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Office of the
Deputy Director
Curriculum Division

No. HEC/CD/NCRC/BOTANY/2024/6284
July 22, 2024

SUBJECT: REVISED CURRICULUM FOR DEGREE PROGRAMS IN BOTANY

The Higher Education Commission (HEC) of Pakistan is mandated by its law to provide guidance to Pakistani Higher Education Institutions (HEIs) on curricula for tertiary education levels as outlined in the National Qualifications Framework (NQF). In response to the dynamic academic trends and evolving market demands, HEC in collaboration with Pakistan Academy of Sciences (PAS), has revised curricular standards for Botany degree programs at NQF levels 5, 6 and 7. These standards are not only intricately aligned with the HEC's Undergraduate Education Policy V 1.1 (2023) and Graduate Education Policy (2023) but also ensure coherence with both national priorities and international standards.

2. With the cooperation of universities in implementation of these curricular standards, HEC envisions a future where Pakistani graduates in Botany lead in scientific discovery and technological innovation thereby contributing significantly to societal progress on both national and global fronts.

3. In light of the foregoing, the revised curricula for Botany degree programs (enclosed) are hereby notified for adoption and implementation by all universities offering programs in the said discipline at the **earliest**. Electronic copy of the document is available on HEC's website.

MUHAMMAD ALI BAIG

Vice Chancellors/Rectors/Heads
All Public/Private Sector Universities/DAIs

Copy for information to:

i. ES to Chairman, Higher Education Commission, Islamabad
ii. ES to Executive Director, Higher Education Commission, Islamabad
iii. PS to Advisor Academics, Higher Education Commission, Islamabad
iv. PS to Secretary General, Pakistan Academy of Sciences, Islamabad
v. PS to Director General, Quality Assurance Division, Higher Education Commission, Islamabad
vi. PS to Director General, A&A Division, Higher Education Commission, Islamabad
vii. PS to Director General, Higher Education Data Repository, Higher Education Commission, Islamabad
viii. In-charge, Higher Education Commission, Regional Centers in Karachi, Lahore, Peshawar & Quetta

CURRICULUM FOR

BOTANY

ASSOCIATE DEGREE | BACHELOR OF SCIENCE
MASTER OF SCIENCE

2024

A COLLABORATIVE VENTURE OF
HIGHER EDUCATION COMMISSION & PAKISTAN ACADEMY OF SCIENCES
GOVERNMENT OF PAKISTAN

CURRICULUM FOR

BOTANY

DEGREE PROGRAMS

2024

Prepared by:
SUBJECT EXPERTS
Different Universities

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Preface

The curriculum serves as a comprehensive blueprint for the teaching-learning process that students must navigate to achieve specific academic objectives. This encompasses a scheme of studies, clearly defined objectives, scheme of studies and learning outcomes. As knowledge rapidly evolves and new fields emerge, it is crucial to continually develop and revise curricula to ensure they remain current, relevant, and impactful.

As mandated by its law through Clause 10-1 (a), (l), (s) and (v), the Higher Education Commission (HEC) of Pakistan has been developing and periodically updating curricula through its National Curriculum Revision Committees (NCRCs). These committees are composed of subject matter experts, researchers, and representatives from accreditation bodies, professional councils, and industry stakeholders. In response to these evolving needs, HEC, in collaboration with the Pakistan Academy of Sciences (PAS), has undertaken the task of developing robust standards for the curricula of degree programs in Botany, at levels 5, 6, and 7 of the National Qualifications Framework. These standards are meticulously structured in accordance with the HEC's Undergraduate Education Policy V 1.1 (2023) and Graduate Education Policy (2023), ensuring alignment with both national priorities and international educational standards. The degree programs in Botany are designed with the aim to equip students with cutting-edge knowledge and practical skills, fostering innovation and research to address Pakistan's unique challenges in agriculture, environmental conservation, and sustainable development.

It is our hope that this document, developed by dedicated subject experts from across the country, will not only fulfill our national educational and economic requirements but also elevate the competency levels of our graduates.

With support of varsities in implementation of these curricular standards, HEC envisions a future where Pakistani graduates in Botany are at the forefront of scientific discovery and technological innovation, driving progress and contributing to the betterment of society both nationally and internationally.

