FIFTH MEETING OF THE DEAPERMENTAL COUNCIL

August 3, 2018

WORKING PAPER

DEPARTMENT OF BOTANY

MIRPUR UNIVERSITY OF SCIENCE & TECHNOLOGY (MUST), MIRPUR, AZAD JAMMU &KASHMIR

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FOR FIFTH MEETING OF THE DEAPERMENTAL COUNCIL (DC)

Venue: Department of Botany **Date**: August 3, 2018 **Time:** 11:00

AGENDA FOR THE FIFTH MEETING OF THE DEAPERMENTAL COUNCIL

Venue: Department of Botany Date: 3rd August, 2018 Time: 11:00

WORKING PAPER

FOR

FIFTH MEETING OF DEPARTMENT COUNCIL OF BOTANY

Fifth meeting of the Departmental Council of Botany was held on 3rd August, 2019. The minutes are available on pages (03-08) of the working paper. The same minutes were circulated to the honorable members.The honorable members had not proposed any comments/suggestions. The deliberations of Departmental Council were accordingly passed by Board of Faculty and Academic Council of the University.

- Dr. Nafeesa Zahid Malik (Chairperson/Convener)
- Prof. Dr. Ghulam Mutaza (Member/Registrar UAJK, MZD)
- Dr. Khizar Hayyat Bhatti (Member/Assoc. Prof, UoG, GUJRAT)
- Dr. Javed Hussain (Member/Assitant Prof, UoK, KOTLI)
- Prof. Rana Shahid (Member/Assitant Prof. PGC MIRPUR)
- Prof. Dr. Rehana Asghar *T.I.* /Nominee (Dean Faculty of Sciences, MUST)
- Engr. Muhammad Waris/Nominee (Registrar, MUST)
- Prof. Dr. Shaukat Mehmood/Nominee (Controller of Examination, MUST)
- Dr. Imtiaz Ahmad (Director QEC, MUST)
- Dr. Muhammad Ishtiaq Ch. (Associate Prof./Member)
- Dr. Muhammad Ajaib (Associate Prof./Member)
- Mrs. Qumqum Noshad (Lecturer/Member)
- Mrs. Waheeda Mushtaq (Lecturer/Member)
- Miss Sadia Jehangir (Lecturer/Secretary DC)

The 5th meeting of Departmental Council in Department of Botany was held on August 3, 2018. The meeting was chaired by Dr. Nafeesa Zahid Malik Chairperson Department of Botany as a Convener Departmental Council in the subject of Botany. The meeteing was started with few verses of Holy Quran recited by Ms. Wheeda Mushtaq. Dr. Nafeesa Zahid Malik formally welcomed all the honorable members of Departmental Council and briefly discussed the main objectives and gave introductory remarks. The agenda of the meeting was precisely presented for discussion and approval.

Item NO.1: Approval of minutes of 4th Departmental Council

Minutes of 4th departmental council minutes were presented and they were approved as such.

Item NO.2: Approval of Scheme of studies of BS in Botany for session 2014-18.

The scheme of study for BS Botany session 2014-18. year program was briefed by convener and it is accepted by all members after having thorough discussion. At the start of B.S programme in the Department of Botany No codes were given to some allied courses so for their result notification the given codes and titles at that time were approved as such.

Item NO.3: Revision of Course codes in Scheme of Studies of BS in Botany for session 2018 and onward.

Codes for courses of B.S Botany session 2018 were revised according to the rule given by university to have unanimous codes in all BS programmes of different departments of university.

Item NO.4: Approval of Scheme of Studies of M.Sc. in Botany for session 2016-2018.

Scheme of study of M.Sc. Botany for session 2016-2018 was presented by the convener. It's all courses along their contents were also presented before all members and it was approved by all members after some discussion

Item NO.5: Approval of Scheme of Studies of M.Sc. in Botany for session 2018 and onward.

In 4th departmental council labs were separated from theory and separate codes were assigned to theories and labs in order to make course with 3 credit hours rather than 3+1. Due to some technical issues of CMS. Labs and theories were assigned same codes with 2+1 credit hours.

Item NO.6: Approval of Course Codes of Seminar and Thesis for M.Phil. in Botany.

Course codes of M.Phil. Seminar and M.Phil. Thesis were changed according to University rule and presented before academic council and new codes approved for seminar and Thesis for M.Phil. are BOT-798 and BOT-799 respectively.

Item NO.7: Approval of Course Codes of Seminar and Thesis for Ph.D. in Botany.

Course codes of Ph.D. Comprehensive Examination (Written & Oral), Seminar 1, Seminar II and Ph.D. Thesis were changed according to University rule and presented

before academic council and new codes approved for these are BOT-896, BOT-897, BOT-898 and BOT-899 respectively.

Item NO.8: Approval of Thesis as Core Course for M.Sc. and B.S students having CGPA 3.00 or above and as Elective for students having CGPA between 2.50 – 3.00.

It was presented by the convener to start the weekend programme of M.Phil/PhD with scheme same as regular classes. But all members suggested that it is university policy and university higher authoriry will decide it.

Item NO.9: Approval of Courses for M.Phil. and Ph.D. in Botany.

Different courses for M.Phil. and Ph.D. were popesed as agenda item and all the courses titles were approved unanimously by the honourable members.

Item NO.10: Approval of Weekend Program for M.Sc., M.Phil. and Ph.D. in Botany

Department of Botany will start Weekend Program for M.Sc., M.Phil. and Ph.D. in Botany. Other rules, regulations, course contents will remained same as regular classes in Department of Botany.

SCHEME OF STUDIES
BS IN BOTANY
DEPARTMENT OF BOTANY

INTRODUCTION:

Botany as a subject is multidisciplinary in nature, involving study of plants and their genetic, morphological and physiological attributes, their surrounding environment and their role in conservation of environment. Botany is a combination of various disciplines such as Molecular Biology, Biochemistry, Biotechnology, Toxicology, Genetics, Physiology, Ecology and Microbiology. This subject has significant role in human resources development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.

Eligibility Criteria: F.Sc. Pre Medical/ A level.

SCOPE OF BS PROGRAMME

The BS programme will enable the students to be acquainted with the latest knowledge of the Plant Sciences.

OBJECTIVES OF TEACHING BOTANY

- To impart knowledge about the major disciplines of Botany. It will enable the students to understand the principles of organizations and inter-relationships in the Biological Systems with particular reference to Plant Diversity.
- To teach different methods of exploration, investigation, organization of plant relevent data and its utilization in Lab and Industry.
- To train students for advanced studies and specialization on recently emerging technological and multidisciplinary fields such as Biodiversity and Conservation, Environmental Science, Biotechnology and Industrial Drug Developwnt etc. After completing the degree, students will be able to apply their knowledge in their respective fields effectively.
- To equip students with knowledge and skills for better planning and management of plant resources, environment, health, medicine, agriculture and population in the country.
- To develop the scientific culture and demonstrate professional skills in teaching, research and managerial positions in conjucion with higb moral ethics in wide range of professions in national and international organizations and public sector.

RATIONALE:

The subject of Plant Sciences has undergone tremendous advances all over the world. It is imperative to update the existing curriculum in Botany to bring it at par with the HEC, national and International standards.

GOAL:

The goal of BS programme is to produce competent professionals in the field of Botany who will be capable to face the challenges of the changing world and make world, natural resources sustainable for current and future generation.

Distribution of Credit Hours

Semester	Theory	Lab	Total
1st	17	01	18
2nd	17	01	18
3rd	15	02	17
4th	15	02	17
5th	10	05	15
6th	10	05	15
7th	8/11	07/04	15
8th	08/11	07/04	15
Total	96	39	130

SCHEME OF STUDIES FOR

4-YEAR CURRICULA

FOR BS IN BOTANY

Categories	No. of Courses Min-Max	Credit Hours Min-Max
Compulsory Requirement (No Choice)	9-9	25-25
General Courses to be chosen from other departments	7-8	21-24
Discipline Specific Foundation Courses	9-10	30-33
Major Courses including Research Thesis/ Internship	11-13	36-42
Electives within the Major	4-4	12-12
Total	40-44	124-136

Duration	8-12 semesters
Couruses	128 credits
Internship	S/ U basis
Comprehensive Oral examination	S/ U basis
Research Thesis/Special paper	6 credits
Total Credits	134 credits

Item NO. 2: Scheme of Studies of BS in Botany for Session 2014-18.

1st Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-3101	Diversity of Plants	3	1	4
PST-3102	Pak Studies	2	0	2
ENG-3103	English I(Functional English)	3	0	3
ZOO-3104	Foundational Zoology(Animal Diversity-I)	3	0	3
CHM-3105	Foundational Chemistry	3	0	3
ARB-3106	Arabic	3	0	3
Total		**17**	**1**	**18**

2nd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-3201	Plant Systematics, Anatomy & Development	3	1	4
ENG-3202	English II(Communication Skills)	3	0	3
ENG-3203	English-IV	3	0	3
ZOO-3204	Foundational Zoology (Animal Diversity-II)	3	0	3
CHM-3205	Physical Chemistry	3	0	3
IST-3206	Islamic Studies	3	0	3
Total		**18**	**1**	**19**

3rd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-4301	Cell Biology, Evolution & Genetics	3	1	4
CHM-4302	Organic Chemistry	3	1	4
COM- 4303	Computer	3	0	3
ZOO-4304	Zoology (Principle of Animal Life-II)	3	0	3
MAT-4305	Mathematics (Pre-Calculus)	3	0	3
ENG-4306	English-III (Technical Report Writing & Presentation Skills)	**3**	**0**	**3**
Total		**18**	**2**	**20**

4th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-4401	Plant Physiology & Ecology	3	1	4
BOT-4402	Biodiversity & Conservation	3	1	4
ZOO-4403	Zoology (Palaeontology and Evolution)	3	0	3
CHM-4404	Analytical Chemistry	3	0	3
BST-4405	Biostatistics	3	0	3
Total		**15**	**2**	**17**

5th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-5501	Bacteriology & Virology	2	1	3
BOT-5502	Mycology & Plant Pathology	2	1	3
BOT-5503	Phycology & Bryology	2	1	3
BOT-5504	Diversity of Vascular Plants	2	1	3
BOT-5505	Plant Systematics	2	1	3
Total		**10**	**5**	**15**

6th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-5601	Plant Anatomy	2	1	3
BOT-5602	Genetics-I	2	1	3

BOT-5603	Plant Biochemistry-I	2	1	3
BOT-5604	Plant Ecology-I	2	1	3
BOT-5605	Plant Physiology-I	2	1	3
Total		**10**	**5**	**15**

7th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-6701	Molecular Biology	2	1	3
BOT-6702	Plant Biochemistry- II	2	1	3
BOT-6703	Plant Ecology-II	2	1	3
BOT-	Research Thesis/ Elective-I	0	3	3
BOT-	Elective-II	2	1	3
BOT-6713	Internship	-	-	-
Total		**8**	**7**	**15**

8th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-6801	Plant physiology –II	2	1	3
BOT-6802	Genetics-II	2	1	3
BOT-6803	Environmental Biology	2	1	3
BOT-	Research Thesis/ Elective-III	-	3	3
BOT- ----	Elective-IV	2	1	3
Total		**8**	**7**	**15**

Grand Total	**134**

List of Elective Papers for BS in Botany for Session 2014-2018.

(Approved in 4th Depermental Council)

S. No.	Course Title	Course Code	Approved/Not Approved
1.	Ethnobotany	BOT-6704	Approved
2.	Phytoremediation	BOT-6705	Approved
3.	Plant Stress Physiology	BOT-6706	Approved
4.	Conservation and Management of Plant Resources	BOT-6707	Approved
5.	Plant Nutrition	BOT-6708	Approved
6.	Phytosociology	BOT-6709	Approved
7.	Economic Botany	BOT-6710	Approved
8.	Flora of Azad Jammu and Kashmir	BOT-6711	Approved
9.	Research Thesis	BOT-6712	Approved
10.	Internship	BOT-6713	Approved
11.	Research Techniques	BOT-6804	Approved
12.	Plant Metabolism	BOT-6805	Approved
13.	Plant Biotechnology	BOT-6806	Approved
14.	Applied Mycology	BOT-6807	Approved
15.	Plant Microbe Interaction	BOT-6808	Approved
16.	Molecular Genetics	BOT-6809	Approved
17.	Phytochemistry	BOT-6810	Approved
18.	Palynology	BOT -6811	Approved
19.	Applied Microbiology	BOT-6812	Approved

Item NO.3: Revision of Course Codes in Scheme of Studies of BS in Botany for Session 2018 and Onward Sessions.

Duration	8-12 semesters
Couruses	124 credits

Internship	S/ U basis
Comprehensive Oral examination	S/ U basis
Research Thesis /Special paper	6 credits
Total Credits	130 credits

Scheme of studies of BS in Botany for Session 2018 and Onward Sessions

1st Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-1101	Diversity of Plants	3	1	4
ZOO-1123	Principles of Animal Life-I	3	0	3
MAT-1115	Mathematics-I	3	0	3
CHE-1104	Inorganic Chemistry	3	0	3
ENG-1107	English-I (Functional English)	3	0	3
PS-1117	Pakistan Studies	2	0	2
Total		**17**	**1**	**18**

2nd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-1201	Plant Systematics, Anatomy & Development	3	1	4
ZOO-1223	Principles of Animal Life –II	3	0	3
CHE-1204	Organic Chemistry	3	0	3
ENG-1207	English-II (Communication Skills)	3	0	3
ARA-1201	Arabic	3	0	3
ISL-1212	Islamic Studies	2	0	2
Total		**17**	**1**	**18**

3rd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-2301	Cell Biology, Genetics & Evolution	3	1	4
ZOO-2323	Animal Diversity-I	3	1	4
CHE-2304	Physical Chemistry	3	0	3
ENG-2307	English-III (Technical Report Writing & Presentation Skills)	3	0	3
COM-2305	Introduction to Computer	3	0	3
Total		**15**	**2**	**17**

4th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-2401	Plant Physiology and Ecology	3	1	4
BOT-2402	Biodiversity and Conservation	3	1	4
ZOO-2423	Animal Diversity –II	3	0	3
CHE-2404	Analytical Chemistry	3	0	3
STA-2420	Biostatistics	3	0	3
Total		**15**	**2**	**17**

5th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-3501	Bacteriology & Virology	2	1	3
BOT-3502	Mycology & Plant Pathology	2	1	3

BOT-3503	Phycology & Bryology	2	1	3
BOT-3504	Diversity of Vascular Plants	2	1	3
BOT-3505	Plant Systematics	2	1	3
Total		**10**	**5**	**15**

6th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-3601	Plant Anatomy	2	1	3
BOT-3602	Genetics-I	2	1	3
BOT-3603	Plant Biochemistry-I	2	1	3
BOT-3604	Plant Ecology-I	2	1	3
BOT-3605	Plant Physiology-I	2	1	3
Total		**10**	**5**	**15**

7th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-4701	Molecular Biology	2	1	3
BOT-4702	Plant Biochemistry- II	2	1	3
BOT-4703	Plant Ecology-II	2	1	3
BOT-	Research Thesis*/ Elective-I	-	3	3
BOT-	Elective-II	2	1	3
Total		**8**	**4**	**15**

*who will obtain CGPA<3+00

8th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-4801	Plant Physiology –II	2	1	3
BOT-4802	Genetics-II	2	1	3
BOT-4803	Environmental Biology	2	1	3
BOT-	Research Thesis*/ Elective-III	-	3	3
BOT- ----	Elective-IV	2	1	3
Total		**8**	**4**	**15**
Grand Total				**130**

List of Elective Courses for BS in Botany for Session 2018 and Onward Sessions

Course Code	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs	Approved/ Not Approved
BOT-4704	Ethnobotany	2	1	3	Approved
BOT-4705	Phytoremediation	2	1	3	Approved
BOT-4706	Plant Stress Physiology	2	1	3	Approved
BOT-4707	Conservation and Management of Plant Resources	2	1	3	Approved
BOT-4708	Plant Nutrition	2	1	3	Approved
BOT-4709	Phytosociology	2	1	3	Approved
BOT-4710	Economic Botany	2	1	3	Approved
BOT-4711	Flora of Azad Jammu and Kashmir	2	1	3	Approved
BOT-4712	Research Thesis	2	1	3	Approved
BOT-4804	Research Techniques	2	1	3	Approved
BOT-4805	Plant Metabolism	2	1	3	Approved
BOT-4806	Plant Biotechnology	2	1	3	Approved
BOT-4807	Applied Mycology	2	1	3	Approved
BOT-4808	Plant Microbe Interaction	2	1	3	Approved
BOT-4809	Molecular Genetics	2	1	3	Approved
BOT-4810	Phytochemistry	2	1	3	Approved

BOT-4811	Palynology	2	1	3	Approved
BOT-4812	Applied Microbiology	2	1	3	Approved
BOT-4813	Bioinformatics	2	1	3	Approved

NOTE: The Course Ouline of BS programme is already approved by 4th Departmental Council, Faculty Council and Academic Council. It is included here for compilation as one main document of Departmental Council/s.

BOT-1101 DIVERSITY OF PLANTS 4(3+1)

Theory: a) Viruses: Introduction. Comparative study of life form, structure (RNA and DNA types), reproduction and economic significance with special reference to tobacco mosaic virus (TMV).

(**b) Bacteria:** Introduction. **S**tudy of life forms, structures and different types of reproduction in bacteria. Economic importance with specific reference to biofertilizers, pathogenicity and industrial importance. Introduction to structure and reproduction in Cyanobacteria (Anabaena).

(c) Algae: Introduction. Study of life forms, structures, classification, different types of reproduction and economic significance of algae with special reference to Spirogyra, Pinnularia and Chara.

(d) Fungi: Introduction. Study of structure, life cycles, classification, types of reproduction and economic significance of Fungi with special reference to Ustilago, Puccinia and Agaricus.

(e) Lichens: Study of structure, habitat, classification, types of reproduction and economic significance of lichens with special reference to Physcia.

(f) Bryophytes: Study of structure, habitat, mode of reproduction, classification and economic significance of bryophytes with special reference to Riccia, Anthoceros and Funaria.

(g) Pteridophytes: Study of structure, habitat, mode of reproduction, classification and economic significance of pteridophytes with special reference to Lycopsida (Selaginella).

(h) Gymnosperms: Study of structure, habitat, mode of reproduction and economic significance of gymnosperms with special reference to Pinus.

(i) Angiosperms: Study of structure, habitat, mode of reproduction and economic significance of angiosperms with special reference to Monocot (Wheat), Dicot (*Solanum nigrum*).

Lab Outline:

- To visit lab to be familiar with instruments and learn operating methods, principles and calibration.
- Culturing and staining of bacteria.
- Culturing and staining of Fungi.
- Maintenance and preservation of cultures of microbes (Bacteria / Cyanobacteria / Algae / Fungi).
- To study anatomical differences between gram positive and gram negative bacteria by Gram staining Procedure.
- Study of morphology and reproductive structures of different Algal types mentioned in theory.
- Study of morphology and reproductive structures of different fungal types mentioned in theory.
- Study of morphology and reproductive structures of different Bryophytes mentioned in theory.
- Study of morphology and reproductive structures of different Pteridophytes mentioned in theory.
- Study of morphology and reproductive structures of different Gymnosperms mentioned in theory.
- Study of morphology and reproductive structures of different Angiosperms mentioned in theory.
- Identification of various types mentioned in theory from prepared slides and fresh collections.

Recommended Books:

- Iftikha,r A. K. and R.U.H. Ramay.(2015). Textbook of Botany (Diversity of Plants). M. I. Publishers, Lahore, Pakistan.
- Vashishta, B. R. (1991). Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
- B. P. Panday. (2006). College Botany. Vol 1 & II. S. 7th Edition. Chand & Co. New Delhi.

- Ingrouille , M. (1992). Diversity and Evolution of Land Plants. Chapman & Hall.
- Mauseth**, J. D. (**2003)**.** Botany**:** An Introduction to Plant Biology 3rd Ed., Jones and Bartlett Pub. UK.

BOT- 1201 PLANT SYSTEMATICS, ANATOMY AND DEVELOPMENT 4(3+1)

Theory: Introduction to plant systematic, its aims, history and importance. **Classification:** Importance brief history, introduction various systems of classification, Engler and Prantels System, Bentham and Hooker's System. **Brief introduction to nomenclature;** Importance of Latin names, systems with an introduction to international code of Botanical Nomenclature (ICBN). **Morphology and Phytography** – a detailed account of various morphological characters of root, stem, leaf, inflorescence, flower, placentation and fruit types. Diagnostics characters, economic importance and distribution pattern of the following families: Brassicaceae (Cruciferae), Leguminosae, Rosaceae, Cucurbitaceae, Solanaceae, Lamiaceae (Labiatae), Asteraceae, Moraceae, Meliaceae, Acanthaceae, Liliaceae and Poaceae.

Anatomy and Development: Cell wall; structure and chemical composition**. Tissue and Tissue System:** Concept; structure and function of various tissues. e.g, Parenchyma, Chlorenchyma, Collenchyma, Sclerenchyma, Xylem and phloem**. Primary Structure** of root, stem and leaf. Definition and various type of meristems. Primary and secondary growth of dicot stem.Early development of plant body (embryology)*Capsela bursa-pastoris or Arabidopsis.*

Lab Outline:

- Identification of families given in syllabus with the help of keys
- Technical description of root, stem and leaves
- Technical description of flower
- Technical description inflorescence
- Technical description of fruit & placentation
- Field trips shall be undertaken to study and collect local plants. Students shall submit 50 fully identified herbarium specimens.
- Study of cross section of monocot and dicot stem.
- Study of simple and compound tissue in macerated and sectional material.
- Study of cross section of bifacial leaf
- To study the prepared slides of secondary growth in dicot stem

- Study of pollen grains by acetolysis method
- Study of L.S of monocot leaf.
- Study of pollen grains.
- Study of fleshy plant specimen.
- Study of herbarium preparation

RecommendedBooks:

- Bold, H.C., (1997). Morphology of Plants. Harper & Row, N.Y.
- Dickison, W.C. (2000). Integrative Plant Anatomy, Academic Press, UK.
- Fahn, A. (1990) Plant Anatomy. Pergamon Press, UK.
- Malik, T.A. (1996). Principles of Botany. The Carvan Press Darbar Market, Lahore.
- Mauseth, J.D. (1998). An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
- Moore, R.C., W.D. Clarke and Vodopich, D.S. (1998) Botany. McGraw Hill Company, USA.
- Pullaiah, T (2007). Taxonomy of Angiosperms 3rd Ed. Regency Publication, New Delhi.
- Raven, P.H., Evert, R.E. and Eichhom, S.E. (1999). Biology. Saunders College Publishing, USA.
- Sharma, O.P. (1993). Plant Taxonomy. Tata McGraw-Hill 7 Patel Nagar, New Delhi.
- Stuessy, T.F. (1990). Plant Taxonomy. Columbia University Press.

BOT-2301 CELL BIOLOGY, GENETICS AND EVOLUTION 4 (3+1)

Theory: a). Cell biology: Introduction to cell biology, brief history and scope. Structure and Function of Bio-molecules, Carbohydrates, Lipids, Proteins, Nucleic Acids**. Cell:** Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell. **Brief description of following cell organelles;** Cell wall, Cell membrane, Nucleus, Endoplasmic reticulum, Plastids, Mitochondria, Dictyosomes**,** Vacuoles. **Reproduction** in somatic and embryogenic cell, mitosis, meiosis and cell cycle. **b). Genetics:** Introduction, scope and brief history of genetics. Mendelian inheritance; introduction to Mendelian inheritance, shortcomings. Laws of segregation and independent assortment. Back cross, test cross, Reciprocal cross, dihybrid cross, monohybrid cross, exception to Mandel's laws. Dominance and incomplete dominance, hetreodominance and over dominance. **c). Evolution:** Definition and history and

scope.The nature of evolutionary forces, adaptive radiations, differential reproductive potential. First plant cell, origin of organized structures, early aquatic and terrestrial ecosystem. First vascular plant, origin and characters.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration
- Study of cell structure using compound microscope.
- Elucidation of ultrastructure of cell from electron microphotographs.
- Measurement of cell size.
- Preparation of temporary and permanent slides.
- Staining techniques simple and differential staining.
- Study of mitosis using onion root tips and comparison with prepared slides.
- Study of meiosis by smear/squash method and from prepared slides.
- Study of chromosome morphology and variation in chromosome number.
- Extraction and estimation of carbohydrate, protein, from plant sources.
- Tests for reducing and non-reducing sugars.
- **Genetics**
- Genetical problems related to transmission and distribution of genetic material.
- Identification of chromosomes in plant material. Carmine/orcein staining.
- Determination of blood groups.

Recommended Books:

- Daniel, L. H. (2000). Essential Genetics. Jones and Bartlett Publishers. .
- Dyonsager, V. R. (1999). Cytology and Genetics. Tata and McGraw-Hill Publication Co. Ltd, New Delhi.
- Lodish. H. (2001). Molecular Cell Biology. W. H. Freeman and Co.
- Sinha, U. and Sinha, S. (1998). Cytogenesis Plant Breeding and Evolution, Vini

BOT-2401 PLANT PHYSIOLOGY AND ECOLOGY 4 (3+1)

Theory: (a) Plant Physiology; Water relations: Introduction to water potential terminologies. Mechanism of absorption and translocation of water in plants. Transpiration, Theories regarding stomatal regulation.

Mineral nutrition: Introduction to macro and micro nutrients. Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.

Photosythesis: Introduction, Oxygenic and non-oxygenic photosynthesis, Mechanism: light reactions and dark reactions. Differences between C3 and C4 plants. Factors affecting this process.

Respiration: Definition and respiratory substrates, mechanism of Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and anaerobic respiration, Respiratory quotients.

(**b) Ecology;** Introduction, aims and applications of ecology. **Soil:** Physical and Chemical properties of soil (soil formation, texture. pH, EC, organism and organic matter etc) and their relationships to plants. **Light and Temperature.** Quality of light, diurnal and seasonal variations. Ecophysiological responses. **Water:** introduction. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants. **Wind:** Wind as an ecological factor and its importance. **Population Ecology:** Introduction. A brief description of seed dispersal and seed bank. **Community Ecology**. Introduction to communities. Ecological characteristics of plant community Methods of sampling vegetation (Quadrat and line intercept) Major vegetation types of the local area. **Ecosystem Ecology**. Definition, types and components of ecosystem, Food chain and Food web. **Applied Ecology:** Causes, effects and control of water logging and salinity with respect to Pakistan.

Lab Outline:

a) Plant Physiology

- Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
- Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
- Measurement of leaf water potential by the dye method.
- Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a potometer/cobalt chloride paper method.
- Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram.
- Study of Absorption Spectra using Spectrophotometer

- Estimation of oxygen utilized by a respiring plant by Winkler's method.
- Determination of the temperature at which beet root cells lose their permeability.
- Extraction of Amylase from Germinating Wheat Seeds and study of its effect on Starch Break Down.
- Measurement of Carbon Dioxide Evolution during Respiration of Germinating Seeds by the Titration Method.

b) Ecology

- Determination of physical and chemical characteristics of soil.
- Measurement of vegetation by Quadrat and line intercept methods.
- Measurements of various population variables
- Effect of light and temperature on seed germination.
- Determination of carbonates and bicarbonates in water
- Measurements of Wind Velocity

Recommended Books:

- Iftikhar, A. K. and R.U.H. Ramay. (2015). Textbook of Botany (Plant Physiology and Ecology). M. I. Publishers, Lahore, Pakistan.
- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th. Ed. Sinauers Publ. Co. Inc. Calif.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- Schultz, J. C. (2005). Plant Ecology. Springer-Verlag, Berlin.

BOT-2402 BIODIVERSITY AND CONSERVATION 4 (3+1)

Theory: Biodiversity; Definition, history and its importance. **Types of biodiversity;** species biodiversity, genetic biodiversity and ecosystem biodiversity. **Threats to Biodiversity;** habitat fragmentation, deforestation, over grazing, hunting, erosion, desertification, ecosystem degradation, bio invasion and climate change. **Biodiversity of Pakistan**. **Measuring biodiversity by;** Alpha, Beta and Gamma diversity. **Ecological services**; indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of Bio resources). **Sustainable and unsustainable** use of biological resources.

Biodiversity Hot spots of Pakistan and the world. **Conservation strategies;** *in situ* and *ex situ*, conservation. **IUCN categorized protected areas** in Pakistan and **red listing categories**. Red data book, blue data book and green data book. **International treaties/agreements** regarding Biodiversity and conservation; **CBD, CITES, Ramsar**. Use of herbarium and Botanical Garden in biodiversity conservation and wild life management. Global Biodiversity Information Facility (GBIF). Commerccial perspectives of impoetant Plant biovdiversity of AJK and Pakistan. Indigenous Plant Buodiversity and Allien Species Cresis.

Lab outline:

- Inventory of plant biodiversity in various habitats.
    - Inventory of Herbline in a community
    - Inventory of shrubline in a community
    - Inventory of treeline in a community
- Identification of wild plant species used by local communities in different ecosystem.
- How species becomes red listed.
- Different types of data books; red data book, green data book and blue data book.
- Calculation of biodiversity
    - By alpha ά diversity
    - By beta β diversity
    - By gemma γ diversity
- Calculation of biodiversity by Simpson method
- Calculation of biodiversity by Shanon method
- Calculation of biodiversity by IBCD method
- Visit/study trips to various National Parks.
- Visit/study trips to various Botanical Garden.
- Preparation of herbaria/ specimen.
- Checklist of Allien species and their loss impact on wild plant biodiversity

Recommended Books:

- Maiti, P. K. and M, Paulam. (2017). Biodiversity: perception, peril and preservation, 2ed edition, PHI learning private limited, Delhi.
- Abbasi, A. M., Khan, M. A., M. Ahmad and M. Zafar. (2012). Medicinal plant biodiversity of Lesser Himalaya Pakistan. Springer Publishers USA.
- IUCN. (1994). *IUCN Red List Categories.* As Approved by the IUCN Council. IUCN.

- Swanson, T. (2005). Global Action for Biodiversity. Earth Scan Publication Ltd.

BOT-3501 BACTERIOLOGY AND VIROLOGY 3(2+1)

Theory: a) Viruses; General features of viruses, viral architecture, classification, dissemination and replication of single and double – stranded DNA/RNA viruses. Plant viral taxonomy.Virus biology and virus transmission. Molecular biology of plant virus transmission. Symptomatology of virus-infected plants: (External and Internal symptoms). Metabolism of virus-infected plants. Resistance to viral infection.Methods in molecular virology.

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

c) Plant microbe interaction: plants relationship with different microbes i.e virus, bacteria and fungi, their remedial mechanisms.

Lab outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- Study of bacterial cell structure using compound microscope.
- Elucidation of ultrastructure of virus from electron microphotographs.
- Measurement of bacterial cell size.
- Preparation of temporary and permanent slides of different bacteria from fresh cultures.
- Gram staining, gram positive and gram negative bacteria.
- Observation of symptoms of some viral infected plant specimens.
- Methods of sterilization of glassware and media etc.
- Preparation of nutrient medium and inoculation.
- Growth of bacteria, sub culturing and identification of bacteria on morphological and biochemical basis (using available techniques).

- Microscopic study of representative genera of Actinomycetes from fresh collection and prepared slides.
- Microscopic study of representative genera of Cyanobacteria from fresh collections and prepared slides.
- Microscopic study of binary fission in bacteria.
- Observation of symptoms of some viral infected plant specimens.

Recommended Books:

- Black, J. G. (2005).Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
- Prescott, L. M., Harley, J. P. and Klein, D. A. (2005). Microbiology McGraw-Hill Companies, Inc.
- Arora, D. R. (2004). Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
- Ross F. C. (2000). Fundamentals of Microbiology. John Willey & Sons, New York.
- Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens. The Haworth Press, Inc.

BOT-3502 MYCOLOGY AND PLANT PATHOLOGY 3 (2+1)

Theory: a) Mycology: Introduction: Brief history of Mycology**.** General characters of fungi**,** Concept of fungal thallus, cell structure and ultrastructure of fungi. **Reproduction:** Asexual and sexual reproduction, reproductive structures, life cycle, haploid, heterokaryotic and diploid states. Homothalism and heterothallism. **Fungal Systematics:** Classification of fungi with suitable examples to illustrate somatic structures, life cycle and reproduction of **Chytridiomycota** (Chitridiales - Chitridia), **Oomycota** (Peronosporales - Peranospora), **Zygomycota** (Mucarales - Mucor), **Ascomycota** (Erysiphales - Erysiphae), **Basidiomycota** (Agaricales - Agaricus, Polyporales – Polyporus, Ustilaginales - Ustilago) and **Deuteromycota**. **Symbiotic relationships** of fungi with other organisms (lichens and mycorrhiza) and their significance.

b) Fungal Pathology: Introduction of fungal pathology and classification of plant diseases caused by fungi, Development of plant diseases. Epidemiology and disease forecast. Reproduction and disease cycles of some important diseases of crops, plants and fruit trees in Pakistan caused by fungi, e.g. Rust of crops and vegetables, Black smut of crops and

vegetabes, Damping off, Downy mildew, Powdery mildew, dieback, red rot of sugarcane, root rots, wilting, Fusarium head blight (FHB), Early blight of potato, Late blight of potato.

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

Lab Outline:

- Study and collection of different locally available types of macroscopic fungi
- Analysis and identification of different microscopic fungal pathogens present on different plant parts by direct culture plate method
- Basic mycological techniques for identification of fungal species
- Identification of fungi by Direct Plate Method from soil
- Isolation of fungi by Serial Dilution Agar Plate Method from soil samples
- Detection of fungi from air by Direct Plate Method
- Identification of fungi by Baiting Technique from water
- Isolation and identification of different aquatic fungi by Direct Plate Method
- Isolation of drinking water fungal spores by Baiting Method
- Isolation and identification of soil fungi by soil culture plate method
- Culture of deep layer soil fungal spores by Serial Dilution Agar Plate Method
- To assess the effect of pH on fungal growth
- To check the effect of temperature on fungal sporulation
- Analysis of fungal growth rate after exposure to light
- Effect of darkness on fungal culture
- To evaluate the effect of nutrients on growth and sporulation of fungal species.

Recommended books:

- Alexopoulos, C.J., Mims C.W and M. Blackwell. (2017). Introductory mycology (4thed), Jhon Wiley & Sons, New York.
- L. N. Nair (2013). Topics in Mycology and Plant Pathology. New Central Book Agency (P) Ltd, London.
- Ram KrushnaKar, NiharManjariMisra (2012). Text Book on Fungi. Kalyani Publishers Ludhiana- New Delhi, India.
- Khan, A. G. and Usman, R., (2005). Laboratory Manual in Mycology and Plant Pathology. Botany Department Arid Agriculture University, Rawalpindi.
- Trigiano, R. N., Windham, M. T. and Windham, A. S., (2004). Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

BOT-3503 PHYCOLOGY AND BRYOLOGY 3(2+1)

Theory: (a) Phycology; definitions by different phycologist, history and classification. Introduction, general account (general and diagonestic characteristics, occurance, structure of plant body, cell structure, reproduction) evolution and classification of the following algal divisions; *Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta* and *Rhodophyta.* Algae as a potential source of biofuel, soil algae and symbiosis, economic importance and ecology of algae.

