Scheme of Studies BS in Botany
Fall 2025

Additional Director Academics
University of Chitral

Department of Botany
University of Chitral

PROGRAM DESCRIPTION

The Bachelor of Science in Botany program is designed in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1. to provide students with a robust understanding of plant sciences, addressing both local and global perspectives. The program integrates molecular, cellular, organismal, and ecological dimensions to equip students with the skills necessary for research, industry, and further academic pursuits in botany and related fields. Spanning eight semesters, the curriculum offers a balanced and progressive learning experience. The first four semesters focus on general education courses, establishing a strong foundation in essential scientific principles and analytical skills. Subsequent semesters delve into specialized major courses that cover a broad range of topics in the field of botany. These courses are particularly tailored to address the unique flora and ecological challenges of Pakistan. Throughout the program, students will be able to gain hands-on experience with modern laboratory and field techniques. Emphasis is placed on practical and technical proficiency, with a focus on molecular biology and environmental assessment tools relevant to Pakistan's biodiversity and agricultural needs. This approach ensures that graduates are well prepared for the real-world challenges and opportunities in plant sciences within the Pakistani context. Through this program, students will be able to learn to effectively convey scientific knowledge and research findings, preparing them for careers in academia, research institutions, environmental organizations, and the biotechnology industry, both within Pakistan and internationally. The ultimate aim of this degree program is to produce well-rounded, knowledgeable, and skilled botanists who are capable of making significant contributions to the field of plant sciences.

The BS program will enable to the students to be acquainted with the latest knowledge of the plant sciences. In the program the contents of various foundation courses have been reviewed, modified and updated such as; Biodiversity and conservation, Plant Anatomy, Genetics, Biochemistry, Biostatistics etc. and the major courses as Physiology, Genetics, Ecology, Ethnobotany, cell biology etc. is incorporated.

Rationale: The subject of plant sciences has undergone tremendous advances all over the world. It is imperative to update the existing national curriculum in Botany to bring it at par with the international standards.

Goal: The goal of BS program is to produce competent professionals in the field of Botany who will be capable to face the challenges of the changing world.

Name of Degree: **Bachelor of Science in Botany**

Eligibility and Admission Criteria: The minimum requirement for admission is at least 45% marks in FSc (Pre-Medical) or an IBCC-equivalent qualification in any science group with Biology as a subject, which is the basic eligibility requirement for admission to the Bachelor of Science in Botany.

The HEC specified Admission Criteria must be evaluated, fulfilled, observed, and followed only by the BS Admission Committee. The whole BS Admission Committee will be held responsible if admission criteria are violated.

PROGRAM STRUCTURE: The Bachelor of Science in Botany is structured in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1. and comprises of minimum 142 credit hours spread over eight (08) regular semesters.

Credit Hours	143
General Education	35credit hours (16 courses)
Core Courses	78 credit hours (26courses)
Interdisciplinary Courses	24 credit hours (10 courses)
Internship	3 credit hours
Capstone Project	3 credit hours
Program Duration	Minimum: 4 Years Maximum: 6 Years The maximum limit is further extendable to another year in extraordinary circumstances subject to approval of the Vice Chancellor.
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)
Course Load (per semester)	15-21 credit hours for regular semesters Up-to 8 credit hours for remedial/deficiency/failure/repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours) per week throughout the semester.
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work/project requires lab contact of three hours per week throughout the semester.

Pathway for Associate Degree Holders:

a) Students having completed Associate Degrees shall be allowed admission in the fifth semester of the undergraduate/equivalent degree program offered in the same discipline without any deficiency course.

b) Where the disciplines of the Associate Degree and the undergraduate/equivalent degree program are different, students shall be required to complete deficiency courses through a bridging semester before the fifth semester as determined by the BS admission Committee.

c) The minimum eligibility for admission in the fifth semester in above cases is 2.00/4.00 CGPA in the prior qualification i.e., Associate Degree.

Pathway for Conventional Two-Year BSc/Equivalent Degree Holders:

a) Students having completed conventional two-year BA/BSc/equivalent degree programs shall be allowed admission in the fifth semester of the undergraduate/equivalent degree program, in which case students shall be required to complete deficiency courses up-to a maximum of 21 credit hours as determined by the BS admission Committee.

b) The minimum eligibility for admission in the fifth semester in this case is 45% cumulative score in the prior qualification i.e., conventional two-year BSc/equivalent degree programs.

Exiting from Undergraduate/Equivalent Degree Program with an Associate Degree: Students enrolled in the undergraduate/equivalent degree program shall be allowed to exit from the program with an Associate Degree provided that the following requirements are met:

a) The student must have completed all credit hours of first-four (04) semesters of the BS program.

Scheme of Study for BS in Botany

1st Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 111	Diversity of Plants	3 (2+1)
GE 111	Quantitative Reasoning-I	3 (3+0)
GE 112	Functional English	3 (3+0)
GE 113	Applications of Information & Communication Technologies	3 (2+1)
GE 114	Inorganic Chemistry	3 (2+1)
Anyone from the following		
GE 115	Islamic Studies	2 (2+0)
GE 116	Ethics	2 (2+0)
Anyone from the following		
GE 117	Fehm-e-Quran-I	1(0+1)
GE 118	Ethics: A General Introduction	1(0+1)
Total Credit Hours		18 (14+4)

2nd Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 121	Cell Biology	3 (2+1)
BOT 122	Phycology & Bryology	3 (2+1)
BOT 123	Mycology	3 (2+1)
GE 121	Quantitative Reasoning-II	3(3+0)
GE 122	Expository Writing	3(3+0)
GE 123	Social Sciences	2 (2+0)
Anyone from the following		
GE 124	Fehm-e-Quran-II	1(0+1)
GE 125	Cyber Ethics	1(0+1)
Total Credit Hours		**18 (14+4)**

3rd Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 231	Phytogeography	3 (2+1)
BOT 232	Principles of Plant Ecology	3 (2+1)
BOT 233	Fundamentals of Plant Taxonomy	3 (2+1)
GE 231	Pakistan Studies	2(2+0)
GE 232	Civics and Community Engagement	2(2+0)
GE 233	Seerat-un-Nabi	1(0+1)
GE 234	Arts & Humanities	2(2+0)
GE 235	Entrepreneurship	2(2+0)
Total Credit Hours		**18(15+4)**

4th Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 241	Principles of Plant Biochemistry	3 (2+1)
BOT 242	Fundamentals of Plant Physiology	3 (2+1)
BOT 243	Plant Anatomy & Embryology	3 (2+1)
GE 241	Ideology and Constitution of Pakistan	2(2+0)
IDS 241	Organic Chemistry	3 (2+1)
IDS 242	Biodiversity and Conservation	3(3+0)
Total Credit Hours		**17(13+4)**

5th Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 351	Advanced Plant Physiology	3 (2+1)
BOT 352	Microbial Botany	3 (2+1)
BOT 353	Pteridophytes & Gymnosperms	3 (2+1)
IDS 351	Molecular Genetics	3 (2+1)
IDS 352	Animal Diversity I (Invertebrates)	3(2+1)
IDS 353	Environmental Chemistry	3 (2+1)
Total Credit Hours		**18 (12+6)**

6th Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 361	Systematics of Angiosperms	3 (2+1)
BOT 362	Plant Pathology	3 (2+1)
BOT 363	Principles in Pharmacognosy	3 (2+1)
BOT 364	Advanced Plant Ecology	3 (2+1)
IDS 361	Principles of Biochemistry	3 (2+1)
IDS 362	Biostatistics	3 (2+1)
	Total Credit Hours	**18 (12+6)**

7th Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 471	Analytical Techniques in Botany	3 (1+2)
BOT 472	Field Botany	3 (2+1)
BOT 473	Forensic Botany	3 (2+1)
BOT 474	Plant Tissue Culture	3 (2+1)
IDS 471	Scientific Inquiry & Research Methods	3 (2+1)
INT 471	Internship	3 (0+3)
Total Credit Hours		**18(9+9)**

8th Semester		
Code	**Name of Courses**	**Credit Hour**
BOT 481	Water Logging and Salinity	3 (2+1)
BOT 482	Economic & Industrial Botany	3 (3+0)
BOT 483	Environmental Biology	3 (2+1)
BOT 484	Edaphology	3 (2+1)
BOT 485	Advanced Plant Biochemistry	3(2+1)
CP 489	Capstone Project	3(0+3)
Total Credit Hours:		**19(12+7)**

Note: The course contents for General Courses and Interdisciplinary/Allied Courses will be available in separate documents, titled "General Courses Cluster" and "Interdisciplinary Courses Cluster" on the University of Chitral website.

GE 111	Quantitative Reasoning-I	3(3+0)
GE 112	Functional English	3(3+0)
GE 113	Applications of Information and Communication Technologies	3(2+1)
GE 114	Inorganic Chemistry	3(3+0)
GE 115	Islamic Studies	2 (2+0)
GE 116	Ethics	2 (2+0)
GE 117	Fehm-e-Quran-I	1(0+1)
GE 118	Ethics: A General Introduction	1(0+1)

GE 121	Quantitative Reasoning-II	3(3+0)
GE 122	Expository Writing	3(3+0)
GE 123	Social Sciences	2(2+0)
GE 124	Fehm-e-Quran-II	1(0+1)
GE 125	Cyber Ethics	1(0+1)

GE 231	Pakistan Studies	2(2+0)
GE 232	Civics and Community Engagement	2(2+0)
GE 233	Seerat-un-Nabi	1(0+1)
GE 234	Arts & Humanities	2(2+0)
GE 235	Entrepreneurship	2(2+0)

GE 241	Ideology and Constitution of Pakistan	2(2+0)

IDS 241	Organic Chemistry	3(2+1)
IDS 242	Biodiversity and Conservation	3(2+1)

IDS 351	Molecular Genetics	3(2+1)
IDS 352	Animal Diversity I (Invertebrates)	3(2+1)
IDS 353	Environmental Chemistry	3(2+1)

IDS 361	Principles of Biochemistry	3(2+1)
IDS 362	Biostatistics	3(2+1)

IDS 471	Scientific Inquiry and Research Methods	3(2+1)

Semester	Code	Name of Courses	Credit Hour	Category
1st	BOT 111	Diversity of Plants	03 (2+1)	Core

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

Course learning Outcomes:

1. To introduce students to the diversity of microorganisms and plants, from viruses to angiosperms.
2. To explain the structural, reproductive, and ecological adaptations of major plant and fungal groups.
3. To compare evolutionary trends and life cycles across different groups of organisms.
4. To highlight the economic, biological, and ecological significance of microbes and plants.
5. To develop skills in identifying and differentiating between lower and higher plant groups

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to virus, General features of virus, Morphology	**17**	Bryophytes- Morphology, Reproduction
2	Viruses, types (RNA & DNA) life cycle	**18**	Economic importance of Bryophytes
3	Viruses – TMV as a model virus; economic and biological significance	**19**	Bryophytes – Funaria: structure, reproduction and life cycle
4	Bacteria – Morphology, reproduction	**20**	Pteridophytes – general features, life cycle
5	Economic role of Bacteria	**21**	Economic importance of Pteridophytes
6	Cyanobacteria – Characteristics and significance in nitrogen fixation	**22**	Gymnosperms – general characters and reproduction
7	Comparative account of Bacteria and Cyanobacteria	**23**	Gymnosperms – Economic uses and ecological significance
8	Algae, Morphology, reproduction	**24**	Angiosperms- general characters and reproduction
9	Economic importance of Algae	**25**	Economic Importance of angiosperm
10	Algae – Chlamydomonas: structure, reproduction, and ecology	**26**	Angiosperms – distinguishing features of monocots and dicots
11	Algae – Chara: morphology, life cycle, and significance	**27**	Monocots – representative features, examples and adaptations

12	Fungi- Morphology, reproduction	**28**	Dicots – representative features, examples and adaptations
13	Economic importance of Fungi	**29**	Comparative study of Pteridophytes
14	Fungi – Penicillium: structure, reproduction, and importance	**30**	Comparative study of Angiosperms
15	Fungi – Puccinia: heteroecious life cycle and impact on crops	**31**	Evolutionary trends in plant life cycle from Algae to Angiosperms
16	Fungi – Agaricus: structure, mode of nutrition and ecological role	**32**	Diversity in reproductive strategies: lower to higher plants
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Introduction to lab safety, tools, and aseptic techniques	**9**	Examination of lichens – crustose, foliose, and fruticose types
2	Culturing and maintenance of bacteria and fungi	**10**	Study of *Funaria* – morphology and reproductive parts
3	Preservation and sub culturing techniques for microorganisms	**11**	Observation of pteridophyte specimens and slides
4	Staining of bacteria (simple and differential staining)	**12**	Study of gymnosperms (e.g., *Pinus*) from preserved and fresh material
5	Microscopic examination of stained bacteria and cyano bacteria	**13**	Comparative slide analysis of monocot and dicot stems/leaves/roots
6	Study of *Chlamydomonas* and *Chara* from fresh material	**14**	Field identification and specimen collection techniques
7	Identification of fungi: *Penicillium*, *Puccinia*, *Agaricus* (slides and fresh samples)	**15**	Drawing, labeling, and reporting of observed plant structures

8	Preparation of temporary mounts of fungal reproductive structures	**16**	Examination of lichens – crustose, foliose, and fruticose types
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Lee, R. E. 1999. Phycology. Cambridge University Press, UK
2. Prescott, L. M., Harley, J. P. and Klein, A. D. 2004. Microbiology, 3rd Ed. WM. C. Brown Publishers.
3. Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. Introductory Mycology. 4th Ed. John Wiley and Sons Publishers.
4. Agrios, G. N. 2004. Plant pathology. 8th Ed. Academic Press London.
5. Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
6. Andrew, H. N. 1961. Studies in Paleobotany. John Willey and Sons.
7. Ingrouille , M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
8. Mauseth, J. D. 2003. Botany: An Introduction to Plant Biology 3rd Ed., Jones and Bartlett Pub. UK
9. Marti. J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP
10. Taylor, T. N. & Taylor, E. D. 2000. Biology and Evolution of Fossil Plants. Prentice Hall.
11. Hussain, F. 2012. A Text Book of Botany and Biodiversity. Pak Book Empire.

Journals/Periodicals: Pakistan Journal of Botany, American Journal of Botany, Canadian Journal of Botany, Annals of Botany

1st	GE 119	Inorganic Chemistry	03 (2+1)	General Education

Course Objectives:

Students will acquire knowledge about the key introductory concepts of chemical bonding, acid-based chemistry, and properties of p-block elements as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

Course Outline:

Mid-Course		**Final-Course**	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Chemical Bonding:	**17**	concept of relative strength of acids and bases
2	Types of chemical bonding	**18**	significance of pH
3	ionic and covalent bonding	**19**	pKa
4	localized bond approach	**20**	pKb
5	theories of chemical bonding	**21**	buffer solutions
6	valence bond theory (VBT)	**22**	theory of indicators
7	hybridization and resonance	**23**	solubility
8	prediction of molecular shapes using	**24**	solubility product
9	Valence Shell Electron Pair Repulsion (VSEPR) model	**25**	common ion effect
10	molecular orbital theory (MOT) applied to diatomic molecules	**26**	Industrial applications of common ion effect
11	delocalized approach to bonding	**27**	**P-Block Elements**
12	bonding in electron deficient compounds	**28**	Physical and chemical properties of p-block
13	hydrogen bonding	**29**	elements with emphasis on some representative compounds
14	**Acids and Bases**	**30**	inter-halogens
15	Brief concepts of chemical equilibrium	**31**	pseudo-halogens
16	acids and bases including soft and hard acids and bases (SHAB)	**32**	polyhalides
Mid-Exam		**Final-Exam**	
Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Lab safety and good laboratory practices	**9**	preparation and standardization of potassium permanganate solution

2	knowledge about material safety data sheets (MSD)	**10**	its use for the determination of purity of commercial potassium oxalate or oxalic acid
3	disposal of chemical waste and first-aid practices	**11**	preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample
4	Qualitative analysis of salt mixtures	**12**	gravimetric analysis
5	quantitative analysis	**13**	determination of barium in a given sample
6	acid- base titrations	**14**	determination of chloride in a given solution
7	preparation and standardization of acid and alkali solutions	**15**	determination of fluoride in a given solution
8	redox titrations	**16**	determination of sulfide in a given solution
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).
5. Lee, J. D., Concise Inorganic Chemistry, 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 3rd ed., Pearson Education, India, (2008).
7. Huheey, J. E., Kieter E. A., Keiter L. R., Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., Inorganic chemistry, 3rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, Inorganic Chemistry, 3rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., Descriptive Inorganic Chemistry, 2nd ed., Brooks Cole, (2010).

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Recommended Journals:

Chemistry of Materials, Chemical Science, Chemical Society Reviews, New Journal of Chemistry

Page

Semester	Code	Name of Courses	Credit Hour	Category
2nd	BOT 121	Cell Biology	03 (2+1)	Core

Objectives: To understand Structure and function of cell.

Learning Outcomes: Student will be able to learn cell and its components

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Structure and Function of Biomolecules	**17**	Leucoplasts, chromoplasts
2	Carbohydrates	**18**	Cytoplasmic Streaming
3	Lipids	**19**	Intracellular Transport
4	Proteins	**20**	Nucleus and Nucloelus
5	Nucleic Acids	**21**	Nuclear Transport
6	Cell	**22**	Vacuoles
7	Cell theory	**23**	Endoplasmic reticulum
8	cell types (prokaryotes, eukaryotes)	**24**	Plastids
9	basic properties of cell.	**25**	Mitochondria
10	Cell wall	**26**	Ribosomes
11	Cell membrane	**27**	Ribosome-Binding Site
12	Potassium Channels Make the Plasma Membrane	**28**	The Ribosome Is Recycled
13	Transport Across Membranes	**29**	Dictyosomes
14	Intracellular Receptors	**30**	Mitosis
15	Intercellular Communication	**31**	Meiosis-I
16	Chloroplasts	**32**	Meiosis-II
Mid-Exam		**Final-Exam**	

Mid-Course		Final-Course	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**

1	Study of cell structure using compound microscope	**9**	Study of variation in chromosome number.
2	Elucidation of ultrastructure from electron microphotographs	**10**	Extraction and estimation of carbohydrate from plant sources.
3	Measurement of cell size.	**11**	Extraction and estimation of protein from plant sources.
4	Study of mitosis by smear/squash method	**12**	Extraction of RNA from plant sources.
5	Study of meiosis by smear/squash method	**13**	Extraction of DNA from plant sources.
6	Study of mitosis from prepared slides.	**14**	Study of somatic cell
7	Study of meiosis from prepared slides.	**15**	Study of embryogenic cell
8	Study of chromosome morphology	**16**	Study of Vacuoles
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V. R. (1986). Cytology and Genetics. Tata and McGraw-Hill Publication Co.
   Ltd,, New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Bruce Albert et al. 2009. Essential cell biology. Garland Sciences Publishers.
5. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). *Essential cell biology*. Garland Science.
6. Becker. (2007). *The world of the cell*. Pearson Education India.
7. Know, L. (2018). *Mitochondria and the future of medicine: The key to understanding disease, chronic illness, aging, and life itself*. Chelsea Green Publishing.
8. Lodish, H. F. (1999). *Molecular cell biology*. W.H. Freeman.
9. Pollard, T. D., Earnshaw, W. C., & Lippincott-Schwartz, J. (2007). *Cell biology E-book*. Elsevier Health Sciences.
10. Pollard, T. D., Earnshaw, W. C., & Lippincott-Schwartz, J. (2007). *Cell biology E-book*. Elsevier Health Sciences.

Journals/Periodicals:

Theoretical & Applied Genetics, the Cell, Heredity.

