UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 22nd (3/2024) meeting held on 30.09.2024, the Vice Chancellor is pleased to approve the revised curricula of the following programs for implementation w.e.f. Fall 2024 provisionally subject to approval by the Syndicate.

i. Associate Degree in Botany — Annex-'A'
ii. BS in Botany — Annex-'B'

(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/25/18

Dated: 09.01.2025

Distribution:

- Chairman, Department of Botany
- Controller of Examinations
- Director Academics

C.C:

- Dean, Faculty of Sciences
- Director, QEC
- Additional Registrar (Affiliation & Registration)
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

SCHEME OF STUDIES

BACHELOR OF SCIENCE

IN BOTANY

(2024 & onwards)

DEPARTMENT OF BOTANY

UNIVERSITY OF SARGODHA

SARGODHA

BACHELOR OF SCIENCE

IN BOTANY

1. **Program Learning Objectives:**
   The BS Botany program aims to develop a deep comprehension of botanical sciences by offering outstanding instruction, hands-on experiences, and pioneering research. The goal is to advance scientific knowledge, promote environmental stewardship, and positively impact the global community.
2. **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
3. **Program Structure:**

<table>
<tr><td>Minimum Credit hours</td><td colspan="2">135</td></tr>
<tr><td>Admission Requirements:</td><td colspan="2">At least 45% marks in F.Sc (Pre- Medical) or equivalent</td></tr>
<tr><td>Degree Completion Requirements:</td><td colspan="2"><table>
<tr><td>General Education</td><td>33 credit hours (15 courses)</td></tr>
<tr><td>Discipline Related Courses / Major</td><td>78 credit hours (26 courses)</td></tr>
<tr><td>Interdisciplinary / Allied Courses</td><td>21 credit hours (7 courses)</td></tr>
<tr><td>Internship</td><td>3 credit hours</td></tr>
<tr><td>Capstone Project</td><td>3 credit hours</td></tr>
<tr><td>Total :</td><td>136</td></tr>
</table></td></tr>
<tr><td>Duration</td><td colspan="2">• 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.</td></tr>
<tr><td>Semester Duration</td><td colspan="2">• 16-18 weeks for regular semesters (1-2 weeks for examination)
• 8-9 weeks for summer semesters (1 week for examination)</td></tr>
<tr><td>Course Load (per semester)</td><td colspan="2">• 15-21 credit hours for regular semesters
• Up-to 8 credit hours for summer semesters (for remedial / deficiency / failure/repetition courses only)</td></tr>
<tr><td>1 Credit Hours (Lab / Field Work)</td><td colspan="2">1 credit hour in laboratory or practical work / project requires lab contact of three hours per week throughout the semester.</td></tr>
</table>

4. **General Education (Gen Ed) Requirements:(Mandatory/Core Curses):**
The minimum requirement for Gen Ed is 31 credits hours and will be offered in first four semesters only.

Sr. No.	Course Code	Course Title	Credit Hours
1.	URCG-5105/ URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)
2.	URCG-5111	Translation of Holy Quran	NC
3.	URCG-5112 / URCG-5113	Fables, Wisdom Literature and Epic / Space, Place & Experiences	2 (2-0)
4.	URCG-5116 / URCG-5117	Science of Society-I / Science of Society-II	2(2-0)
5.	URCG-5118	Functional English	3(3-0)
6.	URCG-5119	Expository Writing	3(3-0)
7.	URCG-5120	Exploring Quantitative Skills	3(3-0)
8.	URCG-5121	Tools for Quantitative Reasoning	3(3-0)
9.	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)
10.	URCG-5123	Applications of Information Communication Technologies (ICT)	3(2-1)
11.	URCG-5124	Entrepreneurship	2(2-0)
12.	URCG-5125	Civics and Community Engagement	2(2-0)
13.	URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)
14.	URCG-5128	Pakistan Studies	2 (2-0)
15.	URCG-5115	The Science of Global Challenges	3(2-1)
GE Courses Credit Hours Total			**33**