Engr. Muhammad Raza Chohan
Advisor Academics

Guiding Principles

MINIMUM STANDARDS

The curricular standards and guidelines prescribed in this document are mandatory at minimum level only. Universities or the concerned departments may however set higher standards provided that the standards prescribed here are not reduced or compromised.

COURSE SEQUENCE, TITLES & CREDITS

For Bachelor of Science (BS) and Master of Science (MS) in Botany, the sequence of courses prescribed in this document is logically arranged and is suggestive only. The offering department may rearrange the sequence and alter the course titles and credits provided that the essence of the courses prescribed in this document remains intact. The department may add more courses as and when required in accordance with HEC guidelines and subject to approval of university's relevant statutory body.

COURSE SYLLABUS

This document serves as a comprehensive guideline delineating the course learning outcomes (CLOs) for each course offered in the Bachelor of Science (BS) and Master of Science (MS) in Botany as minimum standards. The offering department may prepare, modify, and tailor the syllabus of each course, ensuring alignment with the given learning outcomes in this document. It is in this regard imperative that the department utilizes instructional, reference, and reading materials that it deems appropriate to effectively meet the learning outcomes.

GENERAL EDUCATION

For Bachelor of Science (BS) in Botany, the courses prescribed for General Education component must mandatorily be offered with the same titles and credits as prescribed in the HEC Undergraduate Education Policy V 1.1. The concerned departments may adopt and follow the learning outcomes and study contents developed by HEC for these courses as available on its website. The requirement of general education is not applicable for Master of Science (MS) in Botany.

REQUIREMENT FOR INTERNSHIP

Internship of three (03) credit hours is a mandatory degree award requirement for Bachelor of Science (BS) in Botany. This requirement is of six (06) to eight (08) weeks (preferably undertaken during semester or summer break) and must be graded by a faculty member in collaboration with the supervisor in the field. It cannot be substituted with additional course work, capstone or project work.

REQUIREMENT FOR CAPSTONE PROJECT

Capstone project of three (03) credit hours is a mandatory degree award requirement for Bachelor of Science (BS) in Botany. A capstone project is a multifaceted body of work that serves as a culminating academic and intellectual experience for students, which may also be in the form of a research report or thesis. It must be supervised and graded by a faculty member as per the protocols prescribed by the concerned department. This requirement cannot be substituted with additional course work or internship.

ASSOCIATE DEGREE IN BOTANY

The eligibility criteria and the first-four semesters of the Bachelor of Science (BS) in Botany as prescribed in this document guide the admission requirement and the structure of Associate Degree in Botany. Field experience / internship is not a mandatory requirement for the Associate Degree in Botany.

ENTRY & EXIT PROVISIONS

Pathway for Candidates with 12 Years of Education

Students having completed 12 years of education are allowed admission in the Associate Degree or Bachelor of Science (BS) in Botany subject to meeting the eligibility criteria prescribed in this document.

Pathway for Candidates with Associate Degrees

- Students having completed Associate Degree in Botany are allowed admission in the fifth semester of the Bachelor of Science (BS) in Botany with or without any deficiency course up-to a maximum of 6 credit hours as determined by the admitting university / department.
- Students having completed Associate Degree in any discipline within the fields of Biological Sciences, Allied Health Sciences, Environmental Science, Veterinary Sciences, Pharmaceutical Science, Food Sciences and Agricultural Sciences shall be required to complete deficiency courses up-to a maximum of 18 credit hours as determined by the admitting university / department in order to be considered for admission in the fifth semester of the Bachelor of Science (BS) in Botany.
- The minimum eligibility for admission in the fifth semester in above cases is 2.00/4.00 CGPA in the prior qualification i.e., Associate Degree. The admitting university may, however, set higher eligibility criteria for admission in the fifth semester of Bachelor of Science (BS) in Botany.