Semester	Code	Name of Courses	Credit Hour	Category
2nd	BOT 122	Phycology & Bryology	03 (2+1)	Core

Objectives:

To understand the classification, morphology and economic importance of Algae and Bryophytes

Course learning Outcomes:

- To understand the diversity and classification of Algae and Bryophytes.
- To understand the morphology, reproduction and life cycle of Algae and Bryophytes.
- To learn ecological significance and economic importance of Algae and Bryophytes.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Phycology: Definition, history, and scope	**17**	Introduction to Bryology: Scope, history, and significance
2	General account and salient features of algae	**18**	General characters and morphology of bryophytes
3	Evolution and classification of algae	**19**	Classification of bryophytes (modern systems)
4	Biochemistry of algae (photosynthetic pigments, storage products)	**20**	Theories of origin and evolution of bryophytes
5	Ecology of algae (distribution, habitats, role in ecosystems)	**21**	Reproduction in bryophytes: vegetative, asexual, and sexual
6	Algal symbiosis	**22**	Bryophytes in soil formation and succession
7	Economic importance of algae (industrial, agricultural, pharmaceutical uses)	**23**	Hepaticopsida – general features and life cycle
8	Chlorophyta – morphology, reproduction, and life cycle	**24**	Hepaticopsida – Marchantia
9	Chlorophyta – examples and economic significance	**25**	Anthoceropsida – general features and life cycle
10	Charophyta – features, reproduction, and phylogenetic importance	**26**	Anthoceropsida – Anthoceros
11	Xanthophyta – general characteristics and representative forms	**27**	Bryopsida – general features and life cycle

12	Bacillariophyta – structure, reproduction, and importance of diatoms	**28**	Bryopsida – Funaria
13	Phaeophyta – structure, reproduction, and ecological role	**29**	Comparative account of Hepaticopsida, Anthoceropsida, and Bryopsida
14	Rhodophyta – morphology, pigments, reproduction	**30**	Ecological and economic importance of bryophytes
15	Rhodophyta – economic importance and industrial applications	**31**	Practical uses and conservation of bryophytes
16	Comparative study of major algal	**32**	Bryophytes and climate change

	divisions		
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Collection of freshwater and marine algae	**9**	Study of Polytrichum – morphology and reproductive structures
2	Identification of benthic and planktonic algae	**10**	Comparative analysis of studied bryophyte genera
3	Section cutting of thalloid algae	**11**	Observation and sketching of prepared slides
4	Preparation of temporary slides	**12**	Preservation and mounting of algal and bryophyte samples
5	Use of camera lucida/micrographs	**13**	Field-based identification using keys
6	Study of Pellia – morphology and reproductive structures	**14**	Microscopy techniques and slide reporting
7	Study of Porella – morphology and reproductive structures	**15**	Extraction of chlorophyll from algae/bryophytes
8	Study of Anthoceros – morphology and reproductive structures	**16**	Study of Polytrichum – morphology and reproductive structures
Mid-Exam		**Final-Exam**	

Recommended Books:

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

Journals/Periodicals:
Pakistan Journal of Botany, International Journal of Phycology and Phyco- chemsitry, Bryology, Phycology.

Semester	Code	Name of Courses	Credit Hour	Category
2nd	BOT 123	Mycology	03 (2+1)	Core

Objectives: To introduce the students to Mycology and Diseases caused by Fungi.
Course learning Outcomes: Students will be able to learn Diseases caused by Fungi. **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction: General characters of Fungi, Thallus and Cell Structure	**17**	Classification of Plant diseases
2	Ultrastructure of Fungi	**18**	Symptoms of Plant diseases
3	Reproduction: Asexual Reproduction	**19**	Causes and development of Plant diseases
4	Sexual Reproduction	**20**	Disease Control
5	Reproductive structures and life cycle	**21**	Epidemiology
6	Haploid, heterokaryotic and diploid states	**22**	Disease Forecast
7	Fungal Systematics: Somatic structures, life cycle and reproduction of Myxomycota,	**23**	Important diseases of crop plants and fruit trees in Pakistan caused by fungi
8	Chitridyomycota	**24**	Rust
9	Zygomycota	**25**	Smut
10	Oomycota	**26**	Red rot of sugar cane
11	Ascomycota	**27**	Early Blight of Potato
12	Basidiomycota	**28**	Late Blight of Potato
13	Deuteromycota	**29**	Crown Gall Disease
14	Symbiotic Relationships of Fungi with other organisms and their significance	**30**	Powdery Mildew
15	Importance of fungi in human affairs with special reference to Industry and Agriculture	**31**	Apple Scab
16	Pathology: Introduction	**32**	Peach Leaf curl

Mid-Exam	Final-Exam

Mid-Course		Final-Course	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Study of General characters of Fungi	**9**	Collection and identification of Plant Diseases from field.
2	Study of Morphology of Fungi	**10**	Microscopic observation of Plant pathogens in infected tissues.
3	Study of unicellular forms with septate and aseptate hyphae	**11**	Study of Effect of Fungicides on Fungal Growth
4	Study of Mycelial forms with septate and aseptate hyphae	**12**	Disease Assessment Techniques
5	Collection and identification of Fungi from soil, Air and Water.	**13**	Demonstration of Fungal Disease cycles
6	Demonstration of Fungal reproductive structures	**14**	Management Practices for Fungal Diseases
7	Preparation of Temporary and permanent slides of Fungal structures	**15**	Field visit to local Orchards
8	Study of some common examples of saprophytic, parasitic and airborne fungi belonging to different phyla.	**16**	Field visit to Wheat/corn fields for Rust and smut infection
Mid-Exam		**Final-Exam**	

Recommended Books:

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

Journals/Periodicals:

Plant Disease by American Phytopathological Society(APS), Fungal Biology by Elsevier, Mycologia by Mycological Society of America, Phytopathology by APS, Journal of Fungi by MDPI, European Journal of Plant Pathology by Springer, Pakistan Journal of Phytopathology by Pakistan phytopathological Society, Pakistan Journal of Botany by Pakistan Botanical Studies, Sarhad Journal of Agriculture by University of Agriculture, Peshawar .

Semester	Code	Name of Courses	Credit Hour	Category
2nd	GE 121	Quantitative Reasoning-II	03 (3+0)	General Course

Course Objectives:

1. Understanding of logic and logical reasoning;
2. Understanding of basic quantitative modeling and analyses;
3. Logical reasoning ng skills and abilities to apply them to solve quantitative problems and evaluate arguments;
4. Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools.

Course Contents:

1. Logic, Logical and Critical Reasoning
   - Introduction and impo1iance of logic;
   - I inductive, deductive, and abductive approaches of reasoning;
   - Propositions, arguments (valid ; invalid), logical l connectives, truth tables and propositional equivalences;
   - Logical fallacies;
   - Venn Diagrams;
   - Predicates and quantifiers;
   - Quantitative reasoning exercises using logical reasoning concepts and techniques. 2.

2.**Mathematical Modeling and Analyses**

- Introduction to deterministic models;
- Use of li near functions or modeling in real-world situations;
- Modeling with the system of linear equations and their solutions;
- Elementary introduction to derivatives in mathematical modeling;
- Linear and exponential in growth and decay models;
- Quantitative reasoning exercises using mathematical modeling.

3.Statistical Modeling and Analyses

- Introduction to probabilistic model;
- Bivariate analysis, scatter plots;

4. Simple linear regression model and correlation analysis;
5. Basics of estimation and confidence interval;
6. Testing of hypothesis (z-test; t-test);
7. Statistical inference in decision making;
8. Quantitative reasoning exercise using statistical modeling

RECOMMENDED RESOURCES

1. "Using and Understanding Mathematics: A Quantitative Reasoning Approach " by Ben nett, J . 0., Briggs, W. L., & Badalamenti , A .
2. "Discrete Mathematics and its Applications" by Kenneth H. Rosen .
3. "Discrete Mathematics with Applications" by Susan na "Applied Mathematics for Business, Econom i cs and Social Sciences" by Fra n k S Bud nick . 5. "Elementary Statistics : A Step by Step A pproach " by A l lan
4. "Introd uctory Statistics" by Prem S. Man n.
5. "Applied Statistical Modelin g" by Salvatore Babones.
6. "Ban-ons SAT" by Sharvon Weiner Green, M.A and Ira K.Wolf.

Semester	Code	Name of Courses	Credit Hour	Category
2nd	GE 122	Expository Writing	03 (3+0)	General Education

COURSE OBJECTIVES

At the end of the course, the students will be able to:

- Analyze basic communication skills and use them effectively in oral and written English
- Develop skills as reflective and self-directed learners
- Critically evaluate and review various types of texts and summarize them
- Develop analytical and problem-solving skills to address various community-specific challenges
- Intellectually engage with different stages of the writing process, such as: brainstorming, mind mapping, free writing, drafting and revision, etc.

LEARNING OUTCOMES

- Write, edit and proofread a short essay in English language
- Present ideas to the whole class in team presentations using English that is comprehensible and engaging.
- Critically analyze a text written in English using SQW3R strategies
- Conduct small-scale research about their communities
- Draft a letter to editor.

Course Outline:

S. No. of Lecture	Lecture/Topics
1	Introduction to Expository Writing – purpose & scope
2	Types of Expository Writing
3	Usage & applications of Expository Writing
4	Practice & recap of Unit 1
5	Writing process – stages (prewriting, drafting, revising, editing)
6	Steps of essay writing (intro, body, conclusion)

7	Prewriting Strategies I – brainstorming, listing
8	Prewriting Strategies II – clustering, freewriting
9	Essay Outlining – Capstone project & supporting ideas
10	Practice session – creating essay outlines
11	Reflection on personal learning process
12	Learning styles – group discussion
13	Introduction to Personalized Learning
14	Goal setting & creating learning plans
15	Introduction to Oral Presentations – purpose & structure
16	Content selection & slide preparation
17	Peer Review – Gallery walk activity
18	Mini-presentations + feedback
19	Introduction to Authentic Reading (DAWN, academic texts)
20	Skimming & scanning activities
21	SQW3R strategy – explanation & practice
22	Previewing & annotating texts
23	Detailed reading & note-taking (IELTS/TOEFL samples)
24	Writing review reports & annotated bibliographies
Mid Exam	
25	Critical discussion on annotated bibliographies (revision)
26	Documentary on global environmental issues
27	Brainstorming: local vs global issues
28	Reading local news, op-eds, letters to editor
29	Identifying research problems & drafting questions
30	Refining research questions (group work)
31	Drafting interview/survey questions
32	Role-plays: mock interviews
33	Understanding & analyzing interview information
34	Translating interview data into English
35	Outlining the group research report
36	Teacher feedback on outlines (class & groups)
37	Writing first draft of research report

38	Individual reflective writing (project experience)
39	Sharing reflections & peer learning
40	Dissemination activities – posters, ads, social media posts
41	Report-to-letter conversion (drafting letter to editor)
42	Review & feedback of community engagement project
43	Genres of writing – formal vs informal
44	Format & purpose of letters to editor
45	Guest Lecture – Newspaper editor/journalism faculty
46	Drafting letters to editor (group activity)
47	Peer review & revision of letters
48	Finalizing letters + course revision
Final Exam	

Recommended Books:

1. T. K. Carver and S. Fortinos-Riggs, Conversation Book II – English in Everyday Life (New York: Pearson Education Limited, 2006).
2. J. Eastwood, Oxford Practice Grammar (Karachi: Oxford University Press, 2005).
3. J. Swan, Practical English Usage, 3rd ed. (New York: Oxford University Press, 2005).
4. J. Thomson and A. V. Martinet, A Practical English Grammar (Intermediate) (New York: Oxford University Press, 1986)
5. Allama Iqbal Open University, Compulsory English 1 (Code 1423) (Islamabad: AIOU
6. Press).
7. BBC.(2013)LearningEnglish. http://www.bbc.co.uk/worldservice/learningenglish/
8. British Council. Learn English. http://learnenglish.britishcouncil.org/en/
9. British Council and BBC. Learn English. http://www.teachingenglish.org.uk/
10. Grammar English. http://freesoftwarepc.biz/educational-software/ download-

Semester	Code	Name of Courses	Credit Hour	Category
2nd	GE-124	Fehm-e-Quran-II	01 (0-1)	General Education

Course Learning Outcomes:

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Provision of material, content and books:

- **Paper book**: All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.

Course Outline:

Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	6	6	Understanding & Translation of Verses	Present Tenseصيغة جمع مذكر غائب مثل يعبدون
	2.	6	7-8	Understanding & Translation of Verses	Present Tenseصيغة جمع مذكر غائب مثل يعبدون
2.	1.	6	9-10	Understanding & Translation of Verses	Present Tense صيغة مفرد مذكر مخاطب (تعبد) وجمع مذكر مخاطب (تعبدون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر مخاطب (تعبدون) صيغة المتكلم (أعبد)
3.	1.	6	13	Understanding & Translation of Verses	Present Tenseصيغة جمع المتكلم (نعبد)
	2.	6	14-15	Understanding & Translation of Verses	Negative Imperative صيغة المفرد وصيغة الجمع , لا تعبدْ، لا تعبدوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar moawal (مصدرموؤل)
	2.	6	18-19	Understanding & Translation of Verses	Laam uttaleel (لام التعليل&) Laam ul jhood(الجحود لام)

5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice

	2.	6	Revision (Unit 6)	Quiz	
6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tenseصيغة المفرد الغائب
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tenseصيغة المفرد للغائب
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tenseصيغة المفرد للغائب
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tenseصيغة المفرد للغائب
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tenseصيغة المفرد للغائب
		MID TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للغائب عبدوا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للغائب عبدوا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للغائب عبدوا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للغائب عبدوا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للمتكلم عبدنا
	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للمتكلم عبدنا
12.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للمتكلم عبدنا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للمتكلم عبدنا
13.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للمخاطب عبدتم
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tenseصيغة الجمع للمخاطب عبدتم

14.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense صيغة المتكلم والمخاطب عبد ت ، عبد ٔت
	2.	7	7	Understanding & Translation of Verses	Past Tense صيغة المؤنث للغائب عبٔدتْ
15.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول للمفرد
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول الجمع
16.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر للمفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر للجمع

Recommended Book

9. Khulna e Quran by Hafiz engineer Naveed Ahmed
10. Muallim Quran by Dr. Ubaid-VI-Rehman Bashir
11. Tahfeem-ul-Quran by Maulana Maududi
12. Tafseer e Usmani by Mufti Muhammad Taqi Usmani
13. E Majidi, By Abdul Majid Daryabadi
14. Mazameen-e-Quran by Muhammad Hussain
15. Quran e Hakeem Ki Soorton Ke Mazameen Ka Ijmali Tajzia by Dr. Israr Ahmed
16. YouTube Channel of Syed Khalid Hameed Kazmi

Semester	Code	Name of Courses	Credit Hour	Category
3rd	BOT-231	Phytogeography	03 (2+1)	Core

Course learning Outcomes:

1. Understand the concept, scope, and history of phytogeography.
2. Identify patterns and processes of plant distribution at global, regional, and local scales.
3. Explain the roles of climatic, biotic, and anthropogenic factors in shaping vegetation.
4. Analyze floristic regions of the world and Pakistan.
5. Apply phytogeographic methods in field surveys and vegetation mapping.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Phytogeography: Definition, scope, and objectives	**17**	Phytogeography of Pakistan – I
2	Relationship with other botanical sciences, Historical development	**18**	Floristic composition and plant diversity
3	Branches of Phytogeography: Descriptive phytogeography	**19**	Vegetation types of Pakistan (natural and semi-natural)
4	Interpretive phytogeography, Paleophytogeography	**20**	Phytogeography of Pakistan – II
5	Factors Influencing Plant Distribution Abiotic: Climate, soil, topography	**21**	Phytogeographic regions of Pakistan
6	Biotic: Competition, dispersal, human impact	**22**	Western Himalayan
7	Plant Dispersal and Migration: Mechanisms of seed and spore dispersal	**23**	Irano-Turanian
8	Barriers to dispersal	**24**	Saharo-Sindian
9	Migration routes and centers of origin	**25**	Human Influence on Plant Distribution

10	Endemism and Cosmopolitanism: Concepts and types of endemis	**26**	Deforestation and habitat fragmentation
11	Conservation importance of endemic species	**27**	Invasive species and climate change
12	Major Phytogeographic Regions of the World – I	**28**	Conservation strategies and protected areas
13	Major Phytogeographic Regions of the World – II	**29**	Vegetation Mapping and Remote Sensing
14	Vegetation Zones and Biomes	**30**	Techniques in vegetation classification
15	Tropical forests, deserts, grasslands, tundra, etc.	**31**	Vegetation mapping
16	Altitudinal and latitudinal gradients	**32**	Use of GIS and satellite imagery
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Identification of major plant communities in the local area	**9**	Use of GIS and satellite imagery
2	Preparation of vegetation maps	**10**	Google Earth its uses in phytogeography
3	Herbarium preparation and plant documentation	**11**	Floristic mapping of different regions of Chitral
4	Analysis of distribution data using basic GIS tools	**12**	Study Trips to Chitral Gol National Park
5	Visit to a phytogeographically important region	**13**	Study of the Timber line in different local areas
6	Use of GIS Tools	**14**	Study of nearby glaciers
7	Use of ArcGIS in Phytogeography	**15**	Documentation of Cryobiota
8	Use of GIS softwares	**16**	Study of major barriers in the distribution of plants
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Good, R. (1974). *The Geography of the Flowering Plants.*
2. Cox, C.B. & Moore, P.D. (2010). *Biogeography: An Ecological and Evolutionary Approach.*

3. Walter, H. (1985). *Vegetation of the Earth and Ecological Systems.*

4.Nasir, E. & Ali, S.I. (Eds.). *Flora of Pakistan.*

5. Qaiser, M. (2001). *Phytogeographical Regions of Pakistan.*

Journals/Periodicals:

1. The journal of Phytogeography and taxonomy
2. Journal of Alpine Research
3. Journal of Mountain Science
4. Journal of Mountain Research

Semester	Code	Name of Courses	Credit Hour	Category
4th	BOT-242	Principles of Plant Ecology	03 (2+1)	Core

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

Learning Outcomes: Students will be able to lean basics of ecology **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to ecology.	**17**	Responses of plants to temperature
2	History and recent developments in ecology.	**18**	Adaptation to temperature extremes
3	Nature of Soil	**19**	Carbon dioxide: Stomatal responses
4	Properties of soil (Physical and Chemical)	**20**	Water loss and CO2-assimilation rates of plants in contrasting environments
5	Water in the soil-plant-atmosphere continuum	**21**	Functional significance of different pathways of CO2 fixation
6	The ionic environment and plant ionic relations	**22**	Water: Water as an environmental factor
7	Nutrient cycling	**23**	Role of water in the growth, adaptations and distribution of plants
8	Physiology and ecology of N, S, P and K nutrition	**24**	Water status in soil, Water and stomatal regulation
9	Heavy metals (brief description)	**25**	Transpiration of leaves and canopies
10	Salt and drought stress	**26**	Oxygen deficiency

11	Osmoregulation.	**27**	Energy metabolism of plants under oxygen deficiency
12	Soil erosion.	**28**	Morpho-anatomical changes during oxygen deficiency
13	Light: Nature of light	**29**	Post-anoxic stress
14	Factors affecting the variation in light	**30**	Wind as an ecological factor
15	Responses of plants to light	**31**	Wind break
16	Factors affecting the variation in temperature	**32**	Fire as an ecological factor
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Determination of physical properties of soil.	**9**	Measurement of O2 concentration of water.
2	Determination of chemical properties of water.	**10**	Effect of light on germination and growth of plants.
3	Measurements of light under different ecological conditions.	**11**	Effect of temperature on germination and growth of plants.
4	Measurements of temperature under different ecological conditions.	**12**	Effect of moisture and soil type on germination and growth of plants.
5	Measurements of wind velocity.	**13**	Measurement of ions and stomatal conductance in plants in relation to various environmental conditions.
6	Measurement of CO2 concentration of air.	**14**	Measurement of osmotic potential and water potential in plants in relation to various environmental conditions.
7	Measurement of CO2 concentration of water.	**15**	Measurement of xylem pressure and leaf area in plants in relation to various environmental conditions.
8	Measurement of O2 concentration of air.	**16**	Measurement of rate of CO2 exchange in plants in relation to various environmental conditions.
Mid-Exam		**Final-Exam**	

Recommended Books:

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

Journals/Periodicals:

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

Semester	Code	Name of Courses	Credit Hour	Category
3rd	BOT 233	Fundamentals of Plant Taxonomy	03 (2+1)	Core

Objectives: To understand:

1. various systems of classification, identification and nomenclature of Angiosperms,

Learning Outcomes: By the end of this course, students will be able to:

- Understand the principles of plant classification and nomenclature.
- Explain the phylogenetic relationships among different groups of angiosperms. □ Use basic and modern tools to identify plants and construct taxonomic keys.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Plant Taxonomy	**17**	Key formation methods
2	Different systems of classification Artificial system	**18**	How to use key for the identification of angiospermic plants

3	Natural system	**19**	Diagnostic features, general characteristics and economic importance of Rutaceae
4	Phylogenetics system	**20**	Diagnostic features, general characteristics and economic importance of Lamiaceae
5	Brief history of the different systems of classification	**21**	Diagnostic features, general characteristics and economic importance of Apiaceae
6	Aims and scope of plant systematics	**22**	Diagnostic features, general characteristics and economic importance of Asteraceae
7	Bionomial nomenclature and its rule	**23**	Diagnostic features, general characteristics and economic importance of Ranunculaceae
8	Morphological studies: Root types in angiospermic plants and their functions	**24**	Diagnostic features, general characteristics and economic importance of Rosaceae
9	Different types of stems and its function	**25**	Diagnostic features, general characteristics and economic importance of Euphorbiaceae
10	Leaf parts, types and functions	**26**	Diagnostic features, general characteristics and economic importance of Brassicaceae
11	Inflorescence types	**27**	Diagnostic features, general characteristics and economic importance of Cactaceae
12	Description of flower, floral formula and floral diagram	**28**	Diagnostic features, general characteristics and economic importance of Solanaceae
13	Description of different types of fruits	**29**	Diagnostic features, general characteristics and economic importance of Graminae
14	Different types of Seeds	**30**	Diagnostic features, general characteristics and economic importance of Cucurbitaceae
15	Chemotaxonomy and Numerical Taxonomy	**31**	Molecular systematics
16	Palynology, different types of pollen grains	**32**	Phylogenetics, phenetics and morphometrics
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Morphological study of different types of roots	**9**	Identification of plants through keys
2	Morphological study of different types of stems	**10**	Technical description of common flowering plants belonging to families mentioned in theory

3	Morphological study of different types of leaves	**11**	Collection of plants
4	Morphological study of different types of flowers	**12**	How to use key for identification of plants
5	Morphological study of different types of inflorescence	**13**	Floral diagram formation of monocot (*Zea mays*)
6	Morphological study of different types of fresh fruits	**14**	Floral diagram formation of dicot (*Rosa multiflora*)
7	Morphological study of different types of dry fruits	**15**	Description of different types of seeds
8	Morphological study of different types of seeds	**16**	Study of pollen grains of different plants
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Mauseth, J. D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R. C., W. D. Clarke and Vodopich, D. S. 1998. Botany. McGraw Hill Company, U.S.A.
3. Raven, P. H., Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants. W. H. Freeman and Company Worth Publishers.
4. Stuessy, T. F. 1990. Plant Taxonomy. Columbia University Press, USA.
5. Lawrence, G. H. M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
6. Panday, B. P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
7. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition, Regency Publications, New Delhi.
8. Naik, V. N. 2005 Taxonomy of Angiosperms. 20th Reprint. TataMacGraw-Hill Publishing Company, Limited New Delhi.
9. Rajput, M. T., S. S. Hassney and K. M. Khan. 1996. Plant Taxonomy. New Trends Computer Service, Hyderabad, Sindh,

Journals/Periodicals:

European Journal of Taxonomy, Taxon, PhytoKeys, Plant Systematics and Evolution

Semester	Code	Name of Courses	Credit Hour	Category
3rd	GE-231	Pakistan Studies	02	General Education

Course Objectives:

1. Have enhanced knowledge of the geographical, historical, and political aspects of Pakistan. Understand the society and culture of Pakistan.
2. Understand and explain the socio-economic developments in Pakistan.
3. Explore contemporary issues and challenges and their implications for Pakistan

Course Outline:

Mid-Course	Final-Course

S. No. of Lecture	Lecture/Topics	S. No. of Lecture	Lecture/Topics
1	Introduction to Pakistan	**17**	Culture of Pakistan
2	Geographical location and significance	**18**	Socio-cultural diversity
3	Historical background	**19**	Languages of Pakistan.
4	Ancient civilizations in the region	**20**	literature of Pakistan.
5	Factors leading to the creation of Pakistan	**21**	Economic Development of Pakistan
6	Political History of Pakistan	**22**	Agricultural sector of Pakistan
7	Formative phase: Military interventions	**23**	Industrial sector of Pakistan
8	democratic transitions	**24**	Economic challenges of Pakistan
9	Geography of Pakistan	**25**	Contemporary Issues
10	Physiographic: Mountains, plains	**26**	Foreign Relations of Pakistan
11	plateaus, deserts	**27**	Relations of Pakistan with islamic Countries
12	valleys and coastal areas	**28**	Relations of Pakistan with nonislamic Countries
13	River systems	**29**	regional conflicts
14	Indus River and its tributaries	**30**	Environmental problems
15	Climatic regions of Pakistan	**31**	and sustainable development (SDGs)
16	Society of Pakistan	**32**	Media and Social Change
Mid-Exam		**Final-Exam**	

Recommended Books:

1. The struggle for Pakistan by Ishtiaq Husain Qureshi. 1965. University of Karachi.
2. Pakistan, the Formative Phase, 1557- 1945" by Khalid B. Sayeed. 1965. OUP.
3. Hayat, S. (2020). Aspects of the Pakistan movement. M/s Roohani Art Press, Blue Area, Islamabad, Pakistan.
4. Constitutional and Political History of Pakistan" by Hamid Khan. 2020.OUP.
5. 5.Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sarwar.2019. Peace Publication.
6. Pakistan: The Modern History" by Ian Talbot. 2001. South Asia Research.
7. Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed. 1980. Praeger. 8. Papanek, G. F. (2024). Pakistan's development: Social goals and private incentives. Harvard University Press.
8. 9. Candland, C. (2024). The Islamic Welfare State: Muslim Charity, Human Security, and Government Legitimacy in Pakistan. Cambridge University Press.
9. Rumi, R. (2018). Being Pakistani: Society, culture and the arts. Harper Collins

Semester	Code	Name of Courses	Credit Hour	Category
3rd	GE-232	Civics & Community Engagement	02 (2+0)	General Education

Course Objectives:

- To introduce students to the concept of Active Citizenship.
- To define and explain the nature and significance of community.
- To highlight the role of the family within the broader context of the community.
- To assess the role of individuals in contributing to the betterment of society.
- To explore the concepts of identity and culture within the context of social harmony.
- To promote community-based project planning and the formation of action groups.

Course Outline:

S. No. of Lecture	Lecture/Topics
1	Introduction to Civics: Meaning and nature of Civics.
2	Significance of Civics: The importance of civics education and its connection to community engagement.
3	The Family as a Social Institution: Defining the family as the basic social unit.
4	Types of Families: Characterizing different family structures and their roles.
5	The Family's Role in State Development: The importance of family in the development of a state and its responsibilities.
6	Understanding Community: Definition, nature, and significance of a community.
7	Individual and Family in the Community: The role of both an individual and a family in community well-being.
8	Understanding Society: Defining society and its relationship with the individual and the state.
9	The Individual and the State: Introduction to active citizenship, including its ideas, concepts, and philosophy.
10	Approaches to Active Citizenship: Discussing various methodologies and skills for active participation.
11	Citizenship Rights and Duties: A detailed look at the rights and responsibilities of citizens.
12	Social Harmony: Harmonic relationships among different members of society (women, children, senior citizens).
13	Identity and Social Harmony: The concepts of identity, culture, and social harmony in diverse societies.

14	Multi-culturalism: Exploring multi-cultural societies and the importance of inter-cultural dialogue.
15	Individual's Role in Society: Analyzing the role of an individual for the betterment of society.
16	Social Action Project: Introduction: An overview of the Social Action Project and its planning.
Mid Exam	
17	Problem Identification: Methodologies for identifying a problem (area mapping) for the project.
18	Project Ethics: Ethical considerations related to conducting a communitybased project.
19	Resource Assessment: How to assess existing resources (material and nonmaterial) for the project.
20	Project Planning: Community-based project planning and building action groups.
21	Implementation: Dividing roles among action groups for effective project implementation.
22	Monitoring and Evaluation: Strategies for monitoring, evaluating, and assessing the impact of the project.
23	Applied Community Engagement Project (Chitral): Introduction to a local problem-solving project in Chitral.
24	Applied Community Engagement Project (Chitral): Actively engaging with the community to solve identified problems. The teacher will supervise.
25	Applied Community Engagement Project (Chitral): Continued - Implementation and supervision of the community engagement initiatives.
26	Applied Community Engagement Project (Chitral): Continued - Implementation and supervision of the community engagement initiatives.
27	Applied Community Engagement Project (Chitral): Continued - Actively engaging with the community to solve identified problems. The teacher will supervise.
28	Applied Community Engagement Project (Chitral): Continued - Actively engaging with the community to solve identified problems. The teacher will supervise.
29	Applied Community Engagement Project (Chitral): Continued - Implementation and supervision of the community engagement initiatives.
30	Applied Community Engagement Project (Chitral): Conclusion and Grading - Final grading based on active engagement and project outcomes.
31	Review and Discussion: A general review of key course concepts and a Q&A session.
32	Review and Discussion: Continued - Final preparation for the end of the semester.
Final Exam	

Recommended Books:

1. John J. Macionis, Lindaa Marie Gerber, Sociology (New York: Pearson Education, 2010)
2. Community Development, Social Action and Social Planning by Alan Twelvetrees 12 May 2017
3. The Constitution of the Islamic Republic of Pakistan (Pakistan: The National Assembly of Pakistan,2012),also available online at the official website of National Assembly of Pakistan: http://na.gov.pk/uploads/documents/13333523681951.pdf(Accessed on April 25, 2017)
4. Anne Karin Larsen, Participation in Community Work: International Perspectives (Vishanthie Sewpaul, Grete Oline Hole, 2013)
5. British Council, Active Citizen's Social Action Projects Guide (Scotland: British Council,2017)

Semester	Code	Name of Courses	Credit Hour	Category
3rd	GE-233	Seerat un Nabi	01 (0+1)	General Education

Course Outline:

a. The Study of the Seerah of the Holy Prophet (ﷺ) (لازمی) کورس : مطالعہ سیرت النبیﷺ will be non-credit compulsory course. Passing marks will be 50% based on written/oral examination.

b. There will be Two-hour class (es) each week during the semester. The teachers who are engaged in teaching this course "shall be paid remuneration equivalent to approved 2-0 Credit Hour Course under the policy of payment for such classes applicable to all disciplines

Title	Description
Semester	1st Year (2nd Semester)
Nature of Course	Compulsory
C.Hrs.	Non Credit Hours Course Note: This Course will be taught Two (02) Hours a week therefore it will be considered Two (02) Credit Hours Workload.
Total Teaching weeks	18
Code	ISL 128

Objectives of the Course اغراض و مقاصد	1۔طلبہ کو سیرۃ النبیﷺ کے تعارف، مآخذ و اہمیت سے متعارف کرانا 2۔ طلبہ کو حیاتِ طیبہ کے مکی اور مدنی دور کی مستند وجامع احوال سے روشناس کرانا 3۔ طلبہ کو آپﷺ کی سماجی، معاشی، تعلیمی اورعلمی زندگی سے آگاہ کرنا 4۔ طلبہ میں عصر حاضر کے مسائل کو سیرۃ النبیﷺ کی روشنی میں حل کرنے کا رجحان پیدا کرنا

نمبر شمار	عنوانات)ہفتہ وار(	تفصیلات
.1	سیرۃ النبیﷺ کا تعارف	سیرت کا لغوی اور اصطلاحی مفہوم، سیرت کی ضرورت واہمیت سیرت کا آغاز وارتقاء
.2	سیرت النبی ﷺ کے مأخذ	1۔ قرآن وحدیث 2۔ کتب ِسیرت کا تعارف
.3	نبی کریمﷺ کی حیاتِ طیبہ)مکی زندگی (	1۔ قبل از بعثت کے واقعات 2۔ ابتدائے بعثت تا ہجرت مدینہ کے واقعات
.4	نبی کریمﷺ کی حیاتِ طیبہ)مدنی زندگی(	1۔ ہجرت نبویﷺ تا غزوہ احزاب کے واقعات 2۔ صلح حدیبیہ تا وصال نبیﷺ کے واقعات
.5	نبی کریمﷺ کے حقوق وخصائص	1۔ نبی کریمﷺ کے حقوق 2۔ نبی کریمﷺ کے خصائص)کاملیت، تاریخیت، جامعیت، عملیت(
.6	رسول اللہﷺ بحیثیت انسانِ کامل	1۔ رسول اللہﷺ بحیثیت شہری، والد، شوہر، مع ل م اور آپﷺ کے طریقہ ہائے تدریس 2۔ رسول اللہﷺ بحیثیت تاجر، منصف اور سپہ سالار وفاتح
.7	نبی کریمﷺ کے اخلاقِ حسنہ اور ان کے اثرات	1۔نبی کریمﷺ کے اخلاقِ حسنہ کے انفرادی اثرات 2۔ نبی کریمﷺ کے اخلاقِ حسنہ کے اجتماعی اثرات
.8	سیرۃ النبیﷺ اوردعوتِ اسلام	1۔ سیرۃ النبیﷺ اور انفرادی دعوت 2۔سیرۃ النبیﷺ اور اجتماعی دعوت
.9	سیرۃ النبیﷺ اور خواتین	1۔ خواتین کے حقوق 2۔ خواتین کا سماجی وثقافتی مقام ومرتبہ سیرتِ نبوی ﷺ کی روشنی میں
.10	سیرۃ النبیﷺ اورورواداری	1۔غیر مسلموں کے ساتھ رواداری

3rd

		2۔ مسلمانوں کے ساتھ رواداری
.11	سیرۃ النبیﷺ اورمعیشت	1۔مختلف نظام ہائے معیشت کا تعارف 2۔ اسلامی معیشت
.12	سیرۃ النبیﷺ اوررفاہِ عامہ	1۔ رفاہِ عامہ سے متعلق تعلیمات سیرت 2۔ رفاہِ عامہ کی عملی صورتیں
.13	سیرۃ النبیﷺ اورتعلیم وتربیت	1۔اولاد کی تعلیم وتربیت 2۔ دیگر متعلقین کی تعلیم وتربیت
.14	سیرۃ النبیﷺ اوراسلامی ریاست	1۔اسلامی ریاست کا تعارف وتنظیمی ڈھانچہ 2۔حکمران اور رعایا کے حقوق وفرائض
.15	نبی کریمﷺ کی داخلہ اور خارجہ پالیسی	1۔ نبی کریمﷺ کی داخلہ پالیسی 2۔ نبی کریمﷺ کی خارجہ پالیسی
.16	رسول اللہﷺ بحیثیت خاتم النبیین	1۔ختم نبوت کا تعارف، ضرورت واہمیت 2۔عقیدہ ختم نبوت: قرآن، حدیث اور اجماع کی روشنی میں

نصابی کتب

نمبر	نام مصنف	نام کتاب
1	سید سلیمان ندو ی	خطبات مدراس
2	سید سلیمان ندو ی	رحمتِ عالم
3	ڈاکٹر عبدالرووٴف ظفر	اسوہ کامل

حوا لہ جات کتب

نمبر	نام مصنف	نام کتاب
1	ابن ہشام	سیرت ابن ہشام
2	علامہ شبلی نعمان ی/ سید سلیمان ندو ی	سیرۃ النبیﷺ
3	مولاناحکیم عبدالرؤوف داناپور ی	اصح السیر
4	مولانا محمد ادریس کاندھلوی	سیرت المصطف ی
5	پیر کرم شاہ الازہر ی	ضیاء النبیﷺ
6	مولانا مودود ی	سیرت سرور عالم
7	ڈاکٹر محمد حمید اللہ	سیرت النبی ﷺ
7	صفی الرح من مبارک پوری	الرحیق المختوم

Semester	Code	Name of Courses	Credit Hour	Category
3rd	GE-235	Entrepreneurship	02 (2+0)	General Education

Course Outline:

S. No. of Lecture	Lecture/Topics
1	Introduction to Entrepreneurship: Meaning and Definition, Nature and Scope, Objectives of Entrepreneurship, Importance in the Economy
2	Entrepreneurship VS Intrapreneurship: Introduction, Theoretical Understanding, Key Differences, Practical Implications
3	Invention Vs Innovation: Types of Innovation (Product, Process, Business Model), Key Differences, Practical Implications
4	Types of Entrepreneurs: Based on Ownership (Solo, Partnership, Corporate), Based on Growth (Small Business, Scalable Startup), Based on Nature (Innovative, Social, Imitative, Lifestyle)
5	Strategic Perspective in Entrepreneurship: Concept and operationalization, Process of Strategic Perspective, Reasons for Lack of Strategic Perspective
6	Diversity & Inclusion in Entrepreneurship: Theoretical Conceptualization, How to Foster Diversity & Inclusion, Practical Implications
7	Sustainable and Green Entrepreneurship, Triple Bottom Line (People, Planet, Profit), Principles, Challenges, Importance
8	Corporate Social Responsibility & Shared Values (CSR): Definition and Operationalization, Benefits, Example (ISO 26000), Difference between CSR & Sustainable Entrepreneurship

9	Entrepreneurial Intention & Behavioral Models: Theory of Planned Behavior, Factors Affecting Intention
10	Entrepreneurial Motivation & Psychology: Types of Motivation (Personal Growth, Opportunity, Survival), Theories (X & Y Theory, Maslow's Hierarchy, SelfDetermination), Practical Applicability
11	Digital & Creative Entrepreneurship: Digital Platforms, Key Features, Theoretical and Practical Applicability
12	Entrepreneurial Process & Business Model Innovation: Idea Generation, Feasibility Analysis, Business Planning, Funding & Financing, Launch & Growth
13	Business Planning & Pitching in the Digital Era: Importance of a Business Plan, Key Components (Executive Summary, Market Analysis, Marketing Plan, Financial Plan, Operations Plan)
14	Sources of Business Ideas: Internal Sources, External Sources, Innovation in Idea Generation
15	Entrepreneurial Challenges: Financial Market and Managerial Challenges, Legal & Regulatory Challenges
16	Government & Institutional Support for Entrepreneurs: Role of Government, Financial Institutions, Support Programs
Mid Exam	
17	Innovation and Disruption in Entrepreneurship: Disruptive Innovation and Business Model Innovation, Practical Implications and Case Examples
18	Artificial Intelligence & Machine Learning in Startups: AI-driven Business Solutions, Chatbots, Predictive Analytics, Personalization
19	Social Entrepreneurship & Impact Investing: Creating Social and Environmental Impact
20	Startup Ecosystems & Global Innovation Hubs: Role of Incubators, Accelerators, and Co-working Spaces, Cross-border Collaboration and Global Markets
21	Remote Work & Distributed Teams: Building Virtual Startups, Digital Collaboration Tools and Management
22	Fintech & Digital Funding: Crowdfunding, Peer-to-Peer Lending, Venture Capital Trends in Tech Startups
23	Entrepreneurship Post-Pandemic & Resilience Strategies: Building Resilient Business Models, Crisis Management & Adaptive Strategies
24	Legal & Ethical Issues in Modern Entrepreneurship: Data Privacy Laws, Intellectual Property in Digital Age, Ethical AI & Responsible Innovation
25	Gig Economy & Platform-Based Entrepreneurship: Freelance Platforms & Sharing Economy Models (Uber, Airbnb), Regulatory and Social Impacts of Platform Work
26	Mental Health & Well-being Startups: Digital Therapy Platforms, Wellness Apps, Entrepreneurship Focused on Social Impact in Mental Health
27	Blue Ocean vs. Red Ocean Strategy: Theoretical implications, Practical Applicability
28	Mentorship & Incubation Programs: Connecting entrepreneurs with experienced mentors for guidance, Providing access to resources, networks, and funding.
29	Storytelling & Digital Branding: Using storytelling, social media, and content marketing to build brand awareness and attract customers/investors.