(b) Bryology: Introduction and general account of bryophytes, classification, theories of origin and evolution. Brief study of the classes: **Hepaticopsida** (Marchantia), **Anthoceropsida** (Anthocerose), **Bryopsida** (Funaria).

Lab Outline:

- Methods of preparation of temporary and permanent slide.
- Use of camera lucida/micrographs.
- Field trips to study various habitats of algae including ponds, ditches, streams, slow running water and water reservoir.
- Different methods for the collection of algal sample.
- Macroscopic and microscopic study of common, locally available types representing various taxonomic groups of Algae.
- Collection & microscopic study benthonic algae.
- Section cutting of thalloid algae.
- Study of globule and nocule of chara.
- Visits to study bryophytes in their natural habitats.
- Different methods for the collection of bryophytes sample.
- Study of sporophytic and gametophytic plant body of locally available species of bryophytes.
- Collection and identification of locally available species of bryophytes with online available literature.

Recommended books:

- Vashishta, B.R, A.K Sinha and V.P Singh. (2000). Algae, botany for degree students. S.Chand & Company, New Delhi.
- Bhatangar, S.K, A. Saxena & S. Kraan. (2011). Algae biofuel. Stadium press India.
- Acharia, J. (2008). Handbook of Algae. Rajat publications, New Delhi.

- Sharma, O.P. (2011). Algae. McGraw Hills Education Private Limted.
- Pandey, S.N, S.P Misra & P.S Trivedi. (2008). A text book of botany Vol II, 12th ed, Bryophytes, Pteridophytes and Palaeobotany.
- Schofield, W.B. (1985). Introduction to Bryology. Macmillan Publishing Co. London.

BOT-3504 DIVERSITY OF VASCULAR PLANTS 3 (2+1)

Theory: a) Pteridophytes: Introduction, origin, history, features and a generalized life cycle. **Methods of fossilization**, types of fossils, geological time scale and importance of paleobotany. General characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilopsida *Psilotum*), Lycopsida (*Lycopodium, Selaginella*), Sphenopsida (*Equisetum*), Pteropsida (Adiantum, *Dryopteris* and *Marsilea*).

b) Origin and Evolution of seed habit.

c) Gymnosperms: Introduction, Geological history, origin, distribution, morphology, anatomy, classification and affinities of Cycadofillicales, Bennettitales, Ginkgoales, Cycadales and Gnetales. Economic importance of gymnosperms.

d) Angiosperms: Origin, general characteristics, Importance, and life cycle of angiosperms (with taking one monocot and one dicot plant as model).

e) Palynology: An introduction to Neopalynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey and oil and gas exploration.

Lab Outline:

- Methods of preparation of temporary slides.
- Methods of preparation of permanent slides.
- To study the morphological and reproductive features of available genera of Pteridophytes.
- To study the morphological and reproductive features of available genera of Gymnosperms.
- To study the morphological and reproductive features of available genera of Angiosperms.
- To study the anatomical differences in monocot and dicot leaves.
- To study the anatomical differences in monocot and dicot stem
- To study the anatomical differences in monocot and dicot roots.
- Study trips to different parts of Pakistan for the collection and identification of important pteridophytes, gymnosperms and angiosperms.

- Herbarium sheets preparation of collected genra from different parts of Pakistan and AJK.
- Study of pollen morphology

Recommended Books:

- Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Pterodophyta. S. Chand & Co. New Delhi.
- Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Gymnosperms. S. Chand & Co.
- Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
- Taylor, T. N. and Taylor, E. D. 2000. The Biology and Evolution of Fossil Plants, Prentice Hall.
- B. P. Panday. 2006. College Botany. Vol 1 & II. S. 7th Edition. Chand & Co. New Delhi.

BOT-3505 PLANT SYSTEMATICS 3(2+1)

Theory: Introduction, aims and objectives, major goals and evolution of angiosperms. Concept of species and speciation. **Types of speciation**, reproductive isolation. **Variation**: types, continuous and discontinuous variations. **Taxonomic evidences:** importance and types of taxonomic evidences such as anatomical, cytological, chemical, molecular, palynological, geographical and embryological. **Classification:** Importance, brief history, description of classification system of Linnaeus, Bentham and Hooker, Engler and Prantl, Takhtajan and Dahlgren. **Nomenclature;** Brief introduction, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN). Vienna code. Origin of Angiosperms, General characteristics, distribution and economic importance of following families of angiosperms: Apocynaceae, Arecaceae (Palmae), Asclepiadaceae, Asteraceae (Compositae), Chenopodiaceae, Euphorbiaceae, Liliaceae, Malvaceae, Moraceae, Ranunculaceae, Rutaceae, Umbelliferae (Apiaceae).

Lab outlines:

- Technical description of plants of the local flora and their identification upto species level with the help of the Flora of Pakistan
- Technical description of vegetative parts of plants
- Technical description of flowers & inflorescence
- Technical description of fruit and placentation

- Preparation of permanent slide of Pollen grain by acetolysis method and study of different pollen characters.
- Study trip to a local area to evaluate the plants technically
- Study trip for plant collection
- Working in herbarium for submission of properly mounted and fully identified 50 herbarium specimens preparation for terminal examination
- Field trips shall be undertaken to study plants from different ecological zones of Pakistan

Recommended Books:

- Ali, S.I. and Nasir, Y.J. (1970-1992). Flora of Pakistan. Nos. 71, 131, 145, 126, 172, 36, 54, 100, 171, 132, 20, 75, 152. Department of Botany, University of Karachi.
- Ali, S.I. and Qaiser, M. (1992-2010). Flora of Pakistan. Nos. 204, 207, 201, 215. Department of Botany, University of Karachi.
- Davis, P.H. and Heywood, V.H. (1963). Principles of Angiosprms Taxonomy. Oliver and Boyd, London.
- Lawrence G.H. (1951). Taxonomy of Vascular Plants. Prentice Hall College Div.
- Levin, D.A. (2000). The Origin, Expansion and Demise of Plant Species. Oxford University Press.
- Malik, T.A. (1996). Principles of Botany. The Carvan Press Darbar Market, Lahore.
- Pullaiah, T (2007). Taxonomy of Angiosperms 3rd Ed. Regency Publication, New Delhi.
- Sharma, O.P. (1993). Plant Taxonomy. Tata McGraw-Hill 7 Patel Nagar, New Delhi.
- Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.

BOT-3601 PLANT ANATOMY 3(2+1)

Theory: Definition, introduction and brief history of plant anatomy. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body. **Meristematic tissues;** classification, characteristics, initials and their derivatives. **Apical meristem;** different growth zones, evolution of the

concept of apical organization. Shoot and root apices. Origin, structure, functional and evolutionary specialization of the **following tissues;** Epidermis, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem and Periderm. *Anatomical differences of Monocot and dicot;* stem, root, leaves, flowers and seeds.**Guard cells**. **Vascular cambium;** its structure, storied and non-storied cell types, additive and multiplicative division, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth. **Trichomes and Secretory tissues;** Laticifers and Resin Canals.

Lab outline:

- Methods of preparation of temporary slides.
- Methods of preparation of perment slides.
- Different techniques for section cutting.
- Anatomical differences of monocot and dicot root by slide preparation.
- Anatomical differences of monocot and dicot stem by slide preparation.
- Anatomical differences of monocot and dicot leaves by slide preparation.
- Anatomical differences of angiosperms and gymnosperms.
- Study of orginization of parenchyma, collenchymas, sclerenchyma, xylem and phloem in stem.
- Observation of guard cell in the leaves of different plants.
- Collection and observation of monocot and dicot flowers differences.
- Identify the parts of a leaf and distinguish between compound and simple leaves.
- Anatomical differences of collateral and bicollateral (curcurbitaceae) vascular bundles in stem.
- 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.
- Study of abnormal/unusual secondary growth.
- Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.

Recommended Books:

- Katherine, Esaus 2006. Esaus plant anatomy, 3rd edition. Jhon Wily and Sons.
- Pijush Roy. (2010). Plant Anatomy. New Central Book Agency, New Delhi.
- Dickison, W. C. (2000). Integrative plant anatomy. Academic Press, U. K.

- Fahn, A. (1990). Plant Anatomy. Pergamum Press, Oxford.
- Esau, K. (1960). Anatomy of Seed Plants. John Wiley, New York.
- Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.

BOT- 3602 GENETICS-I 3(2+1)

Theory: **Extensions of Mendelian Analysis**: Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity**. 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. **Linkage II:** Special Eukaryotic Chromosome Mapping Techniques: Accurate calculation of large map distances, analysis of single meioses, mitotic segregation and recombination, mapping human chromosomes.**The Structure of DNA:** The genetic material, DNA replication in eukaryotes, DNA and the gene. **The Nature of the Gene:** How genes work, gene- protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites, complementation. **DNA Function:** Transcription, translation, the genetic code, protein synthesis, universitality of genetic information transfer, eukaryotic RNA.

The Extranuclear Genome : Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochrondrial genes in yeast, extragenomic plasmids in eukaryotes. **Developmental Genetics:** Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease. **Population Genetics:** Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration
- Numerical problems related to arrangement of genetic material.
- Numerical problems related to linkage and recombination.
- Numerical problems related to gene mapping in diploid.
- Numerical problems related to recombination in Fungi.
- Recombination in bacteria

- Recombination in viruses.
- Population Genetics: calculation of gene frequencies and equilibrium.
- Population Genetics: calculation of changes in gene frequencies.
- Determination of Blood group and Rh-factor.
- Culture techniques of drosophila.
- Microscopic study of Salivary gland chromosome of Drosophila.
- Fungal Genetics: Saccharomyces culture techniques and study.
- Studies on variation in maize ear size and color variation.
- Bacterial Genetics.
    i. Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
    ii. Transformation.
    iii. Conjugation.

Recommended Books:

- Gelvin, S, B. (2000). Plant Molecular Biology Manual. Kluwer Academic Publishers.
- Pierca, B. A. (2005). Genetics. A conceptual approach, W. H. Freeman and Company, New York.
- Synder, L, and Champness, W. (2004). Molecular Genetics of Bacteria. ASM Press, Washington D. C.
- Klug, W. S. and Cummings, M. R. (2000). Concepts of Genetics, Prentice Hall International Inc.
- Roth Well, N. V. (2001). Understanding Genetics, 2nd Edition, Oxford University Press Inc.

BOT-3603 PLANT BIOCHEMISTRY-I 3 (2+1)

Theory: Carbohydrates: Definition,Occurrence, classification and scope of carbohydrates. Structure elucidation, chemical composition and significance of deoxy-ribsose D-glucose, sucrose, maltose, starch, glycogen, cellulose, hemicellulose, mucilages, pectins and lignins. **Lipids:** Definition, occurrence, classification and scope of Lipids. Structure elucidationand chemical composition and significance of fatty acids, triglycerides, phospholipids, glycolipids, sulpholipids, waxes, cholesterol and sterols. **Proteins:** Definition, occurrence, classification and scope of Proteins. Structure elucidationand chemical composition, properties of all amino acids. Protein targeting, posttranslational modifications (PTMs). Transport, storage, regulatory and receptor proteins. **Nucleic Acids:** Definition,Occurrence,

classification and scope of nucleic acids. Structure elucidation, chemical composition and significance of DNA and RNA. DNA and RNA formation, storage and movement mechanism. **Enzymes:** Definition, occurrence, classification and scope Enzymes. Structure elucidation, chemical composition and significance of Isozymes, ribozymes, abzymes. Enzyme specificity and modals of enzyme action, Enzyme kinetics, Nature of active site and mode of action. Allosteric enzymes and feedback mechanism.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit lab to be familiar with instruments and learn operating methods, principles and calibration.
- To learn how to measure pH of any solution/ solvent using litmus paper and digital pH meter.
- To prepare basic 1 Molar, 0.5 Molar, 1 Molal, 0.01 Molal and 1 Normal solutions of any given salts and liquids; and buffer formation.
- To learn detect and confirm presence of glucose, sucrose, lactose, cellulose and starch in the given solution.
- To detect presence of proteins in the solution by using chemical test methods and its estimation by Biuret or Lowry or Dye-binding method.
- To extract and estimate oil from plant material using soxhlet apparatus.
- To extract leaf and seed proteins and their estimation by Biuret or Lowry or Dye-binding method.
- To extract of DNA from plant material leaf and seed
- To extract RNA from different parts of plant
- Estimation of DNA and RNA by UV absorption orcolour reactions.
- Estimation of chlorophyll contents in leaf
- Estimations of primary metabolites in given part of plant- leaf/seed
- Estimation of secondary metabolites from plant leaf

Recommended Books:

- R.K Murray, D.K Grannar, V. W. Rodwell (2010). Biochemistry, 27th Ed. McGraw-HilHarpers Illustrated.
- Lehninger, A.L., Nelson, D.L. and Co. N.M., (2008). Principles of Biochemistry. W. H. Freeman; 5th edition.

- D. J. Voet, G.J. Voet and C. W. Pratt. (2008). Fundamentals of Biochemistry. 3rd Ed., J. Wiley & Sons Inc.
- Conn E E. and Stumpf P.K., (2002). Outlines of Biochemistry, John Wiley and Sons Inc.New York.
- P. J. J., Haykaas, M.A. Hall, & K.R. (1999). Libbenga,Biochemistry and Molecular Biology of Plant Hormones. Edited by Science Pub.Co.

BOT-3604 PLANT ECOLOGY-I 3(2+1)

Theory: Introduction: history and recent developments in ecology. **Soil:** Distinction between Edaphalogy and Pedology. Nature and properties of soil (Physical and Chemical Characteristics), Soil formation, Texture, Structure and porosity. Inorganic and organic components component of soil. Living Inhabitants of soil, pH. and conductivity. **Water:** Soil-Plant atmosphere system; Atmospheric moisture, Forms of Precipitation and ecological effects, Plant- water relationship, Water balance of plants, Water status in soil, Adaptation based on water availability, Role of water in the diversity of plants. **Light and Temperature**: Nature of light, Physical properties of Light, Effect of shade, altitude, latitude, high or low pressure system, Adaptation to temperature extremes. Ecological response to warm, chilling and freezing temperature. Photoperiodism, Thermoperiodism, Role of temperature in the diversity of plant. **Wind** and **Fir**e as ecological factor.

Lab Outline:

- Determination of physico-chemical properties of soil.
- Determination of physico-chemical properties of water.
- Determination of Soil texture.
- Determination of Soil structure.
- Measurements of light under different ecological conditions.
- Measurements of temperature under different ecological conditions.
- Measurements of wind velocity.
- Measurement of soil conductance by electrical conductivity meter.
- Determination of Humidity by Hygrometer.
- Determination of soil pH by using pH meter.
- Measurement of water relation components: conductance
- Effect of Light and temperature on germination and growth of plants.
- Effect of moisture and salinity on germination and growth of plants.

Recommended Books:

- M. Ahmad and S. S. Shaukat. (2012). A test book of vegetation ecology. Publisher Abrar Sons New Urdu Bazar Karachi.
- Chapin, F. S. et al. (2002). Principle of Terrestrial Plant Ecology, Springer-Verlag
- Barbour, M. G., Burke, J. H and Pitts, W. D. (2004). Terrestrial Plant Ecology, The Benjamin, Cumming Publishing C. Palo Alto, California, USA.
- Hussain. F. (1989). Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education, Islamabad.
- Moree. P. D. and Chapman S. B. (1986). Methods in Plant Ecology, Blackwell Scientific Publication Oxford.

BOT-3605 PLANT PHYSIOLOGY-I 3(2+1)

Theory: Photosynthesis: Introduction. Nature and units of light. Determination of oxygenic and anoxygenic photosynthesis. Ultrastructure of thylakoid vesicle and Various pigments. Absorption and action spectra of different pigments. Mechanism of photosynthesis - light absorption, Photophosphorylation and its mechanism. CO_2 reduction (dark reactions) - C3 pathway and Photorespiration, C-2 Cycle and its consequences, C4 pathway and its different forms, C3-C4 intermediates, CAM pathway. Methods of measurement of photosynthesis.

Respiration: Introduction. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respitaion.

Translocation of Food: Introduction. Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.

Leaves and Atmosphere: Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.

Assimilation *of Nitrogen, Sulphur and Phosphorus*: The nitrogen cycle. Nitrogen fixation. Pathways of assimilation of nitrate and ammonium ions. Pathways of assimilation of sulphur and phosphorus.

Lab Outline:

- Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
- To determine the volume of CO_2 evolved during respiration by plant material.

- To determine the amount of O_2 used by respiring water plant by Winkler Method.
- Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
- Measurement of leaf water potential by the dye method.
- Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a potometer/cobalt chloride paper method.
- Separation of chloroplast pigments on paper chromatogram and their quantification by spectrophotometer.
- Study of Absorption Spectra using Spectrophotometer
- To categorize C3 and C4 plants through their anatomical and physiological characters.
- To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
- To regulate stomatal opening by light of different colours and pH.

Recommended Books:

- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Salisbury F.B. and Ross C.B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- W.B. Hopkins. (1999). Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
- Barton, W. (2007). Recent Advances in Plant Physiology.

BOT-4701 MOLECULAR BIOLOGY 3 (2+1)

Theory: Introduction, history and importance of molecular biology. **Nucleic Acids**; DNA-circular and superhelical DNA. Denaturation, Renaturation, hybridization and synthesis of DNA. **Proteins:** Basic features of protein molecules. Folding of polypeptide chain, α-helical and β-secondary structures. **Transcription;** Enzymatic synthesis of RNA and transcriptional signals. Translation, genetic code, Wobbling, polycistronic and monocistronic RNA. Overlapping genes. **Gene regulation in Eukaryotes;** Differences in genetic organization in 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. **Plant Omics:** Transcriptomics; DNA libraries, their construction, screening and application. **Proteomics;** structural and functional proteomics. Methods to study proteomics. **Metabolomics;** methods to study metabolomics, importance and application of metabolomics. **Bioinformatics and computational biology**. Levels, scope, potential and industrial application of bioinformatics and computational biology.

Lab Outline:

- Preparation of different types of solution.
- Micropipeting
- Microcentrifugation
- Agrose gel preparation
- Preparation of CTAB solution
- Extraction of DNA by two different protocols
    - Analysis of DNA by agarose gel electrophoresis
    - Amplification of extracted DNA by PCR
    - Purification of PCR product and its confirmation
- Extraction of RNA from plant source
    - Purification of RNA
- Extraction of protein from plant source
    - Purification of proteins
- Electrophoreses: One dimensional

Recommended Books:

- Lodish, H. Baltimor, D. Berk, A. Zipurshy, S.L. Matsudaira, P. Darnell, J. (2001). Molecular biology of the cell. Scientific American books, W.H. Freeman and Company, New York.
- Cullis, C. A. (2004). Plant Genomics and Proteomics. Wiley-Liss, New York.
- Gibson, G. and S. V. Muse, (2002). A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
- Lodish, H. et al., (2004). Molecular Cell Biology. 5th Edition. W. H. Freeman & Co., New York.
- Malacinski, G. M. (2003). Essentials of Molecular Biology, 4th Edition. Jones and Bartlett Publishers, Massachusetts.

BOT-4702 PLANT BIOCHEMISTRY-II 3 (2+1)

Theory: **Bioenergetics:** Energy, laws about energy changes. Oxidation and reduction in livingsystems. **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. **Replication of DNA**. Reverse transcription. Biosynthesis of DNA and RNA. Components of protein synthesis, Genetic code, **Protein synthesis:** initiation,elongation and termination. **Alkaloids:** Occurrence, physiological effects, chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role.

Terpenoids: Classification: monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis. **Vitamins:** General properties and role in metabolism.

Lab Outline:

- Basic introduction to Lab hi-tech Instruments i.e. 1-DE; 2-DE and PCR
- Extraction of Proteins from leaves and seeds of plants and their purification
- Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis (1-DE).
- Estimate the amount of vitamin C in a plant organ (orange, apple juice)
- To determine potential alkaloids in plants.
- To estimate terpenoids in plants.
- To quantify saponins in plants.
- To estimate flavonoids in plants.
- To estimate chlorophyll contents in plants
- To Extract DNA from plant leaf and other partsTo run and analyze DNA by using PCR/ Gel electrophoresis approach
- To Extract RNA from plant leaf and other partsTo run and analyze DNA by using PCR/ Gel electrophoresis approach

Recommended Books:

- Conn E. E. and Stumpf, P.K. (2002). Outlines of Biochemistry, John Wiley and Sons Inc.New York
- Smith; E L., Hill; R. L., Lehman; R. I., Lefkowits, R J. and Abraham. H. (2012). Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw HillInternational Book Company.

- Zubay. G. (2003). Biochemistry, MacMillan Publishing Co., New York.
- Chesworth,. J.M., Strichbury T. and Scaife, J. R. (1998). An introduction to agricultural biochemistry. Chapman and Hall, London.
- Heldt, H-W. (2008). Plant Biochemistry. 3rd Edition, Academic Press, U.K.
- Campbell, M.K. and F. Shawn. (2008). Biochemistry 6th Edition

BOT-4703 PLANT ECOLOGY-II 3 (2+1)

Theory: Plant community: Discrete and continuum concepts with modern synthesis. Community Attributes, Leaf Spectra, Life form distribution patterns, periodicity, phynology, species maturity and age class etc. **Vegetation:** Local vegetation and vegetation of Azad Kashmir and Pakistan. **Species diversity concepts**: plant community structure, plant community dynamics (succession). **Methods of Sampling** of plant community: Quadrate line intercept, point centered quarter methods. **Quantitative Community Description:** Gradients, Ordination and classification, productivity, measurement, energy -flow and efficiency. **Population Ecology:** Population structure and plant demography, ecological amplitude and law of tolerance, characteristics of populations. **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. **Seed Bank** and seed dispersal patterns**.**

Lab Outline:

- Determination of seed bank in various populations.
- Seed dispersal pattern of local populations.
- Study of community attributes.
- Sampling of vegetation including Quadrat method.
- Sampling of vegetation including plotless method.
- Sampling of vegetation including transect method.
- Determination of biological spectrum and leaf size spectra.
- Measurement of regeneration capacity of forest.
- Observation of palatability and non palatability.
- Correlation of soil properties with vegetation type.
- Field trip to study different communities located in different ecological regions of Azad Kashmir.

- Slide show of the vegetation of Pakistan.
- Slide show of the major formations of the world.

Recommended Books:

- Ahmad, M. and S. S. Shaukat. (2012). A text book of vegetation ecology. Publisher Abrar Sons, New Urdu Bazar, Karachi.
- Townsend C. R. Begon. M and J. L. Harper (2002). Essentials of Ecology. Blackwell Publishing.
- Chapin, F.S. et al. (2002). Principle of Terrestrial Plant Ecology. Springer-Verlag.
- Barbour M. G. et al., (1999). Terrestrial Plant Ecology. The Benjamin-Cumming Publishing Co.
- Moore P.D. and Chapman S. B. (1986). Methods in Plant Ecology. Blackwell Scientific Publication, Oxford.
- Hussain, F. (1989). Field and Laboratory Manual of Plant Ecology. National Academy of Higher Education. Islamabad.

BOT-4801 PLANT PHYSIOLOGY-II 3 (2+1)

Theory: Water Relations: The soil -plant -atmosphere continuum . Structure and properties of water. Mechanism of absorption of water in plants. Aquaporins,-their structure and types. Cell water relations terminology. **Plant Mineral Nutrition:** Introduction to macro and micro nutrients. Absorption of mineral nutrients. 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. **Plant Growth Regulators:** Introduction, Major natural hormones and their synthetic analogues. Bioassay, biosynthesis, mode of action, transport and physiological effects of Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene. **Phytochromes:** Introduction. Discovery and physical and chemical properties of phytochromes. Distribution of phytochromes among among species, cells and tissues and their role in biological processes. photoperiodic induction. Role of photoperiodism in flowering. Vernalization and its effect on flowering. **Dormancy;** Definition, causes and methods to break seed dormancy. **Plant Movements;** Introduction to plant movements, Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements.

Lab Outline:

- To investigate the preferential absorption of ions by corn seedlings and potato slices.

- To determine osmotic potential of massive tissue by freezing point depression method or by an osmometer.
- To investigate water potential of a plant tissue by dye method and water potential apparatus.
- Determination of K uptake by excised roots.
- Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
- Determination of carbonates and bicarbonates in water
- Qualitative determination of K content in Guard cells by Sodium cobalt nitrite method.
- Demonstration of effect of Auxin on elongation of Barley Seedling
- Effect of Gebberillines on Growth of Lettuce
- Effect of Kinetin on Callus, Tissue Culture
- Demonstration of phototropic and geotropic movements in plants

Recommended Books:

- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Fitter, A. and Hay, R. K. M. (2001). Environmental Physiology of Plants. Academic Press, UK.
- W. B. Hopkins. (1999). Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.

BOT-4802 GENETICS-II 3 (2+1)

Theory:Recombinant DNA: 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. **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. **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. **Mechanisms of Genetic Change II:** Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements. **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. **Human Genome Project:** Strategies and application, achievement and future prospects. **Plant Genome Projects:** Arabidopsis, achievement and future prospects. **Bioethics:** Moral, Religious and ethical concerns.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- Numerical problems related to arrangement of genetic material.
- Numerical problems related to linkage and recombination.
- Numerical problems related to gene mapping in diploid.
- Numerical problems related to recombination in Fungi.
- Isolation and separation of DNA on Gel electrophoresis.
- Isolation and separation of protein on Gel electrophoresis.
- Bacterial chromosome.
- Plasmid DNA (minipreps).
- Plant DNA extraction and analysis.
- Protein extraction from plants.
- DNA Amplification by PCR

Recommended Books:

- Winnacker, E. L. (2003). From Gene to Clones Introduction to Gene Technology, Panima Publishing Corporation, New Delhi.
- Brown, T. A. (2002). Genomes, Bios Scientific Publishers Ltd.
- Lwein, B. (2004). Gene VIII, Pearson Education Int.

- Miglani, (2003). Advanced Genetics, Narosa Publishing House, India,

BOT-4803 ENVIRONMENTAL BIOLOGY 3 (2+1)

Theory: Environment: Introduction, scope, pressure. P**ollution**: definition, classification and impact on habitats. **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. **Water pollution:** Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal pollution. **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. **Noise pollution**. **Radiation pollution** (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal. **Forest:** importance, deforestation, desertification and conservation. **Ozone layer:** i. Formation, ii. Mechanism of depletion, iii. Effects of ozone depletion.Greenhouse effect and global warming: causes, impacts. **Human population explosion:** impact on environment. **Impact assessment:** Industrial urban, civil developments. **National Conservation Strategy:** Brief review of major problems of Pakistan and their solutions. Sustainable Environmental management.

Lab Outline:

- How to sample water from different sources.
- Examination of Total dissolved solids from industrial waste water and Municipal sewage and sludge.
- Examination of pH from industrial waste water and Municipal sewage and sludge.
- Examination of E.C from industrial waste water and Municipal sewage and sludge.
- Examination of BOD from industrial waste water and Municipal sewage and sludge.
- Examination of COD from industrial waste water and Municipal sewage and sludge.
- Determination of Chlorides from industrial waste water and Municipal sewage and sludge.
- Determination of carbonates from industrial waste water and Municipal sewage and sludge.
- Determination of Nitrates from industrial waste water and Municipal sewage and sludge.

- Examination of water samples forms different sites for the presence and diversity of organisms.
- Determination of hydraulic conductivity of a disturbed soil sample by Constant Head Method-Black
- Determination of water content of soil by gravimetric method.
- Effect of air pollutants on plants.
- Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

- M. N. Rao, and H .V .N Rao (2007). Air Pollution. McGraw Hill Companies.
- P.K. Goel (2008). Water Pollution Causes, effects and control. New age International (P) Ltd.
- S.K Agarwal (2009). Noise Pollution. A.P.H Publishing Corporation.
- Environmental Biotechnology: Basic Concepts and Applications, I. S. Thakur, I.K. International Publishing House Pvt. Limited, 2006.
- P.C Jaiswal 2006. Soil, plant and water analysis. Kalyani Publishers.
- Vandermeer, John H. 2011. The ecology of agro-ecosystems - Jones and Bartlett Publishers; Sudbury, Mass; 387 p.

LIST OF ELECTIVE COURSES FOR BS IN BOTANY

BOT-4704 ETHNOBOTANY 3(2+1)

Theory: Definition of Botany and Ethnobotany, aims and objective of ethnobotany, types and Signifince of Ethnobotany. Importance of plants**.** Developmental history of ethnobotany, Ethnobotany of world, Asia and Pakistan, Role of ethnobotany in treatment of different diseases, Role of ethnobotany in biodiversity conservation. **Ethnovaterriny medicines:** their role in Pakistan. **Systems of medicines**: TCM, (traditional Chinese medicine**)**, kampoo system Middle East, Indian system, **Economic importance of plants.** Food plants: rice, corn, wheat, sugar cane, barely etc., their morphology, history, Importance and nature of plant products, **Cereals and Millets:** Classification of cereals, importance, source of food, economic importance of cereals**. Legumes**: Definition examples, types legumes vas beans, importance. Nutritional profile of legumes. **Nuts:** types, importance, health benefits of nuts, chemical composition of nuts. **Vegetables:** different types of vegetables their nutrition profile, **Classification of vegetables**: HarperCollins and Lucy Peel (2004) classification.

Chemical composition of different vegetables. Economic importance of vegetables. **Importance of plants with reference** to food, fibers dyes, oils, spices. **Introduction to Fruits**, Classification of fruits, Economic importance of Fruits. Fruits are source of different vitamins. Importance of Fruits with reference to medicines. **Economic importance of plants** with special reference to food, fibers, fumitories, wood, tannins, rubber, sugar, paper, gums, resins, dyes, beverages, spices, masticatories and oils.**Qualities and quantities** methods of data collection. Methods of data collection and data analysis by ICF, DMR, FL and PR.

Lab Outline:

- Collection, identification and preservation of economically important plants and plant products.
- The students are required to study in nature and in the laboratory economically important local flora.
- Enlistment of Botanical names of 30 vegetables of area.
- Enlistment of Botanical names of 20 nuts of area.
- Conduct ethnobotanical survey by close ended and open ended interview methods.
- Collection of data and apply microstatical tools: ICF, DMR, FL, etc.
- Identification and naming of local flora.
- Chemical screening of 5 vegetables andf ruits of area. Study of morphology of cereal crops and their cultivation techniques.
- Study of medicinally important vegetables fruits and nuts of area.
- Field trip to conduct ethanovatenary survey from local people.
- Conservation techniques.in situ and ex situ
- Herbarium preparation of at least 60 plants.
- Students should be able to write accurate scientific and vernacular name and economic importance of plants and identify them up to species level.
- Cultivation of economically important plants. Germplasm identification
- Herbarium techniques

Books Recommended:

- Fernandez, B. (2003). Edible wild plants of the Himalayas.
- S.N Lal andM.Sing (1998). Medicinal plants of India
- Martin, G. J. (2003). Ethnobotany. Earthscan Publications Ltd. London and Sterling, VA.

- Marty R.K and V.P. Singh (2006). An Introduction to Modern Economic Botany Agrobios India.
- Pandey, S. N. and Chadha, A. (1993). A Textbook of Botany (Plant Anatomy and Economic Botany). Vol. III. Vikas Pub. Co., New Delhi.
- Pandey, B.P. (1983). Economic Botany. S. Chand. Co., New Delhi.
- Simpson, A. (1985). Economic Botany. McGraw Hill Book Co., N. Y.
- Yadav.P.R. and S.R. Mishra. (2003). Environmental Ecology. Discovery Publishing House New Delhi110002.

BOT-4705 PHYTOREMEDIATION 3(2+1)

Theory: Introduction to bioremediation, types, Limitation, present status. Phytoremediation, phytoremediation technologies their use. **Pollutant bioavailability:** Measuring bioavailability in soil ecosystems. Rhizosphere Processes and Remediation. **Environment and pollution:** Introduction to environmental law. New development in phytoremediation. Biological processes and Factors affecting phytoremediation, Treatment technologies. **Plant** tolerance to different contaminants, Adaptations, Characteristics of plants suitable for phytoremediation, Metal accumulators – hyper accumulators and accumulators, **Remediation:** application, limitations (characteristics of roots, growth rate, pollutant concentration), economic and technical aspects**,** conservation of ecosystems. **Phytoremediation mechanisms**: Phytoextraction, Phytodegradation, Rhizofiltration, Rhizodegradation, Phytostabilzation, Phytovolatilization and Phytoengineering. Economic value of phytoremediation**.** How to dispose plants after phytoremediation. Phytoengineered Nanomaterials and Their Applications. Role of genetic engineering in phytoremidation.

Lab Outline:

- Study of pollution site neaer industial areas.
- Study effects of pollution on morphology of plants.
- Study effects of pollution on anatomy of plants
- Cultivation of plants with addition of excessive amounts of pollutants (heavy metals, organic pollutants) in experimental lawn of university
- Determination of effect of pollutants on photosynthesis of plants
- Isolation of BAC-degrading bacteria from the environment
- Bio concentration degree of certain pollutants.
- Collection of plant under stressed condition (heavy metals).

- Enlistment of plants used for phytoremediation.
- Plants used to remediate Zn and lead pollutants
- Plants used for absorption of brick kiln pollution

Recommended Books:

- A.Sing O.P Ward (Eds). (2004). Biodegradation and bioremediation.
- John T. Cookson, Jr. McGraw-Hill, (1995). Bioremediation Engineering: Design and Application. Inc. New York.
- Singh O. P. Ward (Eds), (2004). Applied Bioremediation and Phytoremediation. Springer, New York.
- Bhandari (Eds), (2007). Remediation Technologies for Soils and Groundwater.
- Jan, V., and L. Kröpfelová, (2008). Wastewater treatment in constructed wetlands with horizontal sub-surface flow. Springer.
- Neil W, (2006). Phytoremediation: Methods and Reviews. Humana Publisher USA.
- Ritu Gill, Guy R. Lanza, Lee Newman, (2016). Phytoremediation: Management of Environmental Contaminants Volume-3. Publisher: Springer, Switzerland.

BOT-4706 PLANT STRESS PHYSIOLOGY 3 (2+1)

Theory: Types of environmental stresses, **Salinity:** effects of salinity, physiological changes in plant adaptation to salinity. **Water logging:** physiological effects on plant growth, plant adaptation. **Drought:** effect of drought on plant growth, ultra-structural modifications, plant adaptation to drought. **Metal ion toxicity:** effects on plant growth, physiological adaptation, nutrient deficiency, physiological and biochemical effects. **Cold stress:** freezing injury and adaptations. **High temperature stress:** UV, High CO_2 and other minor stresses and plant adaptations. The effects of ionizing radiations on plant metabolism and growth. **Oxidative stress**. Different types of Reactive oxygen species produced in plants. Antioxidants of plants and their mechanism of functioning. Different types of biotic stresses on plants**.**

Lab Outline:

- Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
- Demonstration of effects of Salt stress on plants
- Demonstration of effects of Drought stress on plants
- Demonstration of effects of Water logging on plants

- Demonstration of effects of oxidative stress on plants
- Demonstration of effects of metal stress on plants
- Various methods of stress assessments in plants
- Ultra-structural and physiological changes associated with various stresses.
- Study effect of yield loss due to water logging.
- Study loss of biomass due to water logging and salinity.
- Study impact of drought in yield loss mechanisms.
- Study loss of biomass of plant due to drought.

