WOMEN UNIVERSITY SWABI

Department of Botany

WOMEN UNIVERSITY SWABI



DEPARTMENT OF BOTANY

Botany Bachelor of Science (BS) 4 Years of 8 Semesters (According to HEC undergraduate policy 2023, HEC Undergraduate Education Policy V 1.1.)

- ***Approved by Board of Studies (BOS) Department of Botany, Women University Swabi in its 4th meeting held on December 4 2025 vide agenda # 2, 5th Meeting of Board of Advanced Studies held on June 8, 2026.***

Applicable from Sessions: Fall 2025 & onwards

Introduction: Department of Botany

The Department of Botany at Women University Swabi, established in 2013, is committed to excellence in teaching, research, and community engagement. Aligned with the University's vision of empowering women through quality education and research, the department provides a dynamic academic environment that nurtures intellectual curiosity, scientific thinking, and professional competence in the field of plant sciences.
The department offers BS (Botany) and MPhil (Botany) programs designed to equip students with comprehensive knowledge of plant biology, biodiversity, ecology, plant pathology, physiology, biotechnology, and environmental sciences. Through a balanced blend of theoretical learning, laboratory training, fieldwork, and research projects, students gain hands-on experience and develop strong analytical and problem-solving skills.
Supported by qualified faculty members and well-equipped laboratories, the department is dedicated to preparing graduates who can contribute effectively to academia, research institutions, agriculture, industry, and environmental management sectors. The department also emphasizes ethical values, inclusivity, and social responsibility, ensuring that its graduates are scientifically competent and capable of addressing regional and global challenges.

Vision

"To empower women in the field of plant sciences by providing high-quality education and research opportunities that enable them to contribute effectively to society, environmental sustainability, and scientific innovation."

Mission

"To deliver quality botanical education and hands-on research experiences that promote intellectual, personal, and professional development of students. The department is committed to fostering inclusivity, equity, and social responsibility by preparing graduates who can address regional and global challenges in plant biology, agriculture, environment, and biotechnology."

PROGRAM LEARNING OUTCOMES
By the completion of Bachelor of Science (BS) in Botany, the graduates will be able to: Demonstrate a comprehensive understanding of fundamental concepts in botany, integrating knowledge across cellular, molecular, organismal, and ecological levels. Effectively use methods and techniques as applied in the field of botany. Communicate scientific knowledge and research findings while demonstrating a commitment to continuous learning and professional development in the field of botany.

ELIGIBILITY CRITERIA
Higher Secondary School Certificate (involving 12 years of schooling with 45%) or an IBCC equivalent qualification in any science group with a subject of Biology is the basic eligibility requirement for admission in the Bachelor of Science (BS) in Botany.

PROGRAM STRUCTURE

The Bachelor of Science (BS) in Botany is structured in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1. and HEC revised Curriculum of Botany 2024. Comprises of minimum 135 and maximum 144 credit hours spread over eight (08) regular semesters.

Minimum Credit Hours	139
General Education	3 credit hours (15 courses)
Discipline Related Courses / Major	78 credit hours (26 courses)
Interdisciplinary / Allied Courses	21 credit hours (7 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 extra-ordinary circumstances subject to approval of university's statutory body.
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 summer semesters • (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.

WOMEN UNIVERSITY SWABI

Department of Botany

SCHEME OF STUDIES FOR 4 YEAR BS PROGRAMME

Scheme of Studies for Bachelor of Science (BS), BOTANY 4 Years (8 Semesters) Fall 2025					
Year	**Semester**	**Category**	**Course Code**	**Course Title**	**Credit Hours**
First Year	**1st**	Major-01	BOT-111	Diversity of Plants	3(2+1)
		Major 02	BOT-212	Biodiversity& Conservation	3(2+1)
		G. Ed.-01	CHEM-101	Introduction to Chemistry (Natural Science*)	3(2+1)
		G. Ed.-02	ENG-101	Functional English**	3(3+0)
		G. Ed.-03	MATH-106	Quantitative Reasoning-I**	3(3+0)
		G. Ed.-04	CS-1 01	Applications of Information and Communication Technologies (ICT)**	3(2+1)
		Total Credits			**18**
	2nd	Major-03	BOT-121	Fundamentals of Plant Taxonomy	3(2+1)
		Major-04	BOT-132	Fundamentals of Genetics & Evolution	3(3+0)
		Interdisciplinary	ZOO-111	Cell Biology	3(2+1)
		G. Ed.-05		Introduction to Psychology (Social Sciences) ***	2(2+0)
		G. Ed.-06	MATH-107	Quantitative Reasoning II **	3(3+0)
		G. Ed.-07	ENG-104	Expository Writing **	3(3+0)
		G. Ed.-08	ISL-103	Fahm -e-Quran-I	1
		Total Credits			**18**
Second Year	**3rd**	Major-05	BOT-214	Phycology & Bryology	3(2+1)
		Interdisciplinary	CHEM-222	Chemical Safety and Risk Management	3(2+1)
		Major-06	BOT-224	Plant Anatomy	3(2+1)
		G.Ed-9		Arts & Humanities	2(2+0)
		G.Ed-10	ISL-101	Islamic Studies	2(2+0)
		Interdisciplinary	MICRO-205	Molecular Biology	3(2+1)
		G. Ed.-11	PS-102	Pakistan Studies	2(2+0)

		G. Ed.-12	ISL-104	Fahm -e-Quran-II	1
		Total Credits			**19**
	4th	Interdisciplinary		IDC 4	3(3+0)/ (2+1)
		Major-7	BOT-251	Fundamentals of Plant Physiology	3(2+1)
		Major-08	BOT-243	Principles of Plant Ecology	3(2+1)
		G.Ed-13	PS-101	Ideology & Constitution of Pakistan **	2(2+0)
		G. Ed.-14	POLS-101	Civics & Community Engagement **	2(2+0)
		G. Ed.-15	MGT-212	Entrepreneurship**	2(2+0)
		Interdisciplinary	BIOT-101	Introduction to Biotechnology	3(2+1)
		Total Credits			**18**
Third Year	**5th**	Interdisciplinary		IDC 6	3(2+1)
		Major-9	BOT-361	Principles of Plant Biochemistry	3(2+1))
		Interdisciplinary		IDC 7	3(2+1)
		Major-10	BOT-352	Plant Physiology	3(2+1)
		Major-11	BOT-373	Microbial Botany	3(2+1)
		Major12	BOT-372	Mycology	3(2+1)
		Total credits			**18**
	6th	Major-13	BOT-326	Systematic of Angiosperms	3(2+1)
		Major-14	BOT-374	Plant Pathology	3(2+1)
		Major-15		Elective – I	3 (2+1)
		Major-16	BOT-364	AI in Botany	3(2+1)
		Major-17	BOT-344	Plant Ecology	3(2+1)
		Major-18	BOT-362	Plant Biochemistry	3(2+1)
		Total Credits			**18**
		Major-19	BOT-470	Analytical Techniques in Botany	3(2+1)
		Major-20	BOT-449	Field Botany	3(0+3)

Fourth Year	**7th**	Major-21	BOT-446	Elective – II	3 (2+1)
		Major-22	BOT-415	Pteridophytes & Gymnosperms	3(2+1)
		Mandatory	BOT-598	Internship	3(0+3)
		Total Credits			**15**
	8th	Major-23	BOT-469	Plant Biotechnology	3(2+1)
		Major-24	BOT-479	Economic & Industrial Botany	3(3+0)
		Major-25	BOT-416	Evolutionary Trends in Plants	3(2+1)
		Major-26	BOT-475	(Elective – III)	3 (2+1)
		Mandatory	BOT-599	Capstone Project	3(0+3)
		Total Credits			**15**

*** The university / offering department may offer any course in the broader category of "Natural Sciences" which should have relevance to the purpose of the degree program. The course of "Introduction to Environmental Science" as mentioned in the scheme of studies is a suggestive course only.**

**** HEC designed model courses may be used by the university.**

*****The university / offering department may offer any course in the broader category of "Social Sciences" such as a course of Psychology, Sociology, Anthropology etc.**

****** The university / offering department may offer any course in the broader category of "Arts & Humanities" including but not limited to a course of language such as Chinese, Arabic, French, Spanish etc., or other courses such as History, Philosophy, Theology etc.**

******* The university / offering department may offer any advanced course in the field of Botany as an elective as per its program objectives, university's geographical location and available academic and faculty resources. Credits combination may accordingly be set.**

MAJOR FIELD OF BOTANY AND ITS RELATED SUBJECTS

Major/Domain of Botany					
S/no	**Major Fields**		**Course Code**	**Subject**	**Cr. Hrs.**
0	**G. Ed.- Natural Sciences (Botany)**				
		1	BOT-101	Introduction to Botany	3(2+1)
		2	BOT-202	Bioremediation	3(2+1)
		3	BOT-203	Economic botany	3(2+1)
1	**Plant Diversity**				

		1	BOT-111	Diversity of Plant	3(2+1)
		2	BOT-212	Biodiversity& conservation	3(2+1)
		4	BOT-213	Diversity of Vascular Plants	3(2+1)
		5	BOT-214	Phycology And Bryology	3(2+1)
		6	BOT-415	Pteridophytes And Gymnosperms	3(2+1)
		7	BOT-416	Evolutionary Trends In Plants	3(2+!)
		8	BOT-427	Phycology & Bryology	3(2+!)
2	**Plant Systematics & Anatomy**				
		1	BOT-121	Fundamental of Plant Taxonomy	3(2+1)
		2	BOT-222	Forensic Botany	3(2+1)
		3	BOT-323	Plant Systematics	3(2+1)
		4	BOT-224	Plant Anatomy	3(2+1)
		5	BOT-325	Gymnospermology	3(2+1)
		6	BOT-326	Systematics Of Angiosperm	3(2+1)
		7	BOT-427	Invasive Plants Species	3(2+1)
		8	BOT-428	Ethnobotany	3(2+1)
		9	BOT-429	Plant Anatomy And Embryology	3(2+1)
3	**Cell Biology & Genetics**				
		1			3(2+1)
		2	BOT-132	Fundamental of Genetics & Evaluation	3(2+1)
		3	BOT-433	Plant Genetics	3(2+1)
4	**Ecology & Environmental Biology**				
		1	BOT-141	Plant Physiology and Ecology	3(2+1)
		2	BOT-242	Phytogeography	3(2+1)
		3	BOT-243	Principles Of Plant Ecology	3(2+1)
		4	BOT-344	Plant Ecology	3(2+1)
		6	BOT-446	Environmental Biology	3(2+1)
		8	BOT-448	Ecosystem Ecology	3(2+1)
		9	BOT-449	Field Botany	
5	**Physiology**				
		1	BOT-251	Fundamentals Of Plant Physiology.	3(2+1)
		2	BOT-352	Plant Physiology	3(2+1)
		5	BOT-455	Plant Hormones	3(2+1)
		6	BOT-456	Plant Nutrition	3(2+1)

6	**Molecular Biology & Biochemistry**				
		1	BOT-361	Principles of Plant Biochemistry	3(2+1)
		2	BOT-362	Plant Biochemistry	3(2+1)
		3	BOT-363	Molecular Biology	3(2+1)
		4	BOT-364	AI in Botany	3(2+!)
		5	BOT-465	Methods & Techniques in Molecular Biology	3(2+1)
		6	BOT-466		
		7	BOT-467	Transgenic Plant	3(2+1)
		8	BOT-468	Plant Tissue Culture	3(2+1)
		9	BOT-469	Plant Biotechnology	3(2+1)
7	**Plant Pathology and Biotechnology**				
		1	BOT-271	Virology & Bacteriology	3(2+1)
		2	BOT-372	Mycology	3(2+1)
		3	BOT-373	Microbial Botany	3(2+1)
		4	BOT-374	Plant Pathology	3(2+1)
		5	BOT-475	Plant Disease Management	3(2+1)
		6	BOT-476	Plant Pathology and Environmental Concerns	3(2+1)
		7	BOT-477	Soil Microbiology	3(2+1)
		8	BOT-478	Plant Microbial Interaction	3(2+1)
		9	BOT-479	Economic And Industrial Botany	3(2+1)
		10	BOT-470	Analytical Techniques in Botany	3(2+1)

INTERDISCIPLARAY COURSES IN BOTANY

SRNO	Course Code	Subject	Cr. Hrs.
1.	ZOO-111	Cell Biology	3(3+0)
2.	BIOT-101	Introduction to Biotechnology	3(2+1)
3.	MICRO-205	Molecular Biology	3(2+1)
4.	CHEM-222	Chemical Safty and Risk Management	3(2+1)
5.		IDC5	3(2+1)
6.	MICRO-490	Scientific Writing & Research Methods	3(2+1)
7.		IDC7	3(2+1)

8.		**Any other Approved Course**	

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

1st Semester

Semester	Category	Course Code	Course Title	Credit Hours
1st	Major-01	BOT-111	Diversity of Plants	3(2+1)
	Major-2	BOT-112	Bio Diversity & conservation	3(2+1)
	G. Ed.-01	CHEM-101	Introduction to Chemistry (Natural Science*)	3(2+1)
	G. Ed.-02	ENG-101	Functional English**	3(3+0)
	G. Ed.-03	MATH-108	Quantitative Reasoning-I**	3(3+0)
	G. Ed.-04	CS-101	Applications of Information and Communication Technologies (ICT)**	3(2+1)
	Total Credits			**18**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Diversity of Plants**	**Course Code:**	**BOT-111**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To introduce the students to the diversity of plants and their structures and Significance.
- To acquaint the students about the morphology, biology and importance of prokaryotes, eukaryotes, algal organisms, fungal organisms, lichens, bryophytes, and Pteridophytes.