30	Financial Literacy & Investor Readiness: Training entrepreneurs on fundraising, financial management, and pitching to investors.
31	Entrepreneurship through Social Media & Influencer Marketing: Leveraging platforms like TikTok, Instagram, and YouTube for marketing and community engagement.
32	Business Idea Pitching: Mastering the Art of Persuasion: Pitch Deck: Clear, visual, concise slides, Skills: Storytelling, confidence, Q&A handling, Practice: Rehearse, get feedback, refine, Goal: Secure support or investment
Final Exam	

Semester	Code	Name of Courses	Credit Hour	Category
4th	BOT-241	Principles of Plant Biochemistry	03 (2+1)	Core

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

Learning Outcomes: Students will be able to elucidate the structure and role of primary metabolites in plants **Course Outline:**

Mid-Course		**Final-Course**	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	The Light Reaction Photosystems	**17**	Amino acids and their structure. Electro chemical properties and reactions of amino acids.
2	ATP SynCapstone project	**18**	Primary, secondary, tertiary and quaternary structure of proteins.
3	CO_2 Fixation	**19**	Protein folding and unfolding.
4	RuBisCo and enzyme kinetics	**20**	Transport, storage, regulatory and receptor proteins.
5	C-3 Cycle, C-4 Cycle	**21**	Protein purification. Protein sequencing.
6	Regulation of photosynCapstone project	**22**	Plant defense proteins
7	Sugar structures	**23**	Purine and pyrimidine bases
8	synCapstone project of polysaccharides,	**24**	nucleosides, nucleotides.
9	Carbon metabolism in the chloroplast	**25**	Properties of DNA and RNA.
10	Starch synCapstone project	**26**	Types and functions of RNA. Nucleic Acid Metabolism.
11	Pentose phosphate pathway	**27**	Nature and functions of enzymes

12	Sucrose synCapstone project	**28**	I.U.E. classification with examples of typical groups.
13	Structure and chemical properties of fatty acids	**29**	Isozymes, ribozymes, abzymes.
14	Fatty acid biosynCapstone project in plants	**30**	Nature of active site and mode of action. Allosteric enzymes and feedback mechanism.
15	Di and triglycerides, phospholipids, glycolipids	**31**	Enzyme specificity. Enzyme kinetics
16	sulpholipids, waxes and sterols.	**32**	Enzymes with multiple functions – mechanisms.
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Study of Solutions	**9**	To extract and estimate oil from plant material using soxhlet apparatus.
2	Study of acids and bases	**10**	Analysis of various lipids by TLC methods.
3	Study of Electrolytes, nonelectrolytes	**11**	To estimate soluble proteins by Biuret or Lowry or Dye-binding method.
4	Study of buffers	**12**	To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
5	To determine the Rf value of monosaccharides on a paper Chromatogram.	**13**	To determine the Rf value of amino acids on a paper chromatogram.
6	To estimate the amount of reducing sugars in plant material titrimetrically/spectrophotometrically.	**14**	Extraction of Nucleic acids from plant material and their estimation by UV absorption or colour reactions.
7	To estimate the amount of nonreducing sugars in plant material titrimetrically/spectrophotometrically.	**15**	To estimate the catalytic property of enzyme catalase or peroxidase extracted from a plant source.
8	To determine the saponification number of fats.	**16**	To determine the PKa and isoelectric point of an amino acid.

Mid-Exam	Final-Exam

Recommended Books:

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

Journals / Periodicals:

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

Semester	Code	Name of Courses	Credit Hour	Category
4th	BOT-242	Fundamentals of Plant Physiology	03 (2+1)	Core

Course Objectives:

To provide comprehensive knowledge on some vital functions and mechanisms of plants.

Learning Outcomes:

- Understand the basic physiological processes that govern plant life.
- Explain the mechanisms of water transport, mineral nutrition, photosynCapstone project, respiration, and hormone regulation in plants.
- Describe how environmental factors affect plant physiology.
- Develop basic skills in laboratory experiments related to plant function. **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Plant Physiology – Definition, scope, and significance	**17**	Growth I – Phases, measurement, differentiation

2	Water Relations – Properties of water; Diffusion, osmosis	**18**	Growth II – Growth curves, environmental factors
3	Imbibition; Water potential	**19**	Hormones I – Auxins, Gibberellins: roles and applications
4	Water Movement – Absorption of water	**20**	Hormones II – Cytokinins, ABA, Ethylene
5	Apoplast and symplast pathways	**21**	Photoperiodism and Vernalization
6	Transpiration – Types, mechanisms	**22**	Dormancy
7	Stomatal regulation, antitranspirants	**23**	Light effects on flowering and vernalization
8	Mineral Nutrition– Essential elements, deficiency symptoms,	**24**	Stress Physiology – Drought, temperature stress
9	Mineral absorption mechanisms	**25**	Salinity/Salt stress
10	PhotosynCapstone project I – Light and dark reactions	**26**	Causes of salinity
11	Chloroplasts, pigments	**27**	Adaptation of plants to salinity
12	PhotosynCapstone project II – C3, C4	**28**	Waterlogging, Effects, and Adaptations
13	CAM Pathways, and Photorespiration	**29**	Hormones I – Auxins
14	Respiration – Aerobic and anaerobic	**30**	Gibberellins: roles and applications
15	Glycolysis	**31**	Unit 13: Hormones II – Cytokinins,
16	Krebs cycle, Electron Transport Chain	**32**	ABA, Ethylene
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Determination of water potential and osmotic potential	**9**	Demonstration of the Transportation of water through xylem
2	Experiment on plasmolysis and	**10**	Demonstration of the effect of light
	deplasmolysis		on photosynCapstone project
3	Demonstration of transpiration using potometers	**11**	Experiment on effect of Salt stress on plant
4	Separation of plant pigments via paper chromatography	**12**	Demonstration of the factors affecting seed germination
5	Observing respiration through CO_2 release	**13**	Factors inducing seed dormancy

6	Effect of light and hormones on seed germination	**14**	Phototropism and the role of light
7	Determination of water potential and osmotic potential	**15**	Experiment on Light-induced Germination
8	Experiment on plasmolysis and deplasmolysis	**16**	Demonstration of vernalization
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Taiz, L., Zeiger, E., Møller, I.M., & Murphy, A. (2015). Plant Physiology and Development. 6th Edition.
2. Hopkins, W.G., & Hüner, N.P.A. (2009). Introduction to Plant Physiology.
3. Devlin, R.M. (2000). Plant Physiology.
4. Salisbury, F.B., & Ross, C.W. (1992). Plant Physiology.
5. Devline and Witham -Plant Physiology
6. Satish C Bhatla · Manju A. Lal- Plant Physiology, Development and Metabolism

Journals/Periodicals:

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

Semester	Code	Name of Courses	Credit Hour	Category
4th	BOT-243	Plant Anatomy & Embryology	03 (2+1)	Core

Objectives:

To provide the students understanding about anatomical features of vascular plants **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	The plant body and its development	**17**	Cytoplasmic characteristics
2	Fundamental parts of the plant body	**18**	Seasonal activity and its role in the secondary growth of root and stem
3	Internal organization	**19**	Abnormal secondary growth
4	Different tissue systems of primary and secondary body	**20**	Epidermis and epidermal emergences
5	Meristematic tissues: classification	**21**	Parenchyma, Collenchyma, Sclerenchyma
6	Cytohistological characteristics of Meristems	**22**	Xylem
7	Initials and their derivatives	**23**	Phloem

8	Apical meristem: Delimitation	**24**	Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions)
9	Different growth zones	**25**	Resin Canals
10	Evolution of the concept of apical organization	**26**	Different types of woods, Periderm.
11	Shoot and root apices	**27**	Early development of plant body
12	Leaf: types, origin, Internal organization	**28**	Structure and development of Anther Microsporogenesis, Microgametophyte
13	Development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions.	**29**	Structure of Ovule Megasporogenesis, Megagametophyte
14	Enlargement of epidermal cells.	**30**	Structure of Ovule Megasporogenesis Megagametophyte
15	Vascular cambium: Origin	**31**	Endosperm formation
16	Origin, structure, storied and nonstoried cell types, types of divisions: additive and multiplicative	**32**	Parthenocarpy, Polyembryony
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Study of stomata.	**9**	T. S of angiosperm stem.
2	Study of epidermis.	**10**	T. S of angiosperm leaf.
3	Tissues of primary body of plant.	**11**	T. S of angiosperm root.
4	Study of xylem 3-dimensional plane of wood.	**12**	Anatomy of flower
5	Study of Phloem	**13**	Anatomy of fruit
6	Study of epidermal hairs.	**14**	Anatomy of seed
7	Anatomy of germinating seeds.	**15**	Anatomical study of root hairs
8	Study of pollens	**16**	Anatomical study of trichomes
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Raymond E, S. E. Eichhorn. 2005. Esau's Plant Anatomy. Meristems cells and tissues of the plant body, 3rd Ed. John Wiley & Sons. Inc.
2. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
3. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
4. Maheshwari, P. 1971. Embryology of Angiosperms, McGraw-Hill. New York.
5. Eames A. J. and L. H Mac Daniels. 2002. An Introduction to Plant Anatomy. Tata-Mac Graw-Hill Publishing Company, Limited, New Delhi.
6. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition, Regency Publications, New Delhi.
7. Naik, V. N. 2005 Taxonomy of Angiosperms. 20th Reprint. TataMacGraw-Hill Publishing Company, Limited New Delhi.
8. Rajput, M. T., S. S. Hassney and K. M. Khan. 1996. Plant Taxonomy. New Trends Computer Service, Hyderabad, Sindh, Pakistan.

Journals / Periodicals: Pakistan Journal of Botany, Taxon, Phyton.

Semester	Code	Name of Courses	Credit Hour	Category
4th	GE-241	Ideology and Constitution of Pakistan	02 (2+0)	General Education

Course Objectives:

1. To develop a vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
2. To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline:

S. No. of Lecture	Lecture/Topics
1	Introduction to Ideology: Defining Ideology: The term, the role of ideas, and the contours of an ideology.
2	Ideology, Truth, and Power: A critical look at the relationship between these concepts.
3	Types of Ideologies: An overview of the Left, Right, and Center debate.
4	Old and New Ideologies: A discussion on the evolution of ideological thought and various views about ideologies.
5	Ideology of Pakistan: The Aims and Objects of Pakistan's Formation.
6	The Importance of the Ideology of Pakistan.
7	The Basics of Pakistan's Ideology: Core principles and foundational concepts.

8	Ideological Rationale: Special reference to the notions of Sir Syed Ahmed Khan (Part I).
9	Ideological Rationale: Special reference to the notions of Sir Syed Ahmed Khan (Part II).
10	Ideological Rationale: Special reference to the notions of Allama Iqbal (Part I).
11	Ideological Rationale: Special reference to the notions of Allama Iqbal (Part II).
12	Ideological Rationale: Special reference to the notions of Muhammad Ali Jinnah.
13	Constitution, Government, and Politics: Constitutional Definitions, Features, and Functions.
14	Constitution, Government, and Politics: Constitutional Development in Pakistan (1947-1956).
15	Constitution, Government, and Politics: The Constitution of 1956: Salient features and reasons for its abrogation.
16	Constitution, Government, and Politics: Constitutional Development (1956-1962).
Mid Exam	
17	Constitution, Government, and Politics: The Constitution of 1962: Salient features and public response.
18	Constitution, Government, and Politics: Salient Features of the Constitution of Pakistan 1973 (Part I).
19	Constitution, Government, and Politics: Salient Features of the Constitution of Pakistan 1973 (Part II).
20	Constitution, Government, and Politics: Fundamental Rights in the Constitution of Pakistan 1973.
21	Constitution, Government, and Politics: Martial Law 1977-88: An analysis of political and constitutional changes.
22	Constitution, Government, and Politics: Civilian Rule 1988-99: A review of political and democratic developments.

23	Constitution, Government, and Politics: Martial Law 1999 Onward: The period of military rule and its impact.
24	Constitution, Government, and Politics: Constitutional Amendments: Major changes and their implications.
25	Land and Peoples: The Geography of Pakistan and its strategic importance.
26	Land and Peoples: Natural Resources: An overview of available resources and their use.
27	Land and Peoples: Agriculture and Industry: Key sectors of the economy and their role in development.
28	Land and Peoples: Population, Manpower, and Education: Demographic trends and challenges.
29	Contemporary Pakistan: Economic Institutions and Issues (Part I).
30	Contemporary Pakistan: Economic Institutions and Issues (Part II).
31	Contemporary Pakistan: Society and Social Structure: Key features and dynamics.
32	Contemporary Pakistan: Foreign Policy of Pakistan and its contemporary challenges.
Final Exam	

Recommended Books:

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976
3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
4. Perspectives on Contemporary Pakistan Governance, Development and Environment Edited By Ghulam Ali, Ejaz Hussain, 2020
5. Any other standard and latest books covering the subject.
6. Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
7. Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
8. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical
9. analysis. Karachi: Oxford University Press, 1993.
10. Mehmood, Safdar. *Pakistan Political Roots & Development.* Lahore, 1994.

Semester	Code	Name of Courses	Credit Hour	Category
4th	IDS-241	Organic Chemistry	03 (2+1)	Interdisciplinary

Course Objectives:

Students will acquire knowledge about basic concepts of organic chemistry, chemistry of hydrocarbons and functional groups and the mechanism of organic reactions. Such information will be useful for qualitative analysis and synthesis of organic compounds.

Course Content:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	*Introduction to Organic Chemistry*	**17**	automerism
2	Organic chemistry	**18**	hyperconjugation
3	the chemistry of carbon compounds	**19**	Classes of Organic Compounds
4	the nature of organic chemistry	**20**	Nomenclature of Organic Compounds
5	a historical perspective.	**21**	Classification of organic compounds
6	Chemical Bonding and Properties of Organic Molecules	**22**	IUPAC nomenclature of hydrocarbons
7	Localized chemical bonding	**23**	IUPAC nomenclature of heteroatom functional groups
8	delocalized chemical bonding	**24**	**Functional Group Chemistry**
9	concept of hybridization leading to bond angles	**25**	A brief introduction to the chemistry of hydrocarbons
10	bond lengths	**26**	Alkane
11	bond energies	**27**	alkene
12	shape of organic molecules	**28**	alkyne
13	inductive effects	**29**	alkyl halides
14	field effects	**30**	aldehydes
15	resonance	**31**	Ketones
16	aromaticity	**32**	Ketones derivatives
Mid-Exam		**Final-Exam**	
Mid-Course		**Final-Course**	

S. No. of Practical Class	Topic of Practical class	S. No. of Practical Class	Topic of Practical class
1	Qualitative analysis of compounds with different functional groups	**9**	oximes from carbonyl compounds
2	synthesis of organic compounds using as a tool for understanding techniques like reflux	**10**	hydrazones from carbonyl compounds
3	Study of distillation process	**11**	an ester from a carboxylic acid
4	Study of filtration process	**12**	an ester from alcohol etc
5	recrystallization and yield calculation	**13**	Study of formation of alkyl halides
6	organic syntheses may include preparation of benzanilide from benzoyl chloride	**14**	Study of formation of aldehydes
7	succinic anhydride from succinic acid	**15**	Study of formation of Ketones
8	phthalimide from phthalic anhydride	**16**	Study of formation of Alkane
Mid-Exam		**Final-Exam**	

Recommended Books:

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

Semester	Code	Name of Courses	Credit Hour	Category
4th	IDS-242	Biodiversity & Conservation	03 (3+0)	Interdisciplinary

Objectives:

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

Learning Outcomes: Students will be able to about environment and pollution types.

Course Outline:

Mid-Course		**Final-Course**	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Biodiversity & Conservation ,Types	**17**	Ramsar
2	Threats to Biodiversity	**18**	Conservation strategies; In situ,
3	Deforestation, over grazing, erosion	**19**	Ex situ
4	Ecosystem degradation, bio invasion, desertification	**20**	In vitro conservation
5	Pollution and climate change	**21**	Conservation vs preservation
6	Biodiversity of Pakistan	**22**	IUCN categorized protected areas in Pakistan;
7	Measuring biodiversity	**23**	Red listing
8	Alpha, Beta and Gamma diversity	**24**	Use of herbarium in biodiversity and conservation
9	Systematic and functional diversity	**25**	Use of Botanical Garden in biodiversity and conservation
10	Ecological services.	**26**	Concept of pastures
11	Indirect value of ecosystem by virtue of their ecological functions	**27**	Wild life management
12	Direct value of ecosystem (i.e. Utility of Bio resources)	**28**	Global Biodiversity Information Facility (GBIF)
13	Sustainable use of biological resources	**29**	Biological resources
14	Biodiversity Hot spots of Pakistan and the world	**30**	Unsustainable use of biological resources
15	International treaties/agreements regarding Biodiversity and conservation	**31**	Environmental Impact Assessment.
16	Convention on biological diversity (CBD)	**32**	Ramsar
Mid-Exam		**Final-Exam**	

Mid-Course	**Final-Course**

S. No. of Practical Class	Topic of Practical class	S. No. of Practical Class	Topic of Practical class
1	Inventory of plant biodiversity in various habitats.	**9**	Public awareness campaign on biodiversity
2	Field survey for baseline studies	**10**	Study of Biodiversity hotspot
3	Impact Assessment.	**11**	Use of herbarium in biodiversity and conservation.
4	Field trip to community protected areas	**12**	Use of botanical garden in biodiversity and conservation
5	Filed trip to different types of forests	**13**	Study of species conservation
6	Concept of pastures and wild life management	**14**	Study of Ecosystem restoration
7	Concept of game reserves and wild life management	**15**	Study of Wetland restoration
8	Field trip to National Park	**16**	Study of climate-resilient conservation
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Abbasi, A. M., Khan, M. A., M. Ahmad and M. Zafar. 2012. Medicinal plant biodiversity of Lesser Himalaya Pakistan. Springer Publishers USA.

2. Hussain, F., 1991. Vegetation and ecology of lesser Himalaya. Department of Botany, Peshawar

3. Shinwari, M. I. and M. A. Khan. 1998. Ethnobotany of Margalla Hills. Department of Biological Sciences, Quaid-i-Azam University Islamabad Pakistan.

4. Shinwari, M. I., M. I. Shinwari and Shah, M. 2007. Medicinal Plants of Margalla Hills National Park Islamabad. Higher Education Commission Islamabad. Pp.218.

5. Provincial conservation strategies

6. Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.

7. Falk, D. A. & Holsinger, K. E. 1991. Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, Oxford, UK.

8. Frankel, O. H., Brown, A. H. D. & Burdon, J. J. 1995. *The Conservation of Plant Biodiversity*. Cambridge University Press, Cambridge, UK.

9. IUCN. 1994. *IUCN Red List Categories.* As Approved by the IUCN Council. IUCN.

Journals /Periodicals

Systematics and Biodiversity, Biological Conservation.