Recommended Books:

- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Hale, M. G. and Orcutt, D. M. (1987). The Physiology of Plants under Stress. John Wiley and Sons, N.Y.
- Russel, H. and Staples, R. C. (1979). Stress Physiology in crop plants. by H. Wiley-Interscience, N.Y.

BOT-4707 CONSERVATION AND MANAGEMENT OF PLANT RESOURCES 3(2+1)

Theory: Introduction to conservation and management, history and scope. Introduction of species, Ecology and genetic diversity. Measurement of Diversity, wildlife in Pakistan, Northern Highlands and plains, Indus plains and deserts of Sindh, Western highlands plains and deserts, Wetlands coastal regions and marine life, extinct species of Pakistan. **Threats to plant diversity:** habitat loss, deforestation, overexploitation, invasive species, pollution and climate change. Importance of the Red data book. IUCN red list categories for threatened species. The IUCN Red List Categories Criteria. Concept of *In situ* and *ex situ* conservation of plants. Role of herbaria and botanical gardens in conservation. List of botanical gardens of Pakistan and the world. **IUCN protected areas categories**: Strict nature reserve, wilderness area, national parks, natural mountains, wildlife sanctuaries, protected landscapes, managed resource protected area. Protected areas and national parks of Pakistan. Protected areas of Azad Kashmir. Gene bank management and operation. Biodiversity action plans of Pakistan.

Conservation organizations and research institutes, (BCGI, CBCN, CABS, CPC, and IPGRI), and Native plant societies.

Lab Outline:

- Inventory of the flora of assign region.
- Field visits; visit to National parks of Pakistan.
- Visit to different herbaria of Pakistan universities and their conservation status.
- Visit to Gene bank (IABGR).
- Visit to protected areas of Azad Kashmir and inventory of flora.
- Role of NGOs in conservation.
- Study how to do field study.
- learn how to collect and preserve plants from forest.
- learn to prepare standardized herbarium.
- Learn mounting of plants in herbarium
- Preparation of herbarium specimens of at least 50 plants of local or district area.
- Analysis of red list of IUCN and comparative analysis of red lists of different years from 2000 to 2019.

Books Recommended:

- Cunningham, A. B. (2001). Applied Ethno botany: People, wild plant use and conservation, Earthspan Publications.
- Dyke, F. V. (2003). Conservation Biology. Mc Graw Hill, New York.
- Gotz S., Gustavo A B, Da Fonseca, C. A Harvey, C. Gascon, H. L Vasconcelos and Anne-Marie Izac, (2004). Agroforestry and BiodiversityConservation in Tropical Landscapes.
- John T. and G. P. Nabhan, (2001). People, Plants and Protected Areas: A Guide to "In Situ" Management.

BOT-4708 PLANT NUTRITION 3(2+1)

Theory: Introduction of plant nutrients, importance of nutrients to plants, mode of nutrition in different plants-autotrophic and heterotrophic nutrition and nutrients, micro and macro nutrients and essential elements, effect of essential nutrients on different plant species, Correlation of non-essential nutrients with plants, Effect of NPK on cash crops, Responses of NPK to vegetables, Deficiencies of NPK in crops and vegetables, Toxicity and deficiency

symptoms of nutrients, Absorption of nutrients and soil texture of crop fields, Plant water relations; Path of water and nutrient uptake, Mechanisms of nutrient uptake, Fertility and plant nutrients correlation, Mechanism of Photosynthesis, affect of nutrients on plant growth, Mechanism of Phloem transport in plants, phloem loading and unloading in plants, source-sink relationship, Function of mineral elements. **Methods of studying plant nutrition:** solution culture techniques, chelating agents, Radiotracer technique, Hydroponic, mycorrhizae and plant nutrients

Lab Outline:

- Application of solution culture techniques on plant growth characteristics
- Experiment conduct at microscale on plants under NPK supplies
- Effect of essential elements on plant growth characteristics
- Assessment of microelements effects on important crops
- Analysis of macronutrients of crops field trials
- Measurement and analysis of growth characters of five important vegetables after micronutrients supply
- Analysis of macro-elements effect on five important vegetables
- Symptomological study of plants for assessment of different nutrient deficiency
- Supply of NPK to plants during control conditions in field trials
- To conduct experiment under greenhouse conditions on crops relating to nutrient supply
- Artificial supply of essential nutrients to spices in small experimental trials
- Effect of non-essential elements on plant growth
- Experiment on plant growth with the application of different fertilizers in soil
- Experimental trials on plants in hydroponic conditions
- Enlist plants nutrients from fertile soils
- Draw a chart of macronutrients and micronutrients required for plants.

Books Recommended:

- Shagufta (2012). Soil, Plant, Water and Fertilizer Analysis. A.P.H. Publishing Coporation, New Delhi, India.
- John L. Havlin, James D. Beaton, Samuel L. Tisdale and Werner L. Nelson (2009). Soil Fertility and Fertilizers. An Introduction to Nutrient Management (7th Edition). PHI Learning Pvt Ltd. New Delhi, India.

- Allen V. Barker, David J. Pilbeam (2006). Handbook of Plant Nutrition (Books in Soils, Plants & the Environment). CRC Press .
- Schmidt, S., Raven, J.A. and Paungfoo-Lonhienne, C. (2013). Plant Nutrition 2: Macronutrients.
- Ann McCauley, Clain Jones and Jeff Jacobsen (2011). Plant Nutrient Functions and Deficiency and Toxicity Symptoms. Montana State University, USA.

BOT-4709 PHYTOSOCIOLOGY 3(2+1)

Theory: The community: analytical and synthetic characteristics of a community,classification of community, basis and unit of classification, dynamics of community, Types of changes: succession on wet and dry habitats, theories of climax, Ecological characteristics of species and population. **Ecosystem ecology:** components of ecosystem, energy transformation in nature and laws governing energy transformation, Food chain, Food web, Pyramid of number in food chain, Trophic levels, Energy flow in an ecosystem. **Biogeochemical cycles with;** nitrogen, phosphorus, sulphur, carbon and water cycles as examples. Principal vegetation types of Pakistan.

Lab Outline:

- Sampling of vegetation including Quadrat method.
- Sampling of vegetation including plotless method.
- Sampling of vegetation including transect method.
- Study of floristic composition of local community.
- Determination of frequency of occurrence in a plant community.
- Determination of Population density and cover of species in a plant community
- Determination of Biological spectrum
- Determination of Leaf size spectrum
- Calculation of diversity indices by Simpson and Shanon –Wiener method.
- Determination of primary productivity of grassland.
- Determination of primary productivity of grassland.
- Determination of seed bank in various populations.
- Seed dispersal pattern of local populations.

Recommended Books:

- Billings, W.D. (2000). Plant and Ecosystem. Wadswoth Pub. Co., California

- Daubenmire, R.F. (1973). Plant Communities. A Textbook of Synecology. Wiley, N.Y. USA.
- Shukla R.S & P.S Chandel. (2006). Plant Ecology S. Chand & Company LTD Ram nagarNew Delhi
- Stiling, R. D. (1992). Ecology, theories and applications. Prentice Hall International Inc.U.S.A
- Schultz et al., (2005). Plant Ecology. SpringerVerlag, Berlin.
- Townsend, C. R., Harper, J. L. and Begon, M. E. (2000). Essentials of Ecology. Blackwell Scientific Publications UK.

BOT- 4710 ECONOMIC BOTANY 3(2+1)

Theory: Introduction, history and significance of Economic botany, Role of plants in life of man in different paradigms, **Role of Plants as Food;** ten highly used crops of world—their names, taxonomy, phytogeography, ethnomedicines and other ethnobotanical uses, **Role of Plants used as Fodder for livestock and birds**; list of ten common plants used in the indigenous area—with their taxonomy, occurrence, threats to them, their ethnomedicinal uses, other ethnobotanical uses. **Role of Plants used as Home/Shelter construction**: List of commonly used home construction and household items preparation; their taxonomy, ethnomedicines and other ethnobotanical uses; **Role of wild plants used as Fruits**, their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; **Role of wild plants used as Vegetables**: their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; **Role of wild** plants used as Condiments their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; **Role of wild plants used as Food Medicines** their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; **Role of wild** plants used as Aesthetics and Cultural rituals, their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; **Role of wild plants used as in Industrial Products** their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Fiber industry, structure & classification of fibers, fiber yielding plants; cotton, jute, sun their origin, distribution, agronomic practices, breeding, Wood industry, wood for timber,timber industry, uses of wood, conversion products of wood, distillation products,**secondary products,Rubber industry**, physical properties, chemical composition, **rubber yielding plants** para rubber, morphology, uses, rubber, rubber, panama rubber. their origin, distribution, agronomic practices,, diseases and their control, Future Prospective of these wild

and cultivated plantsas Domestic use, commercial and industrial growth and process to earn livelihood.

Lab Outline:

- Identification and collection of food plants of local area.
- Study of morphology of all cereal crops and their cultivation techniques.
- Collection of fiber yielding plants from local area.
- Collection of oil yielding plants of area.
- Sugar yielding plants of area.
- Study of morphology of wood plants of local area.
- Herbarium techniques.
- Field survey to enlist wood yielding plants.
- Study of spices and condiments used in daily food.
- Types of forest and protected areas
- Wild ecoregions of Pakistan and AJK
- Submission of 30 economically important plants.

Recommended Books:

- S L Kochhr (2012). Economic Botany of the Tropic areas
- B.P Panday., and S. Chand. (2000). Economic Botany . Springer
- H. D.V. Prendergast, et al. (1998). Plants food and medicine. Kew publishing
- Frances E.M. Cook. (1995). Economic botany data collection standard. Kew publishing.
- Pooja. (2005). Economic botany. Discovery publishing house.
- O.P. Khedar , R.V. Singh, Mahesh Shrinal. Pulses status and cultivation Technology.

BOT-4711 FLORA OF AZAD JAMMU AND KASHMIR 3(2+1)

Theory: Concept of flora, history of flora, Geomorphology and climatology of plant regions in Pakistan and Azad Jammu and Kashmir, Natural vegetation regions, floristic composition and zones, Types of habitat and their vegetation, Life forms in the flora of Azad Jammu and Kashmir, Plant groups in the flora of Azad Jammu and Kashmir, endangered, rare, endemic, economic, aromatic, poisonous, grazing, woody and edible species of Azad Jammu and

Kashmir, Threats to flora ofAzad Jammu and Kashmir, Methods to study flora in field and lab, tools and technique to preserve flora in field and herbarium.

Lab Outline:

- To learn about how flora is written, rules, methods i.e Flora of Pakistan.
- Write morphological note of 20 plants as per rule of Flora of Pakistan.
- Study rules of collection and preservation of different groups of plants for herbarium specimen.
- Study mounting and placing of plants in herbarium.
- Submission of properly mounted and fully identified 50 herbarium specimens at the time of examination.
- Collection of data about the Flora from internet and literature.
- Field trips to study plants from different ecological zones of Pakistan.
- Visit to different established herbarium.

Recommended Books:

- Ali, S.I. and Nasir, Y.J. (1970-1992). Flora of Pakistan. Nos. 68, 71, 131, 145, 126, 172, 36, 54, 100, 171, 132, 20, 75, 152. Department of Botany, University of Karachi.
- Ali, S.I. and Qaiser, M. (1992-2010). Flora of Pakistan. Nos. 204, 207, 201, 215. Department of Botany, University of Karachi.
- Stewart, R.R., (1972). An Annotated Catalogue of the Vascular Plants of West Pakistan and Kashmir. Flora of West Pakistan. E. Nasir and S.I. Ali, (eds.) Fakhri Printing Press, Karachi.
- Stewart, R.R., (1957). The Flora of Rawalpindi District, West Pakistan. E.E. Press, Rawalpindi.
- Nasir, Y.J. and R.A. Rafique. (1995). Wild Flowers of Pakistan. Oxford University Press, Karachi: 298.
- Parker (1956). A Forest Flora for the Punjab with Hazara and Dehli. Ed. (3): 230.

BOT-4804 RESEARCH TECHNIQUES 3(2+1)

Theory: Planning research project/Thesis: Definition of research, types of research (Basic or fundamental and Applied), history and scope and importance. **Problem identification**:

definition and formulation of a problem, feasibility analysis of a problem, validity of problem. The internet as a medium for research, electronic mail, e-journal, online submission of articles, online questionnaire. The attributes of a research scholar. Objectives and goals. Literature search. Development of hypothesis, source and review of literature. **Reference writing:** For books, journals, anonymous, internet etc. Use of digital libraries for research. **Preparation of a research report:** Types of research reports, structure, Graphics, initial writing, rewriting and editing, Characteristics of a good report, accuracy, clarity, free from contradictions. Oral report, importance of oral report. Evaluation of a research report, general evaluation criteria, Specific evaluation criteria, organization of report, visualization, delivery. Microscopy, Centrifugation, Electrophoresis, Genomic DNA extraction, PCR, DNA fingerprinting, Restriction enzyme analysis and genotyping, Transformation.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- To design a report.
- Introduction to research proposal, designing of a good proposal.
- Introduction to internet tools used in research techniques.
- Protein Extraction.
- SDS- PAGE.
- Introduction to PCR technique.
- PCR Optimization.
- DNA Extraction.
- Thin layer Chromatography.
- Microscopy.
- Centrifugation.
- Sterilization techniques.
- Solutions of different concentrations. Molar, molal, normal and percent solutions.
- Use of Spectrophotometer, pipetting and micro pipetting.

Books Recommended:

- Old R.W. and S.B. Primrose (2000). Principles of Gene Manipulation, an Introduction to Genetic engineering (4th edition). Blackwell Scientific Publications.

- John, H.D .and L.W. Roberts (2005). Plant Tissue culture second edition. Cambridge University Press Cambridge.
- Smith R.H (2000). Plant tissue culture techniques and Experiments second Edition Academic Press.
- Arifullah, S and K.M. Bhatti. (1999). Research process simplified. Pan-Graphic (Pvt) Limited. Islamabad.
- Jones, A., R, Reed and J. Weyers. (2003). Lab Outline: skills in Biology. Longman Scientific and Technical.

BOT-4805 PLANT METABOLISM 3(2+1)

Theory: Introduction to Plant metabolism. **Carbohydrates metabolism:** Catabolism and anabolism of Monosaccharides (Glucose), Oliogosaccharides (Sucrose) and Polysaccharides (Starch) inside plant bodies. **Fat Metabolism:** Synthesis, condensation and breakdown reactions of fatty acids and Glycerols in plant body. Introduction to Alpha and beta oxidation of fats. Glyoxalate cycle. **Nitrogen metabolism:** Introduction to biological nitrogen fixation, uptake of nitrogen by roots and its subsequent conversion to different forms inside plant cells. Synthesis of amino acids and proteins. **Plant hormones:** Introduction and Physiological roles of Auxins, Gibberrelins, Cytokinin, Ethylene and Abssissic acid in plant growth and development. Introduction to other Growth regulators like ascorbic acid and salicylic acid. **Mineral nutrition:** Introduction to macro and micro nutrients. Significance and deficiency symptoms of Nitrogen, Potassium, Calcium, Phosphorous and Magnesium.

Lab Outline:

- To learn detect and confirm presence of glucose, sucrose, lactose, cellulose and starch in the given solution and conduct Rf analysis.
- To detect presence of proteins in the solution by using chemical test methods and its estimation by Biuret or Lowry or Dye-binding method.
- To extract and estimate oil from plant material using soxhlet apparatus, checking of its soapnification property and its analysis by TLC methods with/and Rf determination.
- To extract leaf and seed proteins and their estimation by Biuret or Lowry or Dye-binding method.
- To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.

- To learn how to measure pH of any solution/ solvent using litmas paper and digital pH meter.
- Demonstration of effect of Auxin on elongation of Barley Seedling
- Effect of Gebberillines on Growth of Lettuce
- Effect of Kinetin on Callus, Tissue Culture

Recommended Books:

- Bowsher, Steer & Tobin (2008). Plant Biochemistry. Garland Science, Taylor & Francis Group, LLC, New York.
- Buchanan, Gruissem & Jones (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.
- Crozier, Clifford, and Ashihara (2006). Plant Secondary Metabolites: Occurance, Stucture, and Role in the Human Diet. Blackwell Publishing.
- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.

BOT- 4806 PLANT BIOTECHNOLOGY 3(2+1)

Theory: Definition, introduction, history and importance of plant biotechnology. Plant gene structure, Micro propagation, Organogenesis, De-differentiation, Re-differentiation, Callus culture, Cell culture, Ovule culture, Seed culture. **Tissue culture:** Plant tissue culture methods and application to produce clonal plants and bioactive substances. Anther culture and production of androgenic haploids. **Embryogenesis:** Direct Embryogenesis, Indirect Embryogenesis. **Protoplast:** properties of protoplast, protoplast isolation by both mechanical and enzymatic method, culturing and regeneration of protoplast, different methods of protoplast fusion. **Somatic embryogenesis**: Principle, protocol and importance. Artificial seeds – production, applications and limitations. Somatic Hybridization, Gene, Vector, Restriction enzyme, Methods of genes transfer in plants, PCR base techniques, GMOS, Cryopreservation of plant cultures and application of plant tissue culture and Biotechnology. Viruses and Agriculture, production Traits – Virus Cross –Protection.

Lab Outline:

- Safety rules for the biotechnology lab
- Over-view of plant bio technology lab
- Autoclave and its working principal
- Laminar flow and its working principal
- Preparation of solution for SDS-PAGE
- Preparation of media for tissue culture (MS, B5)
- Isolation of meristem
- Callus culture
- Cell suspension culture
- Isolation and culturing of protoplast
- PCR

Recommended Books:

- Slater, A., N. Scott, M. Fowler (2008). Plant biotechnology. Oxford Univ. Press Stewart,
- C.N. Jr. (2008). Plant Biotechnology and Genetics: Principles, Techniques and applications.
- Weaver, R.F. (2008). Molecular Biology. McGraw Hills International Education.
- Trigiano, R.N., D.J. Gray (Eds) (2010). Plant tissue culture, development and biotechnology. CRC Press.

BOT-4807 APPLIED MYCOLOGY 3(2+1)

Theory: General Characteristics of fungi, Taxonomic status and Classification of Fungi, Fungi harmful to mankind, Fungi as pathogen to plants, Animal & Human beings, Spoilage of food stuffs.**Fungi as a food:** Detailed account of mushrooms & their cultivation, Yeast & its related Industries, Single cell proteins & its production. The Economic importance of the fructification of few edible Fungi. **Fungi as medicines:** Industrial production of:- Ergot, Ephedrine, Steroids, Vitamins, Antibiotics**. Fungi in Industries:**Brewery, Baking and Dairy Industries, **Fungi in Enzyme Production:-** Invertase, Zymase, Amylase, Cellulase. **Fungi in production of organic Acids:** Citric Acid, Gluconic Acid, Gallic Acid, Fumaric Acid.

Lab Outline:

- Basic mycological techniques
- Preparation of different nutrient media for growth of fungi
- Process of autoclaving for sterilization purpose

- Experimental work under laminar flow hood in aseptic conditions
- Macroscopic assessment of some common mushrooms
- Microscopic identification of air fungi by Direct Plate Method
- Collection of fungal infected samples of plant parts for detection of fungal pathogens
- Collection and identification of edible mushrooms
- Identification of poisonous mushrooms by isolating their poisonous compounds
- Protocol for the use of Aspergillus fungi in making soya sauce
- Procedure for industrial production of different enzymes
- Procedure for industrial production of Citric Acid
- Protocol for fungal use in Dairy Industries
- Procedure for use of fungi in Baking Industry
- Cultivation of mushrooms at microscale
- Single cell proteins production from fungi

Recommended Books:

- Alexopoulos, C.J., Mims C.W and M. Blackwell. (2017). Introductory mycology (4^{th}ed), Jhon Wiley & Sons, New York .
- Dr. Jamal Uddin (2015). Journal of basic and Applied Mycology. Vol. 11.
- L. N. Nair (2013). Topics in Mycology and Plant Pathology. New Central Book Agency (P) Ltd, London.
- Reeti Singh and U. C. Singh (2011). Modern Mushroom and Cultivation. Agrobios, India.
- Khan, A. G. and Usman, R., (2005). Laboratory Manual in Mycology and Plant Pathology. Botany Department Arid Agriculture University, Rawalpindi.

BOT- 4808 PLANT MICROBE INTERACTION 3(2+1)

Theory: Soil and its features, soil properties and soil ecosystem, importance of soil organisms. Microbial responses in the Rhizosphere and Agriculture soil, signaling molecules for microbe interaction, beneficial type of symbiosis, both beneficial and pathogenic microbe for plants, infection and defense mechanisms in plants. **Mycorrhia:** ectomycorrhiza, endomycorrhiza, vasicular arbuscular mycorrhiza, ericoid mycorrhiza, arbutoid mycorrhiza and orchid mycorrhiza. **PGPR and their mechanisms** of plant growth promotion: direct mechanism (nitrogen fixation, phosphate solubilization, phytohormones production and ACC deaminase activity) and indirect mechanism. Process of nodulation and nitrogen fixation,

Microbial products influence plant growth, Biofertilizers, history of biofertilizers in Pakistan, Precursor inoculums interaction, Physiosignificanse of phytohormones produced by microbes, Effect of root exudates, Introduction of biofilm, Microbial biofilm.

Lab Outline:

- Brief introduction of basic lab safety rules.
- Study of mycorrhizal associations.
- Clearing and staining of mycorrhizal roots.
- Estimation of root length and colonization by mycorrhizal fungi.
- Mycorrhizal inoculums in soil.
- Isolation and identification of Glomalean fungi from field and other soils.
- Synthesis of mycorrhiza from spore inoculums and from root inoculums.
- Assessment of plant growth response by mycorrhizal infection in some seasonal crops.
- Inoculation of PGPR in seasonal crops to asses enhanced plant growth.
- Slide preparation of root nodules.
- Slide show of different types of mycorrhizal association and microbial biofilm.

Books Recommended:

- Ahemad, M and M. Kibert (2014). Mechanisms and applications of plant growth promoting rhizobacteria: Current perspective. Journal of King Saud University – Science (2014) 26, 1–20.
- Naveed, M., I. Mehboob, M. A. Shaker, M. B. Hussain and M. Farooq (2015). Biofertilizers in Pakistan: Initiatives and LimitationsInt. J. Agric. Biol., Vol. 17, No. 3, 2015
- Donlan, R.M (2002). Biofilms: Microbial Life on Surfaces. Emerging Infectious Diseases, Vol. 8, No. 9, September 2002.
- Krishna, K.R (2005). Mycorrhiza. A Molecular Analysis. Oxford & IBH publishing Co., Ltd.
- Rai, M. (2010). Soil Science. Anmol publications and private limited, New Delhi.
- Stacey G. and N. T. Keen. (1996). Plant Microbe Interaction. Springer.

BOT-4809 MOLECULAR GENETICS 3(2+1)

Theory: Definition, history and scope of molecular genetics. **Structure of DNA**: DNA the genetic material, DNA replication in eukaryotes, DNA and the gene. **Nature of the Gene:**

How genes work, Gene protein relationship, Genetic observation explained by enzyme structure, Mutational sites. **Causes of mutations:** replication errors, mutagens. **Repair of mutations:** direct repair of damaged nucleotides, repair by excision and DNA resynthesize. Effects of mutations on the information content of a gene, examples of mutations that result in human genetic disease. **RNA:** Structure, function and Biochemical properties. **From RNA to Protein:** the genetic code, codons & anticodons, the ribosome & translation. **Gene expression in Prokaryotes:** the Lac operon. **Gene expression in Eukaryotes:** regulation of transcription, promoters, enhancer elements; RNA splicing, post-transcriptional and post-translational regulation. Complementation, DNA Function: Transcription, Translation, Protein synthesis, Universality of genetic information transfer, Eukaryotic RNA, **Recombinant DNA:** Restriction enzymes, ecoR1, SMA1, source and activity, the formation of recombinant DNA, Recombinant DNA methodology. **Principles of Genetic Engineering:** gene cloning and genomics Recombinant DNA and social responsibility. Application of Recombinant DNA.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration
- Numerical problems
- Arrangement of genetic material
- DNA extraction Introduction to PCR technology.
- Isolation and separation of protein on Gel electrophoresis.
- Bacterial chromosome.
- Plasmid DNA (minipreps).
- Recombination in virus bacteria and fungi
- Population genetics
- Blood group and RH factors
- Fungal Genetics
- Bacterial genetics.

Books Recommended:

- Gelvin, S. B. (2000). Plant Molecular Biology Manual. Kluwer Acedemic Publishers.
- Pierca, B.A. (2005). Genetics, A conceptual approach. W.H. Fermin and Company, New York.

- Synder, L, and Champness, W. (2004). Moleculan Genetics of Bacteria. ASM Press, Washington D.C.
- Hartl, D. L. and Jones, E.W. (2005). Genetics –Analysis of Gene and Genomics, Jones and Bartlett Publishers. Sudbary, USA.
- Hedrick, P.W. (2005). Genetics of Population. Joness and Bartlett Publishers, Sudbary, USA.

BOT-4810 PHYTOCHEMISTRY 3(2+1)

Theory: **Phytochemistry:** Definition, purpose of photochemistry, Brief history, Characteristics and their uses in taxonomy. Chemical constituents or comparative data and their evolutionary interpretation. **Alkaloids**: Introduction to alkaloids, classification, physical, chemical and general methods for isolation of alkaloids. **Phenylalkylamine alkaloids** (ephedra, Capsicum). **Alkaloids** of quinoline group (structure properties of Cinchona alkaloids), **Phenanthrene** (intro structure chemical physical structure sources of morphine, codeine, thebaine) **Tropane alkaloids** (structure properties and sources of atropine, cocaine). Alkaloids of the carboline group (reserpine). Xanthine alkaloids (caffeine, theophylline, theobromine), Tropolone alkaloids (colchicine), Steroidal alkaloids (solanine), Diterpene alkaloids (taxol), Hallucinating drugs-Introduction, Psychoactive plants: stimulants (cocaine, caffeine), Hallucinogens (Marijauana, LSD), depressants (opium, tobacco, *Datura stramonium*.) Flavonoids, Saponins, Tetraterpenes and Caretonoids (physical and biological properties, natural sources, classification, extraction, isolation, identification and therapeutic applications). Chromatography: Adsorption and column chromatograph, Paper chromatography, thin layer chromatography

Lab Outline:

- Determination of the percentage of total alkaloids of Egyptian henbane
- (*Hyoscyamus muticus*)
- Identification of atropine
- Determination of Cinchona alkaloids
- Identification of quinine
- Identification of ephedrine, caffeine and theobromine
- Phytochemical screening and identification of carbohydrates and/or glycosides, tritepenes and/or sterols, coumarins & alkaloids

- Phytochemical screening and identification of saponins, flavonoids &Anthraquinones
- Separation of coloured materials by column chromatography
- Identification of volatile oils by thin layer chromatography
- Electrophoresis.
- Collection of plants for phytochemical study.
- Iodine brown colour pigment.
- Identification of monosaccharides by paper chromatography

Recommended Books:

- J, B. Harbora. (2004). Phytochemical methods.
- Markham, Techniques of flavonoid identification.
- Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis, Narosa Publishing House, N.D.
- Goodwin,T.W. and Mercer, E.I. (1987). Plant Biochemistry. Pergamon Press,Oxford.
- Mabry T.J.,Markham K.R. & Thomas M.B., (1970). The Systemic Identification of Flavonoids, Springer-Verlag, Berlin–Heidelberg.

BOT -4811 PALYNOLOGY 3(2+1)

Theory: Introduction, history and scope of Palynology in Botany and life. **Types of palynology:** Neopalynology, Palynotaxonomy, Paleopalynology, Melittopalynolgy, Latropalynology, Pharmacopalynology, Copropalynology, Forensic palynology. **Pollens;** types, spore morphology and taxonomy. Composition and structure of pollen, Structure of exine and Intine, sculpturing types of pollen grain. Apertures of pollen grain. Methods of collecting pollen and microscopic examination of pollen. **Aero palynology**: importance, production of air borne pollen. Role of pollen in allergy, Wind, water and insect pollinated pollens. Morphology of angiosperm and gymnosperm pollen. Application of Palynology study in botany, phylogenetic analysis, geology, archaeology, criminology, medicines, honey and oil and gas exploration.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.

- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- Role of pollen in taxonomy and identification.
- Preparation of pollen for microscopic examination.
- Collection of angiosperm pollen of dicot and preservation.
- Collection of angiosperm pollen of monocot and preservation.
- Study of microspores of bryophytes.
- Study of microspores of pteridophytes.
- Collection of plants responsible for pollen allergy.
- Study of pollinia of different plants.

Recommended Books:

- Saxen, M.R. (1993). Palynology by A, Treatise. Oxford & IBH. Co.
- Palynology: spores and pollen by Marjorie D. Munir and William Antony S.
- Jansonius J., and D. C. Mcgregor (1993). Palynology: new directions other applications and floral history.

BOT-4812 APPLIED MICROBIOLOGY 3(2+1)

Theory: **Introduction** of microbiology. Main groups of microorganisms**,** Characteristics microbes (Prions, Viroids, Viruses Rickettsia, Bacteria, Mycoplasma, Cyanobacteria, protests, Algae & Fungi). **Structure;** of microbial cells- prokaryotic and eukaryotic cells, structure of the sub cellular organisms- virus, viroids & prions. **Morphology**; ultra structure, reproduction and classification of bacteria. Major groups of bacteria. **Viruses-**; symmetry of viruses, composition, transmission, replication- plant, animal and bacterial viruses. **Immunology**-; Cells of immune systems, antigens recognition and antibody formation, acquired immunity, hypersensitivity and allergies; serology. **Microbes in Nature:** (1) Microbes in soil, water and air- general account; (2) Nitrifying and denitrifying bacteria, rhizosphere biota, phyllosphere biota and caulosphere micro flora. Microbes and microbial action in Bio-gas production, bio-fertilizers, sewage decomposition and compost formation. **Microbial spoilage of food**- aflatoxicosis, staphylococcus poisoning, botulism and salmonellosis. **Industrial microbiology**: Alcoholic beverages and bread, Microbes and Oriental fermented food- dosa, idly and appam, Microbes and microbial action involved in diary products- cheese and butter, Microbiology of single cell proteins and antibiotics.

Lab Outline:

- Different Methods of isolation of microbes
- Isolation of microbes from soil – dilution plate method.
- Isolation of microbes from different water sources – dilution plate method.
- Isolation of microbes from Air by streak plate method.
- Isolation of microbes from Juices – dilution plate method.
- Isolation of microbes from Meat, Cheese, Milk etc – dilution plate method.
- Streak out a bacterial culture on an agar plate and isolation of colonies.
- Preparation of bacterial smear – staining with methylene blue and Gram's stain.
- Measurement of turbidity of a culture using colorimeter – as indication of microbial growth.
- Microscopic examination of stained cell preparation
- Microtomy: dehydration, infiltration, cutting and staining
- Microscopic measurement of microorganisms
- Extracellular enzymatic activities of microorganisms

Recommended books:

- Ajit Kr. Banerjee and Nirmalaya Banerjee (2008). Fundamentals of Microbiology and Immunology. New Central Book Agency (P) Ltd.
- Talaro, k. and a. Talaro (1996). Foundation in Microbiology. Wm, .C. Brown. Publ. Co. N.Y.
- Ketchum, P. A. (1988). Microbiology, John Wiley and Sons. N. Y.
- Marmion, B. P. (1989). Lab Outline: medical microbiology churchil fiving stone. London and New York.
- Prescot, L.M; Herley, J. P and Klein, D.A (1999). Microbiology. 4th ed. McGraw Hill Book, Co. N.Y.

SCHEME OF STUDIES

M.Sc. IN BOTANY

DEPARTMENT OF BOTANY

SCHEME OF STUDIES of M.Sc. IN BOTANY

INTRODUCTION

The subject of Botany is a part of plant sciences which comprises on different disciplines. In M.Sc (Botany), mainly focused on study of plants, their detailed interactions with surrounding environmental factors and their role in biodiversity and conservation. The main branches of Botany such as Plant Taxonomy, Plant Systematics, Plant Physiology, Molecular Biology, Plant Biochemistry, Plant microbe interactions, Plant Genetics, Plant Ecology, Plant Microbiology, Biodiversity and conservations were studied during MSc in Botany. The students who got better GPA during two semesters taken research work/thesis related to plants.

AIMS AND OBJECTIVES OF TEACHING BOTANY IN M.Sc.

- To deliver knowledge about plants and their interactions with surrounding fields. S tudents will be enable to understand the principles and processes occured in nature and inter-relationships with other disciplines with particular reference to plant sciences.
- To teach different methods of teaching of plant sciences which bulid up good practical human in practical life and its utilization boost up future prospectives of students.
- To train students for applied studies on recently emerging technological and multidisciplinary fields such as Genetic Engineering, Biodiversity and Conservation, Environmental Science, Climatic change, Plant Biotechnology and applied perspectives reralted to plant sciences. After completing the degree / students will be able to apply their knowledge to their respective fields effectively.
- To elaborate scientific culture and professional skills in the field of teaching, applied research, industrial techniques in wide range of professions in national and international organizations.
- To facilite pepuls with knowledge and skills for better planning and management of plant resources, environment, health, medicine, agriculture and population in the country as well as interational level.
- To build up students as a well mannered and good disciplined life in future life.

Eligibility for M.Sc. in Botany:

The criteria for admission in M. Sc. in Botany:

The criterion to apply for the admission in M.Sc. Botany is B. Sc. with Botany with any two of these subjects: Chemistry/Geography/Zoolgy/ having at least second division (45% Marks). An aptitude test is conducted and final merit is computed including the academia marks. Final eligibility for admission in the Department of Botany is aggregate of both (test and academic record).

Duration:	4 – 6 Semesters
Courses:	60 Credits
Thesis/Two elective papers:	6 Credits
Comprehensive oral examination:	S/U basis
Internship/Lab Outline: training:	S/U basis
Total:	66 Credits

Item NO.4: Approval of Scheme of Studies of M.Sc. Botany for Session 2016-2018.