**Courses Quran Translation and Seerat of the Holy Prophet (SAW) will be offered for Muslim students only.*

5. **Major Courses**

Sr. No.	Course Code	Course Title	Credit Hours
1.	BOTN-5101	Cell Biology	3(2-1)
2.	BOTN-5102	Diversity of Plants	3(2-1)
3.	BOTN-5103	Fundamentals of Plant Taxonomy	3(2-1)
4.	BOTN-5106	Phycology & Bryology	3(2-1)
5.	BOTN-5107	Mycology	3(2-1)
6.	BOTN-5108	Plant Anatomy & Embryology	3(2-1)
7.	BOTN-5109	Phytogeography	3(2-1)
8.	BOTN-5110	Principles of Plant Ecology	3(2-1)
9.	BOTN-5111	Principles of Plant Biochemistry	3(2-1)
10.	BOTN-5112	Fundamentals of Plant Physiology	3(2-1)

11.	BOTN-6101	Advanced Plant Ecology	3(2-1)
12.	BOTN-6102	Advanced Plant Biochemistry	3(2-1)
13.	BOTN-6103	Advanced Plant Physiology	3(2-1)
14.	BOTN-6104	Microbial Botany	3(2-1)
15.	BOTN-6105	Pteridophytes & Gymnosperms	3(2-1)
16.	BOTN-6107	Systematics of Angiosperms	3(2-1)
17.	BOTN-6108	Plant Pathology	3(2-1)
18.	BOTN-6112	Analytical Techniques in Botany	3(1-2)
19.	BOTN-6113	Field Botany	3(2-1)
20.	BOTN-6114	Forensic Botany	3(2-1)
21.	BOTN-6116	Plant Biotechnology	3(2-1)
22.	BOTN-6117	Economic & Industrial Botany	3(3-0)
23.	BOTN-6118	Evolutionary Trends in Plants	3(2-1)
24.	BOTN-XXX	ELECTIVE-I	3(2-1)
25.	BOTN-XXX	ELECTIVE-II	3(2-1)
26.	BOTN-XXX	ELECTIVE-III	3(2-1)
Major Courses Credit Hours Total			**78**

6. **Interdisciplinary/Allied Courses:**

1.	BOTN-5104	Biodiversity & Conservation	3 (3-0)
2.	BOTN-5105	Fundamental of Genetics & Evolution	3(2-1)
3.	BOTN-6106	Biostatistics	3(2-1)
4.	BOTN-6109	Molecular Genetics	3(2-1)
5.	BOTN-6110	Sustainable Development Goals	3(3-0)
6.	BOTN-6111	Artificial Intelligence (AI) in Botany	3(3-0)
7.	BOTN-6115	Scientific Inquiry & Research Methods	3(2-1)
Interdisciplinary Courses Credit Hours Total			**21**

7. **Field experience/internship: Minimum 03 credit hours:**
Lasting 6-8 weeks and ideally scheduled during summer breaks after 4th semester for Fall intake and after 5th Semester for Spring intake Programs in Summer break.

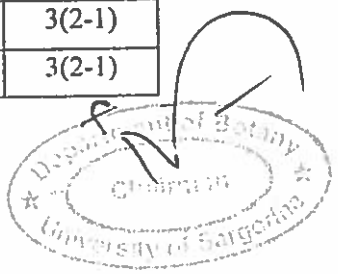
1.	BOTN- 6137	Field experience/Internship	3(3-0)

8. **Capstone project: Minimum 03 credit hours:**
This project will be offered in the 7th or 8th semester as availability of the faculty. It requires faculty supervision and evaluation following department guidelines

1.	BOTN- 6138	Capstone Project	3(3-0)

9. List of Elective Courses

Sr. No.	Course	Title	Credit Hours
1.	BOTN-6119	Plant Seed Physiology	3(2-1)
2.	BOTN-6120	Palynology	3(2-1)
3.	BOTN-6121	Plant Tissue Culture	3(2-1)
4.	BOTN-6122	Seed Production Technology	3(2-1)
5.	BOTN-6123	Advanced Environmental Biology	3(2-1)
6.	BOTN-6124	Plant-Conservation Management	3(2-1)
7.	BOTN-6125	Conservation Genetics	3(2-1)
8.	BOTN-6126	Basic Ecological Genetics	3(2-1)
9.	BOTN-6127	Medicinal Plants	3(2-1)
10.	BOTN-6128	Seed Pathology	3(2-1)
11.	BOTN-6129	Biodegradation and Bioremediation	3(2-1)
12.	BOTN-6130	Water Pollution Management	3(2-1)
13.	BOTN-6131	Air Pollution Management Strategies	3(2-1)
14.	BOTN-6132	Conservation Ecology	3(2-1)
15.	BOTN-6133	Plant Stress Physiology	3(2-1)
16.	BOTN-6134	Advanced Plant Anatomy	3(2-1)
17.	BOTN-6135	Plant Water Relations	3(2-1)
18.	BOTN-6136	Plant Micro Techniques	3(2-1)