Course Learning Outcomes:

- The Importance of Plant Diversity, the difference between Viruses, Bacteria, Algae, Fungi, Bryophytes, Pteridophytes, Angiosperm and Gymnosperm.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction, life form and structure of Viruses **Lab.** Culturing, maintenance, preservation and staining of microorganisms.
Week 2	Comparative study of replication and economic significance of Viruses **Lab.** Culturing, maintenance, preservation and staining of microorganisms.
Week 3	RNA and DNA viruses with special reference to TMV **Lab**. Culturing, maintenance, preservation and staining of microorganisms.
Week 4	study of life form, reproduction, structure and economic importance of Bacteria **Lab.** Culturing, maintenance, preservation and staining of microorganisms.
Week 5	**Cyanobacteria** (Nostoc, Oscillatoria) with specific reference to biofertilizers, pathogenicity and industrial importance **Lab.** study prepared slides of different bacteria
Week 6	structure, reproduction and economic significance of Algae **Lab.** Fresh collections of algae.
Week 7	Short description to Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia **Lab.** Fresh collections of algae
Week 8	Fungi structure, reproduction economical importance and (Penicillium, Puccinia, Agaricus), their implication on crop production and industrial applications. **Lab.** Fresh collections of Fungi
Week 09	Structure, classification, reproduction and economic importance significance of Lichens (Physcia) **Lab.** Fresh collections of Lichen
Week 10	Structure, reproduction and economic significance of Bryophytes **Lab.** Fresh collections of Bryophytes
Week 11	Short description of Bryophytes such as 1. Riccia II. Anthoceros III. Funaria
Week 12	Structure, reproduction and economic significance of Pteridophytes **Lab.** Fresh collections of Pteridophytes
Week 13	Short description of Pteridophytes such as 1. Psilopsida (Psilotum) 2. Adiantum **Lab.** Field Work (Collection of Pteridophytes)
Week 14	Introduction and life cycle of Gymnosperm **Lab.** Field Work (Collection of Gymnosperm)
Week 15	Gymnosperms i. Cycas **Lab.** Field Work (Collection of Gymnosperm)
Week 16	Introduction and life cycle of Angiosperms **Lab.** Field Work (Collection of Angiosperm)

Reference Books (Updated Edition):

1. Haq, R. U., & Khan, I. A. (2022). *Text Book of Botany: Diversity of Plants For B.S (Four Year, Semester 1)* (Revised & Enlarged ed.).
2. Ingrouille, M., & Eddie, B. (2006). *Plants: Diversity and Evolution*. Cambridge University Press.
3. Mauseth, J. D. (2021). *Botany: An Introduction to Plant Biology* (7th ed.). Jones & Bartlett Learning.
4. Willey, J. M., Sandman, K. M., & Wood, D. H. (2023). *Prescott's Microbiology* (12th ed.). McGraw-Hill Education.

Course Title:	**Biodiversity and Conservation**	**Course Code:**	**BOT-212**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To understand current threats to biodiversity
- To understand the opportunities and challenges surrounding community-based conservation

- To create awareness among the students for the conservation of biodiversity.

Course Learning Outcomes:

- Importance of biodiversity for survival and proper functioning of ecosystems.
- Identification of threatened and Endangered in there surrounding Ecosystem.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**Introduction to Biodiversity:** Concept of Biodiversity, different types of Biodiversity; Genetic, species & Ecosystem Diversity, Biodiversity at Global level **Lab**. Collection of Wild Food Plants from local areas
Week 2	**Value of Biodiversity**: Formation of soils, impact on human health **Lab.** Collection of Medicinal Plants from local areas
Week 3	**Major threat to Biodiversity**: Habitat loss, Habitat fragmentation, over exploitation, Climatic Changes **Lab.** Identification of threatened plant species
Week 4	**Major threat to Biodiversity**: Invasive species & Pollution **Lab.** Identification of endangered plant species
Week 5	What is The IUCN Red List? Categories of IUCN Red List: Not Evaluated, Data Deficient, Least Concern, **Lab.** Preservation of seeds of rare plant species in seed/gene Bank
Week 6	Categories of IUCN Red List: Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild and Extinct **Lab.** Preservation of seeds of endangered plant species in seed/gene Bank
Week 7	Ecosystem services: Provisioning Services, Regulating Service, **Lab.** Preservation of seeds of threatened plant species in seed/gene Bank
Week 8	Ecosystem services: Cultural Services and Supporting Service **Lab.** Collection of Medicinal parts of the Plants
Week 09	Measuring biodiversity: Alpha, Beta and Gamma diversity; Systematic and functional diversity **Lab.** Ex-situ conservation of over-exploited species by growing in the University Botanical Garden. A mini research project on the interests of a group of students. They can collect at least single species of over-exploited plants and grow it in the Botanical garden
Week 10	Conservation of Biodiversity: In-situ and Ex-Situ conservation, Use of herbarium and Botanical Garden in biodiversity and conservation. **Lab.** previous one continue
Week 11	Sustainable use of biological resources and role of traditional knowledge in biodiversity conservation. Conservation vs preservation **Lab.** previous one continue
Week 12	Biodiversity Hot spots of Pakistan and the world. **Lab.** previous one continue
Week 13	Biodiversity of Pakistan, Biodiversity Action plan for Pakistan, Impact assessment and Base line studies. **Lab.** Understanding in-situ Conservation: a study trips to Ayubia/Deosai National parks
Week 14	Criteria for determining different categories of Protected Areas, Public awareness strategies **Lab.** The students are required to submit collection at least 30 medicinal plants
Week 15	Concept of pastures and wild life management; CITES and annex; Global Biodiversity Information Facility (GBIF); Environmental Impact Assessment. **Lab**. The students are required to submit collection at least 30 wild plants
Week 16	International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar **Lab**. Measuring Diversity

Reference Books (Updated Edition):

1. Abbasi, A. M., Khan, M. A., Ahmad, M., & Zafar, M. (2012). *Medicinal Plant Biodiversity of Lesser Himalayas-Pakistan*. Springer New York.
2. Adams, W. M. (2004). *Against Extinction: The Story of Conservation*. Earthscan..
3. Van Dyke, F., & Lamb, R. L. (2020). *Conservation Biology: Foundations, Concepts, Applications* (3rd ed.). Springer Nature.

4. Baig, M. B., & Al-Subaiee, F. S. (2009). Biodiversity in Pakistan: Key issues. *Biodiversity*, *10*(1), 20–29..

Semester	Category	Course Code	Course Title	Credit Hours
2nd Semester	Major-02	BOT-427	Fundamentals of Plant Taxonomy	3(2+1)
	Major-03	BOT-132	Fundamentals of Genetics & Evolution	3(3+0)
	IDC		Cell Biology	3(2+1)
	G. Ed.-05		Introduction to Psychology (Social Sciences) ***	2(2+0)
	G. Ed.-06	MATH-109	Quantitative Reasoning II **	3(3+0)
	G. Ed.-07	ENG-104	Expository Writing **	3(3+0)
	G. Ed.-08	ISL-103	Fahm -ul-Quran	1
	Total Credits			**18**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Fundamentals of plant Taxonomy**	**Course Code:**	**BOT-427**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To understand various systems of plant classifications and to classify of plants into classes, Order, Families, Genera, and species
- Students will have extensive knowledge of the morphology of flowering plants.
- To establish Herbarium for future research studies

Course Learning Outcomes:

- Know different families of Angiosperm.
- Understand the importance of Herbarium and Botanical garden in Botanical Research.
- Classify the flowering plants in Taxonomic hierarchy.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**An introduction to Plant Taxonomy**, significance, Basic Terms used in taxonomy such as identification, classification, taxa, rank etc. **Lab:** Field Work (plant Collection)
Week 2	**Phases of Plant Taxonomy:** Exploratory, Systematic, Experimental, and Holotaxonomic Phase

	Lab: Field Work (plant Collection)
Week 3	**History of Plant classification Systems:** Artificial & natural system of classification **Lab:** Identification of Lamiaceae with the help of taxonomic key
Week 4	**History of Plant classification Systems:** modern system of classification **Lab:** Identification of Poaceae with the help of taxonomic key
Week 5	**Descriptive Terminology:** a detailed account of various morphological characters such as: root. **Lab:** Identification of Euphorbiaceae with the help of taxonomic key.
Week 6	**Descriptive Terminology:** a detailed account of various morphological characters such as: Stem, and leaf, **Lab.** Identification of Morphological structure of Leaf
Week 7	**Descriptive Terminology:** a detailed account of various morphological characters such as inflorescence and flower. **Lab.** Identification of Actinomorphic and Zygomorphic Flower
Week 8	**Descriptive Terminology:** a detailed account of various morphological characters such as: placentation, pollen and fruit types. **Lab:** Identification of complete, incomplete, perfect, hypogenous, epigenous Flower
Week 09	**Process of Plant Identification:** Field work, Collection, pressing, and drying of plant specimens. **Lab:** Study of Macro and micromorphological character of Solanaceae by using Light Microscopy
Week 10	**Taxonomic hierarchy:** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; taxonomic, biological, evolutionary. **Lab.** Study of Macro and micromorphological character of Asteraceae by using Light Microscopy
Week 11	**Botanical nomenclature:** History, Source of specific epithet & generic name **Lab:** Making Herbarium Specimen
Week 12	**Botanical nomenclature:** Source of specific epithet & generic name **Lab:** Making Herbarium Specimen
Week 13	**Study of selected Dicot families**: Asteraceae, Fabaceae, Papaveraceae **Lab**: Study of Pollen morphology by using LM and SEM
Week 14	**Study of selected Dicot families**: Lamiaceae, Solanaceae, Myrataceae, **Lab.** Study of Pollen morphology by using LM and SEM
Week 15	**Study of selected Dicot families**: Euphorbiaceae, Cucurbitaceae, Brassicaceae **Lab**. Search flora of Pakistan & The Plant List for taxonomical study
Week 16	**Study of selected Monocot families:** Poaceae, Liliaceae **Lab**. Search flora of Pakistan & The Plant List for taxonomical study

Reference Books (Updated Edition):

1. Simpson, M. G. Plant systematics. Academic press.
2. Gurcharan, S. Plant systematics: an integrated approach. Plant systematics: an integrated approach.
3. Dirk R. Walters, David J. Kil, Bonnie Walters, Zack E. Murrel. Vascular Plant Taxonomy (Paperback). Flipkart Publishers.
4. Sharma. Plant Taxonomy 2nd ed. Tata McGraw-Hill.
5. Gurcharan, S. Plant systematics: an integrated approach. Plant systematics: an integrated approach.

Course Title:	**Cell Biology**	**Course Code:**	

WOMEN UNIVERSITY SWABI

Department of Botany

Credit Hours:	3(2+1)	Pre-Requisite if any:	---------

Course Learning Objectives:

- To understand the Structure and function of cell.
- To understand the structure and function of biomolecules.

Course Learning Outcomes:

- The chemical basis of life, cell structure and function, cell metabolism, energy acquisition and use, cell division.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Structure and Function of Bio-molecules: Carbohydrate **Lab.** Study of cell structure using compound microscope.
Week 2	Structure and Function of Bio-molecules: Lipids **Lab**. Study of cell structure using compound microscope.
Week 3	Structure and Function of Bio-molecules: Proteins. **Lab.** Measurement of cell size plant cell.
Week 4	Structure and Function of Bio-molecules: Nucleic Acids. **Lab.** Measurement of cell size plant cell.
Week 5	Cell: Cell theory, cell types (prokaryotes, eukaryotes). **Lab.** Measurement of cell size animal cell
Week 6	Basic Structure of plant cell. **Lab.** Measurement of cell size animal cell.
Week 7	**Brief description of following cell organelles:** Cell wall, Cell membrane **Lab.** Study of microscopic study of plant cell.
Week 8	**Brief description of following cell organelles: cytoplasm,** Nucleus **Lab.** Study of microscopic study of nuclecs
Week 9	Brief description of following cell organelles: Endoplasmic reticulum and Plastids **Lab.** Study of microscopic study of chloroplast.
Week10	Brief description of following cell organelles: Mitochondria and Ribosomes **Lab.** Study of microscopic study of mitrochondria.
Week 11	Brief description of following cell organelles: Dictyosomes and Vacuoles Lab. Study of microscopic study of Vaculoes.
Week 12	Reproduction in somatic and embryogenic cell, cell cycle. Lab. Study different stages of cell cycle.
Week 13	Reproduction in somatic cells mitosis **Lab.** Study of mitosis by smear/squash method and from prepared slides
Week 14	Reproduction in embryogenic cell, meiosis **Lab.** Study of meiosis by smear/squash method and from prepared slides.
Week 15	Replication of DNA **Lab.** Study of chromosome morphology and variation in chromosome number.
Week 16	Transcription of RNA **Lab.** Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.