1st Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit Hrs
BOT-5101	Diversity of Non-Vascular Plants	3	1	4
BOT-5102	Diversity and Anatomy of Vascular Plants	3	1	4
BOT-5103	Plant Systematics	3	1	4
BOT-5104	Plant Ecology	3	1	4
Total		**12**	**4**	**16**

2nd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-5201	Plant Biochemistry	3	1	4
BOT-5202	Cell Biology	3	1	4
BOT-5203	Plant Physiology	3	1	4
BOT-5204	Genetics	3	1	4
Total		**12**	**4**	**16**

3rd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs

BOT-6301	Environmental Biology	3	1	4
BOT-6302	Biostatics and Introduction to Computer	3	1	4
BOT-6303	Research Methodology &Report Writing	2	0	2
BOT--	Elective Paper	2	1	3
BOT--	Elective Paper/Thesis	-	-	3
Total		**10**	**3**	**16**

4th Semester

Course Code	Course Title	Lect. Hrs	Lab. Hrs	Credit Hrs
BOT-6401	Microbiology	3	1	4
BOT-6402	Plant Biotechnology & Advanced Genetics	3	1	4
BOT-6405	Biodiversity and conservation	3	1	4
BOT-	Elective Paper/Thesis	-	-	3
BOT-	Elective Paper	2	1	3
Total		**11**	**4**	**18**

Approved List of Elective Courses for M.Sc. in Botany.

Course Code	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs	Approved/Not approved
BOT-6304	Recent Trends in Biotechnology	2	1	3	Approved/
BOT-6305	Plant Pathology	2	1	3	Approved
BOT-6306	Fresh Water Ecology	2	1	3	Approved
BOT-6307	Phytosociology	2	1	3	Approved
BOT-6308	Ethnobotany	2	1	3	Approved
BOT-6309	Economic Botany	2	1	3	Approved
BOT-6310	Plant Metabolism	2	1	3	Approved
BOT-6311	Plant Stress Physiology			3	Approved
BOT-6312	Physiological Genetics	2	1	3	Approved
BOT-6313	Medicinal Plants	2	1	3	Approved
BOT-6314	Plant Microbe Interaction	2	1	3	Approved
BOT-6315	Cell & Molecular	2	1	3	Approved

	Biology of Plants				
BOT-6403	Biodegradation	2	1	3	Approved
BOT-6404	Edaphology	2	1	3	Approved
BOT-6406	Environmental Pollution	2	1	3	Approved
BOT-6407	Research Techniques and Lab Tools	2	1	3	Approved
BOT-6408	Wild Plants & Their economic uses	2	1	3	Approved
BOT-6409	Palynology	2	1	3	Approved
BOT-6410	Bioinformatics	2	1	3	Approved
BOT-6411	Mycorrhizae	2	1	3	Approved
BOT-6413	Molecular Genetics	2	1	3	Approved
BOT-6414	Plant Anatomy	2	1	3	Approved
BOT-6415	Virology and Bacteriology				
BOT-6416	Thesis			6	Approved

NOTE: The Course outline of the said scheme have been already approved in 2nd and 4th Departmental Councils and it is included here for compilation as one Document of Department Council for record and future use.

Item NO.5: Approval of scheme of studies of M.Sc. in Botany for Session 2018 and Onward Sessions.

1st Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-5101	Bacteriology & Virology	2	1	3
BOT-5102	Mycology & Plant Pathology	2	1	3
BOT-5103	Phycology & Bryology	2	1	3
BOT-5104	Diversity of Vascular Plants	2	1	3
BOT-5105	Plant Systematics	2	1	3

BOT-5106	Biostatistics	2	1	3
Total		**10**	**5**	**18**

2nd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-5201	Plant Anatomy	2	1	3
BOT-5202	Cell Biology	2	1	3
BOT-5203	Genetics-I	2	1	3
BOT-5204	Plant Biochemistry-I	2	1	3
BOT-5205	Plant Ecology-I	2	1	3
BOT-5206	Plant Physiology-I	2	1	3
Total		**12**	**6**	**18**

3rd Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-6301	Molecular Biology	2	1	3
BOT-6302	Plant Biochemistry- II	2	1	3
BOT-6303	Plant Ecology-II	2	1	3
BOT-	Research Thesis/ Elective-I	-	-	3
BOT-	Elective-II	2	1	3
Total		**8**	**4**	**15**

4th Semester

Course Code	Course Title	Lect.Hrs	Lab. Hrs	Credit.Hrs
BOT-6401	Plant Physiology –II	2	1	3
BOT-6402	Genetics-II	2	1	3
BOT-6403	Environmental Biology	2	1	3
BOT-	Research Thesis/ Elective-III	2/0	1/3	3
BOT- ----	Elective-IV	2	1	3
Total		**10/8**	**5/7**	**15**

Approved List of Elective Courses for M.Sc. in Botany.

Course Code	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs	Approved/Not approved
BOT-6304	Recent Trends in Biotechnology	2	1	3	Approved
BOT-6305	Plant Pathology	2	1	3	Approved
BOT-6306	Fresh Water Ecology	2	1	3	Approved
BOT-6307	Phytosociology	2	1	3	Approved
BOT-6308	Ethnobotany	2	1	3	Approved
BOT-6309	Plant Stress Physiology	2	1	3	Approved
BOT-6310	Plant Metabolism	2	1	3	Approved
BOT-6311	Medicinal Plants	2	1	3	Approved
BOT-6312	Physiological Genetics	2	1	3	Approved
BOT-6313	Plant Microbe Interaction	2	1	3	Approved
BOT-6314	Economic Botany	2	1	3	Approved
BOT-6315	Cell & Molecular Biology of Plants	2	1	3	Approved
BOT-6404	Biodiversity and Conservation	2	1	3	Approved
BOT-6405	Edaphology	2	1	3	Approved
BOT-6406	Biodegradation	2	1	3	Approved
BOT-6407	Environmental Pollution	2	1	3	Approved

BOT-6408	Research Techniques and Lab Tools	2	1	3	Approved
BOT-6409	Wild Plants & Their economic uses	2	1	3	Approved
BOT-6410	Palynology	2	1	3	Approved
BOT-6411	Bioinformatics	2	1	3	Approved
BOT-6412	Molecular Genetics	2	1	3	Approved
BOT-6413	Mycohrrizae	2	1	3	Approved
BOT-6414	Thesis			6	Approved

NOTE: All the course ouline of M.Sc. programme are already approved from 4th Departmental Council and Faculty Council, added here for only compilation, as one document.

BOT-5101 BACTERIOLOGY AND VIROLOGY 3(2+1)

Theory: a) Viruses; General features of viruses, viral architecture, classification, dissemination and replication of single and double – stranded DNA/RNA viruses. Plant viral taxonomy.Virus biology and virus transmission. Molecular biology of plant virus transmission. Symptomatology of virus-infected plants: (External and Internal symptoms). Metabolism of virus-infected plants. Resistance to viral infection. Methods in molecular virology.

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

c) Plant microbe interaction: plants relationship with different microbes i.e virus, bacteria and fungi, their remedial mechanisms.

Lab outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- Study of bacterial cell structure using compound microscope.

- Elucidation of ultrastructure of virus from electron microphotographs.
- Measurement of bacterial cell size.
- Preparation of temporary and permanent slides of different bacteria from fresh cultures.
- Gram staining, gram positive and gram negative bacteria.
- Observation of symptoms of some viral infected plant specimens.
- Methods of sterilization of glassware and media etc.
- Preparation of nutrient medium and inoculation.
- Growth of bacteria, sub culturing and identification of bacteria on morphological and biochemical basis (using available techniques).
- Microscopic study of representative genera of Actinomycetes from fresh collection and prepared slides.
- Microscopic study of representative genera of Cyanobacteria from fresh collections and prepared slides.
- Microscopic study of binary fission in bacteria.
- Observation of symptoms of some viral infected plant specimens.

Recommended Books:

- Black, J. G. (2005).Microbiology - Principles and Exploration, John Wiley and Sons, Inc.
- Prescott, L. M., Harley, J. P. and Klein, D. A. (2005). Microbiology McGraw-Hill Companies, Inc.
- Arora, D. R. (2004). Textbook of Microbiology, CBS Publishers and Distributors, New Delhi.
- Ross F. C. (2000). Fundamentals of Microbiology. John Willey & Sons, New York.
- Khan, J. A. and Dijkstra J. Plant Viruses as Molecular Pathogens. The Haworth Press, Inc.

BOT-5102 MYCOLOGY AND PLANT PATHOLOGY 3 (2+1)

Theory: a) Mycology: Introduction: Brief history of Mycology**.** General characters of fungi**,** Concept of fungal thallus, cell structure and ultrastructure of fungi. **Reproduction:** Asexual and sexual reproduction, reproductive structures, life cycle, haploid, heterokaryotic and diploid states. Homothalism and heterothallism. **Fungal Systematics:** Classification of fungi with suitable examples to illustrate somatic structures, life cycle and reproduction of

Chytridiomycota (Chitridiales - Chitridia), **Oomycota** (Peronosporales - Peranospora), **Zygomycota** (Mucarales - Mucor), **Ascomycota** (Erysiphales - Erysiphae), **Basidiomycota** (Agaricales - Agaricus, Polyporales – Polyporus, Ustilaginales - Ustilago) and **Deuteromycota**. **Symbiotic relationships** of fungi with other organisms (lichens and mycorrhiza) and their significance.

b) Fungal Pathology: Introduction of fungal pathology and classification of plant diseases caused by fungi, Development of plant diseases. Epidemiology and disease forecast. Reproduction and disease cycles of some important diseases of crops, plants and fruit trees in Pakistan caused by fungi, e.g. Rust of crops and vegetables, Black smut of crops and vegetabes, Damping off, Downy mildew, Powdery mildew, dieback, red rot of sugarcane, root rots, wilting, Fusarium head blight (FHB), Early blight of potato, Late blight of potato.

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

Lab Outline:

- Study and collection of different locally available types of macroscopic fungi
- Analysis and identification of different microscopic fungal pathogens present on different plant parts by direct culture plate method
- Basic mycological techniques for identification of fungal species
- Identification of fungi by Direct Plate Method from soil
- Isolation of fungi by Serial Dilution Agar Plate Method from soil samples
- Detection of fungi from air by Direct Plate Method
- Identification of fungi by Baiting Technique from water
- Isolation and identification of different aquatic fungi by Direct Plate Method
- Isolation of drinking water fungal spores by Baiting Method
- Isolation and identification of soil fungi by soil culture plate method
- Culture of deep layer soil fungal spores by Serial Dilution Agar Plate Method
- To assess the effect of pH on fungal growth
- To check the effect of temperature on fungal sporulation
- Analysis of fungal growth rate after exposure to light
- Effect of darkness on fungal culture
- To evaluate the effect of nutrients on growth and sporulation of fungal species.

Recommended books:

- Alexopoulos, C.J., Mims C.W and M. Blackwell. (2017). Introductory mycology (4thed), Jhon Wiley & Sons, New York.
- L. N. Nair (2013). Topics in Mycology and Plant Pathology. New Central Book Agency (P) Ltd, London.
- Ram KrushnaKar, NiharManjariMisra (2012). Text Book on Fungi. Kalyani Publishers Ludhiana- New Delhi, India.
- Khan, A. G. and Usman, R., (2005). Laboratory Manual in Mycology and Plant Pathology. Botany Department Arid Agriculture University, Rawalpindi.
- Trigiano, R. N., Windham, M. T. and Windham, A. S., (2004). Plant Pathology: Concepts and Laboratory Exercises. CRC Press, LLC, N.Y.

BOT-5103 PHYCOLOGY AND BRYOLOGY 3(2+1)

Theory: **(a) Phycology;** definitions by different phycologist, history and classification. Introduction, general account (general and diagonestic characteristics, occurance, structure of plant body, cell structure, reproduction) evolution and classification of the following algal divisions; **Chlorophyta, Charophyta**, **Xanthophyta, Bacillariophyta**, **Phaeophyta** and **Rhodophyta.** Algae as a potential source of biofuel, soil algae and symbiosis, economic importance and ecology of algae.

(b) Bryology: Introduction and general account of bryophytes, classification, theories of origin and evolution. Brief study of the classes: **Hepaticopsida** (Marchantia), **Anthoceropsida** (Anthocerose), **Bryopsida** (Funaria).

Lab Outline:

- Methods of preparation of temporary and permanent slide.
- Use of camera lucida/micrographs.
- Field trips to study various habitats of algae including ponds, ditches, streams, slow running water and water reservoir.
- Different methods for the collection of algal sample.
- Macroscopic and microscopic study of common, locally available types representing various taxonomic groups of Algae.
- Collection & microscopic study benthonic algae.
- Section cutting of thalloid algae.
- Study of globule and nocule of chara.
- Visits to study bryophytes in their natural habitats.

- Different methods for the collection of bryophytes sample.
- Study of sporophytic and gametophytic plant body of locally available species of bryophytes.
- Collection and identification of locally available species of bryophytes with online available literature.

Recommended books:

- Vashishta, B.R, A.K Sinha and V.P Singh. (2000). Algae, botany for degree students. S.Chand & Company, New Delhi.
- Bhatangar, S.K, A. Saxena & S. Kraan. (2011). Algae biofuel. Stadium press India.
- Acharia, J. (2008). Handbook of Algae. Rajat publications, New Delhi.
- Sharma, O.P. (2011). Algae. McGraw Hills Education Private Limted.
- Pandey, S.N, S.P Misra & P.S Trivedi. (2008). A text book of botany Vol II, 12th ed, Bryophytes, Pteridophytes and Palaeobotany.
- Schofield, W.B. (1985). Introduction to Bryology. Macmillan Publishing Co. London.

BOT-5104 DIVERSITY OF VASCULAR PLANTS 3 (2+1)

Theory: a) Pteridophytes: Introduction, origin, history, features and a generalized life cycle. **Methods of fossilization**, types of fossils, geological time scale and importance of paleobotany. General characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilopsida *Psilotum*), Lycopsida (*Lycopodium, Selaginella*), Sphenopsida (*Equisetum*), Pteropsida (Adiantum, *Dryopteris* and *Marsilea*).

b) Origin and Evolution of seed habit.

c) Gymnosperms: Introduction, Geological history, origin, distribution, morphology, anatomy, classification and affinities of Cycadofillicales, Bennettitales, Ginkgoales, Cycadales and Gnetales. Economic importance of gymnosperms.

d) Angiosperms: Origin, general characteristics, Importance, and life cycle of angiosperms. Life form of one monocot and two dicot plant families.

e) Palynology: An introduction to Neopalynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey and oil and gas exploration.

Lab Outline:

- Methods of preparation of temporary slides.
- Methods of preparation of permanent slides.

- To study the morphological and reproductive features of available genera of Pteridophytes.
- To study the morphological and reproductive features of available genera of Gymnosperms.
- To study the morphological and reproductive features of available genera of Angiosperms.
- To study the anatomical differences in monocot and dicot leaves.
- To study the anatomical differences in monocot and dicot stem
- To study the anatomical differences in monocot and dicot roots.
- Study trips to different parts of Pakistan for the collection and identification of important pteridophytes, gymnosperms and angiosperms.
- Herbarium sheets preparation of collected genra from different parts of Pakistan and AJK.
- Study of pollen morphology

Recommended Books:

- Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Pterodophyta. S. Chand & Co. New Delhi.
- Vashishta, B. R., A. K. Sinha and A. Kumar. 2010. Gymnosperms. S. Chand & Co.
- Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
- Taylor, T. N. and Taylor, E. D. 2000. The Biology and Evolution of Fossil Plants, Prentice Hall.
- B. P. Panday. 2006. College Botany. Vol 1 & II. S. 7th Edition. Chand & Co. New Delhi.

BOT-5105 PLANT SYSTEMATICS 3(2+1)

Theory: Introduction, aims and objectives, major goals and evolution of angiosperms. Concept of species and speciation. **Types of speciation**, reproductive isolation. **Variation**: types, continuous and discontinuous variations. **Taxonomic evidences:** importance and types of taxonomic evidences such as anatomical, cytological, chemical, molecular, palynological, geographical and embryological. **Classification:** Importance, brief history, description of classification system of Linnaeus, Bentham and Hooker, Engler and Prantl, Takhtajan and Dahlgren. **Nomenclature;** Brief introduction, importance of Latin names and binomial

system with an introduction to International Code of Botanical Nomenclature (ICBN). Vienna code. Origin of Angiosperms, General characteristics, distribution and economic importance of following families of angiosperms: Apocynaceae, Arecaceae (Palmae), Asclepiadaceae, Asteraceae (Compositae), Chenopodiaceae, Euphorbiaceae, Liliaceae, Malvaceae, Moraceae, Ranunculaceae, Rutaceae, Umbelliferae (Apiaceae).

Lab outlines:

- Technical description of plants of the local flora and their identification upto species level with the help of the Flora of Pakistan
- Technical description of vegetative parts of plants
- Technical description of flowers & inflorescence
- Technical description of fruit and placentation
- Preparation of permanent slide of Pollen grain by acetolysis method and study of different pollen characters.
- Study trip to a local area to evaluate the plants technically
- Study trip for plant collection
- Working in herbarium for submission of properly mounted and fully identified 50 herbarium specimens preparation for terminal examination
- Field trips shall be undertaken to study plants from different ecological zones of Pakistan

Recommended Books:

- Ali, S.I. and Nasir, Y.J. (1970-1992). Flora of Pakistan. Nos. 71, 131, 145, 126, 172, 36, 54, 100, 171, 132, 20, 75, 152. Department of Botany, University of Karachi.
- Ali, S.I. and Qaiser, M. (1992-2010). Flora of Pakistan. Nos. 204, 207, 201, 215. Department of Botany, University of Karachi.
- Davis, P.H. and Heywood, V.H. (1963). Principles of Angiosprms Taxonomy. Oliver and Boyd, London.
- Lawrence G.H. (1951). Taxonomy of Vascular Plants. Prentice Hall College Div.
- Levin, D.A. (2000). The Origin, Expansion and Demise of Plant Species. Oxford University Press.
- Malik, T.A. (1996). Principles of Botany. The Carvan Press Darbar Market, Lahore.
- Pullaiah, T (2007). Taxonomy of Angiosperms 3rd Ed. Regency Publication, New Delhi.

- Sharma, O.P. (1993). Plant Taxonomy. Tata McGraw-Hill 7 Patel Nagar, New Delhi.
- Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.

BOT-5106 BIOSTATISTICS 3(2+1)

Theory: Introduction and scope, definition, characteristics, importance and limitation, of population and samples. **Frequency distribution** and probabilities. Formation of frequency table from raw data, histograms. Different methods of data representation. Measures of central tendencies and dispersion. **Measurign of arithmetic** mean, medium, mode, range, variance and standard deviation, standard error of the mean (SEM), mean deviation, **experimental designing** as CBD, RCBD and seminterquartile range.

Determination of Tests of significance: T-test: Basic idea, confidence limits of means. Significant difference of means, **X^2 –test**: Basic idea, testing goodness of fit to a ratio, testing association (contingency table), **F-test**: introduction and application in analysis of variance, ANOVA-I and ANVOA-II, L.S. D. test, **Dancunm Multiple Range test** (DMRT). PCA, DCA and CCA test. **Ethnomedicinal tests** for data analysis such as ICF, FL, DMR, PR, UV, FI, Biostatistical test used in Ecology (shanon test etc), Biodiversity Conservation Analysis by IBCD, Genetics, Mycology and Systematics.

Lab Outline:

- Probability of simple events.
- Data collection, arrangement of data in frequency table
- Calculation of mean from group and ungrouped data
- Calculation of variance and standard deviation from grouped and un-grouoed data.
- T-test
- X^2 –test.
- Analysis of variance –one factor design
- Analysis of variance –two way analysis
- Analysis of variance – for factorial design.
- Correlation/ PCA, CCA
- Linear Regression
- Ethnobotany test: ICF, FL, DMR, RR, VVs

Books Recommended:

- Bailey .N.T.J. (1993). Statistical Methods in Biology, Cambridge University Press.
- Quinn, G. (2002). Experimental Design and Data Analysis for Biologist.Cambridge University Press.
- Wonnacott, T. H. and Wonnacott, R, J. (1990). Introductory Statistics,John Willey and sons.

BOT- 5201 PLANT ANATOMY 3(2+1)

Theory: Definition, introduction and brief history of plant anatomy. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body. **Meristematic tissues;** classification, characteristics, initials and their derivatives. **Apical meristem;** different growth zones, evolution of the concept of apical organization. Shoot and root apices. Origin, structure, functional and evolutionary specialization of the **following tissues;** Epidermis, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem and Periderm. **Anatomical** differences of Monocot and dicot; stem, root, leaves, flowers and seeds.Guard cells. **Vascular cambium;** its structure, storied and non-storied cell types, additive and multiplicative division, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth. **Trichomes and Secretory tissues;** Laticifers and Resin Canals.

Lab outline:

- Methods of preparation of temporary slides.
- Methods of preparation of perment slides.
- Different techniques for section cutting.
- Anatomical differences of monocot and dicot root by slide preparation.
- Anatomical differences of monocot and dicot stem by slide preparation.
- Anatomical differences of monocot and dicot leaves by slide preparation.
- Anatomical differences of angiosperms and gymnosperms.
- Study of orginization of parenchyma, collenchymas, sclerenchyma, xylem and phloem in stem.
- Observation of guard cell in the leaves of different plants.
- Collection and observation of monocot and dicot flowers differences.
- Identify the parts of a leaf and distinguish between compound and simple leaves.
- Anatomical differences of collateral and bicollateral (curcurbitaceae) vascular bundles in stem.

- 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.
- Study of abnormal/unusual secondary growth.
- Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.

Recommended Books:

- Katherine, Esaus (2006). Esaus plant anatomy, 3rd edition. Jhon Wily and Sons.
- Pijush Roy. (2010). Plant Anatomy. New Central Book Agency, New Delhi.
- Dickison, W. C. (2000). Integrative plant anatomy. Academic Press, U. K.
- Fahn, A. (1990). Plant Anatomy. Pergamum Press, Oxford.
- Esau, K. (1960). Anatomy of Seed Plants. John Wiley, New York.
- Anon. Manual of Microscopic Analysis of Feeding Stuffs. The American Association of feed Microscopists.

BOT-5202 CELL BIOLOGY 3(2+1)

Theory: Definition and brief account of cell biology. Introduction to prokaryotic and eukaryotic cell. Cell Theory. **Structure of plant cell**: **cell wall;** physiochemical nature, ultra structure. **Cell membrane;** structure, characteristics**,** Permeability of cell membrane, membrane transport, receptor proteins and cell to cell interaction. **Cytoskeleton,** history, ultra-structure and function of cell organelles (Golgi boidies, mitochondria, endoplasmic reticulum, vacuoles, plastids, ribosomes and nucleus). Ultra structure of Mitocondria and Plastids, **Chromosomes;** morphology and molecular structure of prokaryotic and eukaryotic chromosomes, Significance of histone and high mobility proteins in packing of chromosomes and gene expression.**Cell cycles;** synchronizing, ananlysis of control and mode of control of cell cycle. Importance for growth and development of multicellular organisms. **Cell divsions** types i.e. Mitosis and meiosis, their cell cycles with diagrams, cell injury and recovery mechanisms in plants.

Lab outline:

- Rules of lab use, lab biosafety and bioetheics.
- Methods of preparation of temperory and permenant slides.
- Techniques of section cutting.
- Differential staining techniques.

- Study of plastids in various plant; *Spirogyra, Tradescantia, Daucus carrota, Solanum tuberosum, Solanum Lycopersicon* and *Citrus.*
- Mitosis: smear/squash preparation of onion roots
- Meiosis: Smear/squash preparation from anthers of plants.
- Germination of pollen grains of various vascular plants.
- Microchemical detection of the protein in the structure of the plant cell.
- Microchemical detection of the carbohydrates in the structure of the plant cell.
- Microchemical detection of the cellulose in the structure of the plant cell.
- Microchemical detection of the lipids in the structure of the plant cell.
- Microchemical detection of the cutin and pectin in the structure of the plant cell.

Recommended books:

- De, Robertis, E.P and De, Robertis, E.M.F. (2008). Cell and molecular biology 8thEdition, Holt Lea and Febiger, New York.
- Roy, S.C & K. Kumar (2011). Cell Biology. New Central Book Agency, Delhi.
- Verma, P.S & V.K Agarwal. (2000). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S.Chand and Co., New Delhi.
- Lodish, H. Baltimor, D. Berk, A. Zipurshy, S.L. Matsudaira, P. Darnell, J. (2001). Molecular biology of the cell. Scientific American books, W.H. Freeman and Company, New York.
- Abert B.B, J. Dlewis, M. Raff, K. Robert, and J.D. Watson, (1994). Molecular Biology of the Cell. Garland Publishing Inc New York.

BOT- 5203 GENETICS-I 3 (2+1)

Theory: Extensions of Mendelian Analysis: Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity**. 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. **Linkage II:** Special Eukaryotic Chromosome Mapping Techniques: Accurate calculation of large map distances, analysis of single meioses, mitotic segregation and recombination, mapping human chromosomes.**The Structure of DNA:** The genetic material, DNA replication in eukaryotes, DNA and the gene. **The Nature of the Gene:** How genes work, gene- protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites,

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

The Extranuclear Genome : Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochrondrial genes in yeast, extragenomic plasmids in eukaryotes. **Developmental Genetics:** Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease. **Population Genetics:** Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration
- Numerical problems related to arrangement of genetic material.
- Numerical problems related to linkage and recombination.
- Numerical problems related to gene mapping in diploid.
- Numerical problems related to recombination in Fungi.
- Recombination in bacteria
- Recombination in viruses.
- Population Genetics: calculation of gene frequencies and equilibrium.
- Population Genetics: calculation of changes in gene frequencies.
- Determination of Blood group and Rh-factor.
- Culture techniques of drosophila.
- Microscopic study of Salivary gland chromosome of Drosophila.
- Fungal Genetics: Saccharomyces culture techniques and study.
- Studies on variation in maize ear size and color variation.
- Bacterial Genetics.
    iv. Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
    v. Transformation.
    vi. Conjugation.

Recommended Books:

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

- Synder, L, and Champness, W. (2004). Molecular Genetics of Bacteria. ASM Press, Washington D. C.
- Klug, W. S. and Cummings, M. R. (2000). Concepts of Genetics, Prentice Hall International Inc.
- Roth Well, N. V. (2001). Understanding Genetics, 2nd Edition, Oxford University Press Inc.

BOT-5204 PLANT BIOCHEMISTRY-I 3 (2+1)

Theory: Carbohydrates: Definition,Occurrence, classification and scope of carbohydrates. Structure elucidation, chemical composition and significance of deoxy-ribsose D-glucose, sucrose, maltose, starch, glycogen, cellulose, hemicellulose, mucilages, pectins and lignins. **Lipids:** Definition, occurrence, classification and scope of Lipids. Structure elucidationand chemical composition and significance of fatty acids, triglycerides, phospholipids, glycolipids, sulpholipids, waxes, cholesterol and sterols. **Proteins:** Definition, occurrence, classification and scope of Proteins. Structure elucidationand chemical composition, properties of all amino acids. Protein targeting, posttranslational modifications (PTMs). Transport, storage, regulatory and receptor proteins. **Nucleic Acids:** Definition,Occurrence, classification and scope of nucleic acids. Structure elucidation, chemical composition and significance of DNA and RNA. DNA and RNA formation, storage and movement mechanism. **Enzymes:** Definition, occurrence, classification and scope Enzymes. Structure elucidation, chemical composition and significance of Isozymes, ribozymes, abzymes. Enzyme specificity and modals of enzyme action, Enzyme kinetics, Nature of active site and mode of action. Allosteric enzymes and feedback mechanism.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit lab to be familiar with instruments and learn operating methods, principles and calibration.
- To learn how to measure pH of any solution/ solvent using litmus paper and digital pH meter.
- To prepare basic 1 Molar, 0.5 Molar, 1 Molal, 0.01 Molal and 1 Normal solutions of any given salts and liquids; and buffer formation.
- To learn detect and confirm presence of glucose, sucrose, lactose, cellulose and starch in the given solution.

- To detect presence of proteins in the solution by using chemical test methods and its estimation by Biuret or Lowry or Dye-binding method.
- To extract and estimate oil from plant material using soxhlet apparatus.
- To extract leaf and seed proteins and their estimation by Biuret or Lowry or Dye-binding method.
- To extract of DNA from plant material leaf and seed
- To extract RNA from different parts of plant
- Estimation of DNA and RNA by UV absorption orcolour reactions.
- Estimation of chlorophyll contents in leaf
- Estimations of primary metabolites in given part of plant- leaf/seed
- Estimation of secondary metabolites from plant leaf

Recommended Books:

- R.K Murray, D.K Grannar, V. W. Rodwell (2010). Biochemistry, 27th Ed. McGraw-HilHarpers Illustrated.
- Lehninger, A.L., Nelson, D.L. and Co. N.M., (2008). Principles of Biochemistry. W. H. Freeman; 5th edition.
- D. J. Voet, G.J. Voet and C. W. Pratt. (2008). Fundamentals of Biochemistry. 3rd Ed., J. Wiley & Sons Inc.
- Conn E E. and Stumpf P.K., (2002). Outlines of Biochemistry, John Wiley and Sons Inc.New York.
- P. J. J., Haykaas, M.A. Hall, & K.R. (1999). Libbenga,Biochemistry and Molecular Biology of Plant Hormones. Edited by Science Pub.Co.

BOT-5205 PLANT ECOLOGY-I 3(2+1)

Theory: Introduction: history and recent developments in ecology. **Soil:** Distinction between Edaphalogy and Pedology. Nature and properties of soil (Physical and Chemical Characteristics), Soil formation, Texture, Structure and porosity. Inorganic and organic components component of soil. Living Inhabitants of soil, pH. and conductivity. **Water:** Soil-Plant atmosphere system; Atmospheric moisture, Forms of Precipitation and ecological effects, Plant- water relationship, Water balance of plants, Water status in soil, Adaptation based on water availability, Role of water in the diversity of plants. **Light and Temperature**: Nature of light, Physical properties of Light, Effect of shade, altitude, latitude, high or low

pressure system, Adaptation to temperature extremes. Ecological response to warm, chilling and freezing temperature. Photoperiodism, Thermoperiodism, Role of temperature in the diversity of plant. **Wind** and **Fir**e as ecological factor.

Lab Outline:

- Determination of physico-chemical properties of soil.
- Determination of physico-chemical properties of water.
- Determination of Soil texture.
- Determination of Soil structure.
- Measurements of light under different ecological conditions.
- Measurements of temperature under different ecological conditions.
- Measurements of wind velocity.
- Measurement of soil conductance by electrical conductivity meter.
- Determination of Humidity by Hygrometer.
- Determination of soil pH by using pH meter.
- Measurement of water relation components: conductance
- Effect of Light and temperature on germination and growth of plants.
- Effect of moisture and salinity on germination and growth of plants.

Recommended Books:

- M. Ahmad and S. S. Shaukat. (2012). A test book of vegetation ecology. Publisher Abrar Sons New Urdu Bazar Karachi.
- Chapin, F. S. et al. (2002). Principle of Terrestrial Plant Ecology, Springer-Verlag
- Barbour, M. G., Burke, J. H and Pitts, W. D. (2004). Terrestrial Plant Ecology, The Benjamin, Cumming Publishing C. Palo Alto, California, USA.
- Hussain. F. (1989). Field and Laboratory Manual of Plant Ecology, National Academy of Higher Education, Islamabad.
- Moree. P. D. and Chapman S. B. (1986). Methods in Plant Ecology, Blackwell Scientific Publication Oxford.

BOT-5206 PLANT PHYSIOLOGY-I 3(2+1)

Theory: Photosynthesis: Introduction. Nature and units of light. Determination of oxygenic and anoxygenic photosynthesis. Ultrastructure of thylakoid vesicle and Various pigments. Absorption and action spectra of different pigments. Mechanism of photosynthesis - light absorption, Photophosphorylation and its mechanism. CO_2 reduction (dark reactions) - C3

pathway and Photorespiration, C-2 Cycle and its consequences, C4 pathway and its different forms, C3-C4 intermediates, CAM pathway. Methods of measurement of photosynthesis.

Respiration: Introduction. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respitaion.

Translocation of Food: Introduction. Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.

Leaves and Atmosphere: Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation. **Assimilation of Nitrogen, Sulphur and Phosphorus**: The nitrogen cycle. Nitrogen fixation. Pathways of assimilation of nitrate and ammonium ions. Pathways of assimilation of sulphur and phosphorus.

Lab Outline:

- Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
- To determine the volume of CO_2 evolved during respiration by plant material.
- To determine the amount of O_2 used by respiring water plant by Winkler Method.
- Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
- Measurement of leaf water potential by the dye method.
- Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a potometer/cobalt chloride paper method.
- Separation of chloroplast pigments on paper chromatogram and their quantification by spectrophotometer.
- Study of Absorption Spectra using Spectrophotometer
- To categorize C3 and C4 plants through their anatomical and physiological characters.
- To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
- To regulate stomatal opening by light of different colours and pH.

Recommended Books:

- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.

- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Salisbury F.B. and Ross C.B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- W.B. Hopkins. (1999). Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.
- Barton, W. (2007). Recent Advances in Plant Physiology.

BOT-6301 MOLECULAR BIOLOGY 3 (2+1)

Theory: Introduction, history and importance of molecular biology. **Nucleic Acids**; DNA-circular and superhelical DNA. Denaturation, Renaturation, hybridization and synthesis of DNA. **Proteins:** Basic features of protein molecules. Folding of polypeptide chain, α-helical and β-secondary structures. **Transcription;** Enzymatic synthesis of RNA and transcriptional signals. Translation, genetic code, Wobbling, polycistronic and monocistronic RNA. Overlapping genes. **Gene regulation in Eukaryotes;** Differences in genetic organization in 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. **Plant Omics:** Transcriptomics; DNA libraries, their construction, screening and application. **Proteomics;** structural and functional proteomics. Methods to study proteomics. **Metabolomics;** methods to study metabolomics, importance and application of metabolomics. **Bioinformatics and computational biology**. Levels, scope, potential and industrial application of bioinformatics and computational biology.

Lab Outline:

- Preparation of different types of solution.
- Micropipeting
- Microcentrifugation
- Agrose gel preparation
- Preparation of CTAB solution
- Extraction of DNA by two different protocols
    - Analysis of DNA by agarose gel electrophoresis
    - Amplification of extracted DNA by PCR
    - Purification of PCR product and its confirmation
- Extraction of RNA from plant source

- Purification of RNA
- Extraction of protein from plant source
  - Purification of proteins
- Electrophoreses: One dimensional

Recommended Books:

- Lodish, H. Baltimor, D. Berk, A. Zipurshy, S.L. Matsudaira, P. Darnell, J. (2001). Molecular biology of the cell. Scientific American books, W.H. Freeman and Company, New York.
- Cullis, C. A. (2004). Plant Genomics and Proteomics. Wiley-Liss, New York.
- Gibson, G. and S. V. Muse, (2002). A Premier of Genome Science, Sinauer Associates Inc. Massachusetts.
- Lodish, H. et al., (2004). Molecular Cell Biology. 5th Edition. W. H. Freeman & Co., New York.
- Malacinski, G. M. (2003). Essentials of Molecular Biology, 4th Edition. Jones and Bartlett Publishers, Massachusetts.