Pathway for Candidates with Conventional BSc / Equivalent Degree Programs

- ·Students having completed two-year conventional BSc / equivalent degree programs are allowed admission in the fifth semester of Bachelor of Science (BS) in Botany in which case, such students shall be required to complete deficiency courses up-to a maximum of 21 credit hours as determined by the admitting university.
- ·The minimum eligibility for admission in the fifth semester in this case is 45% cumulative score in the prior qualification i.e., two-year conventional BSc / equivalent degree programs. The admitting university may however set higher eligibility criteria for admission in the fifth semester of Bachelor of Science (BS) in Botany.

Exit from Bachelor of Science (BS) in Botany with the Associate Degree

Students enrolled in Bachelor of Science (BS) in Botany are allowed to exit the program with the Associate Degree provided that the requirements specified for Associate Degree in Botany as specified in this document are met.

Pathway for Candidates with 16 Years of Education

Candidates having completed 16 years of education are allowed admission in the Master of Science (BS) in Botany subject to meeting the eligibility criteria prescribed in this document.

CURRICULUM FOR

BACHELOR OF SCIENCE (BS)

BOTANY

BS Botany

PROGRAM DESCRIPTION

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

RECOMMENDED NOMENCLATURE

For the purpose of standardization, the recommended nomenclature for the four-year degree program in Botany is **"Bachelor of Science in Botany"**.

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) 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. The admitting university may set minimum eligibility scores and may conduct entry / admission test through its own testing body or an external testing services provider of repute as per the screening, admission and merit calculation criteria approved by its statutory bodies.

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 comprises of minimum 135 credit hours spread over eight (08) regular semesters. Universities may offer courses up-to maximum of 144 credit hours provided that the total number of credit hours are reasonably set to achieve the Program Learning Objectives (PLOs) without putting undue burden on students.

Minimum Credit Hours	135
General Education	30 credit hours (12 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.

The standard scheme of studies for Bachelor of Science (BS) in Botany is given below:

SEMESTER 1			
S.N.	**Course**	**Credits**	**Category**
1	Cell Biology	3 (2-1)	Major
2	Diversity of Plants	3 (2-1)	Major
3	Natural Science Introduction to Environmental Science *	3 (2-1)	General Education
4	Quantitative Reasoning I **	3 (3-0)	General Education
5	Functional English **	3 (3-0)	General Education
6	Applications of Information & Communication Technologies (ICT) **	3 (2-1)	General Education
TOTAL CREDITS: 18			

SEMESTER 2			
S.N.	**Course**	**Credits**	**Category**
1	Fundamentals of Plant Taxonomy	3 (2-1)	Major
2	Biodiversity & Conservation	3 (3-0)	Interdisciplinary
3	Fundamentals of Genetics & Evolution	3 (2-1)	Interdisciplinary
4	Social Sciences ***	2 (2-0)	General Education
5	Quantitative Reasoning II **	3 (3-0)	General Education
6	Expository Writing **	3 (3-0)	General Education
TOTAL CREDITS: 17			

SEMESTER 3			
S.N.	**Course**	**Credits**	**Category**
1	Phycology & Bryology	3 (2-1)	Major
2	Mycology	3 (2-1)	Major
3	Plant Anatomy & Embryology	3 (2-1)	Major
4	Arts & Humanities ****	2 (2-0)	General Education
5	Islamic Studies ** (Ethics for non-Muslim students)	2 (2-0)	General Education
6	Ideology & Constitution of Pakistan **	2 (2-0)	General Education
TOTAL CREDITS: 15			

SEMESTER 4			
S.N.	**Course**	**Credits**	**Category**
1	Phytogeography	3 (2-1)	Major
2	Principles of Plant Ecology	3 (2-1)	Major
3	Principles of Plant Biochemistry	3 (2-1)	Major
4	Fundamentals of Plant Physiology	3 (2-1)	Major
5	Civics & Community Engagement **	2 (2-0)	General Education
6	Entrepreneurship **	2 (2-0)	General Education
TOTAL CREDITS: 16			

SEMESTER 5			
S.N.	**Course**	**Credits**	**Category**
1	Advanced Plant Ecology	3 (2-1)	Major