Reference Books (Updated Edition):

1. Lodish. H. Molecular Cell Biology. W. H. Freeman and Co..

2. Carroll, S. B., Grenier, J. K. & Welnerbee, S. D. From DNA to Diversity Molecular Genetics and the Evolution of Animal Design. Blackwell Science

COMPREHENSIVE COURSE CONTENTS

WOMEN UNIVERSITY SWABI

Department of Botany

Course Title:	**Fundamentals of Genetics and Evolution**	**Course Code:**	BOT-434
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- Understand the fundamental principles of classical and molecular genetics.
- Explain the processes of inheritance, gene interaction, and genetic mapping.
- Comprehend the molecular basis of mutation, gene expression, and regulation.
- Understand the mechanisms of evolution, speciation, and natural selection.
- Develop practical skills in solving genetic problems, pedigree analysis, and evolutionary studies.

Course Learning Outcomes:

- Describe Mendelian principles and apply them to genetic crosses.
- Solve problems related to gene interactions, linkage, and recombination.
- Explain DNA structure, replication, transcription, and translation processes, Interpret the mechanisms of mutations and their evolutionary significance.
- Analyze the principles of population genetics and models of evolution.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to Genetics & Evolution; Historical background (Mendel, Darwin, Modern synthesis) **Lab** orientation, safety, introduction to genetics lab work
Week 2	Mendelian Genetics: Monohybrid and Dihybrid crosses, Laws of segregation & independent assortment. **Lab** Study of prepared slides of mitosis and meiosis
Week 3	Extensions of Mendelian Genetics: Incomplete dominance, codominance, multiple alleles. **Lab** Demonstration of monohybrid & dihybrid crosses in plants (simulation or pea seeds)
Week 4	Gene interactions: Epistasis, complementary genes, lethal genes. **Lab** Solving Mendelian genetics problems (Punnett squares, probability)
Week 5	Linkage and crossing over; genetic mapping. **Lab** Cytological observation of chiasmata in meiosis
Week 6	Chromosomal basis of inheritance; sex-linked, sex-limited, and sex-influenced traits. **Lab** Study of sex chromosomes in prepared slides (e.g., grasshopper testis)
Week 7	Chromosomal mutations: deletions, duplications, inversions, translocations **Lab** DNA extraction from onion
Week 8	Molecular Genetics: DNA structure, replication, central dogma **Lab** DNA extraction from banana
Week 09	Concept of evolution, history of plant life (Importance of studying evolution in botany, Origin of photosynthesis and algae as ancestors) **Lab** Microscopic observation of green algae (e.g., Chlamydomonas, Spirogyra.
Week 10	Evolution of bryophytes (mosses, liverworts), Adaptations for life on land (cuticle, stomata). **Lab** Study of moss gametophyte and sporophyte under microscope (Funaria or Marchantia).
Week 11	Development of vascular tissues, Ferns and their importance in plant evolution. **Lab** observation of fern fronds and sori.
Week 12	Origin of seeds and pollen, Gymnosperms as the first seed plants. **Lab** Study of Pinus cones (male & female).
Week 13	Origin of flowers and fruits, Co-evolution with pollinators. **Lab** Dissection of a flower (hibiscus or lily).

Week 14	Variation, mutation, recombination, Polyploidy and hybridization in plants. **Lab** Study of chromosome number differences in diploid vs. polyploid plants (prepared slides).
Week 15	Fossil plants and geological time scale, Molecular and morphological evidence. **Lab** Observation of fossil plant specimens (if available).
Week 16	Domestication of plants, Artificial selection, crop improvement, **Lab** Germination experiment under stress conditions (salt, drought, or light differences)

Reference Books (Updated Edition):

1. Haq, R.U. & Khan, I.A. Master Success Series Text Book Of Botany Paper C Cell Biology Genetics & Evolution BS BSc/AD
2. Verma, P. S., & Agarwal, V. K. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evoloution and Ecology. S. Chand Publishing.
3. Carroll, S. B., Grenier, J. K. & Welnerbee, S. D. From DNA to Diversity Molecular Genetics and the Evolution of Animal Design. Blackwell Science

2nd Year

3rd	Major-05	BOT-214	Phycology & Bryology	3(2+1)
	Interdisciplinary		IDC 2	3(2+1)
	Major-06	BOT-224	Plant Anatomy	3(2+1)
	Interdisciplinary		IDC3	3(2+1)
	Interdisciplinary		IDC4	3(2+1)
	G. Ed.-9	PS-102	Pakistan Studies	2(2+0)
	G. Ed.-10	ISL-104	Fahm -ul-Quran	1
	Total Credits			**18**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Phycology & Bryology**	**Course Code:**	**BOT-214**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- This course will provide to distinguish and identify the Bryophytes & Phycology in our surroundings
- Be able to understand the distribution and economic importance of Bryophytes & Phycology.

Course Learning Outcomes:

- Explains the basic concepts of plant kingdom.
- Describes plant taxa starting with plant bryophytes and finishing with angiosperms.
- To understand the classification, morphology and economic & medicinal importance of Algae & Lichen

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**Bryology:** Introduction and general account of bryophytes, classification **Lab.** Study of the *Pellia* species
Week 2	Evolution of bryophyte.

	Lab. Study of the *Porella* species
Week 3	Reproduction of bryophytes and their alternation of generation **Lab.** Study of the *Anthoceros* species
Week 4	**Diversity & classification of Bryophytes:** Brief study of the classes: Hepaticopsida **Lab.** Study of the *Polytrichum.*
Week 5	Diversity & classification of Bryophytes: Anthoceropsida and Bryopsida. **Lab.** Study of the *Marchantia*
Week 6	Distribution, systematic position , habitat, body structure, reproduction and life cycle of the *Marchantia* and *Riccia*, **Lab.** Study of the *Funaria*
Week 7	Distribution, systematic position , habitat, body structure, reproduction and life cycle of the *Anthoceros, Polytrichum*, and *Funaria* **Lab.** Field work (fresh collection)
Week 8	Economics & Biological Significance of bryophytes . **Lab.** Field work (fresh collection)
Week 09	**b) Phycology** General introduction: occurrences, origin & distribution **Lab.** Fresh collections of Algae
Week 10	General account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: Chlorophyta **Lab.** Study prepared slides.
Week 11	General account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: Charophyta and Xanthophyta **Lab.** Section cutting of thalloid algae
Week 12	General account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: Bacillariophyta, Phaeophyta and Rhodophyta **Lab.** Preparation of temporary slides
Week 13	Importance of Algae **Lab.** Field Work
Week 14	**c) Lichenology** General Introduction; Characteristics of Lichens; Distribution and Habitat of Lichens **Lab.** Fresh collections of Lichen
Week 15	Associated Members of Lichens, the Structure (Thallus) of a Lichen **Lab.** Examination and identification of collected Lichen specimens
Week 16	Lichen Diversity & Classification of Lichens **Lab.** Examination and identification of collected Lichen specimens

Reference Books (Updated Edition):

1. Haq, R.U. Text Book of Botany Diversity of Plants For BS
2. Khandare, M. Text book of Bryophytes Pteridophytes Gymnosperm & Paleobotany.
3. Vashishta, B. R., Sinha, A.K., & Kumar, A. Algae. S. Chand & Co
4. Vanderpoorten, A. Introduction to Bryophytes. Cambridge University Press
5. Mauseth, J.D. Botany: an introduction to plant biology. Jones & Bartlett Publishers

COMPREHENSIVE COURSE CONTENTS

Course Title:	Plant Anatomy	**Course Code:**	**BOT-325**

WOMEN UNIVERSITY SWABI

Department of Botany

Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To provide the students understanding about anatomical features of vascular plants
- To provide the students understanding about anatomical anomalies of vascular plants

Course Learning Outcomes:

- Students will be able to understand about anatomical features of vascular plants.
- Students will be able to understand about anatomical anomalies of vascular plants

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	The plant body and its development: fundamental parts of the plant body, **Lab.** Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures
Week 2	Internal organization, different tissue systems of primary and secondary body. **Lab.** Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures
Week 3	Meristematic tissues: classification, cytohistological characteristics, initials and their derivatives. **Lab.** Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures
Week 4	Apical meristem: Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices. **Lab.** Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures
Week 5	Leaf: types, origin, internal organization, development of different tissues **Lab.** Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures
Week 6	Study of mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells **Lab.** Study of abnormal/unusual secondary growth in different plants
Week 7	Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions **Lab.** Study of abnormal/unusual secondary growth in different plants
Week 8	Additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth. **Lab.** Study of abnormal/unusual secondary growth in different plants
Week 09	Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma. **Lab.** Study of primary and secondary tissues of different plants
Week 10	Xylem, Phloem with special emphasis on different types of woods, Periderm, Secretory tissues: Laticifers. **Lab.** Study of secretory tissues
Week 11	Anatomy Of Androcium And Gymnosperm. **Lab.** Anatomical study of flowers and pollens
Week 12	Economic aspects of applied plant anatomy

	Lab. Peel and ground sectioning and maceration of fossil material.
Week 13	Molecular markers in tree species used for wood identification **Lab.** Peel and ground sectioning and maceration of fossil material.
Week 14	Anatomical adaptations of different plants **Lab.** Peel and ground sectioning and maceration of fossil material.
Week 15	Anatomical adaptations of different plants **Lab.** Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides
Week 16	Resin Canals **Lab.** Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides

Reference Books(Updated Edition):

1. Vaughan, J. G. The structure and Utilization of Oil Seeds.
2. Chapman and Hall Ltd. London.

DETAIL OF COURSES
FOR BS (4 – YEAR) in Botany

	Category	Course Code	Course Title	Credit Hours
Semester 4th	Interdisciplinary		IDC 5	3(3+0)/ (2+1)
	G.Ed-11	ISL-101	Islamic Studies	2(2+0)
	Major-7	BOT-251	Fundamentals of Plant Physiology	3 (2+1)
	Major 8	BOT-243	Principles of Plant Ecology	3(2+1)
	G.Ed-12	PS-101	Ideology & Constitution of Pakistan **	2(2+0)
	G. Ed.-13	POLS-101	Civics & Community Engagement **	2(2+0)
	G. Ed.-14	MGT-212	Entrepreneurship**	2(2+0)

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Fundamentals of Plant Physiology**	**Course Code:**	**BOT: 251**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- Provide foundation in physiological processes of plants.
- Explain transport, photosynthesis, respiration, and growth.
- Understand environmental influences on physiology.
- Train students in experimental techniques.

Course Learning Outcomes:

- Describe water transport, mineral nutrition, and gas exchange,
- Explain photosynthesis and respiration, Analyze plant growth regulators,
- Apply physiological knowledge in agriculture,

- Conduct basic plant physiology experiments.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to plant physiology **Lab** Lab safety & tools
Week 2	Water relations: diffusion, osmosis **Lab** Osmosis demo (potato strips)
Week 3	Water transport in xylem **Lab** Demonstration with dyes
Week 4	Mineral nutrition **Lab** Hydroponic culture
Week 5	Photosynthesis: light reactions **Lab** Chlorophyll extraction
Week 6	Photosynthesis: dark reactions **Lab** CO_2 effect on photosynthesis
Week 7	Respiration: glycolysis & Krebs **Lab** Measurement of O_2 consumption
Week 8	Detail on the transpiration and types of tranapiration **Lab** Measurement of O_2 consumption
Week 09	Transpiration & stomatal physiology **Lab** Potometer experiment
Week 10	Translocation in phloem **Lab** Aphid experiment demo
Week 11	Growth & development **Lab** Measurement of seedling growth
Week 12	Plant hormones **Lab** Auxin effect on coleoptiles
Week 13	Stress physiology (drought, salinity) **Lab** Salt stress experiment
Week 14	Photoperiodism and types. **Lab** Salt stress experiment
Week 15	Vernalization and its history **Lab** Salt stress experiment
Week 16	Review & exam prep **Lab** Final lab report submission

Reference Books (Updated Edition):

1. Pierca, B. A. Genetics. A conceptual approach, W. H. Freeman and Company, New York.
2. Synder, L., & Champness, W. Molecular Genetics of Bacteria. ASM Press, Washington D. C.
3. Gardner, E. J., Principles of Genetics, John Willey and Sons, New York.
4. Ringo, J. Fundamental Genetics, Cambridge University Press.
5. Daniel H. Genetics Johns and Bartlett Publishers.
6. David H. Introduction to Genetic principles. McGraw-Hill.

COMPREHENSIVE COURSE CONTENTS

Course Title:	Principles of Plant Ecology	**Course Code:**	**BOT:243**

WOMEN UNIVERSITY SWABI

Department of Botany

Credit Hours:	3(2+1)	Pre-Requisite if any:	

Course Learning Objectives:

- Introduce students to ecological principles governing plant life.
- Understand plant–environment interactions.
- Study vegetation types and ecological adaptations.
- Develop basic skills in ecological fieldwork and data collection.