BOT-6302 PLANT BIOCHEMISTRY-II 3 (2+1)

Theory: **Bioenergetics:** Energy, laws about energy changes. Oxidation and reduction in livingsystems. **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. **Replication of DNA**. Reverse transcription. Biosynthesis of DNA and RNA. Components of protein synthesis, Genetic code, **Protein synthesis:** initiation,elongation and termination. **Alkaloids:** Occurrence, physiological effects, chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role. **Terpenoids:** Classification: monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis.**Vitamins:** General properties and role in metabolism.

Lab Outline:

- Basic introduction to Lab hi-tech Instruments i.e. 1-DE; 2-DE and PCR
- Extraction of Proteins from leaves and seeds of plants and their purification
- Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis (1-DE).
- Estimate the amount of vitamin C in a plant organ (orange, apple juice)
- To determine potential alkaloids in plants.

- To estimate terpenoids in plants.
- To quantify saponins in plants.
- To estimate flavonoids in plants.
- To estimate chlorophyll contents in plants
- To Extract DNA from plant leaf and other partsTo run and analyze DNA by using PCR/ Gel electrophoresis approach
- To Extract RNA from plant leaf and other partsTo run and analyze DNA by using PCR/ Gel electrophoresis approach

Recommended Books:

- Conn E. E. and Stumpf, P.K. (2002). Outlines of Biochemistry, John Wiley and Sons Inc.New York
- Smith; E L., Hill; R. L., Lehman; R. I., Lefkowits, R J. and Abraham. H. (2012). Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw HillInternational Book Company.
- Zubay. G. (2003). Biochemistry, MacMillan Publishing Co., New York.
- Chesworth,. J.M., Strichbury T. and Scaife, J. R. (1998). An introduction to agricultural biochemistry. Chapman and Hall, London.
- Heldt, H-W. (2008). Plant Biochemistry. 3rd Edition, Academic Press, U.K.
- Campbell, M.K. and F. Shawn. (2008). Biochemistry 6th Edition.

BOT-6203 PLANT ECOLOGY-II 3 (2+1)

Theory: Plant community: Discrete and continuum concepts with modern synthesis. Community Attributes, Leaf Spectra, Life form distribution patterns, periodicity, phynology, species maturity and age class etc. **Vegetation:** Local vegetation and vegetation of Azad Kashmir and Pakistan. **Species diversity concepts**: plant community structure, plant community dynamics (succession). **Methods of** sampling of plant community**:** Quadrate line intercept, point centered quarter methods. **Quantitative community description:** Gradients, Ordination and classification, productivity, measurement, energy -flow and efficiency. **Population Ecology:** Population structure and plant demography, ecological amplitude and law of tolerance, characteristics of populations. **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. **Seed Bank** and seed dispersal patterns**.**

Lab Outline:

- Determination of seed bank in various populations.
- Seed dispersal pattern of local populations.
- Study of community attributes.
- Sampling of vegetation including Quadrat method.
- Sampling of vegetation including plotless method.
- Sampling of vegetation including transect method.
- Determination of biological spectrum and leaf size spectra.
- Measurement of regeneration capacity of forest.
- Observation of palatability and non palatability.
- Correlation of soil properties with vegetation type.
- Field trip to study different communities located in different ecological regions of Azad Kashmir.
- Slide show of the vegetation of Pakistan.
- Slide show of the major formations of the world.

Recommended Books:

- Ahmad, M. and S. S. Shaukat. (2012). A text book of vegetation ecology. Publisher Abrar Sons, New Urdu Bazar, Karachi.
- Townsend C. R. Begon. M and J. L. Harper (2002). Essentials of Ecology. Blackwell Publishing.
- Chapin, F.S. et al. (2002). Principle of Terrestrial Plant Ecology. Springer-Verlag.
- Barbour M. G. et al., (1999). Terrestrial Plant Ecology. The Benjamin-Cumming Publishing Co.
- Moore P.D. and Chapman S. B. (1986). Methods in Plant Ecology. Blackwell Scientific Publication, Oxford.
- Hussain, F. (1989). Field and Laboratory Manual of Plant Ecology. National Academy of Higher Education. Islamabad.

BOT-6401 PLANT PHYSIOLOGY-II 3 (2+1)

Theory: Water Relations: The soil -plant -atmosphere continuum . Structure and properties of water. Mechanism of absorption of water in plants. Aquaporins,-their structure and types. Cell water relations terminology. **Plant Mineral Nutrition:** Introduction to macro and micro nutrients. Absorption of mineral nutrients. 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. **Plant Growth Regulators:** Introduction, Major natural hormones and their synthetic analogues. Bioassay, biosynthesis, mode of action, transport and physiological effects of Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene. **Phytochromes:** Introduction. Discovery and physical and chemical properties of phytochromes. Distribution of phytochromes among among species, cells and tissues and their role in biological processes. photoperiodic induction. Role of photoperiodism in flowering. Vernalization and its effect on flowering. **Dormancy;** Definition, causes and methods to break seed dormancy. **Plant Movements;** Introduction to plant movements, Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements.

Lab Outline:

- To investigate the preferential absorption of ions by corn seedlings and potato slices.
- To determine osmotic potential of massive tissue by freezing point depression method or by an osmometer.
- To investigate water potential of a plant tissue by dye method and water potential apparatus.
- Determination of K uptake by excised roots.
- Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
- Determination of carbonates and bicarbonates in water
- Qualitative determination of K content in Guard cells by Sodium cobalt nitrite method.
- Demonstration of effect of Auxin on elongation of Barley Seedling
- Effect of Gebberillines on Growth of Lettuce
- Effect of Kinetin on Callus, Tissue Culture
- Demonstration of phototropic and geotropic movements in plants

Recommended Books:

- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.

- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Fitter, A. and Hay, R. K. M. (2001). Environmental Physiology of Plants. Academic Press, UK.
- W. B. Hopkins. (1999). Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York.

BOT-6402 GENETICS-II 3(2+1)

Theory: **Recombinant DNA:** 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. **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. **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. **Mechanisms of Genetic Change II:** Recombination: General homologous recombination, the holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements. **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. **Human Genome Project:** Strategies and application, achievement and future prospects. **Plant Genome Projects:** Arabidopsis, achievement and future prospects. Other plant genome projects**. Bioinformatics:** Application of computational tests to the analysis of genome and their gene products. **Bioethics:** Moral, Religious and ethical concerns.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- Numerical problems related to arrangement of genetic material.
- Numerical problems related to linkage and recombination.

- Numerical problems related to gene mapping in diploid.
- Numerical problems related to recombination in Fungi.
- Isolation and separation of DNA on Gel electrophoresis.
- Isolation and separation of protein on Gel electrophoresis.
- Bacterial chromosome.
- Plasmid DNA (minipreps).
- Plant DNA extraction and analysis.
- Protein extraction from plants.
- DNA Amplification by PCR

Recommended Books:

- Winnacker, E. L. (2003). From Gene to Clones Introduction to Gene Technology, Panima Publishing Corporation, New Delhi.
- Brown, T. A. (2002). Genomes, Bios Scientific Publishers Ltd.
- Lwein, B. (2004). Gene VIII, Pearson Education Int.
- Miglani, (2003). Advanced Genetics, Narosa Publishing House, India,

BOT-6403 ENVIRONMENTAL BIOLOGY 3 (2+1)

Theory: Environment: Introduction, scope, pressure. P**ollution**: definition, classification and impact on habitats. **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. **Water pollution:** Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal pollution. **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. **Noise pollution**. **Radiation pollution** (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal. **Forest:** importance, deforestation, desertification and conservation. **Ozone layer:** i. Formation, ii. Mechanism of depletion, iii. Effects of ozone depletion.**Greenhouse effect and global warming:** causes, impacts. **Human population explosion:** impact on environment. **Impact assessment:** Industrial urban, civil developments. **National conservation strategy:**

Brief review of major problems of Pakistan and their solutions. Sustainable Environmental management.

Lab Outline:

- How to sample water from different sources.
- Examination of Total dissolved solids from industrial waste water and Municipal sewage and sludge.
- Examination of pH from industrial waste water and Municipal sewage and sludge.
- Examination of E.C from industrial waste water and Municipal sewage and sludge.
- Examination of BOD from industrial waste water and Municipal sewage and sludge.
- Examination of COD from industrial waste water and Municipal sewage and sludge.
- Determination of Chlorides from industrial waste water and Municipal sewage and sludge.
- Determination of carbonates from industrial waste water and Municipal sewage and sludge.
- Determination of Nitrates from industrial waste water and Municipal sewage and sludge.
- Examination of water samples forms different sites for the presence and diversity of organisms.
- Determination of hydraulic conductivity of a disturbed soil sample by Constant Head Method-Black
- Determination of water content of soil by gravimetric method.
- Effect of air pollutants on plants.
- Visits to environmentally compromised sites and evolution of remediation methods.

Recommended Books:

- M. N. Rao, and H .V .N Rao (2007). Air Pollution. McGraw Hill Companies.
- P.K. Goel (2008). Water Pollution Causes, effects and control. New age International (P) Ltd.
- S.K Agarwal (2009). Noise Pollution. A.P.H Publishing Corporation.
- P.C Jaiswal (2006). Soil, plant and water analysis. Kalyani Publishers.
- Vandermeer, John H. 2011. The ecology of agro-ecosystems - Jones and Bartlett Publishers.

LIST OF ELECTIVE COURSES FOR M.Sc. IN BOTANY

BOT-6304 RECENT TRENDS IN BIOTECHNOLOGY 3(2+1)

Theory: Introduction, definition and brief history of biotechnology. Techniques in Biotechnology, Application of Tissue culture and achievements in plant biotechnology. **Transgenic crops:** Crop productivity and nutritional quality, Molecular Biotechnology, Construction of synthetic vectors and their uses in r-DNA technology, An over view of gene silencing and its applications. **DNA barcoding in plants;** history, scope and readily used barcode regions. Biotechnology and Biosafety, risk assessment, regulation, Biosafety during industrial Production, Bio safety guidelinesand regulation. **Biotechnology for environment:** Bioenergy, Biofuel, Bioremediation and Climate change. Genomics, Proteomics and Bioinformatics. Sequencing of whole genome, functional and comparative genomics (Rice, Arabidopsis,Soyabean), Proteomics and Proteome analysis.

Lab Outline:

- Biosafety guideline of biotechnology lab.
- Over-view of plant bio technology lab
- Autoclave and its working principal
- Laminar flow and its working principal
- Centrifugations and its working principle.
- Basic definitions, volumes, use of micro pipettes.
- Preparation of agrose gel for DNA, PCR products and Protein.
- Loading of agarose gels
- Plate out transformed cells,
- Aseptic technique
- Data analysis - gel photos viewed.
- PCR
- Provides protocols for DNA purification, transformation and sequencing, PCR,electrophoresis and homology searches and has an active techniques forum.

Recommended Books:

- Slater, A., N. Scott, M. Fowler (2008). Plant biotechnology. Oxford Univ. Press Stewart.
- C.N. Jr. (2008). Plant Biotechnology and Genetics: Principles, Techniques and applications.

- Trigiano, R.N., D.J. Gray (Eds) (2010). Plant tissue culture, development and biotechnology. CRC Press.
- Gupta, P.K. (2006). Cell and Molecular Biology, Third edition. Rastogi Publications, Meerut.
- Kumar, S. and Flading M. (2005). Molecular Genetics and Breeding of Forest Trees.International Book Distributers, Lucknow.

BOT-6305 PLANT PATHOLOGY 3(2+1)

Theory: Definition and history of **plant pathology**, Nature and concept of plant disease, causes of diseases, components of diseases, classification of disease, symptoms of diseases, dissemination of plant pathogens, epidemiology and forecasting of plant diseases, host parasite inter-relationship and interaction, disease cycle, importance of plants diseases, effect of climatic conditions on plant diseases, defense mechanisms, plant disease control. **Diseases caused by Fungi:** Etiology, symptomlogy, epidemiology and control measures. Leaf curl of peach, damping off, late blight of potato, early blight of potato, apple scarb, black stem rust of the wheat, loose smut of the wheat, covered smut of barley and flat smut of wheat.

Lab Outline:

- Basic mycological techniques for identification of fungal species
- Method of study of plant disease. Media preparation
- Culture techniques
- Preparation of culture tubes
- Isolation and identification of different microscopic fungal pathogens present on different plant parts by direct culture plate method
- Study of pathogens in the field.
- Collection of infected parts of plants.
- Inoculation and isolation of different pathogens.
- Plants disease and assessment methods.

Recommended Books:

- Agriose, G.N., (2008). Plant pathology (5th edition). Academic Press, New York.
- Pandey, B.P. (2007). Plant Pathology- Pathogen & Plant Diseases. S. Chand and Company, Ramnagar, New, Delhi.
- Hafiz, A, (1983). Plant disease- PARC, Islamabad, Pakistan.

- Mehrota R.S S, (2007). Plant Pathology, 7th Reprint, McGraw-Hill Publishing Company Ltd.
- Ahmed, I. and Bhutta, A.R., (2003). Textbook of introductory plant pathology. Book foundation, Pakistan.
- Khan, A.G and Usman, R., (2005). Laboratory manual in mycology and plant pathology. Botany Department Arid Agriculture University, Rawalapindi.

BOT-6306 FRESH WATER ECOLOGY 3(2+1)

Theory: Introduction, importance of Aquatic Ecology. **Overview of lake ecosystems**: Physical and chemical processes in lakes, Lake organisms and adaptations, Population and community ecology of lakes, Human impacts on lakes, Lake Origins & Morphometry. **Biological Communities of Lakes**: Plankton, Littoral, Benthos. **Overview of stream and river ecosystems**: Stream organisms and adaptations, Population ecology in streams, Community ecology in streams, Human impacts on streams. **Formation and age of lakes**: estuaries and wetlands. **Wetlands**: Origins, Hydrology and Physical Structure, Chemistry of Wetlands. **Biological Communities of Wetlands**: Primary Producers, Consumers. **Properties of water**: Global water resources, **Laurentian Great Lakes:** Hydrology, climate and water budgets. **Lake attributes**: catchment morphometry. **Rivers and their ecotones**: River Continuum Concept, flood pulse, pulse stability andaquatic-terrestrial transition zones. **Inland Waters**: inland water catchments. **Development of Limnology**: Freshwater as a unique and important substance. **Aquatic systems**: their catchments. Trophic state/trophic dynamics: Energy balance, light and heat, thermal stratification. Seasonal cycles and bioticinteractions: cycling and management of nitrogen and phosphorus along with limiting nutrients. Basic loadingmodels: eutrophication, nutrient remediation. Ecology and taxonomy: include major groups of phytoplankton. Resource competition: Biomass, productivity and seasonality.Wetlands and water quality: Management of Aquatic Systems, Acid rain and acidification of lake ecosystems, Contaminants in freshwater ecosystems: implications for ecosystem and human health. **Reservoir formation for drinking water and hydroelectric production**: their implications for reservoir and downstream ecosystems, Climate Change and the future of freshwaters, **Sustainable clean and healthy freshwater ecosystems.**

Lab Outline:

- Survey of aquatic bodies, Instrumentation, physico-chemical attributes
- Sampling methods and determination of physico-chemical properties of water
- Visits to ponds, reservoirs and raceways
- To Study lake Benthos
- To study phytoplankton
- Field Biotic Sampling& Identification
- Collection & preservation of samples, identification of nekton and plankton
- Study of freshwater ecosystems and report writing
- Qualitative and quantitative estimation of primary productivity of various aquatic ecosystems and nutrient analysis
- Determination of DO, light penetration, total alkalinity, pH, hardness and chlorides.
- Collection of fresh water benthic algae from ponds, pools, ditches, water reservoirs, lakes, rivers and soil surfaces
- Preparation of temporary / permanent slides of various algae
- Collection and study techniques, sampling, preservation and identification of benthos and nektonic fauna
- Analyses of water samples from polluted areas for selected parameters (BOD & COD)
- Identification and preservation of macrophytes

Recommended Books

- Whiles, W.D. M. (2019). Freshwater Ecology, Concepts and Environmental Applications of Limnology. 3rd Edition. ISBN: 9780128132562, Academic Press.
- Jocelyne, H. (2018). Freshwater Ecology and Conservation, Approaches and Techniques. 1st Edition, Academia Press, ISBN: 9780198766421
- Stanley, J. J. E. (2016). Stream Ecosystems in a Changing Environment. 1st Edition, Academia Press, ISBN: 9780124059191.
- Dodds, W, and Matt. W. (2010). Freshwater Ecology: Concepts and Environmental Applications of Limnology (Aquatic Ecology). Academic Press, ISBN-10: 0123747244, p1-829.

- Campbell, L.W. (2008). The marshes of Southwestern Lake Erie. Ohio University Press,Athens.

BOT-6307 PHYTOSOCIOLOGY 3(2+1)

Theory: The community: analytical and synthetic characteristics of a community,classification of community, basis and unit of classification, dynamics of community, Types of changes: succession on wet and dry habitats, theories of climax, Ecological characteristics of species and population. **Ecosystem ecology:** components of ecosystem, energy transformation in nature and laws governing energy transformation, Food chain, Food web, Pyramid of number in food chain, Trophic levels, Energy flow in an ecosystem. **Biogeochemical cycles with;** nitrogen, phosphorus, sulphur, carbon and water cycles as examples. Principal vegetation types of Pakistan. Correlationship between soil and type of plants in ecosystem.

Lab Outline:

- Sampling of vegetation including Quadrat method.
- Sampling of vegetation including plotless method.
- Sampling of vegetation including transect method.
- Study of floristic composition of local community.
- Determination of frequency of occurrence in a plant community.
- Determination of Population density and cover of species in a plant community
- Determination of Biological spectrum
- Determination of Leaf size spectrum
- Calculation of diversity indices by Simpson and Shanon –Wiener method.
- Determination of primary productivity of grassland.
- Determination of primary productivity of grassland.
- Determination of seed bank in various populations.
- Seed dispersal pattern of local populations.

Recommended Books:

- Billings, W.D. (2000). Plant and Ecosystem. Wadswoth Pub. Co., California
- Daubenmire, R.F. (1973). Plant Communities. A Textbook of Synecology. Wiley, N.Y. USA.

- Shukla R.S & P.S Chandel. (2006). Plant Ecology S. Chand & Company LTD Ram nagarNew Delhi
- Stiling, R. D. (1992). Ecology, theories and applications. Prentice Hall International Inc.U.S.A
- Schultz et al., (2005). Plant Ecology. SpringerVerlag, Berlin.
- Townsend, C. R., Harper, J. L. and Begon, M. E. (2000). Essentials of Ecology. Blackwell Scientific Publications UK.

BOT-6308 ETHNOBOTANY 3(2+1)

Theory: Definition of Botany and Ethnobotany, aims and objective of ethnobotany, types and Signifince of Ethnobotany. Importance of plants**.** Developmental history of ethnobotany, Ethnobotany of world, Asia and Pakistan, Role of ethnobotany in treatment of different diseases, Role of ethnobotany in biodiversity conservation. **Ethnovaterriny medicines:** their role in Pakistan. **Systems of medicines**: TCM, (traditional Chinese medicine**)**, kampoo system Middle East, Indian system, **Economic importance of plants.** Food plants: rice, corn, wheat, sugar cane, barely etc., their morphology, history, Importance and nature of plant products, **Cereals and Millets:** Classification of cereals, importance, source of food, economic importance of cereals**. Legumes**: Definition examples, types legumes vas beans, importance. Nutritional profile of legumes. **Nuts:** types, importance, health benefits of nuts, chemical composition of nuts. **Vegetables:** different types of vegetables their nutrition profile, **Classification of vegetables**: HarperCollins and Lucy Peel (2004) classification. Chemical composition of different vegetables. Economic importance of vegetables. **Importance of plants with reference** to food, fibers dyes, oils, spices. **Introduction to Fruits**, Classification of fruits, Economic importance of Fruits. Fruits are source of different vitamins. Importance of Fruits with reference to medicines. **Economic importance of plants** with special reference to food, fibers, fumitories, wood, tannins, rubber, sugar, paper, gums, resins, dyes, beverages, spices, masticatories and oils.**Qualities and quantities** methods of data collection. Methods of data collection and data analysis by ICF, DMR, FL and PR.

Lab Outline:

- Collection, identification and preservation of economically important plants and plant products.

- The students are required to study in nature and in the laboratory economically important local flora.
- Enlistment of Botanical names of 30 vegetables of area.
- Enlistment of Botanical names of 20 nuts of area.
- Conduct ethnobotanical survey by close ended and open ended interview methods.
- Collection of data and apply microstatical tools: ICF, DMR, FL, etc.
- Identification and naming of local flora.
- Chemical screening of 5 vegetables andf ruits of area. Study of morphology of cereal crops and their cultivation techniques.
- Study of medicinally important vegetables fruits and nuts of area.
- Field trip to conduct ethanovatenary survey from local people.
- Conservation techniques.in situ and ex situ
- Herbarium preparation of at least 60 plants.
- Students should be able to write accurate scientific and vernacular name and economic importance of plants and identify them up to species level.
- Cultivation of economically important plants. Germplasm identification
- Herbarium techniques

Books Recommended:

- Fernandez, B. (2003). Edible wild plants of the Himalayas.
- S.N Lal andM.Sing (1998). Medicinal plants of India
- Martin, G. J. (2003). Ethnobotany. Earthscan Publications Ltd. London and Sterling, VA.
- Marty R.K and V.P. Singh (2006). An Introduction to Modern Economic Botany Agrobios India.
- Pandey, S. N. and Chadha, A. (1993). A Textbook of Botany (Plant Anatomy and Economic Botany). Vol. III. Vikas Pub. Co., New Delhi.
- Pandey, B.P. (1983). Economic Botany. S. Chand. Co., New Delhi.
- Simpson, A. (1985). Economic Botany. McGraw Hill Book Co., N. Y.
- Yadav.P.R. and S.R. Mishra. (2003). Environmental Ecology. Discovery Publishing House New Delhi110002.

BOT-6309 PLANT STRESS PHYSIOLOGY 3 (2+1)

Theory: Types of environmental stresses, **Salinity:** effects of salinity, physiological changes in plant adaptation to salinity. **Water logging:** physiological effects on plant growth, plant adaptation. **Drought:** effect of drought on plant growth, ultra-structural modifications, plant adaptation to drought. **Metal ion toxicity:** effects on plant growth, physiological adaptation, nutrient deficiency, physiological and biochemical effects. **Cold stress:** freezing injury and adaptations. **High temperature stress:** UV, High CO_2 and other minor stresses and plant adaptations. The effects of ionizing radiations on plant metabolism and growth. **Oxidative stress**. Different types of Reactive oxygen species produced in plants. Antioxidants of plants and their mechanism of functioning. Different types of biotic stresses on plants**.**

Lab Outline:

- Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
- Demonstration of effects of Salt stress on plants
- Demonstration of effects of Drought stress on plants
- Demonstration of effects of Water logging on plants
- Demonstration of effects of oxidative stress on plants
- Demonstration of effects of metal stress on plants
- Various methods of stress assessments in plants
- Ultra-structural and physiological changes associated with various stresses.
- Study effect of yield loss due to water logging.
- Study loss of biomass due to water logging and salinity.
- Study impact of drought in yield loss mechanisms.
- Study loss of biomass of plant due to drought.

Recommended Books:

- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
- Taiz, L. and Zeiger, E. (2006). Plant Physiology. 4th Edition. Sinnauers Publ. Co. Inc. Calif.
- Hale, M. G. and Orcutt, D. M. (1987). The Physiology of Plants under Stress. John Wiley and Sons, N.Y.

- Russel, H. and Staples, R. C. (1979). Stress Physiology in crop plants. by H. Wiley-Interscience, N.Y.

BOT-6310 PLANT METABOLISM 3(2+1)

Theory: Introduction to Plant metabolism. **Carbohydrates metabolism:** Catabolism and anabolism of Monosaccharides (Glucose), Oliogosaccharides (Sucrose) and Polysaccharides (Starch) inside plant bodies. **Fat Metabolism:** Synthesis, condensation and breakdown reactions of fatty acids and Glycerols in plant body. Introduction to Alpha and beta oxidation of fats. Glyoxalate cycle. **Nitrogen metabolism:** Introduction to biological nitrogen fixation, uptake of nitrogen by roots and its subsequent conversion to different forms inside plant cells. Synthesis of amino acids and proteins. **Plant hormones:** Introduction and Physiological roles of Auxins, Gibberrelins, Cytokinin, Ethylene and Abssissic acid in plant growth and development. Introduction to other Growth regulators like ascorbic acid and salicylic acid. **Mineral nutrition:** Introduction to macro and micro nutrients. Significance and deficiency symptoms of Nitrogen, Potassium, Calcium, Phosphorous and Magnesium.

Lab Outline:

- To learn detect and confirm presence of glucose, sucrose, lactose, cellulose and starch in the given solution and conduct Rf analysis.
- To detect presence of proteins in the solution by using chemical test methods and its estimation by Biuret or Lowry or Dye-binding method.
- To extract and estimate oil from plant material using soxhlet apparatus, checking of its soapnification property and its analysis by TLC methods with/and Rf determination.
- To extract leaf and seed proteins and their estimation by Biuret or Lowry or Dye-binding method.
- To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
- To learn how to measure pH of any solution/ solvent using litmas paper and digital pH meter.
- Demonstration of effect of Auxin on elongation of Barley Seedling
- Effect of Gebberillines on Growth of Lettuce
- Effect of Kinetin on Callus, Tissue Culture

Recommended Books:

- Bowsher, Steer & Tobin (2008). Plant Biochemistry. Garland Science, Taylor & Francis Group, LLC, New York.
- Buchanan, Gruissem & Jones (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.
- Crozier, Clifford, and Ashihara (2006). Plant Secondary Metabolites: Occurance, Stucture, and Role in the Human Diet. Blackwell Publishing.
- Jain, V. K. and Chand, S. (2008). Fundamentals of plant Physiology. Rajendra Ravindra printers, New Delhi.
- Salisbury F. B. and Ross C. B. (1992). Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.

BOT-6311 MEDICINAL PLANTS 3(2+1)

Theory: Introduction importance and scope of medicinal plants, Chemical composition of medicinal plants. Primary and secondary metabolites their role in plant body. **Herbal medicine:** history of herbal medicines, benefits and drawbacks of herbal medicines. Herbal medicines to cure different diseases. **Systems of medicines**: Eastern Medicinal System, TCM (traditional Chinese medicine), Kampo medicine (Japanese) and Ayurveda medicine, Western medical systems homeopathy and naturopathy, Unani system of medicines, advantage and disadvantage. **Herbal philosophy and spiritual practices**, examples from different cultures. **Classification of medicinal plants**: on the basis of stem, root, leaf, part use. **Cultivation of medicinal plants**: utilization of medicinal plants, aroma therapy Processing and utilization of medicinal plants. Conservation status of Medicinal plants, **Introduction to pharmacogonsy**: History and scope of pharmacogonsy. Role of scientists in pharmacogonsy, development in the field of pharmacogonsy.**Crude drugs:** importance scope and Preparation of crude drugs. **Preservation and storage** of crude drugs, different methods of preservation**. Drug adulteration**: Types, different methods of adulteration, disadvantages of adulteration**. Quality and evaluation**: Methods of evaluation (physical, chemical, morphological, analytical and microscopic evaluation). **Classification of crude drugs**: Alphabetical, Morphological, Taxonomic Pharmacological, Chemical and chemo taxonomical classification of drugs.**Veterinary herbal therapy**: Uses of herbal medicines by animals, useful plants for animal therapy. **Extinction of medicinal plants:** methods of preservation of medicinal plants. Herbal gardens. Herbal gardens of world, Asia and Pakistan.

Botanical gardens of world, Asia and Pakistan**. Herbal cosmetics** Cultivation and utilization of medicinal plants.

Lab Outline:

- Survey and Sampling of medicinal plants of local region.
- Study of medicinally important part of plant e.g. leaf, root,fruit.
- Herbal preparations from different plants.
- Study of 10 important medicinal plants their actions, usages.
- Qualitative tests for phytochemicals present in medicinal plants.
- Quantitative tests of phytochemicals of medicinal plants.
- Pharmacological tests for checking adulteration in drugs.
- Herbarium submission of at least 50 medicinally important plants.
- Students should prepare herbal garden at homes.
- Survey to collect ethnozoologicl data from villagers
- Collection and identification of 30 wild medicinal plants from local area,and to find their therapeutic values.
- Phytochemical examination of natural products
- List of Plants currently used in modern medicine
- Diversity of endangered medicinal and aromatic plants

Recommended Books:

- Gupta ,V.k. and G.D.Singh (2012). Phytochemistry ,Pharmacology and Therapeutics (vol ll)
- Kochhar, S. L (2016). Economic Botany in the Tropic. Cambridge University Pres
- Andrew.,C. (2000). Encyclopedia of Herbal Medicine: The Definitive Home Reference Guide to 550 Key Herbs with all their Uses as Remedies for Common Ailments. DK Natural Health.
- Foster, S. and Duke, J. A., (1990). A Field Guide to Medicinal Plants, Houghton Mifflin,.
- Fundamentals of pharmacogonsy and phytotherapy by Michael heinrich, Joanne Barnes,Simon Gibbon.
- Rasool, G. (1998). Medicinal Plants of Northern Areas of Pakistan. Blour Advisory & Social Development Organization (BASDO), Publishers.

- Zabta Khan Shinwari, M. Rahman, Takashi Watanabe, Y. Yoshikawa, (2006). Medicinal and Aromatic Plants of Pakistan (A Pictorial Guide).Publisher: Kohat University of Science &

BOT-6312 PHYSIOLOGICAL GENETICS 3(2+1)

Theory: Plants, **microbes and environment**, Genes and proteins related to biotic and abiotic stress. Physiological and genetic mechanisms of stress tolerance. Genes controlling the pathways responsible for salt, drought, heat, cold, radiation and oxygen stress. Genetic basis of host pathogen specificity in plant disease resistance, specific plant disease resistance. Relationship between specific and non specific resistance. Nature of host **parasite-interaction** (plants and animals). Determinates of virulence, gene for gene concept, Implication of non host resistance for understanding host parasite interactions.

Lab Outline::

- Effect of various concentrations of salt of seed germination and seedling growth.
- Effect of various stresses on microbial growth.
- Characterization of soil pollutants.

Recommended Books:

- Plomin R., Nature and Nurture (1990). An Introduction to Human Behavioral Genetics, Wadsworth Pub Co.
- Plomin R., John C. Defries, Gerald E. McClearn, M. Rutter, (1997). Behavioral Genetics W H Freeman & Co.
- Klug, W. S., and M. R. Cummings. (2003). Concepts of Genetics. Pearson Education. Molecular Biology of the cell
- John King. The Genetic Basis of Plant Physiological Processes Oxford University Press.

BOT-6313 PLANT MICROBE INTERACTION 3(2+1)

Theory: Soil and its features, soil properties and soil ecosystem, importance of soil organisms. Microbial responses in the Rhizosphere and Agriculture soil, signaling molecules for microbe interaction, beneficial type of symbiosis, both beneficial and pathogenic microbe for plants, infection and defense mechanisms in plants. **Mycorrhia:** ectomycorrhiza,

endomycorrhiza, vasicular arbuscular mycorrhiza, ericoid mycorrhiza, arbutoid mycorrhiza and orchid mycorrhiza. **PGPR and** their mechanisms of plant growth promotion: **direct mechanism** (nitrogen fixation, phosphate solubilization, phytohormones production and ACC deaminase activity) and indirect mechanism. Process of nodulation and nitrogen fixation, Microbial products influence plant growth, **Biofertilizers, history** of biofertilizers in Pakistan, Precursor inoculums interaction, significanse of phytohormones produced by microbes, Effect of root exudates, Introduction of biofilm, Microbial biofilm.

Lab Outline:

- Brief introduction of basic lab safety rules.
- Study of mycorrhizal associations.
- Clearing and staining of mycorrhizal roots.
- Estimation of root length and colonization by mycorrhizal fungi.
- Mycorrhizal inoculums in soil.
- Isolation and identification of Glomalean fungi from field and other soils.
- Synthesis of mycorrhiza from spore inoculums and from root inoculums.
- Assessment of plant growth response by mycorrhizal infection in some seasonal crops.
- Inoculation of PGPR in seasonal crops to asses enhanced plant growth.
- Slide preparation of root nodules.
- Slide show of different types of mycorrhizal association and microbial biofilm.

Books Recommended:

- Ahemad, M and M. Kibert (2014). Mechanisms and applications of plant growth promoting rhizobacteria: Current perspective. Journal of King Saud University – Science (2014) 26, 1–20.
- Naveed, M., I. Mehboob, M. A. Shaker, M. B. Hussain and M. Farooq (2015). Biofertilizers in Pakistan: Initiatives and LimitationsInt. J. Agric. Biol., Vol. 17, No. 3, 2015
- Donlan, R.M (2002). Biofilms: Microbial Life on Surfaces. Emerging Infectious Diseases, Vol. 8, No. 9, September 2002.
- Krishna, K.R (2005). Mycorrhiza. A Molecular Analysis. Oxford & IBH publishing Co., Ltd.
- Rai, M. (2010). Soil Science. Anmol publications and private limited, New Delhi.
- Stacey G. and N. T. Keen. (1996). Plant Microbe Interaction. Springer.

BOT- 6314 ECONOMIC BOTANY 3(2+1)

Theory: Introduction, history and significance of Economic botany, Role of plants in life of man in different paradigms, Role of Plants as Food; ten highly used crops of world—their names, taxonomy, phytogeography, ethnomedicines and other ethnobotanical uses, Role of Plants used as Fodder for livestock and birds; list of ten common plants used in the indigenous area—with their taxonomy, occurrence, threats to them, their ethnomedicinal uses, other ethnobotanical uses. Role of Plants used as Home/Shelter construction: List of commonly used home construction and household items preparation; their taxonomy, ethnomedicines and other ethnobotanical uses; Role of wild plants used as Fruits, their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Role of wild plants used as Vegetables: their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Role of wild plants used as Condiments their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Role of wild plants used as Food Medicines their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Role of wild plants used as Aesthetics and Cultural rituals, their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Role of wild plants used as in Industrial Products their names, taxonomic analysis, ethnomedicinal and other ethnobotanical uses; Fiber industry, structure & classification of fibers, fiber yielding plants; cotton, jute, sun their origin, distribution, agronomic practices, breeding, Wood industry, wood for timber,timber industry, uses of wood, conversion products of wood, distillation products,secondary products,Rubber industry, physical properties, chemical composition, rubber yielding plants para rubber, morphology, uses, rubber, rubber, panama rubber. their origin, distribution, agronomic practices,, diseases and their control,Starch and Sugar Industry, chemical composition, uses, starch yielding plants, rice starch, potato starch, wheat starch, sagu starch.their origin, distribution, agronomic practices, breeding, diseases and their control,Future Prospective of these wild and cultivated plantsas Domestic use, commercial and industrial growth and process to earn livelihood.