SEMESTER 5			
S.N.	Course	Credits	Category
2	Advanced Plant Biochemistry	3 (2-1)	Major
3	Advanced Plant Physiology	3 (2-1)	Major
4	Microbial Botany	3 (2-1)	Major
5	Pteridophytes & Gymnosperms	3 (2-1)	Major
6	Biostatistics	3 (2-1)	Interdisciplinary
TOTAL CREDITS: 18			

SEMESTER 6			
S.N.	Course	Credits	Category
1	Systematics of Angiosperms	3 (2-1)	Major
2	Plant Pathology	3 (2-1)	Major
3	Molecular Genetics	3 (2-1)	Interdisciplinary
4	Sustainable Development Goals	3 (3-0)	Interdisciplinary
5	Artificial Intelligence (AI) in Botany	3 (3-0)	Interdisciplinary
6	Elective - I	3	Major
TOTAL CREDITS: 18			

SEMESTER 7			
S.N.	Course	Credits	Category
1	Analytical Techniques in Botany	3 (1-2)	Major
2	Field Botany	3 (2-1)	Major

SEMESTER 7			
S.N.	**Course**	**Credits**	**Category**
3	Forensic Botany	3 (2-1)	Major
4	Scientific Inquiry & Research Methods	3 (2-1)	Interdisciplinary
5	Elective – II *****	3	Major
TOTAL CREDITS: 15			

SEMESTER 8			
S.N.	**Course**	**Credits**	**Category**
1	Plant Biotechnology	3 (2-1)	Major
2	Economic & Industrial Botany	3 (3-0)	Major
3	Evolutionary Trends in Plants	3 (2-1)	Major
4	Elective – III *****	3	Major
5	Capstone Project	3	Capstone
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.

DEGREE AWARD REQUIREMENTS

The following minimum requirements are prescribed for award of Bachelor of Science (BS) in Botany:

1. All courses in the General Education category with titles and credits as prescribed in the HEC Undergraduate Education Policy V 1.1. must be completed.
2. Minimum of 135 credit hours as prescribed in this document must be completed.
3. Capstone / research project of three (03) credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement cannot be substituted with additional coursework or internship.
4. Internship of three (03) credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement cannot be substituted with additional coursework, capstone, research or project work.
5. CGPA must not be below 2.00/4.00 at the time of completion of the degree program. The university may however set higher standard in this regard.

CURRICULUM FOR

MASTER OF SCIENCE (MS)

BOTANY

MS Botany

PROGRAM DESCRIPTION

The Master of Science (MS) in Botany is structured in accordance with the HEC Graduate Education Policy 2023 and designed to equip students with comprehensive knowledge and advanced skills in the field of botanical sciences. This program fosters a deep understanding of plant biology, emphasizing the latest research and technological advancements. Through this program, students will engage in critical analysis and synthesis of complex botanical concepts, preparing them for careers in research, academia, and industry. The curriculum is designed to ensure a rigorous academic experience, incorporating theoretical knowledge with practical applications. Students will master advanced experimental techniques and methodologies, enabling them to conduct independent research and address intricate problems in plant science. The program has incorporated scope of electives which will cover advanced courses in botany that emphasize the importance of addressing global challenges faced by Pakistan such as biodiversity loss, climate change, and sustainable agriculture. The ultimate goal of this program is to ensure that after its completion, the graduates are well-equipped to contribute to the advancement of botanical sciences and tackle pressing environmental issues with innovative solutions.

RECOMMENDED NOMENCLATURE

To ensure uniformity, the standard nomenclature of all graduate degree programs (NQF-7) in Botany must be **“Master of Science (MS) in Botany”**.

PROGRAM LEARNING OUTCOMES

By the completion of Master of Science (BS) in Botany, the graduates will be able to:

- Critically analyze and synthesize advanced concepts and current research in various fields of botany, including plant physiology, taxonomy, molecular biology, and ecology.
- Apply sophisticated experimental techniques and methodologies to conduct independent research and solve complex problems in botanical science.
- Demonstrate the ability to effectively communicate scientific findings and theoretical concepts in botany to both specialized and general audiences.
- Evaluate and implement conservation strategies and biotechnological applications to address global challenges related to plant biodiversity, agriculture and sustainability.