Semester	Code	Name of Courses	Credit Hour	Category
5th	BOT 351	Advanced Plant Physiology	03 (2+1)	Core

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

Learning Outcomes:

Upon completion of the course, students will be able to:

1. Analyze complex physiological processes in plants.
2. Understand the biochemical basis of photosynCapstone project, respiration, and water relations.
3. Explore the roles and mechanisms of plant hormones and signaling molecules.
4. Investigate how plants respond to biotic and abiotic stresses.
5. Apply advanced physiological techniques in laboratory settings. **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Light absorption,	**17**	Root pressure, capillarity, cohesion–tension theory
2	Action spectrum and quantum yield	**18**	Long-distance transport: xylem and phloem mechanisms
3	C3, C4, and CAM pathways:	**19**	BiosynCapstone project, transport, and physiological effects of:
4	Biochemical and ecological significance	**20**	Auxins, gibberellins, cytokinins, abscisic acid, ethylene
5	Regulation of photosynthetic efficiency	**21**	Synthetic growth regulators and inhibitors, Hormonal Cross-talk
6	Photorespiration and photoinhibition	**22**	Receptors and second messengers (Ca^{2+}, cAMP, etc.)
7	The organization and regulation of plant glycolysis	**23**	Signal amplification and gene expression
8	TCA cycle, and electron transport chain	**24**	Role of reactive oxygen species (ROS) and nitric oxide (NO)
9	ATP synCapstone project and energy budgeting in plants	**25**	Abiotic stresses: drought, salinity, temperature, light
10	Alternative oxidase pathway and its role	**26**	Biotic stresses: pathogen and insect responses
11	Mechanisms of nutrient uptake and transport	**27**	Oxidative stress and antioxidant defense systems
12	Nutrient mobility, molecular mechanism and stress	**28**	Stress-responsive genes and proteins
13	Organic vs synthetic fertilizers	**29**	Photoperiodism and vernalization

14	Role of essential macro- and micronutrients	**30**	Apical dominance
15	Nutrient Interaction and Deficiency Symptoms	**31**	The Physiology of Senesce
16	Water potential and its components	**32**	Molecular basis of flowering (FT gene, florigen, etc.)
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of	**Topic of Practical class**	**S. No. of**	**Topic of Practical class**

3rd

Practical Class		**Practical Class**	
1	Measurement of photosynthetic rate using IRGA	**9**	Determine osmotic potential of tissue by freezing point depression method
2	Chlorophyll content determination (Arnon method)	**10**	Determine osmotic potential of tissue by an osmometer.
3	Determination of Rate of PhotosynCapstone project at Different Wave Lengths	**11**	To investigate water potential of a plant tissue by dye method
4	Estimation of proline under drought stress	**12**	To investigate water potential of a plant tissue by potential apparatus.
5	Effect of hormones on seed germination or coleoptile elongation	**13**	Measurement of stomatal index and conductance.
6	Plasmolysis and water potential experiments	**14**	Qualitative determination of K content in Guard cells
7	Measurement of transpiration rates (potometer)	**15**	To investigate the preferential absorption of ions by corn seedlings
8	Detection of catalase or peroxidase activity in stressed plants	**16**	To investigate the preferential absorption of ions by potato slices.
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Taiz, Zeiger, Møller & Murphy – *Plant Physiology and Development*, Sinauer/Oxford University Press
2. Salisbury & Ross – *Plant Physiology*
3. Hopkins & Hüner – *Introduction to Plant Physiology*
4. Frank B. Salisbury (Editor) – *Plant Physiological Ecology*
5. Devline and Witham -*Plant Physiology*
6. Satish C Bhatla · Manju A. Lal- Plant Physiology, Development and Metabolism

Journals/Periodicals:

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

Semester	Code	Name of Courses	Credit Hour	Category
5th	BOT 352	Microbial Botany	03 (2+1)	Core

Objectives:

To understand the morphology, structure and economic importance of Viruses and Bacteria **Course learning Outcomes:**

- To introduce students to the diversity and classification of plant-related microbes.
- To understand the role of microorganisms in plant life and ecosystems.
- To explore symbiotic and pathogenic interactions between plants and microbes.
- To understand the biotechnological applications of microbial-plant interactions.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Microbial Botany: Definition and Scope	**17**	Major Viral Diseases of Plants
2	Historical Background	**18**	Major Fungal Diseases of Plants
3	Difference between Microbiology and Microbial Botany	**19**	Mechanism of Infection
4	Importance In agriculture, Environment , and biotecchnology	**20**	Disease Symptoms and Diagnosis
5	Microbial Diversity: Morphology, classification and Gram staining	**21**	Plant Immune Response
6	Fungi: Structure, Reproduction and Classification	**22**	Microbes in Agriculture and Biotechnology: Biofertilizers and Biopesticides
7	Algae: Cyanobacteria, (Blue-green algae), Green Algae and ecological role	**23**	Genetically modified microbes in plant growth
8	Viruses: Plant viruses, structure and replication	**24**	Composting and Organic farming
9	Microbial-Plant Interactions: Symbiotic Relationships, Mycorrhizae, Rhizobium-Legume interactions	**25**	Microbial biocontrol agents
10	Endophytes and Epiphytes	**26**	Microbes in ecosystem
11	Rhizosphere and Phyllosphere microbiota	**27**	Microbial roles in biogeochemical cycles(Carbon, Nitrogen, Sulfur)
12	Microbial role in Plant Physiology: Nitrogen Fixation	**28**	Soil Microbial Communities
13	Phosphate stabilization	**29**	Microbial Succession
14	Harmone Production (e.g. Auxins by microbes)	**30**	Microbes in Biotechnology and Industry: Antibiotic Production
15	Decomposition and Nutrient cycling	**31**	Microbial enzymes and biofertilizers

16	Plant Pathogenic Microbes: Major Bacterial Diseases of Plants	**32**	Role of Microbes in fermentation and food processing
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical	**Topic of Practical class**	**S. No. of Practical**	**Topic of Practical class**
3rd			
Class		**Class**	
1	Microscopy Techniques: Handling Compound Microscope	**9**	Observation of Symbiosis
2	Observation of Microbial cultures	**10**	Demonstration of Mycorrhizae: Root Staining and Microscopic observation
3	Isolation and Culturing: Nutrient Agar preparation	**11**	Plant Pathogen Identification: Observation of Common Plant diseases
4	Streak Plate Technique	**12**	Study of Infected Plant Tissues
5	Isolation of Fungi from soil/Air	**13**	Isolation of Bacteria from soil
6	Staining Methods: Gram Staining of Bacteria	**14**	Identification of common Algae: Study Morphological features of fresh water Algae
7	Lactophenol cotton blue staining of fungi	**15**	Observation of Fungal Structures: Study spores, mycelium, sporangia using slides
8	Rhizobium Isolation and Nodulation Test: Nodules from Leguminous Plants	**16**	Study of Lichens and Mycorhhiza
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Alexopoulos, C. J., et al. Introductory Mycology
2. Pelczar, M. J. Microbiology
3. Mehrotra, R. S. Plant Pathology
4. Madigan, M. T., et al. Brock Biology of Microorganisms
5. Glick, B. R., & Patten, C. L. Molecular Biotechnology: Principles and Applications

Journals/Periodicals:

FEMS Microbial Ecology, Microbial Ecology, Mycologia, Journal of Phycology, Applied and Environmental Microbiology, Pakistan Journal of Botany, Pakistan Journal of Phytopathology, Journal of Bacteriology and Mycology, Pakistan Journal of Agricultural Sciences

Semester	Code	Name of Courses	Credit Hour	Category
5th	BOT 353	Pteridophytes & Gymnosperms	03 (2+1)	Core

Objectives: To enable the students to understand and appreciate the biology and evolution of plant architecture

Course learning Outcomes:

- To learn the structure, classification, and life cycle of Pteridophytes and Gymnosperms.
- To understand their evolution and relationships with other plant groups.
- To know their ecological and economic importance.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Pteridophytes: Definition Morphology, anatomy	**17**	Introduction to Gymnosperms – Habitat, Morphology, anatomy
2	Origin and evolution of Pteridophytes	**18**	Reproduction in Gymnosperms
3	classification of Pteridophytes	**19**	Fertilization and seed development in gymnosperm
4	Generalized life cycle of Pteridophytes	**20**	Seed dispersal strategies of gymnosperm
5	Heterospory in pteridophytes and its evolutionary significance	**21**	Classification of Gymnosperms
6	Ecological and economic importance of pteridophytes	**22**	Conservation status and threats to gymnosperm
7	Rhyniophyta – Cooksonia	**23**	Physiological adaptations of gymnosperm to different habitats
8	Phylum Psilopsida – Psilotum: Structure and reproduction	**24**	Role of Gymnosperms in climate regulation and carbon storage
9	Phylum Lycopsida – Lycopodium	**25**	Cycadofilicales – Features and affinities
10	Phylum Lycopsida,Selaginella	**26**	Bennettitales
11	Phylum Sphenopsida – Equisetum	**27**	Ginkgoales
12	Phylum Pteropsida – Ophioglossum	**28**	Cycadales
13	Phylum Pteropsida – Dryopteris	**29**	Gnetales
14	Phylum Pteropsida – Azolla	**30**	Comparative study of gymnosperm and angiosperm
15	Phylum Pteropsida- Marsilea	**31**	Distribution of Gymnosperms in Pakistan

16	Comparative evolutionary trends among Psilopsida, Lycopsida, Sphenopsida, and Pteropsida	**32**	Introduction to Gymnosperms – Habitat, Morphology, anatomy
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Field study of pteridophytes	**9**	Field study of gymnosperm
3rd			
2	Morphological study of Psilotum (external features)	**10**	Morphology and anatomy of Cycas leaf, stem, and root
3	Anatomical study of Psilotum stem (permanent/temporary slides)	**11**	Study of Cycas male cone and ovule
4	Morphology and anatomy of Lycopodium stem/leaf	**12**	Morphology and anatomy of Pinus leaf (needle), stem, and root
5	Morphology and anatomy of Selaginella stem and leaf	**13**	Reproductive structures of Pinus (male and female cones)
6	Morphology and anatomy of Equisetum stem (node, internode, vascular bundle)	**14**	Morphology and anatomy of Ginkgo leaf and reproductive organs
7	Study of fronds, rhizomes, and sori in Dryopteris	**15**	Morphology of Ephedra stem and reproductive structures
8	Morphology and reproductive structures of Marsilea and Azolla	**16**	Comparative study of Gymnosperm seeds (Cycas, Pinus, Ephedra)
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Beck, C. B. 1992. Origin and Evolution of Gymnosperms. Vol-1&II, Columbia University Press, New York,

2. Foster, A. S. and Gifford, E. M. Jr. 1998. Comparative Morphology of Vascular Plants. W. H. Freeman and Co

3. Jones, D. 1983. Cycadales of the World, Washington, DC.

4. Mauseth, J. D. 1998. An Introduction to Plant Biology, Multimedia Enhanced, Jones and Bartlett Pub. UK.

5. Moore, R. C., W.d. Clarke and Vodopich, D. S. 1998. Botany McGraw-Hill Company, USA 6. Raven, P. H. Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants, W. H. Freeman and Company Worth Publishers.

7. Ray, P.M. Steeves, T. A. and Fultz, T. A. 1998. Botany Saunders College Publishing, USA.

8. Taylor, T. N. and Taylor, E. D. 2000. The Biology and Evolution of Fossil Plants, Prentice Hall.

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

Semester	Code	Name of Courses	Credit Hour	Category
5th	IDS-351	Molecular Genetics	03 (2+1)	Interdisciplinary

Objectives:

To introduce students recombination of genetic material at molecular levels with emphasis on introduction to biotechnology and genomics.

Learning Outcomes: To understand how the genetic information in prokaryotic and eukaryotic organisms is organized and realized, and to acquire basic knowledge about the methods used to study these topics. It will be important to understand a link between bioinformatics and laboratory-based experiments. The students should also obtain a basic understanding of how this knowledge can be used in applied biotechnology, and be able to suggest experimental solutions to common problems occurring in basic and applied molecular genetic research.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Molecular Biology	**17**	DNA Polymerases
2	History of Molecular Biology	**18**	Different types of Repair
3	Nucleic Acids	**19**	DNA Recombination: Transposable DNA elements
4	Chemical and Physical properties of Nucleic Acids	**20**	Mutations
5	The Structure and Function of DNA	**21**	Types of Mutations
6	RNA	**22**	Causes of Mutations
7	Proteins	**23**	Genomics and Proteomics: Human Genome Project overview
8	Prokaryotic Genes and Genome	**24**	Genome Sequencing
9	Eukaryotic Genes and Genomes	**25**	Gene Expression Analysis (Microarrays, RNA Sequence)

10	DNA Packaging in Chromatin	**26**	Basic concept of proteomics and application
11	Regulation of Chromatin Structure	**27**	Application of Molecular Genetics: Genetic Engineering (GMOS)
12	Structure of Chromosomes	**28**	Gene Therapy and CRISPR-Cas-9
13	Evolution of Genomes(Nuclear and Organelle genome)	**29**	Molecular Diagnosis (Covid-19, Cancer biomarkers)
14	Central dogma of Molecular Biology: DNA Replication: Transcription and Translation	**30**	Forensic DNA Analysis
15	Mutations in DNA	**31**	Gene Regulation in Prokaryotes: Operon Model (Lac operon, trp Operon)
16	DNA repair including description of types of DNA damage	**32**	Gene Regulation in Eukaryotes: Enhancers, Silencers, Transcription factors
Mid-Exam		**Final-Exam**	

3rd

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Preparation of solutions of different concentrations	**9**	Purification of RNA
2	Extraction and purification of nucleic acids from different sources (bacteria, blood, plants, animal tissues) etc.	**10**	Amplification using PCR
3	Quantification of DNA by Spectrophotometer	**11**	Northern Blotting
4	Gel Electrophoresis	**12**	Southern Blotting
5	Qualitative Analysis of Nucleic Acids	**13**	Western Blotting
6	Quantitative Analysis of Nucleic Acids	**14**	Bacterial Transformation with Plastids
7	Purification of Protein	**15**	Restriction digestion and Ligation
8	Purification of DNA	**16**	Use of bioinformatics tools (NCBI BLAST, genome databases)
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Strickberger, M.W. (2009). Genetics, (5th Ed.) Macmillan Publishing N.Y.
2. Goodenough, U. (2006). Genetics. Saunders College Publishing, USA.
3. Old, R.W. and Primrose, S.B. (2004). Principals of Gene Manipulation, (3rd Ed.) University of California Press.
4. Griffiths, A.J. F., Miller, J.H., Suzuki, D. T., Lewontin, R.C. and Gelbart, W. M., (2003).

An introduction to Genetic Analysis. W. H. Freeman and Company, New York.

5. Lewin, L. (2000). Gene V. John Wiley and Sons. New York.
6. Brown, T.A. (1999). Genetics, A Molecular Approach, Van Nostrand Reinhold Int.,
7. Maloy, S.R., Cronan, Jr., J.E. and Freifelder, D. (1994).Microbial Genetics, Jonest Bartelet Publisher, Boston, London.
8. Smith-Keary, P.F. (1975). Genetic Structure and Function, Macmillan Press, Ltd., London.
9. Molecular Biology of the Gene" by Watson et al.
10. Molecular Cell Biology by Lodish et al.

Journals/Periodicals:

Genes MDPI, Frontiers in Genetics, Nature Riviews Genetics, Journal of Molecular Biology, G3: Genes/Genomes/Genetics, Biochemistry and Molecular Biology Education (BAMBeD), Pakistan Journal of Zoology, Pakistan Journal of Botany, Pakistan Journal of Biological Sciences, Journal of Pakistan Medical Association (JPMA), Pakistan Journal of Biochemistry and Molecualr Biology

Semester	Code	Name of Courses	Credit Hour	Category
5th	IDS-352	Animal Diversity-I (Invertebrates)	03 (2-1)	Interdisciplinary

Course Description:

This course introduces students to the taxonomic characteristics and classification of invertebrates. The increasing complexity in organization and functions from protozoans to echinoderms is discussed. The evolutionary perspective of each phylum is described.

Course Learning Outcomes:

This course will be based on following outcomes:

1. Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
2. Understand invertebrate organismal concepts in laboratory and field.
3. Demonstrate major evolutionary innovations for invertebrates with functional importance.
4. Understand how reproduction and development occurred
5. Analyze economic and ecological importance of invertebrates.

Course Contents: 1.

INTRODUCTION

a. Classification of Organisms:

ANIMAL-LIKE PROTISTS: THE PROTOZOA

a. General Characteristics.
b. Classification up to class
c. Symbiotic Lifestyles
d. Locomotion in protozoa
e. Nutrition and Reproduction.

MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

Phylum Porifera

a. Characteristics and classification. Cell Types, Body Wall, and Skeletons;
b. types of canal system;
c. Reproduction.

Phylum Cnidaria (Coelenterate a.
General Characteristics.

b. Classification up to Class.
c. The body Wall and Nematocysts

d.Reproduction

Phylum Ctenophore;

a. General Characteristics, body organization

THETRIPLOBLASTICORGANIZATIONPHYLUM PLATYHELMINTHES(ACOELOMATE)

a. General Characteristics.
b. Classification up to class
c. The Free-Living Flatworms and the Tapeworms

Phylum Nemertea.

General Characteristics

Phylum Gastrotrichea;

General Characteristics

PHYLUM ASCHELMINTHS (PSEUDOCOELOMATE)

a. General Characteristics
b. Classification up to class
c. Characteristics of Phylum Rotifera and Phylum Kinorhyncha.

COELOMATIC ORGANIZATION

PHYLUM ANNELIDA

a. General Characteristics
b. Classification

d. Locomotion, Feeding and the Digestive system, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Reproduction; Regeneration, Development, in Polychaeta, Oligochaeta and Hirudinea.

PHYLUM MOLLUSCA

a. General Characteristics

b. Classification up to class.

c. Shell, Feeding, Digestion, Gas Exchange, Locomotion, d. Reproduction and Development of Gastropods, bivalves, and cephalopods

PHYLUM ARTHROPODA

a. General Characteristics

b. Classification up to class.

c. The Exoskeleton; Metamerism and Tagmatization.

d.Nutrition and digestive system

e. Reproduction: Development, Metamorphosis; (class insecta), crustaceans and Arachnida.

PHYLUM ECHINODERMS

a. General Characteristics

b. Classification up to class.

c. Maintenance Functions, Reproduction; Regeneration, Larval forms and phylogeny of class Asteroidea **Practical:**

Note: ***Classification of each members of each phylum up to order with adaptions in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.***

Study of Euglena, Amoeba, Entameba, Plasmodium, Trypanosome, Paramecium as representative of animals like Protists.

Study of prepared slides of sponges, spicules of sponges, and their various body forms. Study of representatives of classes of Phylum Porifera

Study of principal representatives of classes of Phylum Coelenterate.

Study of principal representatives of classes of Phylum Platyhelminthes.

Study of representatives of phylum Rotifer, Phylum Nematode.

Study of principal representatives of classes of Phylum Mollusca.

Study of principal representatives of classes of Phylum Annelida.

Study of principal representatives of classes of groups of Phylum Arthropoda Study of representatives of classes of phylum Echinodermta.

Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.

Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.

How to make grade-wise series for preparation of temporary and permanent slides.

Recommended Principal Reference Book:

1. Miller, S. A., Harley, J. P., Aloi, J., & Erickson, G. (2002). Zoology. New York: McGraw-Hill.
2. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
3. Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition, (International), Singapore: McGraw-Hill.
4. Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin cummings Publishing Company, Inc.

BOOKS FOR PRACTICAL

Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition International), Singapore: McGraw-Hill.
Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore: McGraw-Hill.

IDS 353 Environmental Chemistry
Credit Hours 3(3+0)
Course Description

During this course students will study the chemistry of the air, water, and soil, and how anthropogenic activities affect this chemistry on planet Earth. This course is divided into 4 major parts that reflect the most pressing issues in Environmental Chemistry today: Radiation Ecology, The Atmospheric and Land Pollution, Green Chemistry, Organic Air Pollutants and Photochemical Smog, and Water Pollution.

Course Learning Outcomes

After Successful Completion of the course, the students will be able to;
EXPLAIN the basic concepts involved in Environmental Chemistry.
CLASSIFY the types of pollutants in air, water, soil, and biological matrices, and understand their fate in ecosystems.
FOLLOW standard analytical procedures to identify the types of pollutants harmful to human.
Maintain ethical conduct in lab and adhere to lab safety procedures while contributing effectively towards individual and/ or group goals.

Course Contents:

Atmospheric Pollution:

The atmosphere, composition, temperature and pressure profile, role of free radicals in the atmosphere, temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone–the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Radiation ecology:

Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws).

Water Pollution:

Water pollution and wastewater treatment, municipal, industrial and agricultural sources of pollution, heavy metals contamination of water, eutrophication, detergents and phosphates in water, water quality criteria, water purification: primary, secondary and advanced treatment, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Land pollution:

Soil and mineral resources, general principles of metal extraction, heavy metals contamination of soil, toxicity of heavy metals, bioaccumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Chemistry:

Atom economy, integrated pest management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water-based paints.

Recommended Books:

• Baird, C. and Cann, M., Environmental Chemistry, 5th ed., W. H. Freeman & Company, (2012).
• Dara, S. S. and Mihsra, D. D., A Text Book of Environmental Chemistry and Pollution Control, 9th ed., S. Chand & Co. Ltd., (2004).
• Singhi, R. and Singh, V., Green Chemistry for Environmental Remediation, John-Willey & Sons, Inc., (2011).
• Holloway, A. M. and Wayne, R. P., Atmospheric Chemistry, 1st ed., Royal Society of Chemistry, (2010).
• Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. Water Treatment Technologies for Removal of High Toxicity Pollutants, Springerlink, UK, (2010).
• Manahan, S. E., Environmental Chemistry, 9th ed., CRC press, Taylor & Francis group, USA, (2009).
• Girard, J. E., Principles of Environmental Chemistry, 2nd ed., Jones and Bartlett publishers, (2010).
• Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. and Hulsal, C., Principles of Environmental Chemistry, 1st ed., Royal Society of Chemistry, (2007).
• Matalack, A., Introduction to Green Chemistry, 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
• Wright, J., Environmental Chemistry, Routledge, (2003).