Lab Outline:

- Identification and collection of food plants of local area.
- Study of morphology of all cereal crops and their cultivation techniques.

- Collection of fiber yielding plants from local area.
- Collection of oil yielding plants of area.
- Sugar yielding plants of area.
- Study of morphology of wood plants of local area.
- Herbarium techniques.
- Field survey to enlist wood yielding plants.
- Study of spices and condiments used in daily food.
- Types of forest and protected areas
- Wild ecoregions of Pakistan and AJK
- Submission of 30 economically important plants.

Recommended Books:

- S L Kochhr (2012). Economic Botany of the Tropic areas
- B.P Panday., and S. Chand. (2000). Economic Botany .
- H. D.V. Prendergast, et al. (1998). Plants food and medicine. Kew publishing
- Frances E.M. Cook. (1995). Economic botany data collection standard. Kew publishing.
- Pooja. (2005). Economic botany. Discovery publishing house.
- O.P. Khedar , R.V. Singh, Mahesh Shrinal. Pulses status and cultivation Technology.

BOT-6315 CELL AND MOLECULAR BIOLOGY OF PLANTS 3(2+1)

Theory: Introduction to molecular biology, definition, history and importance of molecular biology. Basic structure and function of the cell, The basic types of organic molecules that contribute to cells, Cellular processes, Membrane transport and signaling, Intracellular transport, Structure and motility, Energy conversions and Cell division, Cell cycle - An overview of cell cycle; Components of cell cycle control system, Intracellular and Extra-cellular control of cell division, Programmed cell death (Apoptosis), Intrinsic& extrinsic pathways of cell death, Apoptosis in relation with Cancer, Nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, Division, and development, The molecular mechanisms of DNA replication, Repair, Transcription, Protein synthesis, Gene regulation in different organisms, Chromatin structure and function, RNA polymerase dynamics, and regulation of gene expression by different types of RNAs.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- DNA isolation - from Plant cell (leaf of cabbage / mustard),
- Plasmid DNA isolation
- Gel electrophoresis
- Polymerase Chain Reaction
- Gel documentation & photography.
- Study of cell structure using compound microscope.
- Elucidation of ultrastructure of cell from electron microphotographs.
- Preparation of temporary and permanent slides.
- Staining techniques simple and differential staining.
- Study of mitosis using onion root tips and comparison with prepared slides.
- Study of meiosis by smear/squash method and from prepared slides.
- Study of chromosome morphology and variation in chromosome number.
- Extraction and estimation of carbohydrate, protein, from plant sources.
- Tests for reducing and non-reducing sugars.

Recommended Books:

- Brown, (2001). Gene Cloning & DNA Analysis, 5th edition, Blackwell Publishing.
- Cullis, C.A. (2003). Plant Genomics and Proteomics. Wiley-Liss, New York.
- Gibson, G. and S.V. Muse, (2002). A Premier of Genome Science, Sinauer Associates
- Inc. Massachusetts.
- Gilmartin, P.M. and C. Bowler. (2002). Molecular Plant Biology. Vol. 1 & 2. Oxford.

BOT-6404 BIODIVERSITY AND CONSERVATION 3(2+1)

Theory: Biodiversity; Definition, history and its importance. **Types of biodiversity;** species biodiversity, genetic biodiversity and ecosystem biodiversity. **Threats to Biodiversity;** habitat fragmentation, deforestation, over grazing, hunting, erosion, desertification, ecosystem degradation, bio invasion and climate change. **Biodiversity of Pakistan**. **Measuring biodiversity by;** Alpha, Beta and Gamma diversity. **Ecological services**; indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of Bio resources). **Sustainable and unsustainable** use of biological resources. **Biodiversity Hot spots** of Pakistan and the world. **Conservation strategies;** *in situ* and *ex*

situ, conservation. **IUCN categorized protected areas** in Pakistan and **red listing categories**. Red data book, blue data book and green data book. **International treaties/agreements** regarding Biodiversity and conservation; **CBD, CITES, Ramsar**. Use of herbarium and Botanical Garden in biodiversity conservation and wild life management. Global Biodiversity Information Facility (GBIF).

Lab outline:

- Inventory of plant biodiversity in various habitats.
    - Inventory of Herbline in a community
    - Inventory of shrubline in a community
    - Inventory of treeline in a community
- Identification of wild plant species used by local communities in different ecosystem.
- How species becomes red listed.
- Different types of data books; red data book, green data book and blue data book.
- Calculation of biodiversity
    - By alpha ά diversity
    - By beta β diversity
    - By gemma γ diversity
    - By IBCD formula
- Calculation of biodiversity by Simpson method
- Calculation of biodiversity by Shanon method
- Calculation of biodiversity by IBCD
- Calculation of biodiversity by Ethnomedicial approach
- Visit/study trips to various National Parks.
- Visit/study trips to various Botanical Garden.
- Preparation of herbaria/ specimen.
- Management of herbaria in pigeon holes techiques

Recommended Books:

- Maiti, P. K. and M, Paulam. (2017). Biodiversity: perception, peril and preservation, 2ed edition, PHI learning private limited, Delhi.
- Abbasi, A. M., Khan, M. A., M. Ahmad and M. Zafar. (2012). Medicinal plant biodiversity of Lesser Himalaya Pakistan. Springer Publishers USA.
- IUCN. (1994). *IUCN Red List Categories.* As Approved by the IUCN Council. IUCN.
- Swanson, T. (2005). Global Action for Biodiversity. Earth Scan Publication Ltd.

BOT-6405 EDAPHOLOGY 3(2+1)

Theory: Introduction, definition and history. **Field view:** of soil, the soil profile an organized natural body and as a medium of plant growth, origin and nature of parent material. **Weathering:** mechanical, chemical and biological, factors affecting weathering, Classification of weathered parent material. **Soil formation:** the soil forming factors including parent material, climate, organisms, topography and time. Physical properties of soil including classification of soil separates. **Soil textural classes:** Particle density, bulk density, pore spaces, structure soil consistence, tilth and tillage organic matter, soil water, soil air, soil temperature and soil colour. Chemical properties of soil including the essential plant nutrient in the mineral soil (micronutrient elements). The soil collides including the mineral organization of silicates clay, Biological organisms present in the soil, Soil taxonomy and its classification, Soil survey and its utilization.

Lab Outline:

- Soil sampling and preparing techniques.
- Soil Sampling (Physical and Chemical)
- Determination of soil texture.
- Determination of soil structure
- Determination of soil water contents by Oven dry method.
- Determination of Soil infiltration.
- Determination of soil Permeability.
- Determination of soil saturation.
- Determination of carbonates and bicarbonates.
- Determination of organic matter contents.
- Determination of Soil pH.
- Determination of soil electrical conductivity

Recommended Books:

- Nyle C. Brady (1984). The nature and properties of soil 9th edition. Macmillan publishing Co.
- Rai, M. (2010). Soil Science. Anmol publications and private limited, New Delhi.
- White R.I (1979). Introduction to the principles and practices of soil science. Blackwell scientific publications.
- Loth H.D (1981). Fundamentals of soil science. 7th edition. John Willey and Sons.

BOT-6406 BIODEGRADATION 3(2+1)

Theory: Biodegradation: definiation, introduction and history. Bioremediation and biodegradation, Case studies, Bioremediation strategies Method of Bioremediation, Metabolic basics of biodegradation and biotransformation. Types of enzymes that catalyze biological transformations substantial for nature and human beings. Plastic biodegradation. The microbiological processes, biological filtration, microbial interactions with pollutants, microorganisms as bio indicators and active actors in the field of environmental protection. Bioventing, Biosulurping, Biosparging, Bioaugmentation, Biostimulation, Phytoremediation, Rhzoremediation, Biotransformation, Bioremediation monitoring, biodegradation general, Biochemistry of Biodegradation Aerobic and anaerobic Biodegradation, Cometabolism, Zenobiotics, Role of Enzyme in Biodegradation.Control of biodegradation processes and their usage in biotechnology, pharmaceutical, medical, agricultural production and protection. Possible usage of biological agents in wastewater treatment. Bioremediation examples based on biodegradation and biotransformation processes.

Lab Outline:

- Find out mass of microbes
- Recycling of plastic materials.
- Enlistment of biodegradable and non biodegradable materials
- Find fungi effecting degradation
- Role of bacteria in degradation
- Find out rate of biodegradations

Recommended Books:

- David W. and P. Welburn. (2002). Environmental Toxicology. Cambridge University Press UK.
- Sing A. and Ward O. P. (2003). Applied Bioremediation and Phytoremediation. Springer.
- Rattner, B. A., G. A. Burton, and J. Cairns. (2002). Handbook of Ecotoxicology. Hoffman, D. J.(ed). CRC Press, Lewis Publishers.

BOT-6407 ENVIRONMENTAL POLLUTION 3(2+1)

Theory: Introduction to environment. Pollution definition, origin. Pollutants, organic and inorganic pollutants. The environmental complex, Environmental resources, Pollution and environmental health. Air pollution, green house effect, global warming and control. Solid waste pollution. **Thermal pollution:** effect of thermal pollution, control of thermal pollution, beneficial uses of thermally polluted water**. Noise pollution**: effect of noise pollution on plants, human beings, animals and non living things. How can we control noise pollution. **Radiation pollution:** sources of radioactivity in environment, distribution of man made radioactivity in environment, biological effects of radiations. Control of radioactive pollution. **Pesticides and Agro-chemicals:** groups of pesticides, pesticide kinetics in environment, pesticides kinetics in environment, mode of action and toxicity of pesticides. Effect of pollution on biological systems, National and international environmental organizations, Agencies and program. Control of environmental pollution.

Lab Outline:

- Analysis of physical characteristics like Temperature, colour, turbidity, soluble and total dissolved solids of industrial waste waters.
- Analysis of physical characteristics like Temperature, colour, turbidity, soluble and total dissolved solids of industrial sewage waters.
- Determination of pH of Industrial and sewage water by pH paper and pH meter method.
- Determination of Electrical conductivity of polluted water from different sources.
- Determination of BOD.
- Determination of COD.
- Determination of Chlorides of sewage and industrial waters.
- Determination of carbonates and bicarbonates from sewage and industrial waters.
- Determination of Heavy metals from sewage and industrial waters.
- Determination of Trace metals from sewage and industrial waters.
- Nutrient element determination in soil extracts by atomic absorption spectrophotometer.
- Determination of micronutrients in soil extracts.
- Determination of water content of soil by gravimetric method.

Books Recommended:

- M N Rao and H V N Rao (2007). Air Pollution. McGraw Hill Companies.

- P.K. Goel (2008). Water Pollution Causes, effects and control. New age International (P) Ltd.
- Ghosh, A. (2003). Natural Resources Conservation and Environment Management. S.B. Nangia for APH Publishing Cooperation.
- Trivedi, P. C. (2003). Environmental Pollution and Management. Prem, c. Bakliwal for Aavishkar Publishers.
- Wright, R. T. & B. J. Nebel. (2002). Environmental Sciences Towards a Sustainable Future. Pearson Education, Upper Saddle River New Jersey.07358

BOT-6408 RESEARCH TECHNIQUES AND LAB TOOLS 3(2+1)

Theory: Definition of research, Problem identification and feasibility analysis, Validity of problem, objectives and goals, Literature search, Development of hypothesis, Source and review of literature, **Reference writing**: For books, journals, anonymous, internet. Use of digital libraries for research, **Preparation of a research report:** Types of research reports, Structure, Graphics, Initial writing, Rewriting and editing, Evaluation of a research report, General evaluation criteria, Types, Specific evaluation criteria. Microscopy, Centrifugation, Electrophoresis, Genomic DNA extraction, PCR, DNA fingerprinting, Restriction enzyme analysis and genotyping, Transformation, Screening of transformed cells, Spectroscopy, Chromatography, Dialysis.

Lab Outline:

- To design a report
- Protein Extraction
- SDS- PAGE
- PCR Optimization
- DNA Extraction,
- Thin layer Chromatography and Microscopy

Recommended Books:

- Old R.W. and S.B. Primrose (1993). Principles of Gene Manipulation, an Introduction to Genetic engineering (3th edition). Blackwell Scientific Publications.
- John, H.D .and L.W. Roberts (1985). Plant Tissue culture second edition. Cambridge University Press Cambridge.
- Smith R.H. (2000). Plant tissue culture techniques and Experiments second Edition Academic Press.

- Arifullah, S and K.M. Bhatti. (1998). Research process simplified. PanGraphic (Pvt) Limited.Islamabad.
- Jones, A., R, Reed and J. Weyers. (1993). Lab Outline: skills in Biology. Longman Scientific and Technical.
- O' Conner, M. (1993). Writing successfully in science. Chapman and Hall. N. Y.
- Hashmi, N. (1983). Style manual of technical writing. Pakistan Economic Analysis Network Project. Islamabad.

BOT-6409 WILD PLANTS AND THEIR ECONOMIC USES 3(2+1)

Theory: Introduction to wild plants, importance, scope, history of plants as medicines. Description, Occurrence, Chemical composition and economic importance of following plants: Black Elder of Bilberry (*Vaccinium myrtillus*), *Sambucus nigra*, Caraway (*Carum carvi*), Common Nettle (*Urtica dioica*), Common Juniper (*Juniperus communis*), European Centaury (*Centaurium erythraea*), Marshmallow (*Althaea officinalis*), Peppermint (*Mentha x piperita*) Rosehip (Rosa canina), Silver Birch (*Betula pendula*), Walnut (*Juglans regia*), dandelion (*Taraxicum officinale*), Bhang (*Canabis sativus*), Arnoli (*Ricinus communis*), *Datur astramonium*, Chinar (*Platanus orientalis)* , Bhekkar (*Justicia adhatoda*), Lantana (*Lantana camara),* Poppy (*Papaver dubium*), *Ranunculus acris, Viola odorata*. Economic and Medicinal value of wild plants. Collection and processing of plants.

Lab Outline:

- Visit to villagers to collect data of wild plants
- Methods of collection of plants and plants preservation
- Field survey to collect wild plants
- Economic importance of locally important plants
- Chemical screening of some of important medicinal wild plant of area.
- Herbarium techniques.
- Enlistment of the medicinal potential of wild plants of area.
- Ethnobotanical profile of wild plants of area.
- To find conservation status of plants.
- Field survey to enlist wood yielding plants
- Collection of oil yielding wild plants of area
- Wild ecoregions of Pakistan and AJK

- Identification and collection of wild food plants of local area.
- Morphological description of some wild plants of area

Recommended Books:

- M.SinghS.N Lal (2003). Medicinal plants of India.VeriNagg publisher New Dehli.
- D.A Patil (2003) Herbal Cures Traditional approach, Robindar Publisher Co. Utarpardesh India
- P.M Mukhopadlyay, B.G.Mazumdar (2007). Principles and Practices of Herbal Garden.VeriNagg publisher New Dehli.
- O.P. Khedar , R.V. Singh, Mahesh Shrinal. Pulses status and cultivation Technology.VeriNagg publisher New Dehli.

BOT-6410 PALYNOLOGY 4(3+1)

Theory: Introduction, history and scope of Palynology in Botany and life. **Types of palynology:** Neopalynology, Palynotaxonomy, Paleopalynology, Melittopalynolgy, Latropalynology, Pharmacopalynology, Copropalynology, Forensic palynology. **Pollens;** types, spore morphology and taxonomy. Composition and structure of pollen, Structure of exine and Intine, sculpturing types of pollen grain. Apertures of pollen grain. Methods of collecting pollen and microscopic examination of pollen. **Aero palynology**: importance, production of air borne pollen. Role of pollen in allergy, Wind, water and insect pollinated pollens. Morphology of angiosperm and gymnosperm pollen. Application of Palynology study in botany, phylogenetic analysis, geology, archaeology, criminology, medicines, honey and oil and gas exploration.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.
- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration.
- Role of pollen in taxonomy and identification.
- Preparation of pollen for microscopic examination.
- Collection of angiosperm pollen of dicot and preservation.
- Collection of angiosperm pollen of monocot and preservation.
- Study of microspores of bryophytes.

- Study of microspores of pteridophytes.
- Collection of plants responsible for pollen allergy.
- Study of pollinia of different plants.

Recommended Books:

- Saxen, M.R. (1993). Palynology by A, Treatise. Oxford & IBH. Co.
- Palynology: spores and pollen by Marjorie D. Munir and William Antony S.
- Jansonius J., and D. C. Mcgregor (1993). Palynology: new directions other applications and floral history.

BOT-6411 BIOINFORMATICS 4(3+1)

Theory: Definition, scope and importance of bioinformatics**.** Introduction to bioinformatics and its historical perspectives. Introduction of basic genomics, proteomics, pharmacogenomics and cheminformatics**.** Data generation from different biological resources and bioinformatics tools**.** Proteome, protein sequence and structure analyses**.** Generation of genomic and proteomic data and its storage**.** Plant genome and human genome**.** Gene bank and hierarchical genome assembly. Expression cluster analysis. Protein modeling and Protein design**.** Pair wise sequence alignment and Multiple sequence alignment**.** Computer applications in biology. Using programming languages to stimulate and solve Bioinformatics problems**.** Softwares for data retrieving and analysis**.** BLAST, FASTA and other online tools**.** Schemes for gene finding in prokaryotes/eukaryotes and Construction of polygenetic trees**.** Application of bioinformatics in different disciplines of biology**.** Preparation of mini group projects, presentations and Individual project and discussion.

Lab Outline:

- Teach how to use computer, its basic softwares installation and application.
- Use of online surfing and data retrieving methods
- Use of in-silico cell modeling and describing cell parts
- Study of gene search and its identification by use of online tools and softwares
- Use of BLAST software for alignment of sequences.
- Use FASTA softwares for proteins identification.
- Use of TIGER software for analysis of sequences.

Recommended Books:

- Krawetz. Stephen A (2003). Introduction to Bioinformatics: ATheoretical and Practical Approach, Humana Press.

- Fundamental Concepts of Bioinformatics, Dan E. Krane and Michael L. Raymer, San Francisco: Benjamin Cummings, (2009). ISBN: 0-8053-4633-3.
- Biological sequence analysis: Probabilistic models of proteins and nucleic acids By R. Durbin, S. Eddy, A. Krogh and G. Mitchison. 2008.
- Bioinformatics: sequence and genome analysis, By David W. Mount, 2nded, 2005,CBS publishers & Distributers, New Delhi, India.
- Bioinformatics: Methods and applications By S. C. Rastogi, N. Mendirata and P. Rastogi. 2004. ISBN 81-203-2582-6 Prentice Hall of India.
- Bioinformatics: A Practical Guide to the analysis of genes and proteins edited By Andreas D. Baxevanis, B.F. Francis Ouellette, New York: Wiley-Interscience, 2001, 2nd ed. ISBN: 0-471-38391-0.
- An introduction to Bioinformatics Algorithims, By Neil C.Jones, Pavel Persner Gary Benson and Rodric Page. 2004.

BOT-6412 MOLECULAR GENETICS 3(2+1)

Theory: Definition, history and scope of molecular genetics. **Structure of DNA**: DNA the genetic material, DNA replication in eukaryotes, DNA and the gene. **Nature of the Gene:** How genes work, Gene protein relationship, Genetic observation explained by enzyme structure, Mutational sites. **Causes of mutations:** replication errors, mutagens. **Repair of mutations:** direct repair of damaged nucleotides, repair by excision and DNA resynthesize. Effects of mutations on the information content of a gene, examples of mutations that result in human genetic disease. **RNA:** Structure, function and Biochemical properties. **From RNA to Protein:** the genetic code, codons & anticodons, the ribosome & translation. **Gene expression in Prokaryotes:** the Lac operon. **Gene expression in Eukaryotes:** regulation of transcription, promoters, enhancer elements; RNA splicing, post-transcriptional and post-translational regulation. Complementation, DNA Function: Transcription, Translation, Protein synthesis, Universality of genetic information transfer, Eukaryotic RNA, **Recombinant DNA:** Restriction enzymes, ecoR1, SMA1, source and activity, the formation of recombinant DNA, Recombinant DNA methodology. **Principles of Genetic Engineering:** gene cloning and genomics Recombinant DNA and social responsibility. Application of Recombinant DNA.

Lab Outline:

- Rules of Lab use and lab biosafety and bioethics.

- To visit Lab to be familiar with instruments and learn operating methods, principles and calibration
- Numerical problems
- Arrangement of genetic material
- DNA extraction Introduction to PCR technology.
- Isolation and separation of protein on Gel electrophoresis.
- Bacterial chromosome.
- Plasmid DNA (minipreps).
- Recombination in virus bacteria and fungi
- Population genetics
- Blood group and RH factors
- Fungal Genetics
- Bacterial genetics.

Books Recommended:

- Gelvin, S. B. (2000). Plant Molecular Biology Manual. Kluwer Acedemic Publishers.
- Pierca, B.A. (2005). Genetics, A conceptual approach. W.H. Fermin and Company, New York.
- Synder, L, and Champness, W. (2004). Moleculan Genetics of Bacteria. ASM Press, Washington D.C.
- Hartl, D. L. and Jones, E.W. (2005). Genetics –Analysis of Gene and Genomics, Jones and Bartlett Publishers. Sudbary, USA.
- Hedrick, P.W. (2005). Genetics of Population. Joness and Bartlett Publishers, Sudbary, USA.

BOT-6413 MYCORRHIZAE 3(2+1)

Theory: Brief introduction of mycorrhizae association**,** Functional Diversity of Soil Microorganisms with correlation of plants**,** Types of Mycorrhizae with details activity of each type**,** Ectomycorrhizal Fungal Diversity**,** Ericoid mycorrhiza (EM), Arbuscular mycorrhizal fungi (AMF), Mycorrhizal association of green orchids**,** Mycorrhizal association of achlorophyllous plants (mycoheterotrophs)**,** Functioning of mycorrhizae in broader contexts**,** Endosymbiotic bacteria in mycorrhizal fungi**,** Effect of mycorrhizal fungi in plants population**,** Mechanisms in nutrient transport at interface, The relationship between mycorrhizal fungi and host plants, Mechanisms of mutual compound exchange**,** Role of

symbiosis in life cycle of host plants, Influence of global climate change on mycorrhizal symbiosis, Relationships between mycorrhizal fungi and other organisms, mycorrhizal fungi and rhizospheric microorganisms, mycorrhizal fungi and edaphon, mycorrhizal fungi and soil animals, mycorrhizal fungi and herbivors, mycorrhizal fungi and carnivores, Correlation of mycorrhizal fungi with omnivores, Evolutionary study of Mycorrhizas, Physiology of mycorrhizal fungi, Cell biology of Mycorrhizas, Ecology of Mycorrhizas, Genetics of mycorrhizal fungi, Fungal variation for nutrition and growth response, Plant-fungal symbiosis versis pathogensis.

Lab Outlines:

- Observation of mycorrhizal associations with higher plants.
- Enlist mycorrhizal fungi from different plant root samples.
- Identification of endomycorrhizal fungi from collected samples.
- Identification of ectomycorrhizal fungi from collected samples.
- Analysis of ericoid mycorrhizal fungi from plant roots.
- Clearing and staining of mycorrhizal roots of plants.
- Estimation of root length and assessment of colonization by mycorrhizal fungi.
- Bioassay measurements of mycorrhizal inoculums in soil.
- Isolation and identification of Glomalean fungi from field
- Identification of mycorrhizal fungi in different soils near root zones of different plants.
- Synthesis of mycorrhiza from spore inoculums and from root inoculums.
- Assessment of plant growth responses by mycorrhizal association in crops.
- Observation of mutual relationship of mycorrhizal fungi with plants
- Enlist mycorrhizal association of mushrooms with plant roots.
- Observe mycorrhizal association of wild plants of forest area
- Calculate density of different mycorrhizal association

Recommended books:

- Krishna, K. R. Mycorrhizas (2005). Mycorrhizas, A Molecular Analysis. Oxford and IBH Publishing Co. Pvt. Lrd. New Delhi, India.
- Manohara, C. and C. Chamola, (2002). Techniques in Mycorrhizal Studies

- Sally E. Smith, FA.A, and David Read, F.R.S. (2008). Mycorrhizal Symbiosis (Third Edition). ISBN: 978-0-12-370526-6.
- Peterson, R L. (2003). Mycorrhizas: Anatomy and Cell Biology. NRC Research Press, New York.
- Smith, S.E. and Read, D.J. (2008). Mycorrhizal symbiosis. Elsevier/Academic Press.

SCHEME OF STUDIES

M.Phil. IN BOTANY

DEPARTMENT OF BOTANY

SCHEME OF STUDIES

of

M.Phil. in Botany

Eligibility Criteria:

The criteria for admission in M. Phil. Botany is at least second division (45% marks) in annual system while 1st division (CGPA 3.00/65%) is required in semester system in M.Sc. Botany and GAT-General with a minimum 50% score will be necessary at the time of admission to M. Phil. or before submission of Final Thesis for viva.

Duration:	2 - 4 Years
Courses:	24 Credit Hours
Seminar/Conference paper with certificate	01 Credit Hours
Thesis:	06 Credit Hours
Total:	31 Credit Hours

Item NO.6: Approval of Courses, Codes of Seminar and Thesis for M.Phil. in Botany.

No.	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs	Approved/Not Approved
BOT-701	Advances in Plant Physiology	3	0	3	Approved
BOT-702	Advances in Biodiversity and Conservation	3	0	3	Approved
BOT-703	Plant Tissue and Cell Culture	3	0	3	Approved
BOT-704	Ornamental Horticulture	3	0	3	Approved
BOT-705	Advances in Stress Physiology	3	0	3	Approved
BOT-706	Weed Ecology	3	0	3	Approved
BOT-707	Bioenergetics and Molecular Enzymology	3	0	3	Approved
BOT-708	Advances in Phytosociology	3	0	3	Approved

BOT-710	Advances in Genetics	3	0	3	Approved
BOT-711	Advances in Environmental Biology	3	0	3	Approved
BOT-712	Advances in Microbiology	3	0	3	Approved
BOT-713	Advances in Lab Experimental Techniques	3	0	3	Approved
BOT-714	Recombinant DNA Technology	3	0	3	Approved
BOT-715	Plant Soil and Water Relations	3	0	3	Approved
BOT-716	Plant Biotechnology and Genetic Engineering	3	0	3	Approved
BOT-717	Biostatistics and Computer Application	3	0	3	Approved
BOT-718	Pharmaceutical Microbiology	3	0	3	Approved
BOT-719	Applied Ethnobotany	3	0	3	Approved
BOT-720	Advances in Flowering Plant Taxonomy	3	0	3	Approved
BOT-721	Herbarium Management Techniques	3	0	3	Approved
BOT-722	Climate Change and Adoptation of Plants	3	0	3	Approved
BOT-723	Allien Species and Phytoremidiation	3	0	3	Approved
BOT-798	Seminar	1	0	1	Approved
BOT-799	Thesis M.Phil.	0	6	6	Approved

BOT-701 ADVANCES IN PLANT PHYSIOLOGY 3(3+0)

Theory: Specific characteristics of plants in comparison to other organisms. Plant cell: function of membranes, plastids, microbodies, vacuole and cytoskeleton. **Cell wall**: function and biosynthesis of primary and secondary cell wall; surface protection. **Water balance** in plants - uptake, flow through the plant to the atmosphere: cell water potential, water status of a plant, root pressure, cohesion-tension theory, transpiration, guttation. **Solute transport**

across membranes. Mineral nutrition: uptake and translocation of mineral nutrients, nutritional needs of plants. **Assimilation of nitrogen**, sulphur, phosphate, oxygen and cations. Biological nitrogen fixation. Mycorrhiza. **Photosynthesis**: organisation of photosynthetic membranes; photochemical reactions. Carbon reactions of photosynthesis (the Calvin cycle), synthesis of starch and sucrose. Photorespiration, C3-, C4- and CAM plants. Physiological and ecological considerations of photosynthesis. Translocation in the phloem. Heterotrophy in plants – parasitic and carnivorous plants. **Respiration process,** respiration in intact plants and tissues. **Lipid metabolism**. Secondary metabolism in plants. **Plant growth regulators:** auxins, gibberellins – structure, biosynthesis, translocation, physiological effects. Plant growth regulators: cytokinins, abscisic acid, ethylene and brassinosteroids – structure, biosynthesis, translocation, physiological effects. **Effects of temperature** and light on plants: dormancy, photoreceptors, photoperiodism. **Signal transduction.** Stress physiology: plant response to abiotic and biotic stress. Physiology of movements in plants. 1-15 includes content of lectures as well as corresponding exercises and laboratory work.

Recommended Books:

- Taiz, L., Zeiger, E., 2010 (5th Edition): Plant Physiology. Sinauer Associates, Inc., Sunderland, Massachusetts.
- Denffer Ziegler: Botanika (Morfologija i Fiziologija biljaka), Skolska knjiga, Zagreb, 1991.
- Mohr-Schopfer: Planzen Physiologie, SpringerVerlag, Berlin, Hiederberg, New York, Tokyo, 1991.

BOT-702 ADVANCES IN BIODIVERSITY AND CONSERVATION (3+0)

Theory: **Introduction** of Biological and Cultural Diversity, **Types of BD**, Values BD, Major threats of Biodiversity (BD), Definitions of endangered species, rare species, extinct species, threatened species, extinct species, **Factors impacting on BD**, Conservation strategies, sanitary and phytosanitary measures, quarantine and non-quarantine rules, **Pest risk assessment** (PRA), Pest risk management (PRM), **SPS mechanism** and correlation b/w BD, wetland and their conservation, threats to BD in wetland, symptoms of stains, some recommendation to conserve BD, wetland repository, BD and environment sharing, six main

fundamental cause of loss of BD in Pakistan, **Critical eco-regions of Pakistan**, Flora and Fauna of Pakistan, critical endangered and threatened ecosystems of Pakistan, mangrove ecosystems in Pakistan, **External and internal factors impacting ecosystems,** recommendations for conservation, requirement of effective strategies sustainable development for BD in AJK and Northern Areas, Mountain and BD of significance, National and international efforts for BD conservations, Hebetating degradation, Different strategies for BD conservation, ex situ and in situ conservation, flora of Bhimber, Future perspectives of BD in Pakistan. Methods of caterageriza tion of plants according to IUCN; Red data, Rules, Mechanism, Conservation study by ethnobotany and ethnoecology, Conservation study by using data of previous decade. Study of conservation policies and methods of China, India, Sri Laka and US and their application in Pakistan/AJK.

Recommended Books:

- Nasir, E. and S. I. Ali, eds. 2003. Flora of Pakistan. Islamabad and Karachi: National Herbarium, PARC and Department of Botany, University of Karachi.
- Nasir, Y. J. and R. A. Rafiq 1995-2000. Wild Flowers of Pakistan. Karachi: Oxford University Press.
- Pearce, D. W. and D. Moran 2014. The Economic Value of Biodiversity. London: Earthscan.
- Zaman, M.B. and S. K. Khan 2010. Hundred Drug Plants of West Pakistan. Peshawar: Pakistan Forest Institute.
- World Resources Institute 2008. National Biodiversity Planning. IUCN, UNEP, WRI.
- Klemm, C. de 1993. Guidelines for Legislation to Implement CITES. IUCN Policy and Law Paper No. 26. Bonn: IUCN-ELC.
- Davis, S.D. et al. 2006. Plants In Danger: What Do We Know? Gland, Switzerland: IUCN.
- Muahmmad Ishtiaq, Yi Wang and Mehwish Maqbool, 2012. Taxonomical and Pharmaceutical Analysis of Medicinal Plants of China, LAP LAMBERT Academic Publishing GmbH & Co. KG Heinrich-Böcking-Str. 6-8, 66121, Saarbrücken, Germany.

BOT-703 ADVANCES IN STRESS PHYSIOLOGY 3(3+0)

Theory: Types of stress factors: Drought and its effects in plants**,** Short-term and long-term adaptations to drought stress**,** Resistance strategies in plants and animals**,** Osmotic stress and its regulation in plants**,** Changes in gene expression due to stress**,** Stress and ABA production**,** Inhibition of photosynthesis and respiration**. Heat stress**, Production of heat shock/stress proteins (HSPs)**,** Mediation of thermo-tolerance by HSPs**,** Transcription factors for HSPs production**,** Adaptation to heat stress mediated by cytosolic calcium, Short- and long-term adaptation to heat stress, Radiation stress and adaptation strategies, Effects of radiation stress on plants, Salinity stress and adaptation strategies, Effects of salinity on plants and their distribution, Oxygen stress and adaptation strategies, Effects of oxygen stress on plants and animals, Chemical defense against herbivory and pathogens, Strategies for breeding for stress factors in plants, Allen's rule of adaptation, Bergmann's rule of adaptation, Gloger's rule of adaptation

Recommended Books:

- Larcher, W. (1995). Physiological Plant Ecology. Third Edition. Springer. Berlin. New York.
- Fowden, L., Mansfield, T. And Stoddart, J., (1993). Plant Adaptation to Environmental Stress. Chapman & Hall, London.
- Lüttge, U. (1997). Physiological Ecology of Tropical Plants. Springer. Berlin. New York.
- Epstein, E. (1972). Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons Inc., New York.

BOT-704 ORNAMENTAL HORTICULTURE 3(3+0)

Theory: General Aspects: Concepts on Ornamental Horticulture, importance, present situation, problems and scope of growing ornamental plants and their exports, **Classification and Nomenclature of Ornamental Plants:** Different types of classification, Styles of gardening and their components, Landscape and town planning, Elements and principles of landscape gardening . Factor affecting landscape design, Indoor gardening, pot culture and hanging basket, Types of indoor plants, culture media and types of pots, Care and

maintenance of indoor plants, Bonsai making, Flower arrangement; exhibition and flower judging, Establishment and maintenance of lawn, Establishment of nursery enterprises, Nursery media, containers, equipment and structures, Development, Construction and Maintenance of Different Garden and Park: Home garden, institutional garden, rock garden, water garden and park, Landscape Horticulture: Classification, development and management of lawn, turf and hedges, Production and Management of the Following Flowers: Rose, chrysanthemum, dahlia, marigold, jasmines, cosmos, zinnia, calendula, shrubs, palms, ferns and cactus, **Cut Flowers:** Definition, importance, cut flower as a source of income, factors affecting keeping quality of cut flowers and its remedies, Packaging and Marketing of Cut Flowers: Definition, objectives, methods and criteria of good packaging and marketing, Landscape: Analyzing the Residential Landscape, Designing Landscape Areas, Preparing the Landscape Site, Installing and Maintaining Irrigation Systems, Installing Woody Landscape Plants, Groundcovers, Perennials, and Annuals,Uses of ornamental plants in the landscape, general forms and growth habits of plants, environmental requirements for plant growth and development, Basic plant propagation techniques, landscape maintenance and management such as pruning, planting, fertilizing, irrigation system maintenance and repair, lawn mowing, pest and disease control, landscape drafting, landscape irrigation.