ELIGIBILITY CRITERIA

- An undergraduate degree (involving 16 years of education) in the field of Botany or Plant Sciences is the basic eligibility requirement for admission in the Master of Science (MS) in Botany.
- Candidates having undergraduate degrees (involving 16 years of education) in any discipline of Biological, Pharmaceutical, Food, Agricultural, Medical, Allied Health and Chemical Sciences other than but relevant to the field of Botany or Plant Sciences are also eligible for admission in the Master of Science (MS) in Botany subject to completion of deficiency courses up-to 12 credit hours to be determined by the offering department. Relevance of the prior qualification in this regard will also be determined by the offering department.

- In addition to the basic eligibility, the admitting university is further required to conduct a rigorous admission test as an eligibility condition for admission to the program, with a passing score of 50% (OR) accept the GRE/HAT General/equivalent tests, with a passing score of 50%. The admitting university may also set minimum eligibility scores (above 50%) as per the screening, admission and merit calculation criteria approved by its statutory bodies.

PROGRAM STRUCTURE

The Master of Science (MS) in Botany is structured in accordance with the provisions of the HEC Graduate Education Policy (GEP) 2023. Standard structure of the program is as under:

Minimum Credit Hours	30
Minimum Coursework Requirement	24 credit hours (8 courses)
Minimum Research Requirment	6 credit hours
Program Duration	Minimum: 2 Years (4 regular semesters) Maximum: 4 Years (8 regular semesters) **Note:** In case a student is unable to secure the degree within the prescribed timeframe and claims for extension in duration, the university may constitute an appropriate authority and determine the causes of delay. In the event of force majeure (i.e., delay on account of circumstance beyond the control of student), the university may grant an extension in the period of award of degree in accordance with the duration limiting factor(s) and also take corrective measures in case the delay is caused by process or administrative reasons.
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)	09-12 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)
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work requires lab / field contact of three hours per week throughout the semester.

The standard scheme of studies for Master of Science (MS) in Botany is given below:

SEMESTER 1			
S.N.	**Course**	**Credits**	**Category**
1	Advanced Analytical Tools in Botany *	3 (1-2)	Core
2	Recent Trends in Botany *	3 (3-0)	Core
3	Elective – I **	3	Elective
4	Elective – II **	3	Elective
TOTAL CREDITS: 12			

SEMESTER 2			
S.N.	**Course**	**Credits**	**Category**
1	Research Methodology & Scientific Writing *	3 (3-0)	Core
2	Elective – III **	3 (3-0)	Core
3	Elective – IV **	3	Elective
4	Elective – V **	3	Elective
TOTAL CREDITS: 12			

SEMESTER 3			
S.N.	**Course**	**Credits**	**Category**
	Thesis ***	6	Research

SEMESTER 4			
S.N.	**Course**	**Credits**	**Category**
	Thesis ***	Continued	Research

* These are mandatory core courses for the program.

** 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.

*** Research work must be performed by students individually as per university's policy on the same including but not limited to the protocols for topic selection, allocation of supervisor and co-supervisor (where required), thesis submission, defense and evaluation as approved through its statutory bodies.

DEGREE AWARD REQUIREMENTS

The following minimum requirements are prescribed for award of Master of Science (BS) in Botany:

1. Minimum of twenty-four (24) credit hours including nine (9) credit hours for core courses and fifteen (15) credit hours for elective courses as prescribed in this document must be completed.
2. In addition to coursework of twenty-four (24) credit hours, research work / thesis of minimum six (06) credit hours must also be completed individually as partial fulfilment of the degree program. Requirement of research work / thesis cannot be substituted with additional course work.
3. CGPA must not be below 2.50/4.00 at the time of completion of the degree program. The university may however set higher standard in this regard.
4. The minimum duration required to complete the degree is four (04) regular semesters which may be extended up to maximum of eight (08) regular semesters. Summer semester is not considered as a regular semester.

COURSE LEARNING OUTCOMES

FOR BS & MS BOTANY

Course Learning Outcomes

ADVANCED ANALYTICAL TOOLS IN BOTANY

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

- Critically evaluate the theoretical foundations and practical applications of advanced analytical techniques in botanical research.
- Apply advanced analytical instruments and software to conduct comprehensive data collection and analysis.
- Integrate advanced analytical methods to address complex research questions and enhance the precision of botanical studies.