Course Learning Outcomes:

- Explain ecological concepts (population, community, ecosystem).
- Analyze ecological factors (light, temperature, water, soil).
- Identify and classify vegetation types, Apply ecological methods (quadrats, transects, biomass estimation).

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to plant ecology & scope **Lab** Orientation and lab safety
Week 2	Ecological factors: light & temperature **Lab** Measuring temperature & light in field
Week 3	Water as an ecological factor **Lab** Soil moisture measurement
Week 4	Soil ecology: types, fertility, pH **Lab** Soil sampling & pH analysis
Week 5	Biotic factors: plants, animals, humans **Lab** Case study: grazing effect on vegetation
Week 6	Population ecology **Lab** Quadrat method: density & frequency
Week 7	Plant communities & succession **Lab** Species-area curve
Week 8	Introduction to ecosystem and scope of ecosystem **Lab** energy flow demonstration
Week 09	Ecosystems: structure & function **Lab** Energy flow demonstration
Week 10	Productivity & nutrient cycling **Lab** Biomass estimation
Week 11	Biomes of the world **Lab** Drawing biome maps
Week 12	Vegetation of Pakistan **Lab** Field visit: local vegetation
Week 13	Conservation ecology **Lab** list of endangered species
Week 14	Applied plant ecology **Lab** Data analysis: field survey
Week 15	Climate change & global ecology **Lab** Data analysis: field survey
Week 16	Review & final exam prep **Lab** Practical report submission

Reference Books (Updated Edition):

1. Odum, E.P. *Fundamentals of Ecology*. Cengage.
2. Begon, M., Townsend, C.R., Harper, J.L. *Ecology: From Individuals to Ecosystems*. Wiley.
3. Sharma, P.D. *Ecology and Environment*. Rastogi Publications.

4. Singh, J.S. *Ecology, Environment and Resource Conservation*. Anamaya.

DETAIL OF COURSES
FOR BS (4 – YEAR) , 3rd Year

	Category	Course Code	Course Title	Credit Hours
5th Semester	Interdisciplinary		IDC 6	3(2+1)
	Major-9	BOT-361	Principles of Plant Biochemistry	3(2+1))
	Interdisciplinary		IDC 7	3(2+1)
	Major-10	BOT-352	Plant Physiology	3(2+1)
	Major-11	BOT-373	Microbial Botany	3(2+1)
	Major12	BOT-372	Mycology	3(2+1)
	Total			**18**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Principles of Plant Biochemistry**	**Course Code:**	**BOT:361**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:
- Introduce biochemical basis of plant life.
- Understand biomolecules and their metabolic roles.
- Learn enzymology and regulation of plant metabolism.
- Develop lab skills in biochemical analysis.

Course Learning Outcomes:
- Describe structure and function of biomolecules,
- Explain enzymatic mechanisms, Outline carbohydrate, protein, and lipid metabolism,
- Understand secondary metabolites in plants, Perform basic biochemical tests in the lab.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to plant biochemistry **Lab** Lab safety & glassware
Week 2	Carbohydrates: structure & types **Lab** Benedict's test for sugars
Week 3	Carbohydrate metabolism (glycolysis, TCA) Lab Reducing sugar estimation
Week 4	Proteins: structure & classification **Lab** Biuret test for proteins
Week 5	Protein metabolism & enzymes **Lab** Enzyme activity assay
Week 6	Lipids: structure & role **Lab** Lipid extraction from seeds
Week 7	Lipid metabolism **Lab** TLC demonstration
Week 8	Nucleic acids: DNA full details **Lab** DNA isolation if possible
Week 09	Nucleic acids: RNA (full details) **Lab** DNA isolation if possible
Week 10	Nucleotide metabolism **Lab** Agarose gel electrophoresis
Week 11	Secondary metabolites (alkaloids, phenolics) **Lab** Extraction of plant pigments
Week 12	Photosynthetic pigments **Lab** Spectrophotometer use
Week 13	Plant hormones (auxins, gibberellins, ABA) **Lab** Bioassay of auxins
Week 14	Stress biochemistry **Lab** Discussion: ROS in plants
Week 15	Plant biochemistry applications **Lab** Discussion: ROS in plants
Week 16	Review & exam prep **Lab** Submission of lab report

Reference Books (Updated Edition):

1. Lehninger, A.L. *Principles of Biochemistry*. Freeman.
2. Voet, D., Voet, J.G. *Biochemistry*. Wiley.

COMPREHENSIVE COURSE CONTENTS

Course Title:	***Plant Physiology***	**Course Code:**	**BOT-352**
Credit Hours:	3(2+1)	**Pre-Requisite if any:**	

Course Learning Objectives:

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

- To provide students' knowledge regarding the physiological processes carried out inside the plant

Course Learning Outcomes:

- Student will be able to understand plant growth regulators,
- Student will be able to understand various physiological processes in plants.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**Plant Growth Regulators:** Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action, transport, physiological effects of Auxins , Gibberellins, Cytokinins, Abscisic acid, Ethylene, **Lab.** To investigate the preferential absorption of ions by potato slices.
Week 2	Polyamines, Brassinosteriods, Jasmonates, and Salicylic acid. **Lab.** To investigate the preferential absorption of ions by potato slices.
Week 3	**Water Relations:** The soil -plant -atmosphere continuum - an overview. Structure of water. Physico-chemical properties of water. Water in the soil and its potentials. Water in cell components **Lab.** To investigate the preferential absorption of ions by corn seedlings.
Week 4	Absorption of water in plants (pathways and driving forces, Aquaporins,-their structure and types). **Lab.** To investigate the preferential absorption of ions by corn seedlings.
Week 5	Cell water relations terminology. Hofler diagram - analysis of change in turgor, water and osmotic potential with changes in cell volume. **Lab.** Plasmolysis and deplasmolysis (Place onion epidermal cells in different concentrations of sucrose or NaCl solution. Observe plasmolysis under the microscope. Replace with distilled water to show deplasmolysis).
Week 6	Modulus of elasticity coefficient; Hydraulic conductivity. **Lab.** Pressure–Volume Curve (simplified) Use potato or beetroot slices. Record fresh weight, then place in hypertonic solutions for different intervals. Re-weigh and plot water loss against relative water content to mimic Hofler diagram.
Week 7	Osmoregulation, Methods for measurement of water , osmotic and turgor potentials-Pressure chamber, psychrometry, pressure probe, pressure volume curve. **Lab.** Celery/Plant stem hydraulic conductivity (Place celery stalks in colored water. Measure rate of dye movement in xylem (cut cross-sections at intervals). Use as proxy for hydraulic conductivity.
Week 8	**Plant Mineral Nutrition:** Inorganic composition of plant and soil. Absorption of mineral nutrients - roots, mycorrhizae. Effect of soil pH on nutrient availability. **Lab. Osmotic potential using plasmolysis. (**Use onion epidermis in different sucrose molarities. Find the concentration where 50% cells plasmolyze = approximate osmotic potential)
Week 09	Ion traffic into root. The nature of membrane carriers, channels and electrogenic pumps. Passive and active (primary and secondary) transports and their energetics. **Lab. Mineral deficiency symptoms (**Grow seedlings hydroponically (or in washed sand with nutrient solution). Omit N, P, K, Fe, Mg one at a time and observe deficiency symptoms.)
Week 10	Essential and beneficial elements-their functions and deficiency symptoms in plants. Fertilizers and their significance in Agriculture. **Lab. Salt uptake in roots** Place germinated seeds (maize/bean) in dilute NaCl solution. After 1–2 hours, test root exudate or tissue using flame test for Na^+/K^+.Compare passive vs active transport (with and without metabolic inhibitor like DNP if possible).
Week 11	**Phytochromes:** Discovery of phytochromes and cryptochromes. Physical and chemical properties of phytochromes. Distribution of phytochromes among species, cells and tissues and their role in biological processes. Phytochromes and gene expression.

Week 12	**Control of Flowering:** Autonomous versus environmental regulation. Circadien rhythms. Classification of plants according to photoperiodic reaction, photoperiodic induction, locus of photoperiodic reaction and dark periods in photoperiodism. **Lab. Lab. Salt uptake in roots** Place germinated seeds (maize/bean) in dilute NaCl solution. After 1–2 hours, test root exudate or tissue using flame test for Na^+/K^+.Compare passive vs active transport (with and without metabolic inhibitor like DNP if possible).
Week 13	Role of photoperiodism in flowering. Biochemical signaling involved in flowering. **Lab. Photoperiodism in flowering (**Use short-day plants (e.g., soybean, cosmos) and long-day plants (e.g., spinach, wheat). Grow under natural daylength vs artificially extended light (lamp) or dark interruption → observe flowering response.)
Week 14	Vernalization and its effect on flowering. Floral meristem and floral organ development. Floral organ identity genes and the ABC model. **Lab. Etiolation and de-etiolation** Grow seedlings in dark vs light. Observe differences in stem elongation, leaf expansion, greening → role of phytochromes/cryptochromes.
Week 15	**Dormancy;** definition and causes of seed dormancy; methods of breaking seed dormancy; types and physiological process of seed germination. **Lab. Etiolation and de-etiolation** Grow seedlings in dark vs light. Observe differences in stem elongation, leaf expansion, greening → role of phytochromes/cryptochromes.
Week 16	**Plant Movements;** Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements. **Lab.** Observation of Plant Movement in the field

Reference Books (Updated Edition):

1. Fitter, A. & Hay, R. K. Environmental Physiology of Plants. Academic Press, UK.
2. Heldt, H. W. Plant Biochemistry. 3rd Edition, Academic Press, U.K.

COMPREHENSIVE COURSE CONTENTS

Course Title:	Microbial Botany	**Course Code:**	**BOT-373**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To provide students with a detailed understanding of microorganisms, including bacteria, fungi, algae, viruses, and their botanical significance.
- To understand microbial structure, physiology, reproduction, and ecological roles.
- To highlight applications of microbes in agriculture, medicine, and biotechnology.

Course Learning Outcomes:

- Identify and classify different groups of microbes,
- Explain their roles in nutrient cycling, symbiosis, and disease,
- Apply knowledge of microbial processes in agriculture, industry, and biotechnology.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction: scope of microbial botany, history of microbiology, contributions of pioneers. Lab Introduction to lab safety, use of microscope.
Week 2	General characteristics of prokaryotes and eukaryotic microbes. Lab Demonstration of aseptic techniques.
Week 3	Bacteria: structure, nutrition, reproduction, and economic importance. Lab Preparation of bacterial culture media.

Week 4	Cyanobacteria: morphology, physiology, ecological role. Lab Microscopic study of Oscillatoria and Nostoc
Week 5	Viruses: general properties, replication, viral diseases in plants. Lab Observation of viral symptoms on plants.
Week 6	Mycoplasma, viroids, and prions. Lab Study of leaf samples with suspected viral infections.
Week 7	Algae: classification, morphology, reproduction. Lab Microscopic study of Chlamydomonas, Spirogyra.
Week 8	Economic importance of algae. Lab Identification of algae from pond samples.
Week 09	Fungi: classification, structure, reproduction. Lab Slide preparation of Rhizopus, Aspergillus.
Week 10	Mycorrhizae and lichens. Lab Field observation and collection of lichens.
Week 11	Microbial genetics: plasmids, gene transfer in bacteria. Lab Demonstration of bacterial conjugation models.
Week 12	Microbes in soil fertility. Lab Isolation of soil microbes by dilution plate method.
Week 13	Microbes in biotechnology. Lab Demonstration: yeast fermentation (CO_2 test).
Week 14	Microbes in food industry. Lab Observation of bread mold, curd preparation.
Week 15	Microbes and environment. Lab Water testing for coliform bacteria.
Week 16	Review and microbial diversity. Lab Practical exam and submission of lab notebook.

Reference Books (Updated Edition):

1. Madigan, M.T., Martinko, J.M., Bender, K. *Brock Biology of Microorganisms*. Pearson.

Prescott, L.M. *Microbiology*. McGraw-Hill.

2. Aneja, K.R. *Experiments in Microbiology, Plant Pathology and Biotechnology*. New Age Publishers.
3. Tortora, G.J., Funke, B.R., Case, C.L. *Microbiology: An Introduction*. Pearson.
4. Madigan, M.T., Martinko, J.M., Bender, K. *Brock Biology of Microorganisms*. Pearson.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Mycology**	**Course Code:**	**BOT-374**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	**---------**

Course Learning Objectives:

- To understand the classification, morphology and economic & medicinal importance of Fungi

Course Learning Outcomes:

- Diversity and distribution of Fungi.
- Role and significance of Fungi in different Ecosystems.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction and classification of Mycology. **Lab** Observation of general characters of fungi from fresh and preserved specimens.
Week 2	Fungal cell structure and ultrastructure (cell wall, organelles, septa, hyphal modifications).