Scheme of Studies
Bachelor of Science in Botany
Scheme of Studies / Semester-wise workload

Sr #	Code	Course Title	Course Type	Crs. Hrs.
		Semester-I		
1.	BOTN-5101	Cell Biology	Major	3 (2-1)
2.	BOTN-5102	Diversity of Plants	Major	3 (2-1)
3.	URCG-5111	Translation of the Holy Quran – I	General Education	NC
4.	URCG-5118	Functional English	General Education	3 (3-0)
5.	URCG-5120	Exploring Quantitative Skills	General Education	3 (3-0)
6.	URCG-5123	Applications of Information Communication Technologies (ICT)	General Education	3 (2-1)
7.	URCG-5115	The Science of Global Challenges	General Education	3 (2-1)
		Total Credit Hours		**18**
		Semester-II		
1.	BOTN-5103	Fundamentals of Plant Taxonomy	Major	3 (2-1)
2.	BOTN-5104	Biodiversity & Conservation	Interdisciplinary	3 (3-0)
3.	URCG-5116 / URCG-5117	Science of Society-I / Science of Society-II	General Education	2 (2-0)
4.	URCG-5119	Expository Writing	General Education	3 (3-0)
5.	URCG-5121	Tools for Quantitative Reasoning	General Education	3 (3-0)
6.	URCG-5127	Seerat of the Holy Prophet (SAW)	General Education	1(1-0)
7.	URCG-5128	Pakistan Studies	General Education	2(2-0)
		Total Credit Hours		**17**
		Semester-III		
1.	BOTN-5105	Fundamental of Genetics & Evolution	Interdisciplinary	3 (2-1)
2.	BOTN-5106	Phycology & Bryology	Major	3 (2-1)
3.	BOTN-5107	Mycology	Major	3 (2-1)
4.	BOTN-5108	Plant Anatomy & Embryology	Major	3 (2-1)
5.	URCG-5112 / URCG-5113	Fables, Wisdom Literature and Epic / Space, Place & Experiences	General Education	2 (2-0)
6.	URCG-5105/ URCG-5126	Islamic Studies / Ethics	General Education	2 (2-0)
7.	URCG-5122	Ideology and Constitution of Pakistan	General Education	2 (2-0)
8.	URCG-5111	Translation of Holy Quran-II	General Education	NC
		Total Credit Hours		**18**
		Semester-IV		
1.	BOTN-5109	Phytogeography	Major	3 (2-1)
2.	BOTN-5110	Principles of Plant Ecology	Major	3 (2-1)
3.	BOTN-5111	Principles of Plant Biochemistry	Major	3 (2-1)
4.	BOTN-5112	Fundamentals of Plant Physiology	Major	3 (2-1)
5.	URCG-5125	Civics and Community Engagement	General Education	2 (2-0)
6.	URCG-5124	Entrepreneurship	General Education	2 (2-0)
		Total Credit Hours		**16**
		Summer Semester		
1.	BOTN-6137	Internship	Compulsory	3(3-0)

Internship will be offered after 4th Semester for Fall intake and after 5th Semester for Spring intake Programs in Summer break

Semester-V				
1.	BOTN-6101	Advanced Plant Ecology	Major	3 (2-1)
2.	BOTN-6102	Advanced Plant Biochemistry	Major	3 (2-1)
3.	BOTN-6103	Advanced Plant Physiology	Major	3 (2-1)
4.	BOTN-6104	Microbial Botany	Major	3 (2-1)
5.	BOTN-6105	Pteridophytes & Gymnosperms	Major	3 (2-1)
6.	BOTN-6106	Biostatistics	Interdisciplinary	3 (2-1)
7.	URCG-5111	Translation of Holy Quran-III	General Education	NC
Total Credit Hours				**18**
Semester-VI				
1.	BOTN-6107	Systematics of Angiosperms	Major	3 (2-1)
2.	BOTN-6108	Plant Pathology	Major	3 (2-1)
3.	BOTN-6109	Molecular Genetics	Interdisciplinary	3 (2-1)
4.	BOTN-6110	Sustainable Development Goals	Interdisciplinary	3 (3-0)
5.	BOTN-6111	Artificial Intelligence in Botany	Interdisciplinary	3 (3-0)
6.	BOTN-XXX	Elective – I	Major	3 (2-1)
Total Credit Hours				**18**
Semester-VII				
1.	BOTN-6112	Analytical Techniques in Botany	Major	3 (1-2)
2.	BOTN-6113	Field Botany	Major	3 (2-1)
3.	BOTN-6114	Forensic Botany	Major	3 (2-1)
4.	BOTN-6115	Scientific Inquiry & Research Methods	Interdisciplinary	3 (2-1)
5.	BOTN-XXX	Elective – II	Major	3 (2-1)
6.	URCG-5111	Translation of Holy Quran-IV	General Education	NC
Total Credit Hours				**15**
Semester-VIII				
1.	BOTN-6116	Plant Biotechnology	Major	3 (2-1)
2.	BOTN-6117	Economic & Industrial Botany	Major	3 (3-0)
3.	BOTN-6118	Evolutionary Trends in Plants	Major	3 (2-1)
4.	BOTN-XXX	Elective – III	Major	3 (2-1)
5.	BOTN-6138	Capstone Project	Capstone Project	3(3-0)
Total Credit Hours				**15**