ADVANCED PLANT BIOCHEMISTRY

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

- Understand the role of enzymes and coenzymes in plant metabolic processes.
- Describe the structure, role and mechanisms for protein and DNA synthesis.
- Explain the production and regulation of primary and secondary metabolites.
- Use techniques to study plant biochemistry

ADVANCED PLANT ECOLOGY

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

- Identify the factors that influence plant populations and dynamics.
- Understand ecological models used to study plant ecosystems.
- Use principles to contribute to the conservation of plant habitats.
- Ecological challenges and their possible solutions.

ADVANCED PLANT PHYSIOLOGY

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

- Understand the physiological processes, photosynthesis and respiration for plant growth and development.
- Describe how plants respond to environmental stresses.
- Explain the role of hormones in plant growth regulation and their commercial importance.
- Use experimental techniques to study plant physiological processes.

ANALYTICAL TECHNIQUES IN BOTANY

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

- Understand various analytical techniques such as microscopy, spectrophotometry, chromatography, etc. used in plant sciences.
- Apply molecular techniques to study plant proteomics and genomics.
- Interpret botanical data using statistical tools/software.

ARTIFICIAL INTELLIGENCE (AI) IN BOTANY

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

- Understand the applications and ethical aspects of AI in plant Sciences.
- Describe how AI can be used for plant identification, ecological processes, and conservation.
- Explain how machine learning can be applied as predictive models.

BIODIVERSITY & CONSERVATION

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

- Use basic techniques to assess the factors that influence biodiversity.
- Describe strategies for conservation of biodiversity.
- Explain the importance of conservation policies and actions in Protected Areas.

BIOSTATISTICS

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

- Understand the statistical methods in biological research.
- Using different experimental designs to conduct botanical research.
- Use basic statistical methods to analyze and interpret data.
- Apply standard software for statistical analyses in plant research.

CELL BIOLOGY

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

- Understand the structure, function and molecular organization of plant cell and its organelles.
- Describe the processes of cell division in plants.
- Explain how cells transport materials across cellular membranes.
- Use microscopy to study plant cells.

DIVERSITY OF PLANTS

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

- Identify major plant groups.
- Describe the structure, function, reproduction, and adaptation of plants.
- Assess the ecological roles and significance of plant diversity in different habitats.

ECONOMIC & INDUSTRIAL BOTANY

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

- Understand the economic importance of different plant species.
- Describe the industrial uses of plants.
- Explain how economically important plants are cultivated and commercialized.
- Understand plant-based business and entrepreneurship.

EVOLUTIONARY TRENDS IN PLANTS

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

- Understand the major evolutionary trends in plants.
- Describe the significance of the plant fossil record.
- Explain the factors driving plant evolution.
- Use phylogeny to study evolution in plants.

FIELD BOTANY

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

- Understand the techniques for plants collection from field to herbarium and botanical gardens.
- Use basic methods to identify and document plant species.
- Conduct survey to develop botanical inventory and report.

FORENSIC BOTANY

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

- Understand how plants can be used in forensic investigations.
- Describe methods for analyzing plant-based evidence.
- Explain the role of plant material in forensic science.

FUNDAMENTALS OF GENETICS & EVOLUTION

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

- Explain the principles of genetic variation and Mendelian inheritance.
- Use basic genetic techniques to study plant traits.
- Construct genetic maps from linkage and crossing over data.
- Understand the evolutionary processes in plants.

FUNDAMENTALS OF PLANT PHYSIOLOGY

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

- Understand basic plant physiological processes.
- Describe how water and nutrients' availability for plant growth and function.
- Explain photosynthesis, respiration, and transpiration.
- Use experiments to study plant physiological mechanisms.

FUNDAMENTALS OF PLANT TAXONOMY

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

- Understand the principles of plant taxonomy.
- Understand the basics for plant nomenclature, identification, and classification.
- Understand the different systems of classification.