Semester	Code	Name of Courses	Credit Hour	Category
6th	BOT 361	Systematics of Angiosperms	03 (2+1)	Core

Objectives:

To know about identification, classification, nomenclature and flora writings, monographs.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to plant taxonomy	**17**	Classification: Why classification is necessary?
2	What is a species? Biological species, Micro and macro species, Species aggregate, Infra specific categories.	**18**	Linnaeus's systems of classification
3	Mechanism of speciation	**19**	Bentham and Hooker's systems of classification
4	Mutation and hybridization	**20**	Engler and Prantl's systems of classification
5	Geographical isolation	**21**	Bessey's systems of classification
6	Reproductive isolation	**22**	Cronquist's systems of classification
7	Variation: Types of variation	**23**	Takhtajan's systems of classification
8	Continuous and discontinuous variation, Clinal variation.	**24**	Dahlgren's systems of classification
9	Methodology of conducting biosystematics studies	**25**	Apiaceae (Umbelliferae) Arecaceae (Palmae)
10	Various biosystematics categories such as ecophene, ecotype, ecospecies, coenospecies and comparium	**26**	Asclepiadaceae Asteraceae (Compositae)
11	Systematics and Genecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, Various biosystematics categories such as ecophene, ecotype, ecospecies, coenospecies and comparium.	**27**	Boraginaceae Brassicaceae (Cruciferae)
12	Taxonomic Evidence: Importance	**28**	Capparidaceae Caryophyllaceae

13	Taxonomic Evidence: anatomical, cytological, chemical	**29**	Chenopodiaceae Convolvulaceae
14	Taxonomic Evidence: molecular, palynological, geographical and embryological.	**30**	Cucurbitaceae Cyperaceae
15	Important rules of botanical nomenclature including effective and valid publication, typification, principles of priority and its	**31**	Euphorbiaceae Fabaceae (Leguminosae)
	limitations		
16	author citation, rank of main taxonomic categories, conditions for rejecting names.	**32**	Lamiaceae (Labiatae) Liliaceae
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Technical description of plants of the local flora	**9**	Collection of medicinal plants of Chenopodiaceae
2	Identification of species with the help of a regional/Flora of Pakistan	**10**	Collection of medicinal plants of Convolvulaceae
3	Preparation of indented types of keys	**11**	Collection of medicinal plants of Euphorbiaceae
4	Preparation of bracketed types of keys	**12**	Preparation of permanent slides of pollen grains by acetolysis method
5	Field trips to study and collect plants from different ecological zones of Chitral lower.	**13**	Study of different pollen characters
6	Study of conditions for rejecting botanical names.	**14**	Study of variation pattern in different taxa.
7	Collection of medicinal plants of Asclepiadaceae	**15**	Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination
8	Collection of medicinal plants of Asteraceae (Compositae)	**16**	Field trips to study and collect plants from different ecological zones of Chitral upper.
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Ali, S. I. and Nasir, Y. 1990-92. Flora of Pakistan. Karachi Univ. Press, Karachi
2. Davis, P. H. & Heywood, V. H. 1963. Principles of Angiosperm Taxonomy. Oliver & Boyd, London
3. Ingrouille, M. 1992. Diversity and Evolution of Land Plants, Chapman & Hall. London
4. Stace, C. (1992). Plant Taxonomy and Biosystematics, Edward Arnold.
5. Jones, S. B. and Luchsinger, A. E. 1987. Plant Systematics. McGraw-Hill, Inc. New York.
6. Naik, V. N. 2005. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company, New Delhi.
7. Jeffrey C. 1980. An Introduction to Plant Taxonomy. Cambridge University Press.UK
8. Shinwari, M. I. and M. A. Khan. 1998. Ethnobotany of Margalla Hills. Department of Biological Sciences, Quaid-i-Azam University Islamabad Pakistan.
9. Shinwari, M. I., M. I. Shinwari and Shah, M. 2007. Medicinal Plants of Margalla Hills National Park Islamabad. Higher Education Commission Islamabad. Pp.218.
10. Sivarajan V. V and N. K. P Robson 1991 Introduction to the Principles of Plant Taxonomy.

Journals / Periodicals:

Pakistan Journal Botany, Flora of Pakistan, Taxon, Botanical Journal of the Linnaean Society

Semester	Code	Name of Courses	Credit Hour	Category
6th	BOT 362	Plant Pathology	03 (2+1)	Core

Objectives: To introduce the students to Mycology and Diseases caused by Fungi.
Course learning Outcomes: To enable the students to understand about pathology and pathogen.
Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Definition and Scope of Plant Pathology	**17**	White rust of Crucifers
2	The importance of Plant Disease	**18**	Downy mildews of cereals and grasses
3	The nature and classification of Plant Disease	**19**	Corn smut
4	Causes of Plant Diseases	**20**	Loose smut of Barley
5	Nature and classification of Plant Pathogens	**21**	Bunt or stinking smut of wheat

6	Growth and Reproduction of Plant Pathogens	**22**	White rot of deciduous trees
7	Pathogenesis-I: The parasite in relationship with its host	**23**	Black stem rust of wheat
8	Pathogenesis-II: Resistance and susceptibility	**24**	Tobacco Mosaic
9	The production and Liberation of Inoculum	**25**	Diseases in Transit and Storage
10	The dissemination of Plant Pathogens	**26**	The Principles of the control of plant diseases: Quarantines
11	The Phenomena of Infection	**27**	Plant Protection
12	The effect of environment and nutrition on disease	**28**	Cultural Practices in Disease Control
13	Detailed study of the following plant diseases: Black rot of crucifers	**29**	Chemical Control and resistant varieties
14	Bacterial will of cucurbits	**30**	Diagnostic Techniques in Plant Pathology: Field Diagnosis: Symptoms and Signs
15	Damping off caused by Pythium spp.	**31**	Laboratory Techniques: Isolation . staining and Culturing
16	Late blight of potato and tomato	**32**	Molecular Diagnostics: PCR, ELISA (Basic Concept)
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Study of symptoms and signs of plant diseases	**9**	Demonstration of Koch's postulates
2	Collection and preservation of	**10**	Fungicide Sensitivity test
	diseased specimens		
3	Study of important plant diseases	**11**	Field Visit to Survey Major crop diseases and Pathogen identification On-site
4	Demonstration of disease control methods	**12**	Study of disease forecasting tools
5	Microscopic study of Fungal structure	**13**	Preparation of thin sections of infected plant tissues
6	Identification of Nutrient deficiency symptoms	**14**	Study of observation of structural defense responses
7	Diagnosis of Environmental stressinduced disorders	**15**	Microscopic study of pathogen structures

8	Study of Herbicide injury symptoms on Plants	**16**	Pathogen identification using dichotomous keys
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Principles of Pathology of E.C. Stakman and J.G. Harrar.
2. Plant Pathology by J.C. Walker.
3. Plant Pathology by E.J. Butler and S.G. Jones.
4. Principles of Plant Infection of E. Gaumann.
5. Fungi and Plant disease by Mundkar.
6. Fungi of Pakistan by Sultan Ahmed. Part I and II.
7. Principles of Plant Pathology by J.G. Manners.
8. Introduction to Plant Diseases by G.B. Lucas and C.L. Campbell
9. Plant Pathology by George N. Agrios 5th edition.
10. Introduction to Plant Pathology by Richard N. Strange

Journals/Periodicals:

Plant Disease by American Phytopathological Society(APS), Fungal Biology by Elsevier, Mycologia by Mycological Society of America, Phytopathology by APS, Journal of Fungi by MDPI, European Journal of Plant Pathology by Springer, Pakistan Journal of Phytopathology by Pakistan phytopathological Society, Pakistan Journal of Botany by Pakistan Botanical Studies, Sarhad Journal of Agriculture by University of Agriculture, Peshawar

Semester	Code	Name of Courses	Credit Hour	Category
6th	BOT 363	**Principles in Pharmacognosy**	03 (2+1)	Core

Objectives of Course: to identify and know about crud drugs.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to Pharmacognosy. Terminology Used in Pharmacognosy	**17**	Auxins
2	An introduction of traditional Medical systems (Unani, Ayurvedic and Homoeopathic systems of medicine)	**18**	Gibberellins
3	Introduction to herbal pharmacopoeias and modern concepts about Pharmacognosy**.**	**19**	Abscisic acid

4	Crude drugs, commerce of crude drugs, preparation of crude drugs	**20**	Cytokinins
5	official and un-official drugs of crude drugs	**21**	Liliaceae: Garlic
6	Methods of Cultivation of crude drugs	**22**	Labiatae:Peppermint
7	Drying, Storage of crude drugs	**23**	Scrophulariaceae: Digitalis
8	Preservation of crude drugs	**24**	Zingiberaceae:Ginger
9	methods and control of pests with special reference to pyrethrum	**25**	Ranunculaceae: Aconitum
10	tobacco, and other natural pesticides	**26**	Papaveraceae:Papaver somniferum
11	Evaluation of crude drugs i.e. Organoleptic, Microscopic, Physical, Chemical and Biological.	**27**	Leguminosae: Glycyrrhiza
12	Deterioration and Adulteration of crude drugs.	**28**	Umbelliferae:Fennel, Carum
13	Types of adulteration, inferiority, spoilage	**29**	Apocynaceae: Catharanthus
14	admixture, sophistication and substitution of crude drugs	**30**	Asclepiadaceae:Gymnema sylvestre
15	Phytoenzymes: Papain	**31**	Compositae:Silybum marianum
16	Bromelain and Malt Extract	**32**	Solanaceae: Belladonna
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Microscopical Characters of the drugs.	**9**	Identification tests for Ca-oxalate
2	Microscopical Characters of the drugs (T.S of the past used, powdered drugs)	**10**	Study of Volatile compounds
3	Study of organoleptic characters	**11**	Study of fixed oils
4	Study of Physicochemical properties	**12**	Study of tannin
5	Study of Properties of gums	**13**	Study of mucilage
6	A Study Tour for collection of medicinal plants from the Chitral Lower.	**14**	Study of effects of Auxins and Gibberellins on plants

7	Properties of different oils studied in theory.	**15**	Study of effects of Abscisic acid and Cytokinins
8	Identification tests for Starch	**16**	A Study Tour for collection of medicinal plants from the Chitral upper.
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Pharmacognosy. Fundamentals, Applications and Strategies. 1st Edition by Simone Badal McCreath Rupika Delgoda. 2016.
2. Textbook of Pharmacognosy and Phytochemistry. 2009 by Biren Shah, Avinash Seth
3. Trease and Evans- Pharmacognosy 2016.by William Charles Evans
4. Fundamentals of Pharmacognosy and Phtotherapy . 2004. Joanne Barnes, Michael Heinrich, Simon Gibbons
5. Pharmacognosy: Fundamentals, Applications and Strategies.2016. Simone BadalMcCreath. Rupika Delgoda, Simone Badal-McCreath
6. Textbook of Industrial Pharmacognosy. 2018. by A. N. Kalia.
7. Textbook of Pharmacognosy. 2019. by Ali Mohammed
8. Pharmacognosy: Medicinal Plants. 2019. Areej Al-Taweel, Shagufta Perveen, Shagufta Perveen, Areej Al-Taweel
9. An Introduction to Pharmacognosy. 1904 by Smith Ely Jelliffe
10. Textbook of Pharmacognosy. 1946 by Thomas Edward Wallis
11. Pharmacognosy: (pharmacognosy and Phytochemistry). 2008 by Ali Mohammed
12. Textbook of Pharmacognosy and Phytochemistry. 2020 by Sapna Malviya and Swati Rawat

Journals / Periodicals:

Pharmacognosy Research, Pharmacognosy Magazine, Pharmacognosy Reviews, International Journal of Pharmacognosy

Semester	Code	Name of Courses	Credit Hour	Category
6th	BOT 364	Advanced Plant Ecology	03 (2+1)	Core

Objectives:

To provide comprehensive knowledge of population, community, ecosystem ecology and its relevance to mankind.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Historical development of community ecology	**17**	Methods of sampling of plant communities
2	Community concepts and attributes	**18**	Ecological succession
3	Population structure and plant demography	**19**	Community soil-relationship

4	Seed dispersal	**20**	Vegetation of Pakistan
5	Dormancy	**21**	Major formation types of the world
6	Seed Bank	**22**	Ecosystem Ecology
7	Demography	**23**	Ecological concepts of ecosystem
8	Seed dormancy	**24**	Boundaries of ecosystem
9	Life history pattern	**25**	Compartmentalization and system concepts
10	Resource allocation	**26**	Energy flow in ecosystem
11	Density dependent factors	**27**	Biogeochemical cycles
12	Density independent factors	**28**	Carbon Cycle
13	Reproductive effort	**29**	Nitrogen Cycle
14	Seed size vs seed weight	**30**	Phosphorus Cycle
15	Population genetics	**31**	Sulphur Cycle
16	Vegetation of Chitral	**32**	Hydrological cycle
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Determination of seed bank in various populations.	**9**	Braun-Blanqut
2	Seed dispersal pattern of local populations.	**10**	Correlate soil properties with vegetation type
3	Demography of local annual population.	**11**	Field trip to study different communities located in different ecological regions of Pakistan.
4	Life history of local annual population.	**12**	Slide show of the vegetation of Pakistan.
5	Study of community attributes.	**13**	Slide show of the major formations of the world.
6	Sampling of vegetation by Quadrat.	**14**	Soil physical properties.
7	Sampling of vegetation: plotless.	**15**	Soil chemical properties.
8	Sampling of vegetation: Transect	**16**	Soil texture
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Ahmad, M. and S. S. Shaukat. 2012. A test book of vegetation ecology. Publisher Abrar Sons, New Urdu Bazar, Karachi.
2. Schultz J. C. 2005. Plant Ecology, Springer-Verlag.
3. Townsend C. R. Begon. M and J. L. Harper 2002. Essentials of Ecology, Blackwell Publishing,

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

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

IDS 361 Principles of Biochemistry
Credit Hours 3(2+1)
Course Overview: This course introduces the chemical foundations of biological macromolecules, emphasizing their structure, function, and relevance to life sciences. It is tailored for students in biological disciplines, especially zoology, and provides a molecular understanding of cellular processes.
Macromolecules – Structure and Function
1. **Carbohydrates**
● Introduction and biological significance
● Classification: monosaccharides, oligosaccharides, polysaccharides
● Stereoisomerism in carbohydrates
● Structural and functional roles of:
○ Monosaccharides (e.g., glucose, fructose)
○ Oligosaccharides (e.g., sucrose, lactose)
○ Polysaccharides (e.g., starch, glycogen, cellulose)
● Glycosaminoglycans and glycoconjugates: structure and physiological roles
2. **Amino Acids, Peptides, and Proteins**
● Classification and properties of amino acids
● Acid-base behavior and isoelectric point
● Peptide bond formation and primary structure
● Conjugated proteins and their biological roles
3. **Protein Organization and Function**
● Structural levels: primary, secondary, tertiary, quaternary

● Covalent and non-covalent interactions in protein folding
● Functional proteins:
○ Hemoglobin and oxygen transport
○ Cytochrome and electron transport
○ Chymotrypsin and enzymatic activity
○ Alpha-keratin and collagen in structural support
● Proproteins: examples and activation mechanisms
Enzymes
● Definition and biological importance

● Classification and nomenclature (IUB system)
● Mechanism of enzyme action
● Enzyme inhibition
● Factors affecting enzyme activity

Lipids

● Introduction and classification
● Fatty acids: types and properties
● Storage lipids: triacylglycerols and waxes
● Structural/membrane lipids:
○ Glycerophospholipids (ether and ester linkages)
○ Galactolipids and sulfolipids
○ Sphingolipids: types and functions
○ Sterols: structure and biological roles

Nucleic Acids

● Types: DNA and RNA
● Structure and roles of nitrogenous bases
● Nucleosides and nucleotides
● DNA and RNA molecular architecture
● Double helical structure of DNA: organization and chemical features

Practical:

Estimation of glucose from blood serum or any other fluid using ortho Toluidine technique.
Tests for detection of carbohydrates in alkaline medium.
Tests for detection of carbohydrates in acidic medium.
Tests for detection of Disaccharides.
Tests to demonstrate relative instability of glycosidic linkage in carbohydrates.
Detection of Non-Reducing sugars in the presence of reducing sugars.
Demonstration of Acid Hydrolysis of Polysaccharide.
Determination of pKa values of an amino acid by preparation of titration curves
Preparation of standard curve of proteins by Biuret method.
Estimation of blood serum proteins or any unknown concentration of protein using Biuret technique.

Recommended Books

1. Lehninger principle of biochemistry by David L.Nelson and Michael M.Cox , 7th latest edition,ISBN-10:1-4641-2611-9,ISBN-13:978-14641-2611-6
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko; LubertStryer ,ISBN-10:1429229365,ISBN-13:97814229229364
3. Berg, J. M.,Tymoczko,J. L., LubertStryer. 2010. Biochemistry. 7th Ed.
4. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D, Darnell, J. 2012. Molecular Cell Biology.
5. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.
6. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet. D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.

7. Zubay, G.,1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
8. Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York
9. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan Worth Publishers, New York.
10. McKee, T., McKee, J.R. 2003.Biochemistry:
11. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
12. Lodish, H., Berk, A., Zipursky, S. L., Paul.M., Baltimore D,Darnell, J. 2012. Molecular Cell Biology.
13. McKee, T., McKee, J.R. 2003.Biochemistry:
14. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
15. Molecular cell biology W.H Freeman by Lodish, Berk, Krieger, Scott, Bretscher,Ploegh and Matsudaira 8th edition/latest edition,ISBN:1464183392,ISBN-13:97814641183393
Textbook for Practical:
• Plummer, David T., 1990. An Introduction to Practical Biochemistry, 4th Ed. McGrawHill Book Company, London.
• Wilson, K and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4th Ed., Cambridge University Press.
• Sawhney, S.K and Singh, R., 2008. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, India.

Semester	Code	Name of Courses	Credit Hour	Category
6th	IDS 362	Biostatistics	03 (2+1)	Interdisciplinary

Objectives: This course aims to enable you to apply advanced bio statistical methods to address research questions.

Course learning Outcomes:

- Analyze quantitative and qualitative data using biostatistics, • Define the principal concepts about biostatistics.
- Collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data.
- Identify distribution form relating to the variable/variables.
- Apply hypothesis testing via some of the statistical distributions.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Define statistics, the science of statistics and its importance, application of statistics in Botany.	**17**	Define probability, probability definitions (classical/priori, relative/posteriori, axiomatic)
2	Role of statistics in critical thinking and ethics	**18**	Basic terminologies (sample space, sample points, events, mutually & not mutually exclusive events, exhaustive events)
3	Branches of statistics (descriptive & inferential statistics).	**19**	Define set theory, set operations and their application in probability.
4	Define data, types of data/variables, sources of data. Measurement scales (nominal, ordinal, interval, ratio)	**20**	Rules of probability (additive, multiplicative and law of complement)
5	Introduction to data representation and principles of classification and tabulation	**21**	Define hypoCapstone project testing & estimation.
6	Construction of frequency distribution (discrete & continuous)	**22**	Types of hypotheses (null & alternative/research hypoCapstone project)
7	Diagrams, graphs, and their construction (Bar charts, Pie chart, Histogram, Frequency polygon & Frequency curve, Box and Whisker plot, Stem and Leaf plot)	**23**	Errors in decision making (Type I and Type II)

8	measures of central tendency, Types of averages, Median and Mode	**24**	Test statistic
9	Measures of skewness and kurtosis	**25**	Critical value, rejection/acceptance region
10	Shape of distributions and measures of dispersion	**26**	General procedure for testing of hypoCapstone project
11	Different types of absolute dispersion (Range, Variance, Standard Deviation)	**27**	Z distribution, one sample Z test
12	Relative dispersion (Coefficient of variation)	**28**	Degree of freedom
13	Define sample, sampling, sample design, and sample frame.	**29**	T distribution, one sample T test
14	Types of error in sampling	**30**	Chi-square distribution, Chi-square test of association
15	Random sampling (simple, stratified, cluster, systematic, & multistage sampling)	**31**	Concepts of experiment and design
16	Non-random sampling (convenience, purposive, quota, & snow-ball sampling)	**32**	Basic principles of design
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Data collection, arrangement of data in frequency table, calculating frequency, cumulative frequency and preparation of Ogive.	**9**	Analysis of variance - one factor design.
2	Calculating different measure of central tendency such as arithmetic means, harmonic mean, geometric mean, median and mode.	**10**	Multiple Analyses of Variance.
3	Calculation of mean from grouped and ungrouped data.	**11**	Determination of correlation by constructing different types of graphs such as scatter diagram, linear positive correlation, linear perfect negative correlation, no correlation and curvilinear correlation (second degree polynomial, third degree polynomial).