Semester I

BOTN-5101	Cell Biology	3(2-1)

Course Brief:

This course covers fundamental cell biology concepts, including microscopy, cell fractionation, and organelle functions, while also exploring membrane physiology, the cell cycle, stem cells, and cancer. It evaluates current issues in cell biology and their impacts on medicine, agriculture, and biotechnology.

Course Learning Objectives:

The course aims to provide a comprehensive understanding of cell biology, including the fundamental concepts and various microscopy techniques used to visualize cellular structures. Students will learn about cell fractionation and the analysis of biological molecules, focusing on their structures and roles in bioenergetics. The course covers the organization and function of cellular organelles, membrane structure, and cytoplasmic physiology. Key topics include intercellular interactions, the cell cycle, stem cell biology, and cancer mechanisms. Additionally, students will evaluate current issues in cell biology and their impacts on medicine, agriculture, biotechnology, and society.

Course Content:

1. Introduction: the discovery of cells, its basic properties, different types of cells.
2. Structure and function of biological molecules/ Chemical components of cells: Acids, Bases and Buffers, Nature of Biological molecules, four types of biological molecules, carbohydrates, lipids, proteins, Nucleic Acids
3. Cell wall: Cell Wall Structure and Chemical Composition
4. Cell membrane: Membrane functions, history, chemical composition of membranes, structure and function of membranes, membrane lipids and membrane fluidity, movement of substances across cell membrane.
5. Cellular organelles: structure and function of endoplasmic reticulum, Golgi complex, Vacuole, Lysosomes, Ribosomes, Microbodies
6. Cytoskeleton and Cytoplasm: Chemical composition, structure and function. Microtubules, Microfilaments.
7. Mitochondria: structure and function, mitochondrial membranes, mitochondrial matrix, function of mitochondria, Peroxisomes.
8. Chloroplast structure and Function: structure and function, membranes, photosynthetic units and reaction centres, function of chloroplast.
9. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis.
10. Cell signaling Pathways: the basic elements of cell signaling system, G protein coupled Receptors and their second messengers, the role of calcium as an intracellular messenger.
11. DNA and Chromatin: Chemical structure, different types of Chromatins, Euchromatin and Heterochromatin and their function.
12. Extracellular Matrix. Extracellular space, interactions of cells with extracellular materials, interaction of cells with other cells.
13. Cell Division: Cell cycle, Mitosis and Cytokinesis, Meiosis.
14. Chromosomal Aberrations; Changes in the number of chromosomes, aneuploidy and euploidy; Changes in the structure of chromosomes, deletion, duplication, inversion and translocation, special types of chromosomes.
15. Trends in cell Biology: the light microscope, Transmission electron microscope, Scanning electron microscope, use of radioisotopes, cell culture, DNA sequencing, DNA libraries, use of Antibodies.

Lab Outline:

1. Study of cell structure using compound microscope.
2. Identification of general Biomolecules.
3. Extraction and estimation of Biomolecules
4. Extraction and estimation of RNA and DNA from plant material.
5. Elucidation of ultrastructure of cell through electron microphotographs

6. Measurement of cell size
7. Slide preparation of Cell wall and its layers.
8. Study of Nucleus and its staining in different cells.
9. Study of mitosis from prepared slides and by smear/squash method with onion root tip
10. Study of meiosis from prepared slides
11. Study of chromosome morphology
12. Study of variation in chromosome number
13. Study of variation in chromosome structure

Recommended Texts:

1. Urry, L. A., Cain, M., Wasserman, S. A., & Jane, R. (2020). Campbell Biology, (13th Ed.), Pearson Education, New York.
2. Alberts, B. (2022). Molecular Biology of Cell. (7th Ed.). W. W. Norton & Company.