	Lab Microscopic study of fungal cell structure (stained slides, live preparations)
Week 3	Asexual reproduction: spore types, sporangia, conidiogenesis; Special asexual structures (chlamydospores, zoospores) **Lab** Observation of asexual spores and structures from slides and cultures
Week 4	Sexual reproduction: gametes, gametangial copulation, somatogamy, dikaryotic stage; Life cycles. **Lab** Study of unicellular fungi (yeasts) and mycelial forms (septate and aseptate hyphae)
Week 5	Introduction to fungal diversity; Classification systems (traditional vs. molecular); Myxomycota – morphology, life cycle, reproduction. **Lab** Demonstration of slime molds (Myxomycota) in culture/collected specimens
Week 6	Chytridiomycota: zoospores, life cycle, ecological importance. **Lab** Field work: collection of mushrooms and simple fungi from natural habitats
Week 7	Zygomycota: Rhizopus, – morphology, somatic structures, reproduction; Oomycota: Phytophthora, – morphology, somatic structures, reproduction and pathogenic role. **Lab** Study of Zygomycota and Oomycota using slides and culture specimens
Week 8	Ascomycota: general characters, ascus and ascospore formation, life cycle examples (Saccharomyces, Aspergillus). **Lab** Microscopic study of Ascomycota reproductive structures
Week 09	Basidiomycota: clamp connections, basidiospores, fruiting bodies, economic importance (Agaricus, Puccinia) **Lab** Mushroom morphology: fresh specimens & preserved samples.
Week 10	Deuteromycota (Fungi Imperfecti): general features, importance in medicine and agriculture. **Lab** Study of prepared slides (conidia of common imperfect fungi)
Week 11	Symbiotic associations: Mycorrhizae **Lab** Demonstration of diagnostic features across fungal groups.
Week 12	Symbiotic associations, lichens, endophytes; Role of fungi in ecosystems. **Lab** Study of lichens and mycorrhizal associations from collected material
Week 13	Importance of fungi in industry: fermentation (alcohol, citric acid, antibiotics); Role in biotechnology **Lab** Demonstration of yeast fermentation (simple fermentation experiment)
Week 14	Importance of fungi in agriculture: mycorrhizae, biofertilizers, plant pathogens; Control measures of fungal diseases **Lab** Field collections of plant pathogenic fungi (rusts, smuts, mildews)
Week 15	Fungi in medicine and human welfare: mycoses, allergens, edible and poisonous fungi; Role in food industry **Lab** Identification of edible vs. poisonous mushrooms (morphological keys)
Week 16	Recent advances in mycology (molecular techniques, fungal genomics) **Lab** Practical exam / Project presentations on field and lab work.

Reference Books (Updated Edition):

1. Khan, I.A. & Haq, R.U. Text Book Of Botany (Diversity Of Plants) B.S 4th Year: Semester 1 / B.Sc /AD Tow Year Paper A
2. Reddy, S. M. University botany I:(algae, fungi, bryophyta and pteridophyta) (Vol. 1). New Age Internationa

DETAIL OF COURSES
FOR BS (4 – YEAR) , 3rd Year

	Category	Course Code	Course Title	Credit Hours
	Major-13	BOT-326	Systematic of Angiosperms	3(2+1)

6th Semester	Major-14	BOT-374	Plant Pathology	3(2+1)
	Major-15		Elective – I	3 (2+1)
	Major-16	BOT-364	AI in Botany	3(2+1)
	Major-17	BOT-344	Plant Ecology	3(2+1)
	Major-18	BOT-362	Plant Biochemistry	3(2+1)
			Total Credits	**18**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Systematics of Angiosperm**	**Course Code:**	**BOT-326**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To understand various systems of plant classifications and to classify of plants into classes, Order, Families, Genera, and species
- Students will have extensive knowledge of the morphology of flowering plants.
- To establish Herbarium for future research studies

Course Learning Outcomes:

- Know different families of Angiosperm,
- Understand the importance of Herbarium and Botanical garden in Botanical Research,
- Classify the flowering plants in Taxonomic hierarchy.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to Plant Systematics: Definitions, importance, history of angiosperm classification. **Lab:** Introduction to herbarium, tools, and techniques.
Week 2	Types of classification: Artificial, natural, phylogenetic; contributions of Linnaeus, Bentham & Hooker, and Engler & Prantl. **Lab:** Collection and pressing of plant specimens.
Week 3	Modern classification: APG system (latest version), molecular systematics and DNA barcoding. **Lab:** Field collection—identification and pressing techniques.
Week 4	Botanical nomenclature: ICBN rules, typification, priority, and valid publication. **Lab:** Preparation and mounting of herbarium sheets.
Week 5	Morphological characters in taxonomy: root, stem, leaves, inflorescence, floral formula, and floral diagram. **Lab:** Study of vegetative characters in common angiosperms.
Week 6	Reproductive morphology: Flower structure, placentation, fruit and seed types. **Lab:** Floral dissection and preparation of floral diagrams.

Week 7	Taxonomic tools: Microscopy, anatomy, palynology, cytology, chemotaxonomy. **Lab:** Microscopic examination of pollen and anatomical features.
Week 8	Species concept, speciation, and evolutionary trends in angiosperms. **Lab:** Comparative study of species within a genus.
Week 09	Detailed study of selected families: Magnoliaceae, Nymphaeaceae, Ranunculaceae. **Lab:** Morphological study of representative species.
Week 10	Detailed study of families: Brassicaceae, Fabaceae, Rosaceae. **Lab:** Identification using keys and preparation of diagnostic features.
Week 11	Detailed study of families: Euphorbiaceae, Malvaceae, Rutaceae. **Lab:** Description writing and taxonomic key development.
Week 12	Detailed study of families: Lamiaceae, Solanaceae, Apiaceae. **Lab:** Comparative analysis of floral characters.
Week 13	Detailed study of families: Asteraceae, Poaceae, Cyperaceae. **Lab:** Study of inflorescence and spikelet structures.
Week 14	Field taxonomy: Ecology, distribution patterns, and plant diversity of Pakistan. **Lab:** Field trip for plant identification and collection.
Week 15	Herbarium science: Curation, labeling, data management, digital herbaria. **Lab:** Herbarium sheet finalization and cataloging.
Week 16	Revision of major families; construction of simple phylogenetic trees. **Lab:** Practical exam preparation and specimen identification.

Reference Books (Updated Edition):

1. Simpson, M. G. Plant systematics. Academic press.
2. Gurcharan, S. Plant systematics: an integrated approach. Plant systematics: an integrated approach.
3. Dirk R. Walters, David J. Kil, Bonnie Walters, Zack E. Murrel. Vascular Plant Taxonomy (Paperback). Flipkart Publishers.
4. Sharma Plant Taxonomy Tata McGraw-Hill.
5. Gurcharan, S. Plant systematics: an integrated approach. Plant systematics: an integrated approach.
6. Harris, J. G., & Harris, M. W. Plant identification terminology: an illustrated glossary (No. QK9 H37 2001). Utah: Spring lake publishing.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Plant Pathology**	**Course Code:**	**BOT-374**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	**No**

Course Learning Objectives:

- To acquaint students with basic concepts and identification of plant pathogens
- To acquaint students with basic concepts and identification of plant disease

Course Learning Outcomes:

- Know the characteristics of various plant pathogens,
- Understand the difference between Fungi effected and Bacteria effected plants.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction and scope and objective, Economic importance; general characteristics of plant pathology **Lab:** Orientation of laboratory equipment
Week 2	History and development of plant pathology **Lab:** Orientation of laboratory equipment
Week 3	Definition and concept of plant diseases (disease triangle cox posculate) **Lab:** Orientation of laboratory equipment
Week 4	Classification of plant diseases **Lab:** Preparation of media and isolation of fungi cultivation plant pathogens
Week 5	Causes of plant diseases (Abiotic and mesobiotic) **Lab:** Isolation of plant pathogens from aerial parts of plant
Week 6	Causes of plant diseases (biotic causes of plant diseases) **Lab.** Isolation of plant pathogens from rhizosphere
Week 7	Symptoms of plant diseases in detail. **Lab.** Isolation of plant pathogens from rhizoplane
Week 8	General characteristics of plant pathogens Fungi Lab. Identification of plant pathogens.
Week 09	General characteristics of plant pathogens Bacteria. **Lab:** Study of characteristics of various plant pathogens through slides
Week 10	Components of plant disease development **Lab.** Study of characteristics of various plant pathogens through slides
Week 11	Classification of plant Pathogens **Lab:** survey of plant diseases.
Week 12	Principles of plant disease management **Lab:** Study of characteristics of various plant pathogens through slides
Week 13	Disease cycle **Lab**: Study of characteristics of various plant pathogens through slides
Week 14	Management of representative diseases of field and horticultural crops **Lab.** Study of characteristics of various plant pathogens live specimens and their comparative account/study tour Collection
Week 15	Introduction to molecular techniques and their application **Lab**. Preservation and identification of plant diseases based on symptoms.
Week 16	Molecular approaches to control pathogens **Lab**. Preservation and identification of plant diseases based on symptoms.

Reference Books (Updated Edition):

1. Agrios, G.N. Plant Pathology, 5th edition. Academic Press, New York, USA.
2. Khan, J.A. & Dijkstra, J. Plant Virus as Molecular Pathogens. The Haworth Press Inc. USA.
3. Trigiano, R.N., Windham, M.T., & Windham, A.S. Plant Pathology: Concepts and Laboratory Exercises. CRC Press.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Artificial Intelligence in Botany**	**Course Code:**	**BOT-364**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives

- Understand the principles of Artificial Intelligence (AI) and its relevance in plant sciences.
- Explore machine learning, deep learning, and data-driven approaches in botanical research.
- Develop skills in applying AI tools for plant identification, taxonomy, physiology, and ecology.
- Analyze large-scale plant data (images, genomics, remote sensing) using AI-based models.
- Evaluate the role of AI in conservation biology, agriculture, and climate change studies.

Course Learning Outcomes

- Demonstrate understanding of AI fundamentals (machine learning, neural networks, computer vision),
- Apply AI tools to plant identification and classification using image datasets,
- Use AI for predicting plant growth, yield, and responses to environmental stress.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to Artificial Intelligence: history, scope, and applications in life sciences **Lab:** Installing Python, TensorFlow/PyTorch; intro to AI tools
Week 2	Basics of AI and Machine Learning: supervised vs unsupervised learning, algorithms overview **Lab:** Building a simple ML classifier using plant dataset (e.g., iris dataset)
Week 3	Deep Learning Fundamentals: neural networks, convolutional neural networks (CNNs) **Lab:** Training a CNN model for plant leaf image recognition
Week 4	Data Handling in Botany: plant datasets, data preprocessing, image annotation **Lab:** Collecting and preprocessing plant images for training models
Week 5	AI in Plant Identification: image recognition and classification of plant species **Lab:** Image classification of leaves using pre-trained CNN models
Week 6	AI in Plant Taxonomy & Systematics: DNA barcoding data with machine learning **Lab:** DNA sequence classification using machine learning algorithms
Week 7	AI in Plant Physiology: modeling photosynthesis, stress responses, and growth patterns **Lab:** Predicting plant stress from leaf images using AI
Week 8	AI in Phytochemistry: prediction of plant metabolites and bioactive compounds **Lab:** Using AI tools to predict bioactive compounds from chemical datasets
Week 09	AI in Agriculture: crop yield prediction, disease detection, and smart farming **Lab:** Disease detection in crop leaves using CNN models
Week 10	AI in Ecology: biodiversity monitoring, habitat modeling, and ecosystem analysis **Lab:** AI-based species distribution modeling with ecological data
Week 11	AI with Remote Sensing & GIS: vegetation mapping and climate change impact studies **Lab:** Remote sensing image classification for vegetation cover
Week 12	AI in Conservation Biology: endangered species identification and monitoring **Lab:** Training models to classify images of rare species
Week 13	Integrating Omics with AI: genomics, transcriptomics, metabolomics applications **Lab:** Analyzing gene expression datasets with AI clustering algorithms
Week 14	Advanced Topics: reinforcement learning, AI ethics, explainable AI in botany **Lab:** Simple reinforcement learning demo for plant growth simulation
Week 15	Student Seminars & Case Studies: presentation on real-world AI applications in botany **Lab:** Group project presentations (AI applications in plant science)
Week 16	Integration & Future Directions: AI in sustainable plant science, review and exam prep **Lab:** Capstone project presentations and course wrap-up

Reference Book (Updated Edition)

1. Goodfellow, I., Bengio, Y., & Courville, A. Deep Learning. MIT Press.
2. Russakovsky, O. et al. ImageNet Large Scale Visual Recognition Challenge. International Journal of Computer Vision.
3. Zhang, Q. et al. Artificial Intelligence Applications in Plant Science. Trends in Plant Science.

4. Jensen, J. R. Introductory Digital Image Processing: A Remote Sensing Perspective (4th ed.). Pearson.
5. Kumar, V., & Minz, S. Artificial intelligence applications in agriculture. Artificial Intelligence in Agriculture.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Plant Ecology**	**Course Code:**	**BOT-344**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:
- To provide comprehensive knowledge of population, community and ecosystem
- To provide comprehensive knowledge of ecology and its relevance to mankind.