4	Calculation of variance and standard deviation from grouped and ungrouped data.	**12**	Linear Regression models.
5	Calculating dispersion, relative dispersion, standard deviation, standard error, standard score and coefficient variation by hand and machine method.	**13**	Multiple regression models.
6	Problems concerning probability, binomial distribution	**14**	MS Excel software packages.
7	Problems concerning T-test	**15**	MSTAT software packages.
8	Chi square test.	**16**	Hands-on SPSS (data analysis and visualization).
Mid-Exam		**Final-Exam**	

Recommended Books:

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

Recommended Journals:

Journal of the American Statistical Association (JASA), Journal of the Royal Statistical Society (Series A: Statistics in Society, Series B: Statistical Methodology), Annals of Applied Statistics, Biometrics, Biostatistics, Statistics in Medicine, JP Journal of Biostatistics,

Semester	Code	Name of Courses	Credit Hour	Category
7th	BOT 471	Analytical Techniques in Botany	03 (1+2)	Core

Learning outcomes:

On the completion of the course, the students will be able to:

- Learn open-source advanced analytical tools involving machine learning and perspective analysis of data related to botany
- Become acquainted with the infrastructure-based and cloud-based tools of data analyses related to botany.
- Become capable of building multiple diverse ways to visualize data from simple data visuals to complex ones with drill-down capabilities.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Techniques for isolation of proteins form plants	**17**	Techniques for determining mineral nutrient in plants
2	Techniques for characterizing proteins in plants	**18**	Destructive techniques for determining nutrients in plant tissues
3	Techniques for determining nucleic acids in plants	**19**	Non-destructive techniques for determining nutrients in plants parts
4	Mass spectrometric analysis of biochemical compounds in plants, xray diffraction analyses in plants	**20**	Techniques for determining mineral nutrients in soil samples
5	X-ray crystallographic analysis in plants	**21**	Soil sample preparation techniques, mineral nutrient quantification techniques for soils
6	Techniques for synthesizing nanoparticles from plants	**22**	Techniques for determining heavy metals in plants and soils
7	Nanoparticle application and uses in plant science	**23**	Plant sample preparation techniques for determination of heavy metals
8	Light microscopic techniques in Botany	**24**	Soil sample preparation techniques for determination of heavy metals
9	Fluorescent microscopic techniques in Botany	**25**	Heavy metal quantification techniques for plants and soils

10	Confocal microscopic techniques in Botany	**26**	Soil and plant sample preparation techniques for determination of organic pollutants
11	Fluorochromes in Botany, use of flow cytometry (FACS) in plants	**27**	Techniques for identifying composition of the organic pollutants in plants and soil
12	Application of chromosome banding technique in plants	**28**	Quantification techniques for organic pollutants in plants and soil
13	Application of FISH in plant sciences	**29**	Application of auto-radiographic techniques in plants
14	Application of chromosome painting in plants	**30**	Application of pulse chase experiment techniques in plants
15	Application of transmission electron microscopy (TEM) in plants	**31**	Application of other radioisotopic techniques in different branches of Botany
16	Application of scanning electron microscopy (SEM) in plants	**32**	Application of MRI for monitoring live tissues and organs of plants, application of distributed fibre optic sensing in plants
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Hands on AI search algorithms and optimization	**9**	Extraction of heavy metals from plants samples
2	Virtual interactive session about application of UAVs, UGVs, and UAAs for plant monitoring	**10**	Extraction of heavy metals from soil samples
3	Interactive session on Google Earth Engine and its application in Botany	**11**	Extraction of organic pollutants from plant samples
4	Interactive session on ArcGIS and its application in Botany	**12**	Use of binocular microscope for identification of plant specimens
5	Acquaintance with chemical methods of DNA extraction from plants and microbes	**13**	Usage of SEM for the identification of plant samples
6	Acquaintance with physical methods of DNA extraction from plants and microbes	**14**	Preparation of plant sample for TEM studies

7	Acquaintance with DNA structure characterization	**15**	Role of TEM for plant identification
8	Cell fractionation and organelle isolation techniques	**16**	Role of silver/gold nanoparticals for drug discovery
Mid-Exam		**Final-Exam**	

Recommended Books:

1. World Health Organization. (2023). International Code of Conduct on Pesticide Management. Guidance on use of pesticide regulation to prevent suicide. World Health Organization.
2. Fouda, H. Z. (2022). The latest technologies in agriculture and plant sciences: Improved techniques, methods, and yields. Delve Publishing, Arcler Education Inc., Burlington, Canada.
3. van Dusschoten, D., Metzner, R., Kochs, J., Postma, J. A., Pflugfelder, D., Bühler, J., ... & Jahnke, S. (2016). Quantitative 3D analysis of plant roots growing in soil using magnetic resonance imaging. Plant physiology, 170(3), 1176-1188.
4. Tei, M., Soma, F., Barbieri, E., Uga, Y., & Kawahito, Y. (2024). Non-destructive realtime monitoring of underground root development with distributed fiber optic sensing. Plant Methods, 20(1), 36.
5. Reddy, C. S. (2015). Applications of remote sensing in plant sciences: An overview. Plant Biology and Biotechnology: Volume I: Plant Diversity, Organization, Function and Improvement, 713-727.
6. Sun, Z., Wang, X., Wang, Z., Yang, L., Xie, Y., & Huang, Y. (2021). UAVs as remote sensing platforms in plant ecology: review of applications and challenges. Journal of Plant Ecology, 14(6), 1003-1023.
7. Watson, S., Duecker, D. A., & Groves, K. (2020). Localisation of unmanned underwater vehicles (UUVs) in complex and confined environments: A review. Sensors, 20(21), 6203.

Recommended Journals

International Journal of Experimental Spectroscopic Techniques, Journal of Chemical Technology and Metallurgy, Journal of Spectroscopy, Spectroscopy Journal,

Semester	Code	Name of Courses	Credit Hour	Category
7th	BOT 472	Field Botany	03 (1+2)	Core

Course learning Outcomes:

1. Identify common plant species using taxonomic keys and field guides.
2. Understand and apply standard techniques of vegetation sampling and ecological survey.
3. Record and analyze data on plant communities in various habitats.
4. Preserve plant specimens and prepare herbarium sheets.
5. Understand plant biodiversity and its ecological importance through direct field observation.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Definition and scope of field botany	**17**	Surveying forests, grasslands, wetlands, and alpine zones
2	Importance of field studies in plant sciences	**18**	Indicators of habitat types and ecological gradients
3	Ethical and legal considerations in plant collection	**19**	Plant community dynamics
4	Morphological characteristics used in identification	**20**	Collection protocols and specimen pressing
5	Use of field guides and dichotomous keys	**21**	Drying and mounting of specimens
6	Basic botanical terminology in fieldwork	**22**	Labeling and databasing
7	Field notebooks, GPS, altimeter, soil kits Usage	**23**	Field to herbarium: documentation standards
8	Collection bags, presses, pruning tools	**24**	Recording abiotic parameters: pH, temperature, moisture
9	Safety measures and field protocols	**25**	Phenological observations
10	Quadrat and transect methods	**26**	Species richness and diversity indices
11	Point-centered quarter method	**27**	Introduction to ordination and classification techniques
12	Frequency, density, and cover estimation	**28**	Endemic, rare, and threatened species

13	Use of Braun-Blanquet scale	**29**	Red List categories and criteria (IUCN), Conservation ethics in field botany
14	Surveying forests, grasslands, wetlands, and alpine zones	**30**	Exploration of nearby ecosystems (e.g., riverine, mountainous)
15	Indicators of habitat types and ecological gradients	**31**	Mapping local plant diversity
16	Plant community dynamics	**32**	Documentation of ethnobotanical knowledge
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Introduction to basic plant collection and note-taking	**9**	Activity 1: Herbarium Techniques (1)
2	Study of vegetation analysis in a forested area of Chitral	**10**	Activity 2: Herbarium Techniques (2)
3	Study of wetland biodiversity study	**11**	Activity 3: Herbarium Techniques (3)
4	Study of Grassland visit in Chitral	**12**	Activity 4: Herbarium Techniques (4)
5	Field Trip 1: Visit to a local herbarium or botanical garden	**13**	Activity 5: Herbarium Techniques (5)
6	Field Trip 2: Visit to a local National Park	**14**	Activity 6: Herbarium Techniques (6)
7	Study of conservation of areas	**15**	Activity 7: Herbarium Techniques (7)
8	Herbarium preparation workshop	**16**	Activity 8: Herbarium Techniques (8)
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Plant Systematics by Michael G. Simpson: Elsevier Academic Press 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA 525 B Street, Suite 1900, San Diego, California 92101-4495, USA 84 Theobald s Road, London WC1X 8RR, UK.

2. Flora of Pakistan (Volume 1-224) University of Karachi
3. Plant Systematics (Third edition) by Gurcharan Singh University of Delhi, Delhi India.
4. Plant Identification Terminology: An Illustrated Glossary by James G. Harris.
5. Manual for Field Botany by Dr. Vinaya Ghate, Dr. Hema Sane and Dr. Mandar Datar.
6. Field Manual of Ecology Prof. Dr. Farrukh Hussain (Rtd), Department of Botany, University of Peshawar.

Journals/Periodicals:

Pakistan Journal of Botany Department of Botany, University of Karachi, Karachi-75270, Pakistan, Published by the Pakistan Botanical Society, Flora: TU Bergakademie Freiberg Interdisciplinary Environmental Research Centre, Leipziger Strabe 29, 09596, Freiberg, Germany, Journal of Ethnobiolgy and Ethnomedicine: Springer Nature, European Journal of Taxonomy, Journal of Taxonomy and Biosystematics

Semester	Code	Name of Courses	Credit Hour	Category
7th	BOT 473	Forensic Botany	03 (1+2)	Core

Learning objective:

- By the end of this course, students will be able to:
- Understand how plants can be used in forensic investigations. Describe methods for analyzing plant-based evidence.
- Explain the role of plant material in forensic science

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	introduction, expectations, evaluations; introduction to botanical forensics	**17**	Survey of the higher plant body part II
2	Use of Botanical Evidence in Criminal Investigation: Botanical evidence and crime scene	**18**	Forensic mycology - spores, fruiting bodies, botanical decomposition, site conditions, commercial concerns
3	Source, transfer, evidence recognition,	**19**	Analyses of Samples: Pollen grains; Anatomical structures; Diatoms, DNA.
4	Collection, preservation of pollen and spores	**20**	Branches of Botany in Forensic Study: Palynology, Limnology, Plant Anatomy,

5	Documentation of botanical evidences in criminal investigation.	**21**	Plant ecology, Plant Molecular Biology.
6	Role of forensic scientist	**22**	Plants as poisons
7	Lab safety; basic lab equipment; expectations and grading; sample preparation	**23**	Illegal logging and endangered tree species harvested for timber
8	The state of US forensic science; forensic and botanical principles underlying valid inference	**24**	Wood training
9	Civil vs. criminal forensic botany	**25**	Forensic wood science part I
10	Trace evidence scavenger hunt; interpreting evidence; documenting evidence	**26**	Forensic wood science part II
11	Science influencing policy and law; forensic-like inquiry in science	**27**	Wood practice
12	Review of the plant body as a source for physical evidence; other types of botanical evidence	**28**	Forensic phycology and lichenology - drowning, trace evidence, time of deposition
13	Survey of the higher plant body part I	**29**	Plant ecology in forensic botany (gravesite analysis, time of deposition, geomorphology, etc)
14	Flowers, fruits, as types of evidence	**30**	Wood evaluation
15	Seeds, and pollen as types of evidence	**31**	Drug Enforcement: Botanical contributions to drug enforcement.
16	Plant taxonomy and identification; primacy of the context of a forensic question	**32**	Careers in forensic biology
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Lab safety; basic lab equipment; expectations and grading; sample preparation	**9**	How diatoms play a role in determination of a crime.
2	Trace evidence scavenger hunt; interpreting evidence; documenting evidence	**10**	How pollen grains play a role in determination of a crime

3	Science influencing policy and law; forensic-like inquiry in science	**11**	Role of wood particles in determination of a crime
4	Review of the plant body as a source for physical evidence; other types of botanical evidence	**12**	Role of plant (vegetative parts) growth pattern in a crime area
5	Survey of the higher plant body part I: Flowers, fruits, seeds, and pollen as types of evidence	**13**	Role of DNA analysis in criminal and civil investigation
6	Plant taxonomy and identification; primacy of the context of a forensic question	**14**	Time since death can be approximated by the state of digestion of the stomach contents
7	Survey of the higher plant body part II: Forensic mycology - spores, fruiting bodies	**15**	How the pollen fingerprint help in the determination of a crime in a particular time and place
8	Botanical decomposition, site conditions, commercial concerns	**16**	Plant physiology and growth in forensic botany (gravesite analysis, time of deposition, geomorphology, etc)
Mid-Exam		**Final-Exam**	

Recommended Books:

1. David W. Hall and Jason Byrd. 2012. Forensic Botany: A Practical Guide *Essentials of Forensic Science*. John Wiley & Sons. ISBN 0470661232, 9780470661239.
2. Coyle, H. M. 2000. Forensic Botany Principles and Application to Criminal Casework. CRC Press s LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431.
3. Jane H. Bock and David O. Norris. 2014. Handbook of Forensic Botany. ISBN-13 9781588291233.
4. Robert C Shaler. 2011. Crime Scene Forensics A Scientific Method Approach. CRC Press. Print ISBN 9781439859957.
5. Howard A. Harris and Henry C. Lee. 2019. Introduction to Forensic Science and Criminalistics, Second Edition. Print ISBN 9781498757966.

Recommended Journals:

Journal of Forensic Botany, Science & Justice, International Journal of Forensic Expert Alliance, Journal of Forensic Science, Plant Science.

Semester	Code	Name of Courses	Credit Hour	Category

7th	BOT 474	Plant Tissue Culture	03 (2+1)	Core

Objectives:

1. Introduce the underlying principles of aseptic culture of plant organs.
2. Provide information about equipment, procedures and terminology of aseptic culture.
3. Provide an understanding of the advantages of using cell culture system.
4. Provide students with an understanding of the benefits and issues of tissue culture. **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Introduction to plant cell and tissue culture.	**17**	Disease elimination by tissue culture.
2	Plant tissue culture, plant genetic engineering and crop improvement.	**18**	Disease elimination by chemotherapy.
3	Tissue culture in Botany	**19**	Disease elimination by thermotherapy.
4	Explant types, size, age, quality, location and season.	**20**	Initiation, maintenance, growth characters and uses of cell suspension culture.
5	Sterilization of explants.	**21**	Introduction of anther and microspore culture.
6	The basic laboratory layout and equipment.	**22**	Pollen culture. Haploid for plant breeding and genetics.
7	Sterilization of glassware, equipments and working area.	**23**	Factors affecting the success of anther culture.
8	Inorganic nutrients, organic nutrients	**24**	Organ and embryo culture. Culturing of Hairy roots, Minitubers and Microtubers.
9	vitamins, amino acids, carbohydrates, gelling agents	**25**	Callus culture, Meristem culture, and fern spore culture.
10	antibiotic, plant hormones, complex organic supplements.	**26**	Types of isolation, determination of protoplast, viability, protoplast morphology
11	Preparation of MS media from commercial packages and from stock solution.	**27**	culture of isolated chloroplast, cell wall regeneration by cultured protoplast
12	Contamination and its disposing. Safety in the laboratory.	**28**	uses of protoplast, protoplast fusion.

13	Origin and types of callus. Role of callus in embrogenesis	**29**	Origin, mechanism and uses of somaclonal variation.
14	organogenesis and cell culture. Initiation and propagation of callus cultures.	**30**	Somaclonal variations for salt, herbicide, drought, and disease tolerance.
15	Monitoring the growth of callus. Genetic transformation of callus.	**31**	Somaclonal variations in major crops.
16	Sub-culturing of callus. Organogenesis (Rooting and Shooting). Deflasking or Acclimatization.	**32**	Protoplast fusion and hybridization.
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Starting a primary culture (tissue digestion, cell count and cell culture).	**9**	Production of haploids from microspore culture
2	Maintenance of a cell line.	**10**	Isolation of single cells from intact organs
3	Cryopreservation of cell line.	**11**	Media preparation in plant tissue culture
4	Plant cell culture.	**12**	Safety measure and First Aid
5	Vital staining.	**13**	Dos and Don'ts in Lab
6	Organ culture	**14**	Aseptic culture techniques in lab
7	Meristem Tip Culture	**15**	Surface sterilization protocols for explants
8	Callus induction and culture	**16**	Protoplast culture
Mid-Exam		**Final-Exam**	

Recommended Books:

1. John, H.D. and L.W. Roberts. Plant tissue culture. Second edition. Cambridge University Press Cambridge. 1985.
2. Smith.R.H. Plant Tissue Culture Techniques and experiments. Second edition. Academic press 2000.
3. Evans, D.E. J.O.D. Coleman and A. Kearns. Plant Cell Culture. BIOS Scientific Publishers London.
4. Chopra V.L., V.S.Malik and S.R. Bhat. Plant Biotechnology. Oxford IBHPublishers New Delhi.
5. Attege, C.R and B. Kristiansen.2001. Basic Biotechnology, CambridgeUniversity, PressUK.

6. Halford, N., 2006. Plant Biotechnology: Current and Future Applications of Genetically Modified Crops. John Wiley and Sons Limited.
7. Vunjak-Novakovic, G., Freshney, R.I., 2006.Culture of Cells for Tissue Engineering.1st Edition Wiley, John & Sons
8. Freshney, R.I., 2006. Culture of Animal Cells: A Manual of Basic Technique. 5th Edition. Wiley, John & Sons.
9. Neumann, K-H., Kumar,A., Imani, J., 2009. Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application .1st Edition. Springer-Verlag New York, LLC.
10. Abbot. 2013. Recent Advances in Plant Tissue Culture and Biotechnology. RDM

Recommended Journals:

Plant Cell Reports, Biotechnology Advances, Plant Physiology, In Vitro Cellular & Developmental Biology

Semester	Code	Name of Courses	Credit Hour	Category
7th	IDS 471	Scientific Inquiry & Research Methods	03 (2+1)	Interdisciplinary

Course Outcome:

1. Explain the principles of scientific inquiry and research design in microbiology.
2. Analyze and interpret data using appropriate research methodologies.
3. Apply research methods to conduct independent studies and contribute to microbiological knowledge.

Course Objectives:

a. Fundamental researh design.
b. Fundamental experimental design
c. Data anaylysis.
d. Research fundamentals.
e. Non experimental research. **Course Outline:**

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	RESEARCH FUNDAMENTALS	17	NON EXPERIMENTAL RESEARCH
2	Rehabilitation Research	18	Qualitative Research
3	Theory in Rehabilitation Research	19	Epidemiology
4	Research Ethics.	20	Outcomes Research
5	RESEARCH DESIGN	21	Survey Research
6	Research Problems, Questions, and Hypotheses	22	Measurement Theory

7	Research Paradigms	23	Methodological Research.
8	Design Overview	24	DATA ANALYSIS
9	Research Validity	25	Statistical Reasoning
10	EXPERIMENTAL DESIGNS	26	Statistical Analysis of Diffrences; The basics
11	Group Designs	27	Statistical Analysis of Diffrences; Advanced and special Techniques
12	Single-System Design.	28	Statistical Analysis of Relationships; The basics
13	NON EXPERIMENTAL RESEARCH	29	Statistical Analysis of Relationships; Advanced and special
14	Overview of Non experimental Research	30	Locating the Literature
15	Clinical Case Reports	31	Evaluating Evidence One Article at a time
16	Case studies in Botany	32	Synthesizing Bodies of Evidence
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	cyclical progression of making observations	9	Communicating Results of a resarch
2	formulating questions and hypotheses	10	Experimental (or randomized
			controlled) experiments in research
3	designing and conducting experiments	11	Quasi-experiments in research
4	analyzing results, and reporting findings	12	Observational (non-experimental) studies in research
5	Observation and Question in research	13	Writing a Bibliography in APA and MLA styles With Examples
6	Conducting research to gather information about the topic	14	Methods for analyzing data
7	Formulating a HypoCapstone project in research	15	Using probability sampling methods.
8	Design and Conduct an Experiment	16	Using non-probability sampling methods.