Suggested Readings:

1. Verma, P. S. & Agarwal, V.K., (2016). Cell biology (cytology, biomolecules and molecular biology) (1st Ed.). India: S. Chand Publishing.
2. Milo, R. & Phillips, R., (2015). Cell biology by the numbers (1st Ed.). London: Taylor and Francis publications.
3. Templeton, N. S., (2015). Gene and cell therapy (4th Ed.). London: Taylor and Francis publications.
4. Sybille, M. & Maria, S., (2015). Tumor cell metabolism (1st Ed.). New York: Springer Publications.

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BOTN-5102	Diversity of Plant	3(2-1)

Course Brief:

This course provides a comprehensive study of diverse biological systems, including viruses, bacteria, algae, fungi, bryophytes, Pteridophytes, and Gymnosperms. Students will explore their structures, reproductive strategies, and ecological significance, with a focus on their economic importance and practical applications. The course integrates theoretical knowledge with practical insights to address real-world issues in agriculture and environmental management.

Course Learning Objectives:

The purpose of this course is to understand the discovery and general characteristics of viruses, including their unique structure and diverse replication mechanisms, and evaluate their economic significance.

They will gain comprehensive knowledge of the structure and replication cycles of DNA viruses (T-phages) and RNA viruses (Tobacco Mosaic Virus), and their economic impact on crops, livestock, and human health.

The course will enable students to examine the discovery and characteristics of bacteria, focusing on their cell structure and reproductive methods, including conjugation, transformation, and transduction, and analyze their roles in ecosystems and industry. Students will also study the characteristics, classification, and economic importance of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms, understanding their morphology, life cycles, and ecological significance, with detailed examinations of specific representatives within each group.

Course Content:

1. Comparative study of life form, structure, reproduction and economic significance of:
2. Viruses (RNA and DNA types) with special reference to TMV
3. Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with specific reference to bio fertilizers, pathogenicity and industrial importance.
4. Algae (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)

5. Fungi (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus) their implication on crop production and industrial applications.
6. Lichens (Physcia)
7. Bryophytes (Riccia, Anthoceros, Funaria)
8. Pteridophytes: Psilopsida (Psilotum) ,Pteropsida (Marsilea), Sphenopsida (Equisetum) Lycopsida (Selaginella)
9. Gymnosperms (Cycas,Pinus, Ephedra)
10. Angiosperms: Monocot (Poaceae) , Dicot (Solanaceae)

Lab Outline:

1. Culturing, maintenance, preservation and staining of microorganisms.
2. Study of morphology and reproductive structures of the types mentioned in theory.
3. Identification of various types mentioned from prepared slides and fresh collections.

Recommended Texts:

1 Ali, S. I. and Nasir, Y. (1995-to date). Flora of Pakistan. Karachi Univ. Press, Karachi.
2 Davis, P.H. and Heywood, V. H. (1963). Principles of Angiosperm Taxonomy. Oliver & Boyd, London.
3 Greuter, W., McNeill, J. Barrie, F.R., Burdet, H. M., Demoulin, V., Filguerras, T.S., Niclson, D.H., Silva, P.C., Skog, J.E., Trehane, P., Turland, N. J. and Hawksworth, D. L. (2000). International code of botanical nomenclature (Saint Louis Code) adopted by the Sixteenth International botanical congress St. Louis Missouri, July –August 1999. Koeltz, Konigstein. (Regnum Veg.138.)
4 Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M. J. (2015). Plant Systematics; A phylogenetic Approach, Sinauer, USA.
5 Levine, D. A. (2000). The Origin, Expansion and Demise of Plant Species. Oxford University Press.

Suggested Readings:

1. Simpson, M. G. (2018). Plant Systematics (3rd edition). Elsevier Academic Press, UK. .(Latest edition)
2. Singh, G. (2016). Plant Systematics; An Integrated Approach (3rd edition), University of Dehli, India (Latest edition).
3. Briggs, D.J. and Walters, S.M.. (2016) Plant Variation and Evolution, Cambridge University Press & Assessment
4. Journal Articles/ Reports: Pakistan journal of Botany, Mycotaxon, Plant systematics and Evolution, etc.