Course Learning Outcomes:
- Students will understand the concept of ecology,
- Students will be able to understand the concept of ecology and its importance.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**A. Population Ecology** 1. Population structure and plant demography: **Lab.** Determination of seed bank in various populations
Week 2	Seed dispersal, Dormancy, Seed Bank, Seed dormancy, Recruitment, Demography **Lab.** Determination of seed bank in various populations
Week 3	Life history pattern and resource allocation : Density dependent and density independent factors, **Lab.** Determination of seed bank in various populations
Week 4	Resource allocation, Reproductive effort, Seed size vs seed weight, **Lab.** Seed dispersal pattern of local populations.
Week 5	Population genetics, Evolution **Lab.** Demography and life history of local annual population.
Week 6	**B. Community Ecology:** Historical development of community ecology **Lab.** Study of community attributes
Week 7	Community concepts and attributes, **Lab.** Sampling of vegetation including Quadrat,
Week 8	Methods of sampling of plant communities, **Lab.** Sampling of vegetation including plotless and transect method
Week 09	Ecological succession **Lab.** Sampling of vegetation including Braun-Blanqut.
Week 10	Community soil-relationship **Lab.** Correlate soil properties with vegetation type
Week 11	Local Vegetation**,** **Lab.** Field trip to study different communities located in different ecological regions of Pakistan.
Week 12	Vegetation of Pakistan, Major formation types of the world **Lab.** Field trip to study different communities located in different ecological regions of Pakistan.
Week 13	**C. Ecosystem Ecology:** Ecological concepts of ecosystem, Boundaries of ecosystem **Lab.** Field trip to study different communities located in different ecological regions of Pakistan.
Week 14	Compartmentalization and system concepts

	Lab. Slide show of the vegetation of Pakistan. Slide show of the major formations of the world.
Week 15	Biogeochemical cycles: water carbon and nitrogen Case studies: any example **Lab.** Soil physical properties
Week 16	Energy flow in ecosystem, **Lab.** Soil chemical properties

Reference Books (Updated Edition):

1. Townsend C. R. Begon. M. & Harper, J.L. Essentials of Ecology, Blackwell Publishing,
2. Chapin, F.S. et al. Principle of Terrestrial Plant Ecology, Springer-Verlag
3. Gurevitch, et al., The Ecology of Plants, Sinauer Associates, Inc.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Plant Biochemistry**	**Course Code:**	**BOT-362**
Credit Hours:	3(2+1)	**Pre-Requisite if any:**	

Course Learning Objectives:

- To explicit the fundamentals of metabolic energy
- To explain the Metabolism and Plant Constituents.

Course Learning Outcomes:

- Students will be able to understand various metabolic processes,
- Students will be able to understand various plant metabolites and their role in the plant body.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**Bioenergetics:** Energy, laws about energy changes. Oxidation and reduction in living systems. **Lab.** Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.
Week 2	**Metabolism:** i. Biosynthesis, degradation and regulation of sucrose and starch. **Lab.** Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.
Week 3	Breakdown of fats with special reference to beta-oxidation and its energy balance. **Lab.** Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.
Week 4	Biosynthesis of fats. **Lab.** Separation of nucleic acids by gel electrophoresis.
Week 5	**Alkaloids:** Occurrence, physiological effects **Lab.** Separation of nucleic acids by gel electrophoresis.
Week 6	Chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. **Lab.** Separation of nucleic acids by gel electrophoresis.
Week 7	**Terpenoids:** Classification: monoterpenes, sesquiterpenes, diterpenes, **Lab.** To estimate the amount of vitamin C in a plant organ (orange)
Week 8	triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis **Lab.** To estimate the amount of vitamin C in a plant organ (apple juice).
Week 09	**Vitamins:** General properties and role in metabolism. **Lab.** To estimate the amount of vitamin C in a plant organ (Lemon juice).
Week 10	Replication of DNA. Reverse transcription. Biosynthesis of DNA and RNA. **Lab.** To determine potential alkaloids in different plants.
Week 11	Genetic code, protein synthesis:

	initiation, elongation and termination. **Lab.** To determine potential alkaloids in different plants.
Week 12	Components of protein synthesis. **Lab.** To determine potential alkaloids in different plants.
Week 13	Aflatoxins, their nature and role **Lab.** To estimate terpenoids in different plants.
Week 14	Role of biochemistry **Lab.** To estimate terpenoids in different plants
Week 15	Biochemistry of enzymes **Lab.** To estimate terpenoids in different plants
Week 16	Secondary metabolites role (flavonoids) **Lab.** To estimate flavonoids in different plants

Reference Books (Updated Edition):

1. Conn E. E., & Stumpf, P. K. Outlines of Biochemistry, John Wiley and Sons Inc. New York.

DETAIL OF COURSES

FOR BS (4 – YEAR) IN BOTANY

4th Year Semester 7th	**Category**	**Course Code**	**Course Title**	**Credit Hours**
	Major-19	BOT-470	Analytical Techniques in Botany	3(2+1)
	Major-20	BOT-449	Field Botany	3(0+3)
	Major-21		Elective – II	3 (2+1)
	Major-22	BOT-415	Pteridophytes & Gymnosperms	3(2+1)
	Mandatory	BOT-598	Internship	3(0+3)
Total Credits				**15**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Analytical Techniques in Botany**	**Course Code:**	**BOT-470**
Credit Hours:	3(2+1)	**Pre-Requisite if any:**	**No**

Course Learning Objectives

- Understand the theoretical basis of analytical techniques used in modern botany.
- Acquire knowledge of classical and advanced microscopy methods for studying plant structure.
- Develop skills in applying spectroscopic and chromatographic techniques to analyze plant metabolites.
- Explore molecular analytical methods for DNA, RNA, and protein characterization.
- Apply integrative techniques in ecology and plant systematics, including isotopes and remote sensing.

Course Learning Outcomes

- Demonstrate proficiency in sample preparation, microscopy, and imaging of plant tissues,

- Apply UV-Vis, fluorescence, FTIR, Raman, and atomic spectroscopy in plant physiological studies,
- Perform chromatographic separation and analysis of plant metabolites (TLC, HPLC, GC),
- Conduct molecular-level experiments such as PCR, electrophoresis, sequencing, and protein profiling.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction & Basics: scope of analytical techniques, sampling methods, safety in plant research **Lab:** Orientation to lab equipment, safety protocols, sample collection & preparation
Week 2	Basic Microscopy: principles of light microscopy, staining techniques, slide preparation **Lab:** Preparation of temporary and permanent slides; staining with safranin and fast green
Week 3	Advanced Microscopy I: fluorescence microscopy, phase contrast, polarized microscopy **Lab:** Observation of plant tissues under phase contrast and fluorescence microscopes
Week 4	Advanced Microscopy II: SEM, TEM, confocal microscopy, live-cell imaging **Lab:** Demonstration of SEM/TEM micrographs; confocal imaging of stomata
Week 5	UV-Vis Spectroscopy: principles, analysis of photosynthetic pigments **Lab:** Extraction and quantification of chlorophyll using UV-Vis spectrophotometer
Week 6	Fluorescence & Luminescence Techniques: chlorophyll fluorescence, fluorescent dyes **Lab:** Measurement of chlorophyll fluorescence to assess photosynthetic efficiency
Week 7	Infrared (FTIR) & Raman Spectroscopy: metabolite analysis, stress physiology **Lab:** FTIR analysis of plant metabolites (leaf extracts)
Week 8	Atomic & Mass Spectroscopy: nutrient analysis, metabolite profiling **Lab:** Demonstration of atomic absorption spectroscopy for mineral content
Week 09	Chromatography I: principles, paper chromatography, TLC **Lab:** Separation of plant pigments using paper chromatography and TLC
Week 10	Chromatography II: HPLC – applications in phytochemistry **Lab:** HPLC demonstration for flavonoid separation
Week 11	Chromatography III: Gas Chromatography (GC), metabolomics **Lab:** Demonstration of GC analysis for volatile compounds
Week 12	Molecular Techniques I: DNA/RNA analysis, electrophoresis, PCR **Lab:** Agarose gel electrophoresis of DNA samples
Week 13	Molecular Techniques II: sequencing, DNA barcoding, applications in taxonomy **Lab:** DNA isolation and barcoding demo using PCR products
Week 14	Protein Analysis: SDS-PAGE, western blotting, immunoassays **Lab:** SDS-PAGE of plant proteins
Week 15	Ecological & Remote Sensing Tools: stable isotope analysis, GIS applications **Lab:** Use of GIS software to map vegetation distribution
Week 16	Integration & Future Perspectives: omics technologies, AI in plant sciences, course review **Lab:** Student group presentations and integration of multi-omics approaches

Reference Book (Updated Edition):

1. Evert, R. F. & Eichhorn, S. E. *Raven Biology of Plants* – A comprehensive plant biology reference with sections on microscopy, plant anatomy, and physiology.
2. Sharma, A. K. & Sharma, A. *Chromosome Techniques: Theory and Practice*. – Excellent for cytology and microscopy techniques in plant research.
3. Gupta, P. K. *Laboratory Manual of Analytical Techniques in Botany*. – Practical lab-focused guide with protocols and experiment details.
4. Jensen, W. A. *Botanical Histochemistry: Principles and Practice*. – Classic reference on staining and microscopy in plant sciences.
5. Hall, J. B. & Haworth, P. *Practical Plant Anatomy*. – Applied approaches to light and electron microscopy.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Field Botany**	**Course Code:**	**BOT-449**

WOMEN UNIVERSITY SWABI

Department of Botany

Credit Hours:	3(0+3)	**Pre-Requisite if any:**	**No**

Course Learning Objectives

- Introduce students to the diversity of plants in their natural habitats.
- Develop practical skills for identifying, classifying, and documenting plant species in the field.
- Understand ecological interactions and the role of plants in ecosystems.
- Provide training in field sampling, herbarium techniques, and ecological data collection.
- Encourage appreciation of plant biodiversity and its conservation.

Course Learning Outcomes

- Identify and classify common plant species in natural habitats,
- Demonstrate proficiency in field sampling and plant specimen collection,
- Prepare herbarium specimens and maintain proper field records.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**Lab:** Introduction to Field Botany – scope, safety, importance Orientation to field tools and safety measures
Week 2	**Lab:** Tools & Techniques for Field Study – presses, GPS, field notebooks Training in plant pressing and field note-taking
Week 3	**Lab:** Plant Identification – use of guides, floras, keys Practice with dichotomous keys for common plants
Week 4	**Lab:** Plant Taxonomy in the Field – family-level identification Identifying 5–10 families in the field
Week 5	**Lab:** Vegetation Analysis Methods – quadrats, transects Quadrat sampling in a local vegetation patch
Week 6	**Lab:** Ecological Data Collection – frequency, density, dominance, IVI Field survey and IVI calculation for a plant community
Week 7	**Lab:** Field Visit I – local flora survey Identification and collection of 20 local species
Week 8	**Lab:** Herbarium Techniques – pressing, drying, labeling Preparation of herbarium specimens
Week 09	**Lab:** Field Visit II – grassland/forest ecosystem Vegetation sampling in grassland/forest habitat
Week 10	**Lab:** Ethnobotany – documenting plant uses Interviews with local communities on medicinal plants
Week 11	Field Visit III – aquatic/marshland vegetation survey **Lab:** Identification of hydrophytes and marshland species
Week 12	**Lab:** Plant Adaptations in Different Habitats – xerophytes, hydrophytes, halophytes Field observation of adaptive features in plants
Week 13	**Lab:** Field Visit IV – mountainous/protected area flora Collection and documentation of high-altitude species
Week 14	**Lab:** Biodiversity Assessment – conservation status evaluation Diversity indices calculation from field data
Week 15	**Lab:** Student Group Projects – field reports and presentations Group fieldwork data analysis and report writing
Week 16	**Lab:** Integration & Review – applications of field botany Final field presentations and wrap-up discussions

Reference Books (Updated Edition):

1. Sharma, O. P. Plant Taxonomy. Tata McGraw-Hill.
2. Mueller-Dombois, D. & Ellenberg, H. Aims and Methods of Vegetation Ecology. Blackburn Press.

3. Simpson, M. G. Plant Systematics (3rd ed.). Academic Press.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Pteridophytes & Gymnosperms**	**Course Code:**	**BOT-315**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To study the structure, reproduction, and evolution of pteridophytes and gymnosperms.
- To understand the ecological and economic significance of vascular cryptogams and gymnosperms.
- To trace evolutionary trends from simple to complex vascular plants.

Course Learning Outcomes:

- Differentiate between pteridophytes and gymnosperms,
- Describe their morphology, anatomy, and reproduction,
- Interpret their evolutionary significance and fossil records.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to vascular plants: significance and classification. **Lab** Orientation, lab safety, introduction to plant specimens.
Week 2	General characteristics of pteridophytes, life cycle patterns. **Lab** Observation of pteridophyte specimens.
Week 3	Psilopsida (Psilotum). **Lab** Slide study of Psilotum anatomy
Week 4	Lycopsida (Lycopodium, Selaginella). **Lab** Observation of heterospory in Selaginella.
Week 5	Sphenopsida (Equisetum). **Lab** Study of strobilus and anatomy of Equisetum.
Week 6	Pteropsida (Ferns). **Lab** Observation of sori and sporangia in Pteris.
Week 7	Fossil pteridophytes **Lab** Diagrammatic study of fossil pteridophytes.
Week 8	Economic importance of pteridophytes. **Lab** Diagrammatic study of fossil pteridophytes.
Week 09	General characters of gymnosperms, classification. **Lab** Observation of gymnosperm cones.
Week 10	Cycadales (Cycas). **Lab** Study of Cycas leaf, stem, and coralloid roots.
Week 11	Coniferales (Pinus, Cedrus). **Lab** Observation of Pinus needle cross-section.
Week 12	Ginkgoales (Ginkgo biloba). **Lab** Morphological study of Ginkgo leaves.
Week 13	Gnetales (Ephedra, Gnetum). **Lab** Observation of Ephedra stem, Gnetum leaves.
Week 14	Fossil gymnosperms. **Lab** Fossil plant specimens or models.
Week 15	Economic importance of gymnosperms. **Lab** Collection and identification of plant products (resins, cones).
Week 16	Comparative study of Pteridophytes & Gymnosperms.

