, B.R., Funke, B. and Case, C. (2006).** *Microbiology: An Introduction*. Pearson Education Publishers.
2. **Borlak, J. (2005).** *Handbook of Toxicogenomics: Strategies and Applications*. John-Wiley and Sons Limited.
3. **Heikki, M., Hokkanen, T. and Hajek, A.E. (2004).** Environmental Impacts of microbial Insecticide: Needs and Methods for Risk Assessment, Science.
4. **McEldowney, S., Hardmen, D.J. and Waite, S. (2003).** *Pollution: Ecology and Biotreatment*. Longman Scientific Technical.
5. **Mitchell, R. (2002).** *Environmental Microbiology*. (2nd Ed.), Wiley Liss.
6. **Tickner, J.A. (2002).** *Precaution, Environmental Science, and Preventive Public Policy*. Island Press.
7. **Sunahara, G.I., Agnes, Y., Renoux, A.Y., Thellen, C., Gaudet, C.L., and Pilon, A. (2002).** Environmental Analysis of Contaminated Sites. John-Wiley and Sons Limited.
8. **Chapelle, F.H. (2001).** *Ground – Water Microbiology and Geochemistry* (2nd Ed.), John Wiley and Sons. Inc.
9. **Alexander, M. (1999).** *Biodegradation and Bioremediation*. Academic Press, Inc.
10. **Poole, R.K. and Gadd, G. M (1989).** *Metal Microbe Interaction*. IRL Press.

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title	Cr. Hrs.	
BOT-630	Microbes, Man and Environment (Optional)	03(02-1)	

Syllabus Outline: Types of Microbes and their Evolution; Distribution of Microbes in the Environment and Strategies for Success, Positive and negative Interactions of microbes with men.

Course Outline:

Microbial Evolution and Nutrition: The Origin of Life, Phylogeny, Evolution of Microbes, Bacteria, Archaea and Fungi, Evolution of Microbes into Diversifying Ecosystems, Diversity of Energy Generating Systems of Microbes.

Microbial Structure, Replication and Motility: Bacterial Replication, Adhesion, Motility and Growth, Fungal Replication, Yeasts, Molds and Spores, Diversity of Viruses and Viral Replication.

Microbes in the Environment: Microbes and Nutrients. Carbon Cycling in the Ecosystem. Brown rots and White Rots, Microbes and Nutrients, Nitrogen Cycling in the Ecosystem., Ammonification, Nitrification, De-Nitrification.

Microbial Partnership: Microbial Associations with Plant Roots, Legumes, Rhizobia and Nitrogen Fixation, Mycorrhizal Associations with Plant Roots, from Trees to Orchids, Animal Fermenters, Ruminants and Hind Gut Fermenters, Cellulose Digestion, Methanogens and Chytrids, Microbes and Insects.

LAB COURSE

Course Outline:

The practicals in this course will introduce the students to a wide range of Microbiological Laboratory Techniques. Skill development in the handling and growth of Microorganisms is a key part of the Practicals. Students will perform Assays on Antibiotics and study a range of Yeast, Bacteria and Fungi. Assessment will comprise a practical skill Competence Test and short Answers Questions.

Module Aims: To highlight the Role of Microbes in the Environment and Ecosystem and to show their Beneficial and Detrimental Roles in the Environment and on men.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory Work
4. Seminar/ Workshop

Learning Outcome: To enhance the understanding of Microbes to students, their Importance and Positive/Negative Interactions with Man.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments

3. Class Discussion
4. Quiz
5. Tests

Books Recommended:

1. **Edwards, C. (2008).** *Microbiology of Extreme Environments; Environmental Biotechnology.* McGraw Hill Publishers.
 2. **Mitchell, R. (2006).** *Environment Microbiology.* John Wiley and Sons, Inc. New York.
 3. **Black, J.G. (2005).** *Microbiology: Principles & Explorations.* (6th Ed.). McGraw Hill, Publishers.
 4. **Holt, J.G., Krieg, N.R., Speath, P.H.A., Steley, J.T. and Williams, S.T. (2005).** *Bergey's Manual of Determinative Bacteriology.* (10th Ed.), William and Wilkins Publishers.
 5. **Cappuccino, J.G. and Sherman, N. (2002).** *Microbiology, A laboratory Manual,* (4th Ed.), The Benjamin Cummings Publishing Company Inc.
 6. **Sayler, G.S. and Fox, R. and Blackburn, J.W. (2001).** *Environmental Biotechnology for Waste Treatment.* Plenum Publishing Corporation.
 7. **Alexander, M. (2001).** *Biodegradation and Bioremediation.* Academic Press, Inc.
 8. **Mitchell, R. (1992).** *New Concepts in Environmental Microbiology.* Alan R. Liss.
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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title	Cr. Hrs.	
BOT-631	Water Pollution, its management and control (Optional)	03(02-1)	

Syllabus Outline: To identify Water Quality and its Parameters; Organic and Inorganic Pollutants, Pesticides, Oil, Thermal and Heavy Metal Pollutions in Water; Water Pollution Management and Control.