Recommended Books:

- Jaime A. Teixeira da Silva. 2008. Floriculture, Ornamental and Plant Biotechnology Advances and Topical Issues. 1st Edition, volume 5.
- Jack Ingels. 2009. Ornamental Horticulture. 4th Edition, Cengage Learning Publishers, ISBN-10: 143549816X.
- Lee Reich. 2009. Landscaping with Fruit, 2nd Edition, Storey Publishing, ISBN-13: 9781603420914.

BOT-705 PLANT TISSUE AND CELL CULTURE (3+0)

Theory: Define plant tissue culture. Elaborate its brief introduction, History of plant tissue culture, Basics of plant cell and tissue culture, Current and future status of plant tissue culture,Planning and organization of tissue culture laboratory, Basic techniques of plant tissue culture, Procedures for germplasm conservation, Important techniques of plant tissue culture,Tissue culture in pharmaceuticals, Hairy root cultures and their significant contribution in biology,Somatic embryogenesis and organogenesis, The role of silicon in plant tissue culture, Induction and maintenance of callus culture, Define cell suspension

culture and elaborate its procedure, Study of differentiation through organogenesis and embryogenesis, Cell line selection through suspension culture for the production of stress resistant plants, Suspension and their application in crop improvement, Tissue culture techniques for haploid production and their application in agriculture, Meristem culture for mass and clonal propagation of ornamental plants, Virus resistant plants and forests trees, In vitro pollination and shotgun wedding, Embryo rescue technique and embryo culture, Encapsulation of somatic embryos, Shoot apices for artificial seeds, Vegetative organ cultures in laboratory, Plant tissue cultures in horticulture, Choice of explants in tissue culture, Regeneration pathways in tissue culture, Cryopreservation techniques for germplasm conservation, Protoplast isolation, culture and regeneration, Somatic hybridization and selection mechanism for hybrids and cybrids, with special reference to crop plants, Delivery systems for gene transfer in plants through co-cultivation of explants and Agrobacterium, or through direct methods-electroporation, silicon carbide method, Transgenic plants details, Use of transgene for herbicides, Use of transgene for insecticides, Use of transgene for virus, Use of transgene for drought, Use of transgene for salinity, Use of transgene for insect resistance, Use of transgene for male sterility and restoration system, Use of transgene for molecular farming, Industrial application of plant tissue culture for secondary metabolites for commercial purpose, Industrial application of plant tissue culture scale up and down stream processing for secondary metabolites, Define somaclonal variation. Application of somaclonal variations, Production of secondary metabolites using tissue culture techniques, Explain somatic cell hybridization, Production of fruits of transgenic agriculture, Nanotechnology and plant tissue culture

Books Recommended:

- V.K. Khanna, N.T. Meetei (2016). Plant Tissue Culture. Kalyani Publishers, India (Available in Library).
- Singh, B.D. (2005). Plant Tissue and Cell Culture, Blackwell Scientific Publ., UK(Available in Library).
- S.S. Purohit (2015). Plant Tissue Culture. Jodhpur, India.
- George M. Malacinski and David Freifelder (2006). Essentials of Molecular Biology (3rd edition). Johns and Bertlet Publishers.
- M. K. Razdan (2013). Introduction to Plant Tissue Culture. Science Publishers.

BOT-706 ADVANCES IN ENVIRONMENTAL BIOLOGY (3+0)

Theory: Ecosystem: Major component of ecosystem, why biodiversity is important? Energy in ecosystem.**Evolution and Biodiversity:** Adaptability of life on earth, Biological evolution, Effect of geological and climatic changes after evolution, Ecological niche, Effect of extinction, Speciation and human activities on biodiversity, How genetic engineering affect evolution, Adaptability of earth life's and sustainability.**Community and Population Ecology:**Effect of sustainability of community, Role of species within a community, Species interaction, Response of communities to changing environmental conditions. Environmental problems their causes and sustainability, Environmentally sustainable society, Impact of ecological foot print on earth, **Principals of sustainability:**Geology and nonrenewable mineral resources, the nanotechnology revolution, Earth's major geological processes, Harmful environmental effects of using mineral resource, Sustainability of mineral resources, Nanotechnology and sustainability, Air pollution, Climatic changes and ozone depletion, major air pollution problems, climatic changes expected in future, Effect of warmer atmosphere, Global warming, volcanic eruption, Climatic change and sustainability.Environmental economics, politics and worldviews, Relation of economic system to biosphere, use of economic tools to deal environmental problems.

Recommended Books:

- Miller. , G. T. and S. Spoolman. 2009. Introduction to Environmental Science.
- Rana. , S. V. 2009. Essentials of Ecology and Environmental Science. PHI learning private limited New Dehli.
- Shukla. , R. S and P.S. Chandel. 2000. Plant Ecology. S. Chand and Company Ltd, Ram Nagar New Dehli.
- Millennium Ecosystem Assessment. 2005. Ecosystem and well-being Synthesis report. Washington DC: Island Press.

BOT-707 BIOENERGETICS AND MOLECULAR ENZYMOLOGY 3(3+0)

Carbohydrate catabolic pathways and microbial growth on C1 Compounds**:** EMP, HMP, ED, Phosphoketolase pathway, TCA cycle, methylglyoxal bypass. Anaplerotic sequences, catabolism of different carbohydrates, glycerol metabolism, regulation of carbohydrate metabolism, Pasteur effect. Substrate level phosphorylation. Microbial growth on C1

Compounds (Cyanide, Methane, Methanol, methylated amines and carbon monoxide). **Bacterial** fermentations (biochemical aspects) and Biosynthesis**:** Alcohol, lactate, mixed acid, butyric acid, acetone-butanol, propionic acid, succinate, methane, and acetate fermentations. Biosynthesis of Purines, Pyrimidines and fatty acids. **Endogenous metabolism** and degradation of aliphatic and aromatic compounds: Microbial degradation of aliphatic hydrocarbons (microorganisms involved, mon-terminal, biterminal oxidation of propane, decane, etc.) and aromatic hydrocarbons and aromatic compounds (via catechol, protocatechuate, meta-cleavage of catechol and protocatechuate, dissimilation of catechol and protocatechuate, homogentisate and other related pathways). **Properties of Enzymes**: Classification of enzymes into six major groups with suitable examples. Numerical classification of enzymes. Different structural conformations of enzyme proteins. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action. Mechanism of action of lysozyme, chymotrypsin and ribonuclease. **Enzyme kinetics**: Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time). Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of enzyme reaction.

Recommended Books:

- N Gray and M Calvin (2012). Enzymes Biotechnology. CBS Publishers and Distributers Pvt Ltd.
- Garrett and Grisham (2005). Biochemistry. Thomson learning Inc.
- Biochemistry by Stryer 5th Edition WH Freeman 2001.
- Understanding enzymes: An introductory Text 2019
- Laboratory techniques in Biochemistry and Molecular Biology by Work and Work.
- Fundamentals of Enzymology. 3rd Edition by Price
- Methods in Enzymology by Drolittle.

BOT-708 ADVANCES IN LAB EXPERIMENTAL TECHNIQUES 3(3+0)

Theory:

1. **Staining**
    a) Preservatives

b) All stains used in laboratory for different structures
c) Microtome sectioning, dehydration, paraffin embedding
d) Double staining procedures

2. **Staining of the members of followings classes**
   - **a)** Lycopsida
   - **b)** Fillicopsida
   - **c)** Sphenopsida
   - **d)** Hepatcopsida
   - **e)** Anthocerotopsida

Part -2

1. Staining of different steles
2. Different tissues in the plants
3. Staining of different woods of trees with technical description
4. Test for carbohydrates, Proteins, Flavonoid, DNA and RNA
5. Training for chromatography
6. Epidermal Anatomy of the Plants
7. Tissue culture techniques.
8. Palynology.

Part- 3

1. **Plant Biochemical Analysis**
   1. Balance
   2. pH Meter
   3. Conductivity Meter
   4. Oxygen Meter
2. **Spectrophotometery**
   1. Introduction
   2. Principles and types.
   3. Working with spectrophotometer
   4. Preparation of standard curse
   5. Result interpretation
3. **Chromatographic Techniques**
   1. Introduction

2. Principles and types
3. Methodologies/Protocols of different types for different plant primary and secondary metabolites
4. **Electropheretic Techniques**
    1. Introduction
    2. Principles and types
    3. Protocol for Proteins, Nucleic acid and lipids
    4. Protocol for Secondary metabolites.

Recommended Books:

- S. Sundra Rajan ; 2000 Lab Outline: manual of Bryophytes, Anmol Publications. New Delhi-110002 India.
- S. Sundra Rajan ; 2000 Lab Outline: manual of P Tridophtes, Anmol Publications. New Delhi-110002 India.
- A.Rashid; 2006, An Introduction to Bryophytes, Vikas Publishing House. Delhi 110007.
- T.N Kaul, 1997; Introduction Mushroom Science; Oxford +IBH Publishing Co. 66 Janpath. New Delhi 110001.
- Konira Sharma; 2007; Manual of Microbiology , 2nd Ed.Ane Book, India C-26, Seclor-A Mahanagar. Luckmow 226006. Lacknow.
- Gibbs. R.D.1974; Chemotaxonomy of flowering Plants 14, McGil Queen's University Monteal.

BOT-710 ADVANCES IN GENETICS 3(3+0)

Theory: **Advanced Gene Technologies**: mutation- and expression analysis, isolation and mapping of genes, animal models for functional studies, cytogenetics, **Short DNA Fragments**: classic restriction enzyme and ligation based techniques for recombinant DNA, **Long DNA** Fragments: manipulating large DNA fragment using homologous recombination based techniques, Embryonic Stem Cells, Introduction to Epigenetics: Germ Cells and Genetic Imprinting, The Molecular Mechanism of Pluripotency: Deep Sequencing, New Genome Editing Methods: Chromatin Organization, DNA methylation, Histone Modification, Association mapping in plants: the post-GWAS genomics era, Multi-omics approaches: strategic improvement of stress tolerance in underutilized crop species: A

climate change perspective, Understanding human DNA variants: affect on pre-mRNA splicing in the NGS era, Population-scale genomics: Enabling precision public health.**Fundamental Techniques** of Gene Manipulation: Basic Techniques, Gene Cloning Strategies, Sequencing Genes and Short Stretches of DNA. The eukaryotic operon structure and function, gene clusters, genes in organelles: The Eukaryotic Operon: Organization, implications, transcription,Post-Transcriptional Processing, The Signal Hypothesis, nuclear transport, **Changing Genes:** Site-directed Mutagenesis and Protein Engineering. **Gene Transfer to Plants:** Advanced Transgenic Technology, **Eukaryotic transcription**: General transcription factors, basal transcription complex formation. Eukaryotic transcriptional activators: specific TF structural classes. Chromatin structure & regulation, histone modifiers, coactivators & corepressors, PCR based cloning and sequencing methods,construction of mutant and chimeric dna using pcr, quantification of mrna using pcr, sequencing of expressed sequence tags (est), Microarray analysis ("DNA chip technology"), **Genome Analysis, Genomics and Beyond:** The Organization and Structure of Genome, Mapping and Sequencing Genomes, Large-Scale Mutagenesis and Interference, Analysis of the Transcriptome. **Applications of Gene Manipulation and Genomics:** Understanding the Basis of Polygenic Disorders and Identifying Quantitative Trait Loci, Applications of Recombinant DNA Technology.

Recommended Books:

- Rakesh S. Sengar, Amit Kumar, Reshu Chaudhary, Ashu Singh. 2018. Advances in Molecular Techniques, 1st Edition, CRD Press, ISBN 9780815370758
- Gonzalo Riadi, Xiao-chun Chen, Helen Liapis, Pamela Anna Burger. 2017. Advances in Molecular Genetics. Academia Publishing, ISBN: 978-1-61896-303-1.
- Bruce Alberts. 2017. Molecular biology of the cell, 6th Edition, Garland Science, ISBN-13: 978-0815345244.
- Jeffrey Hall. 2005. Advances in Genetics, Volume 55, 1st Edition, Academic Press, ISBN:9780080522333.

BOT -711 WEED ECOLOGY (3+0)

Theory: Weeds: Definition, Characteristic of weed, Losses caused by weed, useful aspects of weed,sampling of weed in different crops. **Methodology** for Density, Frequency, Canopy Cover Life form and Leaf spectrum. **Medicinal weed**, Method of weed control in field, important weed in maize and wheat field of Azad Jammu and Kashmir,Eradication of annual

biennial and perennial weeds. **Applications of Biotechnology in** weed management,Genetic manipulation of crop tolerance in herbicides in vitro, mutant selection at the cell or tissue level,impact of biotechnological techniques.Herbicide resistant **in weeds and its management,**introduction, mechanism of resistance,incidence, Evolution of herbicides resistance, Major factor influencing the evolution of herbicide resistance, Weed control by biological methods, Plant competition.

Recommended books:

- Walia, U.S. 2003. Weed management Kalyani Pub. Dehli.
- Zindhal, R.L. 1998. Fundamentals of weed science. Academic press, Inc. Newyork.
- Wapohere, A.J. 1983. Biological control of weeds. In biology. & Ecology of weeds. W. Holzner& N. Numata .W. Junk Pub. The Haque.

BOT-712 ADVANCES IN MICROBIOLOGY 3(3+0)

Theory: Introduction of Microbiology, Types of micro-organisms, Theory of microorganisms, Microorganisms and diseases pathogenecity of microorganisms, Human air, food and water borne infections and their control, Contact diseases of animals, Host-microbe interactions, Resistance and immunity, Fundamental of control, control by physical and chemical agents, Antibiotics and other chemotherapeutic agents, Microbial toxins and their role in the pathogenecity of disease, Mechanism of pathogenecity caused by microbial toxins, Pathogenesis of cholera, typhoid, diphtheria and septicemia, Environmental and industrial Microbiology, Microbiology of air: indoor microbiology, aero allergens water, Microbiology of water:types of water, ground water microorganisnm, marine microbiology, fresh water microbiology, sedimentation, disinfection, Microbiology of milk and milk products, Microbiology of cheese, Biotechnology of dairy food.

Recommended Books:

- Ajit Kr. Banerjee and Nirmalaya Banerjee (2008). Fundamentals of Microbiology and Immunology. New Central Book Agency (P) Ltd.
- Tortora Funke (2007). Microbiology, Pearson Education Publishing Inc.
- Pelczar Jr., Chan,E.C.S. and Krieg, M.R.,(Latest Ed) Microbiology,McGraw Hill,London.

- Peltler., G.L.A Laboratory Manual of Microbiology.
- Pelczar Jr., Chan,E.C.S. and Krieg, M.R.,(Latest edition Latest),Concepts and Applications, Essentials of Microbiology Latest edition
- Fundamentals of Microbiology (Latest edition).

BOT- 713 ADVANCES IN PHYTOSOCIOLOGY (3+0)

Theory: Ordination Technique, Detrendent correspondent analysis (DCA), Canonical correspondence analysis (CCA), Sampling vegetation techniques; Qualitative characters, Quantitative characters, Diversity and its components, Degree of aggregation and its types, Homogeneity and Heterogeneity, Age class, Index of similarity and dissimilarity, Life form, Leaf spectra, Data and its types, Diversity indices, types of diversity, measurement, Dominance diversity curve, Descriptive statistics and exploratory data analysis; Measurement of central tendency, frequency tables and histogram, Measurement of dispersion, The Mann-Whittney U test for independent samples, Correlation and Regression analysis.

Books Recommended

- Barbour, M.G; J.H.Burke and W.D.Pitts. 1999, Terristial Plant Ecology.
- Kent M and P. Coker 1992. Vegetation description ana analysis. Jhon Wiley & Sons.
- Chapman,J.L and Reiss, M.J.1999. Ecology: Principal and Applications. Cambridge University Press, UK.
- Hussain,F. 1989. Field and Laboratory Manual of Plant Ecology. National academy of Higher Education, Islamabad.
- Krebs,C. J.1997. Ecology. Harper and Row publishers.
- Moore,P. D and S.B. Chapman.1986.Methods in Plant Ecology. Blackwell Scientific publication, Oxford.
- Newman,E. I.2001.Applied Ecology.Blackwell Science.UK.
- France,H. 2000 Vanishing Borders: protecting the plant in the age of globalization. W.W.Norton and Company, NY

BOT-714 RECOMBINANT DNA TECHNOLOGY (3+0)

Theory: General Information on Recombinant DNA Technology: Development and applications,Overview of making recombinant DNA: Isolating, cutting, joining of DNA, amplifying the recombinant DNA. **Types of vectors**: Plasmids; Lambda based

vectors and derivatives, Insertion vectors, replacement vectors, cosmids, phasmids, phagemids. **In-vitro packaging**: selection schemes, high-cloning capacity vectors. **Single** stranded DNA vectors (M13, fd, f1); YACs, BACs, PACs, BIBACs, Plant Transformation vectors: Ti, Ri plasmids, Binary, Conjugate, selection schemes.Protein Expression Vectors: Expression systems for high level protein expression in E.coli and yeast, transcriptional efficiency, inducible promoters, translational efficiency, translational initiation, elongation, codon usage. Protein extraction and purification: protein purification tags, histidine and GST tags, IMAC. Making a Library. Source of vector DNA, Source of donor DNA.Probing for gene: DNA probe, protein probe, Complementation, Positional cloning, Tagging, **Analysis of cloned genes**: Gel electrophoresis, Restriction enzyme mapping, Southern, Northern, Western Blot.**DNA Sequencing of a gene**: Maxam-Gilbert base destruction method, Sanger dideoxy method.**Site Directed Mutagenesis**: PCR based methods for site-directed mutagenesis. **Single Primer Method:**Mis-incorporation of mismatched oligos, Over-lap extension, whole plasmid single round PCR, Mis-repair of mutant oligonucleotides, **Selection of Mutant**: dut/ung E. coli strains for SDM through uracil replacement, Ligase chain reaction, **In-silico analysis:** manipulation and annotation of DNA sequences.

Recommended Books:

- M. R. Green, J. 2012. Sambrook. Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbor Press.
- M. Wink. 2011. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology. 2nd Edition, Wiley Publishing.
- K. Wilson, J. Walker. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th Edition, Cambridge University Press.
- Bernard R. Glick and Jack J. Pasternak, Cheryl L. Patten. 2009. Molecular Biotechnology: Principles & Applications of Recombinant DNA. 4th Edition, Washington, DC: ASM Press.
- S. B. Primrose, R. Twyman. 2006. Principles of Gene Manipulation and Genomics. 7th Edition, Wiley-Blackwell Publishers, ISBN: 978-1-405-13544-3.

BOT-715 PLANT SOIL AND WATER RELATIONS 3(3+0)

Theory: General introduction of the course, Physical properties of water and their biological implications, Functions and properties of aqueous solutions, Thermodynamics in relation to water and solute movement, Components of water potential and measuring water potential methods, Methods of measuring water status, Soil water relations, Mechanisms and flow paths associated with movement of water in the soil-plant-atmosphere continuum, Transpiration, Water use efficiency, Plant response to water deficit, Plant response to soil saturation.

Recommended Books:

- Kramer, P.J. and J.S. Boyer. 1995. Water Relations of Plants and Soils. Academic Press, New York.
- Scott, H. D., 2000, Soil Physics: Agricultural and Environmental Applications.
- Paul J Kramer. 2012. Water Relations of Plants. Academic Press.
- M.B. Kirkham. 2014. Principles of Soil and Plant Water Relations. Science Direct.

BOT-716 PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING (3+0)

Introduction to plant biotechnology and genetic engineering, Types of culture, Cell and tissue culture ,Tissue culture media ,callus culture ,suspension culture,single cell culture , embryo culture and embryo rescue, Shoot tip culture, anther pollen and ovary culture, Protoplast isolation culture and fusion, Organogenesis and somatic embryogenesis, Clonal propagation and production of virus free plants, Basic techniques in genetic engineering, Isolation of genes, vectors making of chimera vectors picking up the transgenic genotype, Plant transformation technology Vector mediated or direct gene transfer, Agrobaterium, Basis of tumor formation, Role of virulence gene, Use of Ti and Ri plasmid as vector, Binary vector,Virus mediated gene transfer and integration into plant genomes, Direct gene transfer, Chemical mediated gene transfer, Microinjection, Electroporation, Particle gun, Other methods, Transgenic stability and gene silencing, Important consideration, Use of 35 s promoter, Genetic marker, Reporter gene with introns, Multiple gene transfer, Application of plants transformation for productivity and performance, Stress tolerance, Biotic stress, Abiotic stress, Transgenic plants as biofactories, Molecular markers aided Breeding, Molecular markers, the basic steps of this technique, Marker based on PCR amplification, Marker based on hybridization, Molecular marker assisted selection, Linkage analysis, Map

based cloning, Arid and semiarid Plant Biotechnolgy, Green house and green home technology, Selection of rDNA clones and their expression products, Analysis of cDNA library, Process of mutagenesis and PCR site directed mutagenesis, DNA fingerprinting, Production of protein from cloned genes, Recombinant protein production in *E. coli*, Synthesis, cloning and expression of other recombinant proteins, Filamentous fungi for protein expression, Eukaryotic gene synthesis and expression

Recommended Books:

- H. K. Das. (2010). Text Book of Biotechnology. 4th Edition. John Wiley and Sons, USA (Available in Library).
- Chopra, V.L., Malik, V.S. Bhatt, S.R. 2014. Applied Plant Biotechnology.Oxford& IBH (Available in Library).
- Bhowmik .G. S. (2017). Depertmental councile Analytical technique in Plant Biotechnolgy (Available on Internet).
- Dr. R. C. Dubey (2008). Adnanced Biotechnology. S. Chand and Pvt. Ltd. New Delhi(Available in Library).
- M. O. Neill, M. M. Hopkins (2012). A Biotech Manager's Handbook. Woodhead Publishing Series in Biomedicine. Elsevier (Available on Internet).

BOT- 717 BIOSTATISTICS AND COMPUTER APPLICATIONS 3(3+0)

Theory: Introduction to Biostatistics: Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.

Measures of central tendency: Measures of central tendency: Mean, Median, Mode. Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of KarlPearsons co-efficient of correlation. Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.

Tests of significance Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions,

(concept without deviation) binomial, poison and normal (only definitions and problems) Computer oriented statistical techniques. Frequency table of single discrete variable, bubble spot, computation of mean, variance and standard Deviations, t test, correlation coefficient

Introduction to computers and computer applications: Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction to Q basic and C. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.

Net working concepts: Networking fundamentals, client, server, LAN, WAN, Flp, TelNET, INTERNET, NICNET, WWW, html, e mail, intoduction to MEDLINE, CCOD and PUBMED, for accessing biological information. An introduction to bioinorganic software, C/C++, bioperl, biojava, bioXML, bioORACLE, etc. Introduction to Havard graphics and coral draw.

Recommended Books:

- Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.
- Lab Outline: Statistics for experimental biologist by Wardlaw, A.C. (1985).
- How Computers work - 2000. By Ron White. Tech. Media
- How the Internet Work 2000 by Preston Gralla Tech. Media.
- Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
- Statisticsfor Biologist by CampbellR.C. (1974) Cambridge University Press, UK.

BOT- 718 PHARMACEUTICAL MICROBIOLOGY 3(3+0)

Theory: Antibiotics and synthetic antimicrobial agents: Aminoglycosides, β lactams, tetracyclines, ansamycins, macrolid antibiotics, Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives. **Mechanism of action of antibiotics**:Mechanism of action of antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting. Drug delivery system in gene therapy Bacterial resistance to antibiotics. Mode of action of bacterial killing by quinolinones. Bacterial resistance to quionolinones. Mode of action of non – antibiotic antimicrobial agents. Penetrating defenses – How the antimicrobial agents reach the targets (cellular permeability barrier, cellular transport system and drug diffusion). **Microbial**

production and Spoilage of pharmaceutical Products: Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase). New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials. **Regulatory practices, biosensors and applications in Pharmaceuticals**: Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective.

Books Recommended:

- Pharmaceutical Microbiology 2004 by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
- Analytical Microbiology 2014 by Frederick Kavanagh Volume I & II. Academic Press New York.
- Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.
- Drug Carriers in biology & Medicine Edt. by Gregory Gregoriadis. Academic Press New York.
- Quality Assurance in Microbiology by Rajesh Bhatia, Rattan lal 11. Ihhpunjani. CBS Publishers & Distributors, New Delhi.

BOT-719 APPLIED ETHNOBOTANY (3+0)

Theory: Definition Ethnobotany, objectives, types and significance of Ethnobotany, Developmental History of Ethnobotany.Typology and Branches of Ethnobotany, Historical perspectives of Ethnobotany in Pakistan, Famous Ethnomedicinal systems of world i.e. Traditional Chinese Medicines (TCMs), Africa, Middle East or Islamic ethnomedicines systems, India Ethnomedicine system, Ethnoveterinary medicines and ethnozoological medicines and their scope, Ethnobotany and wild plants as source of food, fodder and medicines, Role of Ethnobotany in cultural study and preservation with example, Role of Ethnobotany in plant biodiversity conservation with example, Role of Ethnobotany in Drug discovery and development, Scientific protocols vs folklore techniques, Role of Ethnobotany in treatment of diseases (five diseases) with their prescription and recipes, Correlation of Ethnobotany with subjects such: Botany, Ecology, Cultural Anthropology, Agronomy,

Forestry and Horticulture, Economics, Biodiversity Conservation, Principles and Methods/ Analysis of Ethnobotany, Ethnobotanical data collection method, Methods and requirements of Field Documentation, Qualitative methods & Quantitative methods, Data Computation and Processing, Data Analysis by Microstatistical tools, Presentation of Ethnobotanical data in research thesis and paper, Ethnobotanical Research Institutes and Departments in world/Pakistan and their work and links for collaboration, Five impact factor research papers on Ethnomedicinal and Ethnobotanical in international journals, their key objectives, methodology used and application, Methods of study of genetic features in Ethnobotany.

Books Recommended:

- Trotter, RT.; Logan, MH. Informant consensus: A new approach for identifying potentially effective medicinal plants. In: Etkin NL. , editor. *Plants in indigenous medicine and diet.* Bedford Hills, NY , Redgrave; 2006.
- Balick, MJ.; Cox, PA. *Plants, people, culture: the science of ethnobotany.* New York, Scientific American Library; 2005.
- Alcorn, J. B. (2010). The scope and aims of ethnobotanyin a developing world. In *Ethnobotany:evolution of a discipline* (ed. R. E. Schultes and S.von Reis), pp. 23-39. Chapman and Hall, London,UK.
- Alexiades, M. (2009). Selected guidelines for ethnobotanical research: a field manual, pp. 306. New York Botanical Garden Scientific Publications, New York, USA.
- Anderson, E. F. (2005). Ethnobotany and the liberal arts. In *Ethnobotany: evolution of a discipline* (ed.R. E. Schultes and S. von Reis), pp. 183-186.Chapman and Hall, London, UK.
- Cunningham, A. B. (2001). *Applied ethnobotany: people,wild plant use and conservation*. Earthscan,London, UK.
- Farnsworth, N. R. & Soejarto, D. D. (2008). *Global importance of medicinal plants. In The conservation of medicinal plants* (ed. O. Akerele, V.Heywood and H. Synge), pp. 25-51. Cambridge University Press, Cambridge, UK.
- Fisseha M., Sebsebe D., Tilahun T., (2009). An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia, Journal of Ethnobiology and Ethnomedicine, 5:28 doi:10.1186/1746-4269-5-28.

BOT-720 ADVANCES IN FLOWERING PLANT TAXONOMY (3+0)

Theory: Principles of Systematics, nomenclature & its rules, Concept of species, Genus concept and Family concept, Overview on types of classification: Sexual system of classification (Linnaeus), Natural system of classification (Bentham & Hooker), Phylogenetic system of classification (Engler & Prantle) and modern system of classification (Takhtajan), Comparative study of classification systems of;i) Bentham and Hooker, ii) Engler and Prantle, iii) Bessey, iv) Eichlerand Hutchinson, Angiosperm introduction: Characteristics,Evolution,Diversity, History of flowering plants,Taxonomic studies of the following families (Bentham and Hooker): i) Dicots: Rununculaceae, Malvaceae, Leguminaceae, Compositaceae, Solanaceae, Cucurbitaceae ii) Monocots: Orchidaceae, Gramminae. Role of morphology in taxonomy, Role of anatomy in taxonomy, Role of cytology in taxonomy, Role of embryology in taxonomy, Role of phytochemistry in taxonomy.

Recommended Books:

- Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- Datta S C., 1988 Systematic Botany, 4th Ed, Wiley Estern Ltd., New Delhi
- Eames A. J. 1981 Morphology of Angiosperms - McGraw Hill, New York.
- Naik V.N., 1991 Taxonomy of Angiosperms Tata Mcgraw-Hill Pub. Co. Ltd., New Delhi.
- Pandey, S. N, and S.P. Misra (2008) Taxonomy of AngiospermsAne Books India, New Delhi.
- Takhatajan,Flowering Plants Edinburg, Oliver & Boyd.

SCHEME OF STUDIES

Ph.D. IN BOTANY

DEPARTMENT OF BOTANY

Item NO.7: Approval of course codes of seminar and thesis for Ph.D. Botany

Scheme of Studies of Ph.D. in Botany

Eligibility Criteria:

For admission to Ph.D. the minimum CGPA should be 3.00 or 1st division in MS/M.Phil (as per HEC criteria). In addition, the candidate must pass GAT subject Test/GRE international with minimum percentile score 60% at admission time or before final submission of Ph.D. Dissertation.

Scheme of Studies of Ph.D. Botany:

Duration:	3 - 8 Years
Courses:	18 Credit Hours
Seminar	02 Credit Hours
Thesis:	50 Credit Hours
Total:	70 Credit Hours

List of Approved Courses for Ph.D. in Botany

No.	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs	Approved/Not Approved
BOT-801	Plant Chemotaxonomy	3	0	3	Approved
BOT-802	Advances in Edaphology	3	0	3	Approved
BOT-803	Fungal Ecology and Biotechnology	3	0	3	Approved
BOT-804	Advances in Molecular Biology of Plants	3	0	3	Approved
BOT-805	Phytogeography and Plant Adoptations	3	0	3	Approved
BOT-806	Advances in Phycology	3	0	3	Approved
BOT-807	Soil Fertility and Plant Nutrition	3	0	3	Approved
BOT-808	Wild plants and their Economic Importance	3	0	3	Approved
BOT-809	Advances in Research Techniques	3	0	3	Approved

BOT-810	Advances in Proteomics	3	0	3	Approved
BOT-811	Advances in Bioinformatics	3	0	3	Approved
BOT-812	Statistical Genomics	3	0	3	Approved
BOT-813	Plant Growth and Development	3	0	3	Approved
BOT-814	Advances in Plant Biosystematics	3	0	3	Approved
BOT-815	Project Planning, Monitoring and Evaluation	3	0	3	Approved
BOT-816	Integrated Biological Resource Management	3	0	3	Approved
BOT-817	Climate Change and Agricultural Plant Adaptations	3	0	3	Approved
BOT-818	Herbarium Management and its Digitalization	3	0	3	Approved
BOT-819	Climate Change and Forest Conservation Studies	3	0	3	Approved
BOT-896	Comprehensive Examination (Written & Oral)	0	0	0	Approved
BOT-897	Seminar I	1	0	1	Approved
BOT-898	Seminar II	1	0	1	Approved
BOT-899	Thesis Ph.D.	0	50	50	Approved

BOT- 801 PLANT CHEMOTAXONOMY (3+0)

Theory:

- **Introduction**: Definition, objectives, purpose, scope and a brief history of chemotaxonomy
- Overview on chemotaxonomy - Compilation of chemotaxonomy term and different classes of secondary metabolites and knowing the functional groups
- The use of chemical data in taxonomic study of plant
- Occurrence and Compatrmentation of selected class of secondary metabolism

- **Secondary Metabolites** Structure, bisynthesis, physiological actions of Flavonoids, Carotenoids, Betalains, Terpenoids, Steroids, Iridoid compounds, Alkoloids, Glucosinlates, Amino acids, Lipids and waxes, Nucleic Acids, Proteins, Cyanogenic compounds

- **Classification**: Chemical characters as guide for classification, Chemical characters as aid in delimitations, Chemical characters as aids in unambiguous identification of plants

- **Factors limiting the taxonomic values of chemical characters**: Parallelism and diversification, Limitations caused by incorrect identification and by the omission of documentation

Recommended Books:

- Michael Wink, Flavia Botschen, Christina Gosmann,Holger Schäferand, Peter G. Waterman. 2010. Chemotaxonomy Seen from a Phylogenetic Perspective and Evolution of Secondary Metabolism. John Wiley & Sons, Inc.

- Philip M. Smith. 2009. The chemotaxonomy of plants. Hodder & Stoughton Educational,Cornell University.

- Bruce A. Bohm. 1998. Introduction Flavonoids. Harwood Academic Publishers, Amsterdam, Netherlands.

- Erich Grotewold. 2006. The Science of Flavonoids. Springer Science + Business Media, Inc.Gibbs, Ronald Darnley. 1974. Chemotaxonomy of Flowering Plants (four volumes). McGill Queens Univ Press, Montreal.
- Sharma, O.P. 2004. Plant Taxonomy. Tata McGraw-Hill Publishers, Limited, New Delhi.
- Tadeusz Aniszewski. 2007. Alkaloids – Secrets OF LIFE: Alkaloid Chemistry, Biological Significance, Applications and Ecological Role. Elsevier B.V.

BOT- 802 ADVANCES IN EDAPHOLOGY (3+0)

Soil Perspective: What is soil, A field view of soil, Soil profile, Mineral vs. Organic soils. Four major Components of Soils, Mineralconstituents in soils, Soil organic matter.

Important Physical Properties of Mineral Soils: Soil texture and Soil Structure, Classification of soil particles, Physical nature of soilseparates, Soil texture classes. Mechanical analysis, Preparation of the Sample, Factorsaffecting dispersion. **Soil Water:** Structure and related properties of water, Soil water energy concept, Soil Moisturecontent versus Suction, Measuring Soil moisture, Capillary Fundamentals, Types of soil water movement, Saturated flow through soils, unsaturated flow in soils, Retention of soilmoisture in the field, Conventional soil moisture classification, Factors affecting amountand use of available soil moisture, Capillarity and root extension.**Plant Nutrients and Fertilizers:** Factors controlling the growth of higher plants, fertilizer as plants nutrients, Mixed Fertilizers, Methods ofapplying solid fertilizers, Application of liquid Fertilizers.**Saline and Sodic Soils:** Diagnosisof Saline and Sodic Soils, Reclamation Steps of Salt-affected soils, Crop tolerance to Salinity.

Recommended Books:

- Brady, N.C. (2008). The Nature and Properties of Soils (14th Edition). Macmillan Co. Ltd. USA.
- Rashid, A. and K. S. Memon. (1996). Soil Science. National Book Foundation, Islamabad.
- Tanji, K.K. 1990. Agricultural salinity assessment and management. ASCE No.71, New York, USA.
- Gupta, I.C. 1990. Use of saline water in Agriculture. Oxford and IBH Pub. Co., New Delhi, India.