	Lab Final practical exam and submission of lab record.

Reference Books (Updated Edition):

1. Stewart, W.N., Rothwell, G.W. *Paleobotany and the Evolution of Plants*. Cambridge University Press.
2. Rashid, A. *An Introduction to Pteridophyta*. Vikas Publishing.

DETAIL OF COURSES
FOR BS (4 – YEAR) IN BOTANY, 4th Year

	Category	Course Code	Course Title	Credit Hours
8th Semester	Major-23	BOT-469	Plant Biotechnology	3(2+1)
	Major-24	BOT-478	Economic & Industrial Botany	3(3+0)
	Major-25	BOT-475	Evolutionary Trends in Plants	3(2+1)
	Major-26	BOT-373	Elective – III	3
	Mandatory	BOT-599	Capstone Project	3
	Total Credits			**15**

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Plant Biotechnology**	**Course Code:**	**BOT-469**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning objectives:

- Understand the fundamentals of plant biotechnology, including its scope, history, and role in sustainable agriculture, and environment.
- Demonstrate knowledge of plant tissue culture techniques**,** such as media preparation, sterilization, and micropropagation.
- To study plant cell biology, and crop improvement strategies.

Course Learning Outcomes:

- Explain the fundamental concepts, history, and scope of plant biotechnology,
- Describe genetic engineering methods in plants, including Agrobacterium-mediated and direct gene transfer techniques,
- Utilize molecular tools such as DNA isolation, PCR, and molecular markers for plant biotechnology research.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Definition, scope, and importance of plant biotechnology **Lab:** Observation of plant cells and tissues under compound and stereo microscopes.

Week 2	Ethical, legal, and social issues in biotechnology **Lab:** Preparation of a biosafety guideline chart for handling genetically modified organisms (GMOs).
Week 3	Principles and techniques of plant tissue culture **Lab:** Isolation of genomic DNA from plant tissue
Week 4	Sterilization methods and aseptic techniques **Lab:** Adjustment of pH and sterilization by autoclaving
Week 5	Culture media: types and preparation **Lab:** Preparation of Murashige & Skoog (MS) medium
Week 6	Recombinant DNA technology and cloning vectors **Lab:** Agarose gel electrophoresis of DNA samples
Week 7	Transgenic plants: production and applications **Lab:** DNA isolation and PCR analysis for detection of transgenes
Week 8	Marker genes and reporter genes **Lab:** Screening of transformed explants using antibiotic resistance markers
Week 09	Types of molecular markers **Lab:** Isolation of genomic DNA from plant leaves for marker analysis
Week 10	Applications of genomics in crop improvement **Lab:** Demonstration of PCR-based marker analysis for trait selection
Week 11	Production of biofuels and bioplastics **Lab:** Preparation of starch-based biodegradable plastic film
Week 12	Phytoremediation and environmental biotechnology **Lab:** Demonstration of pollutant removal using duckweed
Week 13	Plant cell culture for pharmaceuticals and industrial enzymes **Lab:** Use of bacteria or algae for decolorization of dye-containing water
Week 14	Biosafety levels, risk assessment, and regulation of GM crops **Lab:** Preparation of a biosafety chart showing BSL-1 to BSL-4 with examples in plant research
Week 15	Synthetic biology and systems biology approaches **Lab:** Analysis of transcriptomic or proteomic datasets to identify regulatory genes
Week 16	Role of plant biotechnology in sustainable agriculture **Lab:** Isolation and study of *Rhizobium* from legume root nodules

Reference Books (Updated Edition):

1. Kung, S. D., & Arntzen, C. J. *Plant Biotechnology: Biotechnology* (Vol. 11). Elsevier.
2. Gresshoff, P. M. *Plant biotechnology and development*. CRC Press.
3. Bahadur, B., Rajam, M. V., Sahijram, L., & Krishnamurthy, K. V. *Plant biology and biotechnology* (pp. 361-383). New Delhi: Springer.

COMPREHENSIVE COURSE CONTENTS

Course Title:	Economic and Industrial Botany	**Course Code:**	**BOT-426**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning objectives:

- Understand the scope of economic and industrial botany by identifying the relationship between plants, human society, and industries.
- Classify major groups of plants of economic value.

Course Learning Outcomes:

- Identify major economically important plants and their uses,
- Understand the industrial significance of plant-based resources,

- Develop awareness about sustainable use and conservation of biodiversity

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Definition, Scope, and importance of Economic & Industrial Botany; Classification of economically useful plants **Lab:** Identification of economically important plants
Week 2	Cereals & Millets; Pulses & Legumes; Fruits & Nuts **Lab:** Comparative Study of Seed Morphology
Week 3	Timber and Non-timber forest products **Lab:** Study of plant products (Fibers, Oils)
Week 4	Industrial and commercial crops; Fibers; Sugar and Starch crops **Lab:** Extraction of starch, Oils and sugars
Week 5	Importance of medicinal plants in Ayurveda, and Unani **Lab:** Phytochemical Screening and Antioxidant Assay of Medicinal plants used in Ayurveda and Unani
Week 6	Pharmaceutical applications of medicinal, aromatic plants, and essential oils **Lab:** Phytochemical Screening of Bioactive Compounds from Medicinal Plants
Week 7	Role of plants in landscaping and gardening **Lab:** Identification of Ornamental Plants Used in Landscaping
Week 8	Beverages; Spices and Condiments, Ornamental plants **Lab:** Comparative Analysis of Polyphenols in Beverages
Week 09	Plant-based biofuels & renewable energy **Lab:** Production of Biodiesel from Vegetable Oils
Week 10	Industrial enzymes & biotechnology from plants **Lab:** Production of Plant-based Enzymes for Industrial Applications
Week 11	Plant-based polymers; Plant resources in cosmetics & nutraceuticals **Lab:** Extraction and Characterization of Starch as a Natural Polymer
Week 12	Threats to economically important plants **Lab:** Identification of Insect Pests and Their Damage Symptoms on Economically Important Crops
Week 13	Germplasm conservation: ex situ & in situ methods **Lab:** Seed Collection, Processing, and Storage for Conservation
Week 14	Botanical gardens; seed banks; tissue culture **Lab:** Identification of Plant Diversity in a Botanical Garden
Week 15	Sustainable utilization of plant resources **Lab:** Identify a wild useful plants
Week 16	Role of plants in sustainable industries **Lab:** Extraction of essential oil.

Reference Books (Updated Edition):

1. Kochhar, C. L. *Textbook of Economic Botany*. Cambridge University Press India. Good for fundamentals, classification, and industrial applications.
2. Kochhar, S. L. *Economic botany*. Cambridge University Press.
3. Wickens, G. E. *Economic botany: principles and practices*. Springer Science & Business Media.
Levetin, E., & McMahon, K. *Plants and society* McGraw-Hill Education.

COMPREHENSIVE COURSE CONTENTS

Course Title:	Evolutionary Trend in Plants	**Course Code:**	**BOT-475**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning objectives:

- Explain the major evolutionary trends in vegetative and reproductive organs of plants, especially in angiosperms.
- Assess evolutionary trends in pollination, fertilization, and seed development in relation to plant diversity and adaptation.
- Utilize fossil records, morphological features, and phylogenetic data to trace evolutionary lineages in plants.

Course Learning Outcomes:

- Identify and differentiate primitive and advanced morphological characters in angiosperms,
- Analyze evolutionary modifications in leaves, stems, flowers, fruits, and seeds with examples,
- Evaluate evolutionary hypotheses related to Heterobathmy, mosaic evolution, and parallel evolution.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Origin of life and early photosynthetic organisms **Lab:** Isolation and microscopic identification of cyanobacteria from local water
Week 2	Geological time scale and major plant evolutionary events **Lab:** Mapping the Evolution of Vascular and Seed Plants Through Time
Week 3	Primitive plants: Algae and Bryophytes as evolutionary markers **Lab:** Examine primitive types using specimens and diagrams
Week 4	Concept of progressive evolution in plants **Lab:** Microscopic study of pollen grains
Week 5	Evolutionary trends in thallus organization, reproduction, and life cycles **Lab:** Microscopic Examination of Gametophyte and Sporophyte Stages
Week 6	Bryophytes: Origin and evolution; gametophyte sporophyte relationship; progressive elaboration of sporophyte **Lab:** Microscopic Observation of Gametophytic and Sporophytic Phases in Bryophytes
Week 7	Pteridophytes: Evolutionary trends in sporophyte; stelar system; leaf evolution **Lab:** Comparative Morphology of Microphylls and Megaphyll in Pteridophytes
Week 8	Origin and evolution of gymnosperms: conifers, ginkgo, gnetales **Lab:** Microscopic Examination of Gymnosperm Wood Anatomy
Week 09	Evolutionary trends in flowers: perianth differentiation, symmetry, fusion of floral parts **Lab:** Observation of underground aerial and subaerial modifications as evolutionary adaptations.
Week 10	Fruit evolution: simple, aggregate, multiple, dry, and fleshy types **Lab:** Comparative analysis of dry fruits and their dispersal mechanisms
Week 11	Fossil record and its significance in tracing plant evolution **Lab:** Microscopic Examination of Fossilized Plant Tissues
Week 12	Paleobotanical evidence of evolutionary trends **Lab:** Observe a collection of macrofossils from different geological periods
Week 13	Molecular phylogeny and systematics: DNA sequencing, cladistics, and phylogenetic trees **Lab:** Extraction of DNA
Week 14	Evolutionary adaptations to terrestrial life **Lab:** Observing the function of the waxy cuticle
Week 15	Evolution of photosynthetic pathways (C3, C4, CAM) **Lab:** Observe the differences between Kranz anatomy in C4 plants and standard leaf anatomy in C3 plants.
Week 16	Plant evolution and ecosystem development **Lab:** Collect and analyze soil samples from different areas to investigate the relationship between soil properties and the types of plants and vegetation present

Reference Books (Updated Edition):

1. Minelli, Alessandro. *Plant Evolutionary Developmental Biology: The Evolvability of the Phenotype.* Cambridge, UK: Cambridge University Press.
2. Takhtajan, Armen. *Evolutionary Trends in Flowering Plants.* New York: Columbia University Press

ELECTIVE COURSES

COMPREHENSIVE COURSE CONTENTS

Course Title:	***Environmental Biology***	**Course Code**	**BOT-343**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:
- To provide updated knowledge of major environmental problems
- To provide updated knowledge of Sustainable environmental management.

Course Learning Outcomes:
- To understand major environmental problems,
- To understand sustainable environmental management

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Environment: Introduction, scope, pressure **Lab.** Examination of industrial waste water and Municipal sewage and sludge for pH and EC
Week 2	Pollution: definition, classification and impact on habitats **Lab.** Examination of industrial waste water and Municipal sewage and sludge for pH and EC
Week 3	Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, remediation. Photochemical smog. Smog. **Lab.** Examination of industrial waste water and Municipal sewage and sludge for pH and EC
Week 4	Acid rain: 1. Theory of acid rain, 2. Adverse effects of acid rains. Chlorofluorocarbons and its effects. **Lab.** Examination of industrial waste water and Municipal sewage and sludge for pH and EC
Week 5	Water pollution: Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, thermal Pollution. **Lab.** Examination of industrial waste water and Municipal sewage and sludge for i. Total dissolved solids.
Week 6	Sediments pollution: fungicide, pesticides, herbicide, major sources of soil **Lab.** Examination of industrial waste water and Municipal sewage and sludge for Chlorides, carbonate, and Nitrates
Week 7	Pollution and its impact. Prevention, control remediation. Impact assessment: Industrial urban, civil developments. **Lab.** Examination of water samples forms different sites for the presence and diversity of organisms.
Week 8	Heavy metals Pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and Polluted waters. **Lab.** Examination of water samples forms different sites for the presence and diversity of organisms.