Course Outline:

Introduction; Nature and Scope, Water Requirements in Society, Water Pollution Parameters., Properties of Polluted Water, Sources of Water Pollution.

Organic Pollution and Eutrophication, Origin of Organic Pollutants, Pathogens. Effects of Organic Pollutants, Eutrophication, Sources of Nutrients, Effects of Eutrophication and its Control.

Heavy Metals in Aquatic Environment, Nature and Concern about Heavy Metals, Sources of Contamination of Mercury, Lead, Cadmium, Arsenic, Chromium, Zinc, Copper and Manganese and their Toxicity.

Waste Water Management; Introduction, Chemical Treatment (Primary, Secondary and Tertiary Treatments), Biological Treatment (Aerobic and Anaerobic Treatments).

Water Pollution Control: Background Information, Legislation, Various approaches to Water Pollution Control.

LAB COURSE

Course Outline:

1. Water Sampling: General Considerations in Sampling.
2. Analysis of Industrial and Sewerage Waste-Water for important Physical and Chemical Parameters.
3. Field Work: Visit to Industrial Sites showing Water Pollution.

Module Aims: To highlight the importance of Water Pollution to student and to acquaint them with its different types. To teach them the ways to Control Water Pollution and teach its Arrangements.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory Work
4. Seminar/ Workshop

Learning Outcome: The student is expected to know the parameters which determine Water Pollution, the various ways in which it can become polluted, the Management and Control of Polluted Water Habitants.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class Discussion
4. Quiz
5. Tests

Books Recommended:

1. **Lenihan, J. and Fletcher, W.W. (2004).** *The Marine Environment: Environment and Man* (Vol. VI). (Ed.). Blackie and Sons, Glasgow and London.
2. **Southwick, C.H. (2003).** *Global Ecology*. Sinauer Associates Inc. Publishers. Sunderland, Massachusetts.
3. **Ciaccio, L.L. (2001).** *Water and Water Pollution Handbook*. Marcel-Dekker, Inc. New York.
4. **Mason, C.F. (2001).** *Biology of Freshwater Pollution*. Longman Printing Company, London and New York.
5. **Harrison, R.M. (2000).** *Pollution: Causes, Effects and Control*. The Royal Society of Chemistry. Cambridge.

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Year 4th		Discipline	
Semester 8th		Botany	
Code	Subject Title		Cr. Hrs
BOT-632	Challenges of a changing earth (Optional)		03(03-0)

Syllabus Outline: Impact of Air Pollution on Plant Growth, Impact of Industrial Waste Effluents on Plant Growth, Climate Change in Pakistan.

Course Outline:

Achievements and Challenges; Food, Land, Water and Oceans, Out of Breath, Air Quality in the 21st Century, Managing Planetary Metabolism, The Carbon Cycle, Global Change and the Challenge for the Future, Advances in Understanding Global Biogeochemistry, Understanding the Metabolic System of the Planet, Land Ocean Interactions, Regional Global Linkages, The Climate System: Prediction, Change and Variability, Hot Spots of Land Use Change, The Climate System; A Regional or Global Concern, Looking at the Future: Stimulating and Observing the Earth System, Does the Earth System need Biodiversity? Can Technology spare the Planet towards Global Sustainability?

Module Aims: This course is designed to provide the knowledge about the present Conditions of the Earth, major Challenges and possible Strategies to coup the Present Day Earth's Crisis.

Learning Strategies:

1. Lectures
2. Group Discussion
3. Laboratory Work
4. Seminar/ Workshop

Learning Outcome: After studying this subject, student will have an insight of learning the major achievements of modern day earth and various global challenges that earth is facing. Student may also have knowledge of past, present climate prospects and future's plans to combat these challenges.

Assessment Strategies:

1. Lecture Based Examination (Objective and Subjective)
2. Assignments
3. Class Discussion
4. Quiz

Books Recommended:

- 1. Bell, J.N.B. and Treshow, M. (2002).** *Air Pollution and Plant Life*. John Wiley & Sons, Inc. New York.
 - 2. IGBP New Letter, (2002).** The Newsletter of the International Geosphere Biosphere Programme: A study of Global Change. The Royal Swedish Academy of Science, Stockholm, Sweden.
 - 3. Newman, E.I. (2000).** *Applied Ecology and Environmental Management*. Blackwell Science Ltd., Oxford.
 - 4. Burrough, T. (2001).** *Climate Change: A Multidisciplinary Approach*. Cambridge Univ. Press, Cambridge, U.K.
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Scheme and Syllabi of BS (4 years) Botany are designed by Dr. Saadullah Leghari (Associate Professor) and Dr. A.K.K. Achakzai (Professor TTS), Botany Department UoB, Quetta.