BOT-803 FUNGAL ECOLOGY AND BIOTECHNOLOGY (3+0)

Brief introduction of Fungal ecology, Concepts about Biotechnology, Introduction of Ecosystem and Fungal Community, Systematic and significance of fungi with special reference to ecosystem, Economic importance of fungal biotechnology, Characteristics to fungi,Functions of fungal ecosystem, Autecology and synecology studies in analysis, Soil pollutants and their effects on mycoflra in the system, Decomposition of Biological chemical wastes.Life style of Fungi, Heterotrophy, Determinants of life style, types of subtracts, growth forms and responses, Fungal biology:Brief introduction, Fungi as organism, Fungi as parasitic symbionts of plants,Mutualism symbionts in ecdomychorhizae and decomposers,population structures, variations and its consequences, Strategies in saprophytic

fungi, Stress tolerance, Fungi inhabitants of aquatic environment, Fungi are part of animal faeces, Correlation of fungi with rganic matters and extreme environments, Myco-biocontrol against Pathogen, Control methods/principles of plant disease,Wheat and maize diseases caused by fungi and biological control, Fungi as biocontrol agents, Myco-control in crop, Mycobiological control insect pests, Nematode control,Mychorhzae and plant control, Introduction of Medical Mycology, Mycotoxin, Effects of ergot alkaloids, Fungi and allergenic agents, Expression of fungi in Clinical and mycosis, Fungi and Food Processing, Method of Bread production by use of fungi, Cheese production and its types, Soya sauce formation by use of fungi, Improve yield of crops by fungal biotechnology, Reduced vulnerability of crops to environmental stresses

Books Recommended:

- C. S. Chandoliya. 2009. Fungi: Biotechnological Diversity. Cyber Tech Publications. India (Available in Library).
- Lynch, J. M &Hobbic, J. M. Blackwell.2011. Microorganism in action: Concept and application in Microbial Ecology. Sci Publication, Oxford, UK (Available on Internet).
- S. Geetha, S. Jebaraj, P. Pandiyarajan. 2008. Agricultural Biotechnology. Agrobios, India (Available in Library)
- Chopra, V.L., Malik, V.S. Bhatt, S.R. 2014. Applied Plant Biotechnology.Oxford& IBH (Available in Library).
- Microorganism in action: Concept and application in Microbial Ecology, 1998. Lynch, J. M &Hobbic, J. M. Blackwell Sci Publication, Oxford, UK.
- Ravi Toteja. 2010. Textbook of Biotechnology. Ane Books Pvt. Ltd. India (Available in Library).

BOT-804 ADVANCES IN MOLECULAR BIOLOGY OF PLANTS (3+0)

Theory: Brief introduction of molecular biology of plants, Molecular structure of gene and chromosome, Structural organization of eukaryotic chromosome, Organelles DNA, Transcription of coding genes, Stepwise synthesis of protein and DNA replication, Transcription control of Gene expression, Regulatory sequence in Protein coding genes, Activator and repressor of transcription, Post transcription Gene controlling mechanism and

nuclear transport, Processing of pre m RNA, Regulation of pre m RNA processing, Macromolecules transport across the nuclear envelope, Cytoplasmic Mechanism of post transcriptional control, Processing of r RNA and t RNA, Inactivation of function of specific genes in Eukaryotes, Gene Inactivation RNA, DNA microarray analysis, Recombinant DNA technology, Amplification fragment length polymorphism (AFLP, Aneuploidy and Annealing, Biotin labeling and Bit mapped, Biotechnological approach to the study of biofilms, Microbial production of industrial enzymes, Genetic engineering of crop plants, Mortality of agroforestry trees, Cold tolerance in maize crop, Growth and productivity of legumes, Plant genes and nodulation, Production of virus free plants, Androgenesis and pathway of development of pollen, Methods of artificial seeds production

Books Recommended:

- Chopra, V.L., Malik, V.S. Bhatt, S.R. 2014. Applied Plant Biotechnology.Oxford& IBH (Available in Library).
- C. P. Malik Bhavneet Kaur and Chithra Wadwani (2008). Advanced topics in biotechnology and plant biology. MD Publishers Pvt Ltd. India (Available in Library).
- Applied Molecular Genetics by Miesfeld. (c) 2001. Wiley-Liss.
- Cullis. C. A. 2004. Plant Genomics and Proteomics. Wiley-Liss, New York.
- Gibson. G. and S. V. Muse. 2002. A Premier of Genome Science. Sinauer Associates Inc. Massachusetts.

BOT-805 PHYTOGEOGRAPHY AND PLANT ADOPTATIONS 3(3+0)

Theory: Introduction, Importance of phytogeography to man. The history of phytogeography, Principles of Phytogeography, Geographical factors: Factors influencing distribution of plants over continents, climatic factors, temperature, light, air and water, nutritive factors, biotic factors, floristic regions, life form classes. Climate and vegetation. Plant communities and association, Plant types and distribution, ecological plant geography, proximity and competition. Major divisions, theories of discontinuous variation, continental drift, ecoregions. Ecological zones of Pakistan. Vegetation of Pakistan, Plant communities of marine, desert ecosystem. Phytogeography of forest, mangrove, Thar desert, up and lowland, alpine zone, hilly tract Mapping of vegetation, study of climatic, biotic and nutritive factors of any area, Determination of life form classes and plant communities, Vegetation of any given area, Field visit to some phytogeographical areas.

Books Recommended

- Champion, H.G., S.K. Seth and G.M. Khattak. 1968. Forests Types of Pakistan. Forest Institute, Peshawar
- Good, R. 1994. The Geography of Flowering Plants. Longman, London.
- Hussain, F. and I. Ilahi. 1991. Ecology and Vegetation of Lesser Himalayas, Pakistan, Jadoon Printing Press, Peshawar.

BOT- 806 ADVANCES IN PHYCOLOGY (3+0)

Theory: Define phycology and their recent trend in biological sciences, Algal cell structure and their evolution, Taxonomic description of phycology, Phylogenic reflection on the algae, Distribution of algae, Ecology of phycology, Anatomical variation in algal divisions, Reproduction of phycology, Life histories of algalogy, Phylogeny of algal protists, Cell wall polysaccharides of algae, Endosymbiosis and algae, The origin of algal chloroplasts, Algal toxins and monitoring of harmful algae, Commercial utilization of algal products, Algae used as bioremediation purpose. Discuss, Laboratory culturing techniques of algae, Bioactivity of common algae present in water, Photochemistry of some important algae, The unique nature of the Pakistani algal flora, Current themes in algal research, The principle characteristics of the prasinophyceae, Detail account on Chlorophyceae, Levels of organization of the chlorphyte thallus, Types of mitosis and cytokinensis in the chlorophyta, Description of Ulvophyceae: Order Ulvales, Details of Cladophorophyceae, Characteristics of Bryopsidophyceae, Order: Bryopsidales, General properties of Dasycladophyceae, Order: Dasycladales, Explain Zygnematophyceae , Order: Zygnematales, Affinities of Yellow green algae (Xanthophyceae), General characteristics of Chrysophyceae, Bacillariophyceae, Cryptophyceae, Dinophyceae, Euglenophyceae, Pheophyceae, Rhodophyceae, Evolution of one membrane of chloroplast and endoplasmic reticulum, Cell structure and symbiotic association of cryptophyta, Cooling of the earth, cloud condensation by algae, Chemical defence mechanism of algae, General symptoms shown by toxic algae, Ultraviolet radiation, The ozone hole and sunscreens produced by algae, Control of algal Nuisance

Books Recommended:

- Robert Edward Lee (2012). Phycology (4th edition). Cambridge University Press, USA (Available in Library).

- C Van Den Hoek, D.G Mann and H.M. Jahns (2012). Algae, An introduction to Phycology. Cambridge University Press, USA (Available in Library).
- Christian V. D. H., D. G. Mann., H. M. Jahns. 2003. An Introduction to Algae. Cambridge Uni. Press.
- Stevenson, Y.P., J. P. Kociolek and J.C. Kabingston. Springer –Verlage. (2006). Adances in Algal Biology : A Commemoration of the work of Rex Lowe Edited by R.J Reprinted from Hydrobiologia , Volume 561.
- Wehr J.D. and R.G. Sheath. (2003). Fresh Water Algae of North America: Ecology and Classification. Acad Press London. 918pp.

BOT-807 SOIL FERTILITY AND PLANT NUTRITION (3+0)

Theory: Soil Fertility and Plant Nutrition, Basic Soil-Plant Relationships, Nutrient Transport in Plants, Soil Acidity and Alkalinity, Nitrogen, Phosphorus and Potassium in Soil, Phosphorus and Potassium in Plants, Sulfur, Calcium, and Magnesium in Soil, Sulfur, Calcium, and Magnesium in Plants, Micronutrients in Soil, Micronutrients in Plants, Pathway of micronutrients in plants, Pathway of macronutrients in plants, Plant water relations with special reference to plant nutrition, Path of water and nutrient uptake in plants, Different mechanisms of nutrient uptake, Absorption of nutrients and soil texture status of crop fields, Mechanism of Phloem transport in plants, source-sink relationship in photosynthetic plants, Toxicity and deficiency symptoms of nutrients, Evaluation of Soil Fertility and Plant Nutrition, Nutrient Management, Nutrients and Environmental Quality, Comparison of mycorrhizal association and plant nutrients, Methods of studying plant nutrition.

Recommended Books:

- Russell's Soil Conditions and Plant Growth by A. Wild (Ed.). 1988.
- Soil Science Principles & Practices by R.L. Hausenbuiller. 1985.
- Mineral Nutrition of Higher Plants by H. Marschner. 1995.
- Principles of Plant Nutrition by K. Mengel and E.A. Kirkby. 2001.
- Plant Analysis Handbook II:A Lab Outline: Sampling, Preparation, Analysis, and
- Mineral Nutrition of Plants by Epstein and Bloom, 2004

BOT-808 WILD PLANTS AND THEIR COMMERCIAL AND ECONOMIC IMPORTANCE (3+0)

Theory: Diversity in Physiography**,** Wild herbs as culinary purpose**,** Source of aromatic chemicals**,** Wild plant as Genetic resources**,** Need of conservation of wild Germplasm**,** Strategy of conserving the wild flora**,** Some herbs, shrubs & trees of A. J & K their Economic uses**,** Importance, present status and scope of Medicinal and Aromatic plants, Classification of Aromatic and Medicinal plants**,** Importance, scope and present status of species, Conservation strategies of medicinal plants**,** Pests and pest management in medicinal plants.

Recommended Books

- Farnsworth, N. R. & Soejarto, D. D. (2008). *Globalimportance of medicinal plants. In The conservationof medicinal plants* (ed. O. Akerele, V.Heywood and H. Synge), pp. 25-51. CambridgeUniversity Press, Cambridge, UK.
- Fisseha M., Sebsebe D., Tilahun T., (2009). An ethnobotanical study of medicinal plants in Wonago Woreda, SNNPR, Ethiopia, Journal of Ethnobiology and Ethnomedicine, 5:28 doi:10.1186/1746-4269-5-28.
- Trotter, RT.; Logan, MH. Informant consensus: A new approach for identifying potentially effective medicinal plants. In: Etkin NL. , editor. *Plants in indigenous medicine and diet.* Bedford Hills, NY , Redgrave; 2006.

BOT-809 ADVANCES IN LAB RESEARCH TECHNIQUES

(3+0)

Theory: Staining Techniques; all stains used in the laboratory for different perspectives, Microtome sectioning, Dehydration paraffin embedding double staining procedure, Staining of member of following classes: Lycopsida, Filicopsida, Sphenopsida, Hepatocopsida, Anthocerotopsida, Staining of different stele, Different tissues in the plant staining of different wood of trees with technical description test for carbohydrate protein, flavonoid DNA, RNA, **Chromatography,** Epidermal anatomy of plants, Tissue culture techniques, Palynology, Plant biochemical analysis Balance, pH meter, oxygen meter, **Spectrophotometery**, Introduction principle and types working with spectrophotometer preparation of standard curve, Result interpretation, Chromatographic techniques introduction, Principle and types protocol for protein Nucleic acid and lipids, Protocol for secondary metabolites. **Mycological Methods**; Autoclaving, Use of Laminar flow bench, Direct plate method, Serial dilution agar plate method, Baiting Technique, Identification of fungi by PCR amplification method.

Recommended books:

- SundaraRajan 2010. ;Lab Outline: manual of Bryophytes Anmol Publication New Dehli -11002 India,
- SundaraRajan, 2000, Lab Outline: manual of Pteridophytes ,Anmol Publication New Dehli -11002 India
- A.Rashid 2006 , An Introduction to BryophytesVikas Publishing house Delhi 11007
- T.N.Kaul 1997 Introduction to Mushrooms Science Oxford Publishing
- Konira Sharma 2007, manual of microbiology 2nd Ed Ane Book ,India c -26
- Gibbs R.D1974 ,Chemotaxonomy of flowering plants 1-4 Mc Gill University Monteal.

BOT-810 ADVANCES IN PROTEOMICS (3+0)

Theory: Proteomics and proteome: Definition of Proteomics, Introduction to proteomics, History and scope of Proteomics, Proteomics and new biology, The proteome, **Tools of proteomics:** Protein extraction and sample preparation, Protein quantification and purification, Sample loading and analysis, **Protocol optimization**, 1-DE, 2-DE, IFE, SDS-PAGE, Protein staining techniques, Analytical and biological variability, Protein gel images and statistical analysis, Detection of protein spots, Master gel and gel comparison, In-situ digestion and extraction of peptides, **Protein identification** by using MALDI-TOF-MS and Multidimensional peptide chromatography and LC-MS, RP LC-MS, LC-MS-MS, PMF and Tandem Mass spectrometry techniques, Protein biomarkers, Computer Programmes & Softwares for protein identification and comparison. **Western blotting (WB),**Protein identification and WB, Up-regulation and down-regulation of proteins, Identifications of post-translational modifications (PTMs), Identifying protein-protein interactions, Mapping protein modifications (PM), Deducing PMs from MS data, Mining MS data for studying PMs, Computational detection of functional linkages between proteins, Phylogenetic profiles,Rosetta Stone Method, Gene neighbor method; Proteins arrays and Protein chips, Anti-body array, Protein micro-arrays, Use of DNA arrays to study protein functions, **Significance of proteomics**:Prediction of gene function, Prediction of protein function, Plant biosystematics, Phylogenetic analysis, Evolutionary study, GM plants, Drug protein interaction, Drug discovery, Drug quality control, Environmental effects on vegetation,

Agriculture, Forestry, **One gene many proteomes:**Basic structural and functional composition of proteins, Protein structure prediction, Protein structure comparison, Role and importance of proteins, **Introduction to databases**, Database searching, Exercise in data-evaluation of peptide mass, Fingerprinting data and of LC-MS data sets , **Biostatistical tools** for the exploration and interpretation of proteomics data, Identify the technologic limitations related to proteomics, Future directions for the field of proteomics.

Recommended Books:

- Richerd Simpson J. Purifying Proteins for Proteomics (a laboratory manual) Cord Spring Harbor Laboratory Press.
- Rastogi *et al.* 2004. Bioinformatics methods and applications. Genomics, Proteomics and Drug discovery.
- Daniel C. Liebler, Introduction to Proteomics, Tools for the New Biology ,ISBN: 0-89603-991-9,. 2002 Humana Press Inc.999 Riverview Drive, Suite 208, Totowa, New Jersey 07512
- Walker, J. M. (2006) Protein Protocols Handbook. Humana Press, Totowa, NJ.
- Siuzdak, G. (2010) Mass Spectrometry for Biotechnology. Academic Press, San Diego.
- Proteomics by Timothy Palzkill, ISBN: 0-306-46895-6, 2002. Kluwer Academic Publishers, New York.

BOT- 811 ADVANCES IN BIOINFORMATICS (3+0)

Theory: Definition of Bioinformatics; Introduction to bioinformatics, Historical perspectives of bioinformatics, Review of the fundamentals of molecular biology and genetics**, Introduction to genomics and proteomics.** Introduction to pharmacogenomics and cheminformatics. Data generation from different biological resources and bioinformatics tools, Review of the basics: DNA/RNA & protein structures and their sequences, **Proteome**, protein sequence and structure analyses, **Generation of genomic** and proteomic data and its storage, Plant genome and human genome, **Gene bank**, Hierarchical genome assembly, Expression cluster analysis, **Protein modeling** , Protein design, Pair wise sequence alignment, Multiple sequence alignment, Building and using scoring matrices, **Computer applications** in biology, Using programming languages to simulate and solve Bioinformatics problems, Soft wares for data retrieving and analysis, BLAST, FASTA and Advanced

BLAST, Sequence databases and information retrieval, Schemes for gene finding in prokaryotes/eukaryotes, Construction of polygenetic trees, Molecular phylogenetic analyses, **Application of bioinformatics** in different disciplines of biology, Preparation of mini group projects and presentations, Individual project and discussion.

Recommended Books:

- Bioinformatics: Sequence and genome analysis By David Mount. 2001. ISBN: 9-87969-608-7.
- Biological sequence analysis: Probabilistic models of proteins and nucleic acids By R. Durbin, S. Eddy, A. Krogh and G. Mitchison. 2008. ISBN: 0-521- 62971.
- Bioinformatics: Methods and applications By S. C. Rastogi, N. Mendirata and P. Rastogi. 2004. ISBN 81-203-2582-6 Prentice Hall of India.
- Pharmaceutical biotechnology By Purohit, Kakrani, Sauja, 2006.
- Fundamental Concepts of Bioinformatics, Dan E. Krane and Michael L. Raymer, San Francisco: Benjamin Cummings, 2009. ISBN: 0-8053-4633-3.
- Bioinformatics: A Lab Outline: Guide to the analysis of genes and proteins edited By Andreas D. Baxevanis, B.F. Francis Ouellette, New York: Wiley-Interscience, 2001, 2nd ed. ISBN: 0-471-38391-0.
- An introduction to Bioinformatics Algorithims, By Neil C.Jones, PavelPersnerGary Benson and Rodric Page. 2004.
- Bioinformatics: sequence and genome analysis, By David W. Mount, 2nd ed, 2005,CBS publishers & Distributers, New Delhi, India.
- Borgeron Bryan. 2008. Bioinformatics Computing Pearson Education.

BOT-812 STATISTICAL GENOMICS (3+0)

Theory:

Introduction to Genomics: Definition of Genomics and Genome, Introduction to Genomics and Genome, History and scope and Genomic, Description of Genome Structure, Genome variation and colinearity, Source of genome of variation

Quantitative genomics: DNA model, RNA model, Single gene model, Prokaryote genome, Eukaryote genome

Extraction and analysis methodologies: For DNA, For RNA

Biological techniques in genomics: Genetic mapping constriction, Comparative mapping, Mapping genes of intrest, Physical mapping, DNA fragmentation , DNA vector

Genetic markers: Polymorphism and informatively, Morphological and cytogentic marker, Protene markers, DNA markers, STS and EST, PCR, Mini and micro-satellite markers, RAPD markers, Comparisons among different markers, Statistical genomics, Distributions, Likelihood, Hypothesis tests, Estimation, Statistical properties of an estimator, Sample size estimation

Importantce of genomics: Identification of disease gene and its therapy, Imprinting, Methylation and cancer, "life " A river of DNA, Survival of time of DNA, Global warming and genomic diversity, Regulation of activity of genome, Evolution of species, Biological weapons, Genome as reflector of ecological niche, Typical human gene, Human genome epilog, Goal of human genomics, Future direction of genomics

Mutations: Different types of mutations, How to detect mutations, Effects of mutations

Computer tools in genomics: Linkage analysis and map construction, Specific pakage for QTL mapping, QTL mapping using SASA, Plant genome research initiative (PGRI), -Data type, -Data formate, -linkage analysis and map construction, -linkage map merging, -QTL analysis and breeding plants, -output samples

Books Recommended:

- David M.W.Bioinformatics sequences and genome analysais. 2nd ed. Publishers and distributers.
- Ben Hui Liu, statistical genomics, linkage mapping and QTL analysis, CRC press, Washington D.C.
- Cullis, C.A. 2004. Plant genomics and proteomics. Willey-Liss, Newyork.
- Gibson, G.and S.V. Muse, 2002. A premier of Genome science, Sinauer Associates Inc. Massachusetts.
- Rastogi et al.,2004.Bioinformatic methods and applications. Genomics, Proteomics and Drug discovery.
- Richard Simpson J. Purifying proteins for proteomics (A laboratory manual) Cord Spring Harbor Laboratory Press.

BOT- 813 PLANT GROWTH AND DEVELOPMENT (3+0)

Theory: Introduction of plant growth phenomena, Brief elaboration of Plant development process, Alteration of generation, Growth, differentiation and morphogenesis, Reasons for cell differentiation, Cell division and growth, Growth pattern of plants at seedling level, Plant growth in different ways, Primary plant growth interactions, Cell expansion of plants, Genome sequencing at different developmental stages of plants, Regulation of development, Genetic analysis of developmental processes, Recognition and isolation of development genes, Molecular analysis of development phenotypes, Structure and expression of sub – genomes, The molecular genome; the plastome, Chondriome; interaction between different genetic compartments, Inducers and modulators of development, Effect of light; phytochrome;the biological clock; phytohormones; Role of phytohormones in developmental processes, Flowering plants life cycle, Embryogenesis Process, Post-embryogensis, Vegetative development, The generative phase, Developmental mutant plants, Gene expression and regulation in plants, Signal transduction in development, Gametogenesis in plant development, Single cell specification in plant development, Ascidian development, Development of the plant embryo, Development of the seedling, Shoot and root meristems, Leaf development, Flower development

Recommended Books:

- R.M. Twyman (2003). Developmental Biology. Viva books pvt. Ltd India (Available in Library).
- Dr. Prashant Kumar Sirohi (2015). Plant Breeding. Random Publications. India (Available in Library).
- Srivastava. L. M. 2002. Plant Growth and development:Hormones and Environment.
- Leyser, O. and S. Day. 2002. Mechanism in plant development. Black well Publishing.
- Westhoff, P., H. Jeske, G. Jurgens, K. Kloppstech and G. Link. 1998. Molecular plant development Oxford University Press.

BOT-814 ADVANCES IN PLANT BIOSYSTEMATICS (3+0)

Theory: Chemotaxonomy: Secondary metabolitesand higher classification of angiosperms, Comparative systematic treatmentof Glueosinolade containing families, Cronquist, Takhtajan, thorn, Dahlgrae, Comparative systematic treatment of irodoid-

containing families and other major non irodoid symjptaling families, Dahlgram, eronquist, Takhtajan Theory

Taxonomic evidences and interrelationship; General charecteristics, distribution, evolutionary evidences, specialized phyletic relationships and economic importance of the following super orders with orders. (Bentham and Hooker) **Dicots:** Rununculaceae, Malvaceae, Leguminaceae, Compositaceae, Solanaceae, Cucurbitaceae **Monocots:** Orchidaceae, Gramminae

Interdiscipilenery importance of taxonomy: Role of morphology in taxonomy, Role of anatomy in taxonomy, Role of cytology in taxonomy, Role of embryology in taxonomy, Role of phytochemistry in taxonomy.

Biosystematics and its phylogenetic impact for different monocot and dicot families.

Recommended Books:

- Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- Datta S C., 1988 Systematic Botany, 4th Ed, Wiley Estern Ltd., New Delhi
- Eames A. J. 1981 Morphology of Angiosperms - McGraw Hill, New York.
- Naik V.N., 1991 Taxonomy of Angiosperms Tata Mcgraw-Hill Pub. Co. Ltd., New Delhi.
- Pandey, S. N, and S.P. Misra (2008) Taxonomy of AngiospermsAne Books India, New Delhi.

BOT- 815 PROJECT PLANNING, MONITORING AND EVALUATION (3+0)

Theory: Definition: types of projects and hierarchy of approving authorities. Rational, identification: problem perception, acquisition of information, validity of problem. Preparation: Techniques for completion of various project formats, plan of work, budget considerations. Executions: utilization of budget, hiring of manpower, report preparation and presentation. Monitoring and evaluation. Post project liabilities: follow up, fate of project capital, human resources and transfer of technology. Study of model project of ISF, PSF and HEC and its practice for preparation

Books Recommended:

- Amir, P. and M. Hussain. (1997). Reference Methods on Project Preparation. FAO/UNDP.
- Asian Development Bank. (1986). Environmental Planning and Management. ADB, Manila
- CBE Style Manual Committee. (1983). CBE Style Manual. 5th ed. Council of Biology Editors, Inc. Bethesda, MD, USA.
- FAO. (1986). Guide for Training in Formulating Agricultural and Rural Investment
- Projects. Policy Study and Training Service. Olicy Analysis Div., FAO, Rome.
- FAO. (1990). Rural Area Development Planning. ESP/TMAP/4. Policy Study and Training Service. Policy Analysis Di., FAO, Rome.
- Hussain, M.Ch. (1985). Project Appraisal Monitoring & Evaluation Process with special reference to Pakistan. Vol.I, II, III & IV. Royal Book company
- Insul, A.D. and C.E. Nash. (1990). Aqua-culture Project Formulation, Fisheries Paper No. 316, FAO, Rome.
- Nash, C.E. (1995). Aqua-culture Sector, Planning and Management. Fishing new books. Cambridge
- Projects Wing, Planning and Development Division, Government of Pakistan (1991). Manual for Development Projects.

BOT-816 INTEGRATED BIOLOGICAL RESOURCE MANAGEMENT (3+0)

Theory: Agro-biological resources of Pakistan; their present potentials/exploration and futuremanagement/prospects: agriculture, ethnobotanical, fisheries, poultry, livestock, wildlife, forest, sericulture, apiculture, environmental resources and future concerns. Issues of international concern; trade and importance, recent developments in world agricultural trade and current issues. Current international policy initiatives, adjustment implications and issues in Pakistan. Macro-economic policies, proc policies, role of public sector in financing and management of agriculture in pakistan. International concern of agencies.

Books Recommended:

- Alexandratos, N. (1988). World Agriculture: Toward 2000. An FAO study. Food and Agricuture Organization of the united Nations. Belhaven Press, London.

- Alexandratos, N. (1976). 'Formal Techniques of Analysis for Agricultural Planning', FAO Studies in Agricultural Economics and Statistics 1952-1977. FAO, Rome, 1978 (Reprinted from monthly bulletin of agricultural economics and statistics, 25(6), June 1976).
- Roffe, T.J. et al. 1999. Brucellosis in Yellowstone National Bison: Quantitative Serology and Infection. Journal of Wildlife Management. 63, 1132-1137.
- Sarma, J. and P. Yeung. 1985. Livestock products in the third world: Past trends andprojections to 1990- and 2000, IFEPRI Research report No. 49.
- Sasaki, T., and B. Burr. 2000. International rice genome sequencing project: the effortto completely sequence the rice genome. Current opinion in plant biology. 3, 138-141.

List of Local External Examiners for M.Sc., M.Phil. and Ph.D.

Note: List of local external examiners is already approved in 3th Departmental Councel and here just jincluded as to compilation on booklet form in Departmental Councel data.

01	Prof. Dr. Mir Ajab Khan Ex Dean of Biological Sciences, QAU, Islamabad mirajab@hotmail.com Ph: 051-90643010
02	Dr. Abdul Samad Mumtaz Associate Professor Department of Plant Sciences, QAU, Islamabad Email:asmumtaz@qau.edu.pk Ph:0342-5188685
03	Dr. Mushtaq Ahmed Associate Professor Department of Plant Sciences, QAU, Islamabad

	Email: mushtaq@qau.edu.pk Cell; 0300-5599117
04	Dr. Saeed Ahmed Sheikh Associate Professor Department of Botany, Fatima Jinnah Women University, Rawalpindi saeed@yahoo.com Ph:+92-51-9292900
05	Dr. Rifat Naseem Malik Associate Professor Department of Enviromental Sciences QAU, Islamabad rifat@gmail.com Ph: +92-519064-3017
05	Dr. Amin ul Allah Shah Assistant Professor Department of Botany, Sargodha University, Sargodha shahaminullah@yahoo.com Ph: 0332-7664833
06	Prof. Dr. Habib Ahmed Department of Botany, Hazara University, Mansehra Ph:0997-531551, Fax: 0997- 530046 E-mail: drhahmad@gmail.com
07	Prof. Dr. Zabta Khan Shiwari

	Chairman, Department of Biotechnology QAU, Islamabad Email: shinwari2008@gmail.com Ph: 03339608998
08	Prof. Dr. Hamid Khan Chairman Department of Bioinformatics, CUST Islamabad hamad@maju.edu.pk Ph:
09	Dr. Zubaida Ahmed Associate Professor Department of Botany, Hazara University, Mansehra chaudharyzgmail.com Ph:0997-531551, Fax: 0997- 530046
10	Sajid ul Ghafoor Assistant Professor Department of Botany Hazara University, Mansehra Email: sajidulghafoor@gmail.com Ph:0997-531551, Fax: 0997- 530046
11	Dr. Ghulam Murtaza Professor/Director

	Department of Botany, University of AJK, Muzaffarbad Email: gmurtazaq@hotmail.com, ghulam.murtaza@ajku.edu.pk Ph; 05822960431
12	Dr. Qaisar Mehmood Professor Department of Environtal Sciencws, COMSATS, Abottabad Email: mahmoodzju@gmail.com Cell No. 0092-344-6171606
13	Prof. Dr. Majid Shah Department of Botany, University of AJK, Muzaffarabad samajida@hotmail.com Ph; 05822-960431
14	Dr. Waqar Ahmed Professor/Chairman Department of Pharmacy, University of Malakand, Chakdara, Malakand Email: waqar75@hotmail.com Ph: 092-936-763441-2,
15	Dr. Khizar Hayat Bhati Associate Professor Department of Botay, University of Gujrat Email: khizar.hayat@uog.edu.pk Ph: 0332-5660922

16	Dr. Sahar Khan Assistant Professor Department of Bioinformatics, CUST Islamabad Email: Sahar@maju.edu.pk Ph:
17	Dr. Fazal e Rabi Assistant Professor NIBGE, Faisalabad Email: Fazali@yahoo.com Ph: 0334-4117448
18	Prof. Dr. Ghulam Jilani Department of Soil Sciences, NARC Islamabad jilani11@yahoo.com
19	Dr. Mudassar Ahmed Senior Research Scientist NIAB, Faisalabad Email: mudassar@gamil.com
20	Dr. Sardar Khan Professor Department of Environment Sciences

	Peshawar University, sardarkhan@gmail.com Ph: +92919216742
21	Dr. Muhammad Arshad Chairman Department of Botany, Arid Agriculture University, Rawalpindi. Email:arshad2uaar@yahoo.com Ph:03005213804
22	Professor Dr. Zaheer-Ud- Din Khan Professor of Botany G.C University, Lahore khan_zaheerpk@yahoo.com Ph: 0333-4202522
24	Prof. Dr. Zahid Hussain Department of Botany, University of AJK, Muzaffarabad Email: malikzh51@yahoo.com Ph:03453924587
25	Dr. Saiqa Ishtiaq Assistant Professor, Department of Pharmacy, University of Punjab saiqa_ishtiaq@yahoo.com Ph: +92-42-99211616
26	Dr. Sabahat Zahra Saddiqui

	Assistant Professor Department of Chemistry, GC University, Lahore Email:sabahat.gcu@gmail.com Ph: 0303-4445521
27	Dr. Ayesha Kiran Assistant Prof. Department of Botany University of Agriculture Faisalabad Contact # 923017752939 E.mail: draawt@gamil.com
28	Dr. Abdul Wakeel Assistant Prof. Soil & Environmental Sciences University of Agriculture Faisalabad Contact# 923315391775
29	Dr. M. Sheraz Ahmed Assistant Prof. Department of Biochemistry PMAS Arid Agriculture University Rawalpindi Contact # 03335706221 E.mail: dr.sheeraz@uaar.edu.pk
30	Dr. Farooq Ahmed Assistant Prof. Department of Botany University of Agriculture Faisalabad Contact # 03065118498
31	Dr. Audil Rasheed Assistant Prof. Department of Environmental Sciences

	PMAS Arid Agriculture University Rawalpindi Contact # 0519290058 Email: audil@uaar.edu.pk
32	Dr. Bashir Ahmed Assistant Prof. Department of Biosciences International Islamic University Islamabad Email: bashir.ahmed@iiu.edu.pk Ph. # 0519019837
33	Dr. Saddiqa Firdos Assistant Prof. Department of Botany University of Azad Jammu & Kashmir Muzaffarabad Contact# 03345342869 Email. ssfirdous@hotmail.com
34	Dr. Tariq Habib Assistant Prof. Department of Botany University of Azad Jammu & Kashmir Muzaffarabad Contact# 03469707166 Email. Tariqhabib76@gmail.com
35	Dr. Hamayun Shaheen Assistant Prof. Department of Botany University of Azad Jammu & Kashmir Muzaffarabad Contact#03445952552 Email. hamayunmaldial@yahoo.com

36	Dr. Ejaz ul Islam Dar Assistant Prof. Department of Botany University of Azad Jammu & Kashmir Muzaffarabad Contact# +92-5822960431 Email. ejazdar1@gmail.com
37	Dr. Rizwan Taj Assistant Prof. Department of Botany University of Azad Jammu & Kashmir Muzaffarabad Email: rizwantajkhan@gmail.com Contact#03445596933
38	Dr. Safder Ali Mirza Assoiate Professor, Department of Botany, GC University, Lahore afdaralimirza@gmail.com Ph: 0314-4108281
39	Dr. Abdul Waheed Professor, Department of Botany PMAS Arid Agriculture University Rawalpindi Email: null1@yahoo.com Ph: +923009719053
40	Dr. Gulshin Irshad Assistant Professor, Department of Plant Pathology PMAS Arid Agriculture University Rawalpindi Email: gulshanirshadpp@gmail.com

	Ph: +92-301-5351111
41	Dr. Abida Ikram Associate Professor, Department of Botany PMAS Arid Agriculture University Rawalpindi Email: abidaakram@uaar.edu.pk Ph: +92-51-9292145
42	Dr Farah Naz Assistant Professor, Department of Plant Pathology PMAS Arid Agriculture University Rawalpindi Email: Ph: +92-300-5075319
43	Dr. Shoib Ahmed Malik Assistant Professor, Department of Botany Women University Bagh, Azad Kashmir Email: malikshoaib1165@yahoo.com Ph: +92-345-3812987
44	Dr. Ansar Mehmood Assistant Professor, Department of Botany University of Poonch, Rawalakot, Azad Kashmir Email: ansar.mehmood321@gmail.com Ph: +92-346-5387843
45	Dr. Khwaja Shafiq Ahmed

	Assistant Professor/Chairman, Department of Botany University of Poonch, Rawalakot, Azad Kashmir Email: shafiquebot@yahoo.com Ph: +92-333-5403442
	Prof Dr Aamir University of Sargodha Email: Mobile:

Note: List of foreign referees/external examiners is already approved in 3th Departmental Councel and here just included as to compilation on booklet form in Departmental Councel data.

List of Foreign Examiers for Ph.D. Thesis Evaluation (From Technologically Advanced Countries)

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