Mid-Exam	Final-Exam

Recommended Books:

1. Essentials of clinical research By Stephan P. Glasser.
2. Rehabilitation Research (Principles and Applications) 3rd Edition By Elizabeth Domholdt.
3. Essentials of clinical research By Stephan P. Glasser.
4. Rehabilitation Research (Principles and Applications) 3rd Edition By Elizabeth Domholdt.
5. Franklin, M. I. (2012). Understanding research: Coping with the quantitative-qualitative divide. Routledge.London.
6. Merriam, S. B. (2014). Qualitative Research: A Guide to Design and Implementation. John Wiley & Sons.
7. Leavy, P. (2022). Research Design: Quantitative, Qualitative, Mixed Methods, ArtsBased, And Community-Based Participatory Research Approaches, 2nd Edition. Guilford Press.London. 4. Merriam, S. B., & Tisdell, E. J. (2020). Qualitative research: A guide to design and implementation. 5th edition. John Wiley & Sons.
8. Alasuutari, P., & Qadir, A. (2023). Introduction to Research Methods: A Beginner's Guide To Quantitative, Qualitative, And Mixed Methods Research. Routledge.London.
9. Creswell, J. W., & Guetterman, T. C. (2018). Educational Research: Planning, Conducting, and Evaluating Quantitative And Qualitative Research, 6th Edition. Pearson. Publications.
10. Merriam, S. B., & Tisdell, E. J. (2015). Qualitative research: A guide to design and implementation. John Wiley & Sons.

Recommended Journals:

Journal of Research in Science Teaching**,** International Journal of Qualitative Methods**,** Journal of Research Practice**,** Scientific Inquiry and Review**,** Nature Methods**,** Journal of Biological Methods

Semester	Code	Name of Courses	Credit Hour	Category
8th	BOT 481	Waterlogging and Salinity	03 (2+1)	Core

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Origin of water logging	**17**	Origin of saline
2	Physical changes in soil as a result of water logging	**18**	Origin of sodic soils
3	chemical changes in soil as a result of water logging	**19**	Measurement of salinity

4	Measurement of soil redox potential	**20**	Measurement of sodicity
5	iron and manganese relations in water logged soils	**21**	Classification of saline
6	Adaptations of plants to water logging	**22**	Classification of sodic soils
7	Mechanism of water logging tolerance in plants	**23**	inter-relations of water logging and salinity
8	Extent of water logging in Pakistan	**24**	Effects of soil salinity on plant growth
9	Delay in cultivation of plants	**25**	Effects of alkalinity on plant growth
10	Preventive measures	**26**	Osmotic effect
11	Curative measures	**27**	Specific ion effect
12	Efficient Surface drainage	**28**	Nutritional imbalance
13	Reducing percolation from canals	**29**	Quality of irrigation water
14	Corrosive actions on plants	**30**	Classification of irrigation water from view viewpoint of its quality
15	Controlled irrigation	**31**	Management and reclamation of saline and sodic soils
16	Treatment by mulching	**32**	Mechanism of salt tolerance; methods of increasing salt tolerance in plants.
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Measurement of pH and EC of a waterlogged soil.	**9**	Study of increasing salt tolerance in plants.
2	Field trips to saline and water logged areas of Pakistan.	**10**	Study of Biotic approach and genetic engineering for improvement of salt tolerance in crops
3	Measurement of electrical conductivity of soil saturation extract.	**11**	Study of Extent of salinity in Pakistan.
4	Measurement of cation-exchange capacity of soil.	**12**	Classification of irrigation water from the viewpoint of its salinity and sodium hazard.

5	Determination of the amounts of soluble calcium.	**13**	Effects of salinised media on seed germination of seed of different crop plants.
6	Calculation of exchangeable sodium	**14**	Experimental investigation to test
	percentage of soil from its sodium adsorption ratio.		the salt tolerance of difference crop plants.
7	Determination of the amounts of chlorides and sulphates in a soil saturation extract.	**15**	Quantitative studies of halophytes in the field.
8	Analysis of irrigation water for the following: Electrical Conductivity, sodium adsorption Ratio, chlorides, sulphates	**16**	Analysis of irrigation water for the following: carbonates, bicarbonates, total dissolved salts, nitrates fluorides, iron and silica. .
Mid-Exam		**Final-Exam**	

Books Recommended

1. Richards, L.A. (ed) 1954. Diagnosis and Improvement of Saline and Alkali Soils Handbook 60, USDA, Washington, D.C.
2. Chapman, V.J., 1971. Salt Marshes and Salt Deserts of the World.
3. Waisel Y., 1972. Biology of Halophytes.
4. UNESCO, 1973. Irrigation Drainage and Salinity.
5. Armstrong, W., 1973. Water-logged Soils. In Environment and Plant Ecology (Etherington, J.R.) John Wiley and Sons, London.
6. FAO, 1975. Quality of Water in Agriculture. Bulletin 29, Irrigation and Drainage Series.

Recommended Journals:

Journal of Irrigation and Drainage Engineering**,** International Journal of River Basin Management**,** Hydrological Processes**,** Archives of Agronomy and Soil Science**,** Plant and Soil**,** Agricultural Water Management

Semester	Code	Name of Courses	Credit Hour	Category
8th	BOT 482	Economic & Industrial Botany	03 (3+0)	Core

Course learning Outcomes:

- To learn the diverse human uses of plants and plant products.
- To learn the taxonomic diversity of useful plants.
- To learn the biological reasons why certain plant resources are important.
- To acquire an increased awareness and appreciation of plants and plant products encountered in everyday life.
- To recognize geographic, historical, & cultural differences in the uses and importance of plants.
- To relate diverse aspects of human cultural endeavors to plant resources, and to gain a better understanding and perspective of the origins, histories, and roles of important plants and plant products to the development of human culture **Course**

Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Plant and their value in the service of mankind	**17**	Ephedra,
2	Fibers: Cotton	**18**	Opium,
3	Textile and Paper industries in Pakistan- elementary knowledge	**19**	Artemisia
4	Timber woods: identification, properties and uses	**20**	Spices: Ginger
5	Details of selected timbers: Shisham,	**21**	Turmeric
6	Deodar	**22**	Clove
7	Tannins: sources and uses	**23**	Black Pepper,
8	Dyes: natural sources and applications	**24**	Beverages: Non-Alcoholic Tea
9	Gums :types and economic importance	**25**	Coffee
10	Resins: types and economic importance	**26**	Fumitories and masticatories: Tobacco
11	Rubber and latex sources, properties and applications	**27**	Betel nut
12	Cereal crops. wheat	**28**	Cannabis sativa

13	Essential oils: properties, extraction methods and uses	**29**	Origin and evolution of crop plants: introduction
14	Fatty oils: Groundnut	**30**	Centres of origin of crop plants
15	Sugars: Sugar cane	**31**	Major food crops and their wild relatives
16	Medicinal plants I: Aconitum,	**32**	Case studies of local ethno botanical practices
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Study of economically important plant parts: seeds, fruits, barks, and roots	**9**	Microscopic study of starch grains and sugar crystals (potato, maize, rice, sugarcane).
2	Examination of fiber-yielding plants: Cotton, Flax, Jute, Hemp, Coir	**10**	Identification and organoleptic evaluation of spices (ginger, turmeric, clove, black pepper, cardamom).
3	Identification and analysis of wood samples: Teak, Shisham, Deodar, Neem	**11**	Morphological and microscopic study of selected medicinal plants (Aconitum, Ephedra, Artemisia, Rauwolfia).
4	Study of tannin and dyeproducing plants and their staining properties	**12**	Study of beverage plants: comparative analysis of tea leaves and coffee beans (morphology, preparation, taste).
5	Visit to local herbal shops or forest area for sample collection	**13**	Fumitories and masticatories: examination of tobacco, betel nut, and cannabis samples.
6	Collection and testing of gums, resins, and latex-producing plants	**14**	Preparation of herbarium sheets of local economic plants (fieldcollected).
7	Extraction and analysis of essential oils from aromatic plants	**15**	Ethno botanical survey: documentation of traditional uses of plants from local communities (short group project).
8	Testing of fatty oils: groundnut, sesame, mustard, linseed, etc.	**16**	Preparation of simple plant-based products (e.g., herbal tea, dye from turmeric, or gum solution)
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Jains, S. K. 1987. A Manual of Ethnobotany Scientific Publisher jodhpur India.
2. Jain, S. K. 1991. Contribution to Ethnobotany of India. Scientific Publisher, Johdpur, India.
3. Simpson, B.B. and Ogorzaly, M.C. 2015. *Plants in Our World: Economic Botany*. 4th Edition. McGraw-Hill Education, New York, USA.
4. Wickens, G.E. 2001. *Economic Botany: Principles and Practices*. Kluwer Academic Publishers, Dordrecht, The Netherlands.
5. Achaya, K.T. 1998. *Economic Botany in the Tropics*. Oxford & IBH Publishing Co., New Delhi, India.
6. Cotton, C.M. 1996. *Ethnobotany: Principles and Applications*. John Wiley & Sons, Chichester, UK.
7. Vavilov, N.I. 1992. *Origin and Geography of Cultivated Plants*. Cambridge University Press, Cambridge, UK.
8. Van Wyk, B-E. 2005. *Food Plants of the World: An Illustrated Guide*. Timber Press, Portland, Oregon, USA.
9. Ross, I.A. 2003. *Medicinal Plants of the World*. Vols. I–III. Humana Press, Totowa, New Jersey, USA.
10. Bhattacharjee, S.K. 2000. *Handbook of Medicinal Plants*. Pointer Publishers, Jaipur, India.

Journals/Periodicals: Economic Botany. *Springer, Society for Economic Botany, New York, USA.,* Journal of Ethnopharmacology. *Elsevier, Amsterdam, The Netherlands,* Ethnobotany Research and Applications.

Semester	Code	Name of Courses	Credit Hour	Category
8th	BOT 483	Environmental Biology	03 (2+1)	Core

Course Objectives:

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

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Environment: Introduction1	**17**	Forest: importance
2	Scope of environmental Biology	**18**	deforestation
3	Pollution: definition, classification, and impact on habitats	**19**	Conservation of forests
4	Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants	**20**	Ozone layer: Formation
5	prevention, control, remediation of air pollution	**21**	Mechanism of depletion iii. Effects of ozone depletion
6	Photochemical smog	**22**	Greenhouse effect and global warming: causes, impacts
7	Acid rain: Theory of acid rain, Adverse effects of acid rains	**23**	Human population explosion: impact on environment
8	Chlorofluorocarbons and its effects	**24**	Impact assessment: Industrial urban, civil developments
9	Water pollution: Major sources of water pollution and its impact on vegetation, prevention	**25**	National conservation strategy: Brief review of major problems of Pakistan and their solutions
10	Water pollution: control remediation, eutrophication, thermal pollution	**26**	Sustainable Environmental management
11	Sediments pollution: fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control remediation	**27**	Wetlands and sanctuaries protection
12	Heavy metal pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and polluted waters	**28**	The pressures, problems and solutions

13	Noise pollution	**29**	Range management: Types of rangelands, potential threats
14	Radiation pollution (including nuclear)	**30**	sustainable management
15	Measurement, classification and effects	**31**	Aerobiology (Pollen allergy)
16	Principle of radiation protection, waste disposal	**32**	dust allergy
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Examination of industrial waste water	**9**	Study of Chlorides
2	Examination of industrial Municipal sewage	**10**	Study of carbonate
3	Examination of industrial waste sludge	**11**	Study of Nitrates
4	Total dissolved solids	**12**	Examination of water samples forms different sites for the presence
5	Study of pH	**13**	Examination of water samples forms different sites for the diversity of organisms
6	Study of EC	**14**	Effect of air pollutants on plants
7	Study of Biochemical oxygen demand (BOD)	**15**	Visits to environmentally compromised sites
8	Study of Chemical Oxygen Demand (COD)	**16**	Study of evolution of remediation methods
Mid-Exam		**Final-Exam**	

Recommended Books:

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

5. Hall, C. A. S. and Perez, C. L. 2000. Quantifying Sustainable Development. Academic Press, UK.
6. Bazzaz, F. A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.
7. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.
8. Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.
9. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Physiological Ecology.
10. Mohamamd Ashfaq and Mushtaq A. Saleem. Environmental Pollution and Agriculture.

Recommended Journals:

Journal of Environmental Biology, Journal of Environmental Management, Journal of Ecology, Remote Sensing of Environment, Journal of Hazardous Materials, Journal of Aerosol Science

Semester	Code	Name of Courses	Credit Hour	Category
8th	BOT 484	**Edaphology**	03 (2+1)	Core

Objectives:

To understand:

1. scope of edaphology, soil fertility and their properties,
2. Importance of water, and various fertilizers and their effects,
3. Secondary and micronutrients, soil salinity and waterlogging and conservation.

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	soil, land and earth	**17**	Soil water classification
2	Mineral and organic soils	**18**	measurement of soil water
3	topsoil, subsoil	**19**	water retention and curve
4	Soil as a medium for plant growth.	**20**	Hysteresis, soli water effective use and lose.
5	Plant nutrients	**21**	Functions of nitrogen in plants
6	Liebgs Law of the minimum	**22**	symptoms of deficiency and excess, nitrogen efficiency
7	soil solution, intensity and quantity factor in plant nutrition	**23**	Determination of available nitrogen in soil.
8	dynamic equlibria in soils	**24**	role of phosphorus in plants
9	evaluation of soil fertility: soil plant relation	**25**	phosphorus content in soil

10	Soil texture, soil structure	**26**	factors affecting phosphorus availability to plants.
11	soil consistency, soil pores	**27**	Functions of potassium in plants
12	soil density, soil color, soil temperature.	**28**	symptoms of deficiency
13	Ion water interaction, soil constituents	**29**	luxury consumption, potassium availability.
14	soil pH, cation exchange equation	**30**	Calcium, magnesium and sulfur effect on plants.
15	soil redox potential	**31**	Role of Boron, Manganese, Zinc in plant growth.
16	biochemical properties of rhizosphere soil	**32**	water erosion effects on plants
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Testing of soils minerals of different locations	9	Investigation of soil pH
2	Determination of soil pH and soil temperature.	10	investigate of living organisms
3	Classification of different soil of various locations.	11	Observing water levels in different soil samples
4	Collection of plants affected with nitrogen deficiency.	12	Assessing water retention
5	Identification of Phosphorus deficient soils.	13	studying the effects of soil composition on seed germination.
6	Identification of water logged soils of locations.	14	Testing of the soil's ability to support plant growth
7	Investigation of water content	15	examining nutrient distribution
8	Investigation of soil nutrients	16	evaluating soil for contamination
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Soil science & management. 1985. Edward J. Plaster. 6th edition. Cengage Learning, Inc.
2. Physical Edaphology: The Physics of Irrigated and Nonirrigated Soils. 1972. Gaylen L. Ashcroft and Sterling A. Taylor. San Francisco, W.H. Freeman. 10th edition.

3. Principles of Soil and Plant Water Relations. 2004. Kirkham M.B. Academic Press. 2nd edition.
4. The Soil Resource: Origin and Behavior. 1980. Hans Jenny. Springer Velog. 2nd Edition.
5. Principles of Soil Physics. 2004. Rattan Lal. Taylor and Fancis Group. 1st edition.
6. Guidelines for analysis and description of soil and regolith thin sections. 2021. Georges Stoops. Wiley. 1st edition.
7. Edaphology. 2012. Jesse Russell, Ronald Cohn. 1st edition.
8. Handbook of Soil Sciences Properties and Processes. 2011. Pan Ming Huang , Yuncong Li , Malcolm E. Sumner. Roudlege Handbook Online. 3rd edition.
9. The Nature and Properties of Soils. 2017. Raymond R Weil and Nyle C Brady. Pearson Education. 15th edition
10. Soil Science for Gardeners: Working with Nature to Build Soil Health.2020. Robert Pavlis. Paperback. 1st edition.

Recommended Journals:
Plant and Soil, Geoderma, Soil Biology and Biochemistry, Soil Science Society of America Journal, Journal of Plant Nutrition and Soil Science, International Journal of Plant & Soil Science, Soil Genesis, Catena

Semester	Code	Name of Courses	Credit Hour	Category
8th	BOT-485	Advanced Plant Biochemistry	03 (2+1)	Core

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

Course Outline:

Mid-Course		Final-Course	
S. No. of Lecture	**Lecture/Topics**	**S. No. of Lecture**	**Lecture/Topics**
1	Bioenergetics	17	Occurrence of alkaloids
2	Energy, laws about energy changes.	18	physiological effects due to alkaloids
3	Oxidation and reduction in living systems.	19	chemical nature of solanine, nicotine

4	Metabolism	20	chemical nature of morphine, theine and caffeine
5	BiosynCapstone project of sucrose	21	Aflatoxins, their nature and role
6	Degradation of sucrose	22	Terpenoids
7	Regulation of sucrose	23	Classification of Terpenoids
8	Degradation of starch.	24	Monoterpenes
9	Regulation of starch.	25	Sesquiterpenes
10	Breakdown of fats	26	Diterpenes
11	BiosynCapstone project of fats	27	Triterpenes
12	Replication of DNA.	28	Tetraterpenes
13	Genetic code	29	Polyterpenes
14	Transcription.	30	Chemical constitution and biosynCapstone project of Terpenoids
15	BiosynCapstone project of DNA and RNA.	31	General properties of Vitamins
16	protein synCapstone project: initiation, elongation and termination.	32	Vitamins' role in metabolism.
Mid-Exam		**Final-Exam**	

Mid-Course		**Final-Course**	
S. No. of Practical Class	**Topic of Practical class**	**S. No. of Practical Class**	**Topic of Practical class**
1	Extraction and Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.	**9**	Quantification of morphine in plants.
2	Separation of nucleic acids by gel electrophoresis.	**10**	Quantification of DNA of plant sample

3	To estimate the amount of vitamin C in a plant organ (orange, apple juice).	**11**	Quantification of RNA of plant sample
4	To determine potential alkaloids in plants.	**12**	Quantification of monoterpenes
5	To estimate terpenoids in plants.	**13**	Quantification of sesquiterpenes.
6	To estimate solanine in potato.	**14**	Quantification of tetraterpenes
7	To determine aflatoxin	**15**	Quantification of triterpenes
8	Differentiation in monoterpenes and sesquiterpenes.	**16**	Quantification of diterpenes
Mid-Exam		**Final-Exam**	

Recommended Books:

1. Conn E. E. and Stumpf, P. K. 2002. Outlines of Biochemistry, John Wiley and Sons Inc. New York.
2. Albert L. Lehninger, 2004. Principles of Biochemistry. Worth Publishers Inc.
3. Voet, D. Voet J. G. and Pratt, C. W. 1998. Fundamentals of Biochemistry, John Wiley and Sons, New York.
4. Dey, P. M. and Harborne, J. B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
5. Smith; E L., Hill; R. L., Lehman; R. I., Lefkowits, R J. and Abraham. H. Principles of Biochemistry, (General Aspects). White. International Student Edition. McGraw Hill International Book Company.
6. Heldt, H., & Piechulla, B. (2010). *Plant biochemistry*. Academic Press.
7. Bowsher, C., Steer, M., & Tobin, A. (2008). *Plant biochemistry*. Garland Science.
8. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry and molecular biology of plants*. John Wiley & Sons.

Journals / Periodicals:

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