INTRODUCTION TO ENVIRONMENTAL SCIENCE

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

- Understand basic concepts and interdisciplinary nature of environmental science.
- Identify major components of environment i.e. lithosphere, hydrosphere, atmosphere and biosphere, and their interactions.
- Understand human-environment interactions and their implications for environmental management.

MICROBIAL BOTANY

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

- Understand the diversity and roles of microorganisms associated with plants.
- Understand the importance of the plant-microbe interactions.
- Use biological techniques to study plant-microbe interactions.

MOLECULAR GENETICS

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

- Explain structure of different forms of DNA and RNA.
- Describe gene structure and organization of genomes.
- Understand gene expression and its regulation at various levels.
- Apply molecular techniques to investigate genetic variation and gene function in plants.

MYCOLOGY

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

- Evaluate the taxonomy, morphology, and physiology of fungi and their roles in various ecosystems.
- Identify and understand various fungal groups.
- Apply mycological techniques to identify fungal species and assess their ecological and economic impacts.

PHYCOLOGY & BRYOLOGY

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

- Understand the identification, classification, and life cycles of algae and bryophytes.
- Describe the roles of algae and bryophytes in ecosystems.
- Understand economic importance of algae and bryophytes.

PHYTOGEOGRAPHY

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

- Evaluate the historical, climatic, and ecological factors influencing plant distribution and diversity.
- Understand the concept of different biomes, phytogeographic regions, and endemism.
- Analyze the distribution patterns of plant species and communities across different geographic regions.
- Application of GIS and Geo-locate for plant distribution and mapping.

PLANT ANATOMY & EMBRYOLOGY

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

- Describe the internal structure and development of plant cell and tissues.
- Use microscopy techniques to examine plant cells and tissues and embryological stages.
- Explain the stages of plant embryological development, fertilization and seed formation.

PLANT BIOTECHNOLOGY

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

- Understand the principles of plant biotechnology.
- Describe the techniques of tissue culture, genetic engineering, and Phyto nanotechnology.
- Application of biotechnological methods for commercialization.
- Explain the ethical implications of plant biotechnology.

PLANT PATHOLOGY

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

- Identify the symptoms of various diseases and their causal agents.
- Understand the host-pathogen interactions and defense mechanisms.
- Explain the control measures for plant diseases.

PRINCIPLES OF PLANT BIOCHEMISTRY

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

- Understand basic plant biochemical processes.
- Describe the roles of primary and secondary metabolites.
- Explain enzymatic reactions in plant metabolism.
- Use basic techniques to study plant biochemistry.

PRINCIPLES OF PLANT ECOLOGY

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

- Understand the principles of plant ecology.
- Describe plant-environment interactions.
- Explain ecological processes affecting plant distribution.

PTERIDOPHYTES & GYMNOSPERMS

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

- Identify and describe the morpho-anatomical, and reproductive characteristics of pteridophytes and gymnosperms in diverse ecological environments.
- Analyze the evolutionary significance and phylogenetic relationships of pteridophytes and gymnosperms.
- Understand distribution and ecological role of pteridophytes and gymnosperms with special reference to Pakistan.

RECENT TRENDS IN BOTANY

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

- Analyze recent advancements and emerging trends in the field of botany.
- Critique the impact of current botanical research on emerging issues faced by Pakistan.
- Predict future directions and potential breakthroughs in botanical sciences based on current trends.

RESEARCH METHODOLOGY & SCIENTIFIC WRITING

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

- Apply the hallmarks and principles of scientific writing.
- Design robust experimental protocols to address botanical research questions.
- Implement advanced statistical and computational tools for data analysis in botanical studies.
- Critically assess contemporary research methodologies and their applications as applied in the field of botany.

SCIENTIFIC INQUIRY & RESEARCH METHODS

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

- Understand the principles of scientific research.
- Use research techniques to conduct botanical experiments.
- Explain ethical considerations for research scientific writing.

SUSTAINABLE DEVELOPMENT GOALS

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

- Understand the concepts of Sustainable Development Goals.
- Describe the role of plants sciences in sustainable development.
- Explain the strategies to ensure SDGs in plant research.

SYSTEMATICS OF ANGIOSPERMS

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

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

A COLLABORATIVE VENTURE OF
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GOVERNMENT OF PAKISTAN