Week 09	Radiation pollution (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal **Lab.** Effect of air pollution on plants
Week 10	**Forest:** importance, deforestation, desertification and conservation, **National conservation strategy:** Brief review of major problems of Pakistan and their solutions. **Lab.** Study of sanctuaries and conservation parks in Pakistan
Week 11	**Ozone layer:** i. Formation ii. Mechanism of depletion ii. Effects of ozone depletion **Lab.** Study of sanctuaries and conservation parks in Pakistan
Week 12	Greenhouse effect and global warming: causes, impacts, Human population explosion: impact on environment. **Lab.** Study of effects of green house
Week 13	Sustainable Environmental management. **Lab.** Sustainable Environmental management techniques
Week 14	Wetlands and sanctuaries protection: The pressures, problems and solutions**.** Study of wetlands
Week 15	**Range management:** Types of rangelands, potential threats, sustainable Management. **Lab.** Visit to industrial areas
Week 16	**Aerobiology** (Pollen allergy & dust allergy). **Lab.** Visit to industrial areas

Reference Books (Updated Edition):

1. Santra, S. C. Fundamentals of ecology and environmental biology – New Central Book Agency; London; 2010 - 353p.
2. Newman, E. I. Applied Ecology. Blackwell Science. UK
3. Mooney, H. A. & Saugier, B. Terrestrial Global Productivity. Academic Press, UK.
4. Eugene, E. D. & Smith, B. F. Environmental Science: A study of interrelationships. McGraw-Hill. USA.

COMPREHENSIVE COURSE CONTENTS

Course Title:	***Plant Disease Management***	**Course Code:**	**BOT-373**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To introduce the students to plant disease management practices
- To introduce the students to different plant disease types

Course Learning Outcomes:

- To introduce the students to various plant disease and their management practices,
- To understand various principles of disease management.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Principles of Plant Disease management
Week 2	Methods based on avoidance, exclusion, eradication of pathogens, protection (preventive and curative) and resistance (pathogen derived resistance, host resistance) **Lab.** Demonstration of different disease management practices;

Week 3	Management of plant diseases with emphasis on regulatory, cultural, biological, physical and chemical strategies **Lab.** Demonstration of different disease management practices;
Week 4	Induced systemic resistance, Demonstration of different disease management practices; **Lab.** Demonstration of different disease management practices;
Week 5	Equipments and machinery used for disease management and their calibration; **Lab.** safety measures for disease managing chemicals; handling and application procedures;
Week 6	Equipments and machinery used for disease management and their calibration; **Lab.** safety measures for disease managing chemicals; handling and application procedures
Week 7	safety measures for disease managing chemicals; handling and application procedures; **Lab.** safety measures for disease managing chemicals; handling and application procedures
Week 8	Crop Agro Ecosystem Analysis, Histon **Lab.** safety measures for disease managing chemicals; handling and application procedures
Week 9	Crop Agro Ecosystem Variations Analysis (history and types) **Lab.** safety measures for disease managing chemicals; handling and application procedures
Week 10	Philosophy of TOF (Training of Facilitators) and FFS (Farmer Field School) **Lab.** Crop Agro Ecosystem Analysis
Week 11	Seed health certification system **Lab.** Crop Agro Ecosystem Analysis
Week 12	Seed health certification system **Lab.** Crop Agro Ecosystem Analysis
Week 13	Integrated disease management (IDM) **Lab.** Crop Agro Ecosystem Analysis
Week 14	Epidemiological basis of disease management strategies **Lab.** safety measures for disease managing chemicals; handling and application procedures;
Week 15	Concept of field biodiversity; conservation and crop appraisal **Lab.** Crop Agro Ecosystem Analysis
Week 16	**Viral and bacterial disease and its management** **Lab.** Crop Agro Ecosystem Analysis
Week 17	Fungal disease and its management **Lab.** Crop Agro Ecosystem Analysis

Reference Books (Updated Edition):

1. Ahmad, I. & Bhutta, A.R. Textbook of Introductory Plant Pathology. National Book Foundation, Islamabad, Pakistan.
2. Bhutta, A.R. Text book of Introductory Seed Pathology. HEC, Pakistan.
3. Gadewarr, A.V. Plant Protection in New Millennium. Hardcover Publisher.
4. Helyer, N., Brown, K. &Cattlin, N.A. Biological Control in Plant Protection (A Colour Hand Book). Manson Publication Ltd, London, UK.
5. Agrios. G.N. Plant Pathology Academic Press New York.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Phytogeography**	**Course Code:**	**BOT: 446**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:

- To introduce the students to the principles of phytogeography and its significance in botany.
- To study the distribution of plants across the globe and the ecological factors influencing it.
- To understand different types of vegetation and floristic regions of the world and Pakistan.
- To develop skills in field observation, plant mapping, and vegetation analysis.
- To encourage conservation awareness and highlight the importance of biodiversity in ecosystems.

Course Learning Outcomes:

- Define phytogeography and explain its scope and applications,
- Identify and classify vegetation types of different regions,
- Analyze the role of climate, soil, altitude, and biotic factors in plant distribution,
- Differentiate between floristic regions of the world and Pakistan.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to phytogeography: definition, history, and scope **Lab** Orientation, safety, and introduction to lab equipment
Week 2	Basic concepts: plant distribution, endemism, cosmopolitan species **Lab** Identification of local wild plants
Week 3	Factors affecting plant distribution: climatic factors **Lab** Measuring temperature, humidity, and light in the field
Week 4	Edaphic (soil) and topographic factors in plant distribution **Lab** Simple soil analysis (pH, texture)
Week 5	Biotic factors: role of animals, humans, and competition in plant spread **Lab** Survey of grazing/browsing effects on vegetation
Week 6	Major vegetation types of the world (forests, grasslands, deserts, tundra) **Lab** Drawing vegetation maps
Week 7	Floristic regions of the world (Good's and Takhtajan's classifications) **Lab** Group project: chart/model of floristic regions
Week 8	Floristic regions of the world (Good's and Takhtajan's classifications) (continue) **Lab** Group project: chart/model of floristic regions
Week 09	Phytogeography of Pakistan: main plant regions (Himalayan, Baluchistan, Indus plain, coastal areas) **Lab** Field visit to a local vegetation site
Week 10	Endemism and biodiversity hotspots in Pakistan **Lab** Species frequency & density using quadrat method
Week 11	Migration, dispersal, and succession of plants **Lab** Seed dispersal observation (wind, water, animals)
Week 12	Human impacts: deforestation, urbanization, agriculture **Lab** Case study discussion: deforestation in northern Pakistan
Week 13	Conservation of vegetation and protected areas (national parks, reserves) **Lab** Visit to botanical garden or herbarium/ National Parks.
Week 14	Applied phytogeography: agriculture, forestry, climate change **Lab** Data analysis of vegetation survey
Week 15	Recent advances: GIS and remote sensing in vegetation mapping **Lab** Demonstration: use of Google Earth / maps for vegetation study
Week 16	Course review and final exam preparation **Lab** Final practical: vegetation report submission

Reference Books (Updated Edition):

1. Cox, C.B., Moore, P.D. & Ladle, R.J. Biogeography: An Ecological and Evolutionary Approach. Wiley
2. Lomolino, M.V., Riddle, B.R., Whittaker, R.J. Biogeography. Sinauer Associates.
3. Malik, S. Plant Geography. Ilmi Kitab Khana, Lahore (local reference).

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Molecular Genetics**	**Course Code:**	**BOT-384**
Credit Hours:	**3(2+1)**	**Pre-Requisite if any:**	

Course Learning Objectives:
- To understand the nature and function of genetic material
- To understand the Structure of DNA

Course Learning Outcomes:
- Know the Nature of the Gene,
- Understand the role of genetics in Recombinant Technology

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	**Extensions of Mendelian Analysis:** Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and Expressivity
Week 2	**Linkage I: Basic Eukaryotic Chromosome Mapping :** The discovery of linkage, recombination, linkage symbolism, **Lab: Arrangement of genetic material**: Linkage and recombination
Week 3	Linkage of genes on the X chromosome, linkage maps, three-point testcross, interference, linkage mapping by recombination in humans **Lab: Arrangement of genetic material**: Gene mapping in diploid
Week 4	**Linkage II:** Special Eukaryotic Chromosome Mapping Techniques: **Lab:** Arrangement of genetic material: Recombination in Fungi.
Week 5	Accurate calculation of large map distances, analysis of single meiosis, mitotic Segregation and recombination, mapping human chromosomes. **Lab: Arrangement of genetic material**: Recombination in bacteria.
Week 6	**Recombination in Bacteria and their Viruses:** Bacterial chromosome, **Lab. Arrangement of genetic material**: Recombination in viruses.
Week 7	Bacterial conjugation, bacterial recombination and mapping the E.coli chromosome **Lab. Population Genetics:** Gene frequencies and equilibrium.
Week 8	Bacterial transformation, bacteriophage genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer. **Lab: Population Genetics**: Changes in gene frequencies
Week 09	The Structure of DNA: DNA: The genetic material, DNA replication in Eukaryotes, DNA and the gene **Lab:** Drosophila: Culture technique
Week 10	**The Nature of the Gene:** How genes work, gene- protein relationships, genetic observations explained by enzyme structure **Lab.** Drosophila: Culture technique
Week 11	Genetic fine structure, mutational Sites, complementation. **Lab: Drosophila:** Salivary gland chromosome
Week 12	**DNA Function:** Transcription **Lab: Fungal Genetics**: Saccharomyces culture techniques and study
Week 13	**Translation,** the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA **Lab**: Studies on variation in maize ear size and color variation

Week 14	**The Extranuclear Genome:** Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochrondrial genes in yeast, extragenomic plasmids in eukaryotes. **Lab.** Bacterial cultural techniques, Gram staining (E. coli, B. subtilis)
Week 15	**Developmental Genetics:** Gene Regulation and Differentiation, Crown gall Disease in plants, cancer as a developmental genetic disease**.** **Lab**. Bacterial Genetics: Transformation.
Week 16	**Population Genetics:** Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium. **Lab**. Bacterial Genetics: Conjugation.

Reference Books (Updated Edition):

1. Synder, L., & Champness, W. Molecular Genetics of Bacteria. ASM Press, Washington D. C.
2. Gardner, E. J., Principles of Genetics, John Willey and Sons, New York.
3. Ringo, J. Fundamental Genetics, Cambridge University Press.
4. Daniel H. Genetics Johns and Bartlett Publishers.
5. David H. Introduction to Genetic principles. McGraw-Hill.
6. Daniel, L.H., Elizabeth W. J. Analysis of genes and genomes.

COMPREHENSIVE COURSE CONTENTS

Course Title:	**Forensic Botany**	**Course Code:**	**BOT-221**
Credit Hours:	3(2+1)	**Pre-Requisite if any:**	**No**

Course Learning Objectives

- Understand the role of botany in forensic investigations and legal systems.
- Identify, analyze, and preserve plant evidence from crime scenes.
- Apply microscopic, anatomical, chemical, and molecular techniques for forensic plant identification.
- Use ecological and environmental indicators in forensic cases (e.g., time of death, body relocation).
- Develop practical skills in handling botanical samples with proper chain of custody.

Course Learning Outcomes

- Collect and document plant evidence following forensic protocols.
- Identify plant species through morphology, anatomy, palynology, and DNA barcoding,
- Apply microscopy, chromatography, and molecular tools in forensic investigations.

Course Contents (week wise break up):

Weeks	Topics to Cover
Week 1	Introduction to Forensic Botany: scope, history, applications in law Lab: Introduction to forensic lab safety, handling of plant evidence
Week 2	Crime Scene Investigation: sampling, documentation, chain of custody Lab: Collection & preservation of plant materials from simulated crime scenes
Week 3	Morphological Evidence: leaves, stems, seeds, fruits Lab: Identification of unknown plant samples using morphological keys
Week 4	Microscopic Evidence: plant tissues, fibers, stomata, trichomes Lab: Microscopic examination of fibers, stomatal patterns, and epidermal peels
Week 5	Palynology: pollen and spores in forensic studies Lab: Pollen isolation and microscopic identification from dust/soil samples
Week 6	Wood & Timber Identification: forensic aspects, illegal logging cases

	Lab: Wood anatomy analysis using thin sections
Week 7	Algae, Fungi, & Bryophytes in Forensics (e.g., drowning cases, soil links) Lab: Algal and fungal evidence from water/soil samples
Week 8	DNA Barcoding & Molecular Tools: plant identification in forensics Lab: DNA extraction and PCR amplification of plant material
Week 09	Chromatography in Forensics: TLC, HPLC, phytochemical profiling Lab: TLC separation of plant pigments or toxins
Week 10	Poisonous & Toxic Plants: detection in forensic cases Lab: Detection of alkaloids/phenolics using simple tests
Week 11	Drugs of Plant Origin: narcotics, hallucinogens, legislation Lab: Microscopic & chemical tests for plant-based drugs
Week 12	Soil & Plant Ecology in Forensics: linking suspects to crime scenes Lab: Comparative soil and vegetation sampling for site differentiation
Week 13	Plant-Based Estimation of PMI (Post-Mortem Interval) Lab: Study of plant growth stages around mock graves
Week 14	Remote Sensing & GIS in Forensic Botany Lab: GIS software demonstration for mapping crime scenes
Week 15	Report Writing & Courtroom Presentation Lab: Preparation of mock forensic botany report
Week 16	Future Directions: omics, AI, databases in forensic botany; course review Lab: Student seminar presentations on forensic case studies

Reference Books (Updated Edition)

1. Coyle, H. M. *Forensic Botany: Principles and Applications to Criminal Casework*. CRC Press.
2. Bock, J. H., & Norris, D. O. *Forensic Plant Science*. Academic Press.
3. Miller Coyle, H., et al. *Botanical Evidence in Forensic Science: Applications in Criminal Casework*. Routledge.