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URCG-5111	Translation of Holy Quran-I	Non-Credit

Semester / Level:

In some discipline 1st semester and in some discipline 2nd Semester/ ADP Program 1st Year

Course Learning Objectives:

- To familiarize the students to keys and fundamentals of recitation of the holy Quran.
- To develop the skill of the students of recitation the last revelation.
- Students will learn the basic Arabic grammar in a practical way.
- To develop an eagerness among the students to explore the last divine Book.

Course Content:

- تیسواں پارہ-ناظرہ مع تجوید
- بنیادی عربی گرامر

اسم اور اسکے متعلقات: اسم فاعل، مفعول، تفضیل، مبالغہ

فعل اور اسکی اقسام: ماضی، مضارع، امر، نہی

حرف اور اسکی اقسام: حروف علت، حروف جارہ، مشبہ بالفعل

Memorization:

تیسویں پارے کی آخری بیس سورتیں (حفظ مع ترجمہ)

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New

URCG-5120	Exploring Quantitative Skills	3(3-0)

Course Brief:

This is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

Course Learning Outcomes:

By the end of this course, students shall have:

1. Fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately;
2. Understanding of fundamental mathematical and statistical concepts;
3. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

Course Content:

1. Numerical Literacy
   - Numbers system and basic arithmetic operations;
   - Units and their conversions, dimensions, area, perimeter and volume;
   - Rates, ratios, proportions and percentages;
   - Types and sources of data; Measurement scales;
   - Tabular and graphical presentation of data;
   - Quantitative reasoning exercises using number knowledge
2. Fundamental mathematical concepts
   - Basics of geometry (lines, angles, circles, polygons etc.);
   - Sets and their operations; Relations, functions, and their graphs;
   - Exponents, factoring and simplifying algebraic expressions;
   - Algebraic and graphical solutions of linear and quadratic equations and inequalities;
   - Quantitative reasoning exercises using fundamental mathematical concepts.
3. Fundamental Statistical Concepts Proportions, rates, ratio and percentages
   - Population and sample;
   - Measures of central tendency, dispersion and data interpretation;
   - Rules of counting (multiplicative, permutation and combination);
   - Basic probability theory;
   - Introduction to random variables and their probability distributions;
   - Quantitative reasoning exercises using fundamental statistical concepts.

Recommended Texts:

1. Sevilla, A., & Somers, K. (2012). Quantitative reasoning: tools for today's informed citizen. New Jersey, John Wiley & Sons.
2. Burzynski, D., & Ellis, W. (2008). Fundamentals of mathematics. USA, Saunders College Publishing.

Suggested Readings:

1. Zaslow, E. (2020). Quantitative reasoning: thinking in numbers. Cambridge, Cambridge University Press.
2. de Mesquita, E. B., & Fowler, A. (2021). Thinking clearly with data: A guide to quantitative reasoning and analysis. New Jersey, Princeton University Press.

3. Bennett, J., & Briggs, W. (2019). Using & understanding mathematics: a quantitative reasoning approach. Pearson.
4. Rosen, K. H., & Krithivasan, K. (2012). Discrete mathematics and its applications (Vol. 6). New York: McGraw-Hill.
5. Chatfield, C. (2018). Statistics for technology: a course in applied statistics. Routledge.
6. Lock, R. H., Lock, P. F., Morgan, K. L., Lock, E. F., & Lock, D. F. (2020). Statistics: Unlocking the power of data. New Jersey, John Wiley & Sons.

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URCG-5118	Functional English	3(3-0)

Course Brief:

The course aims at providing understanding of a writer's goal of writing (i.e. clear, organized and effective content and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master the grammatical academic writing skills. The course would enable the students to develop argumentative writing techniques.

Course Learning Objectives:

The students would be able to logically add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in an objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

Course Content:

1. Developing Analytical Skills
2. Transitional devices (word, phrase and expressions)
3. Development of ideas in writing
4. Reading Comprehension
5. Precis Writing
6. Developing argument
7. Sentence structure: Accuracy, variation, appropriateness, and conciseness
8. Appropriate use of active and passive voice
9. Organization and Structure of a Paragraph
10. Organization and structure of Essay
11. Types of Essays

Recommended Texts:

1. Bailey, S. (2011). Academic writing: A handbook for international students (3rd Ed.). New York: Routledge.
2. Eastwood, J. (2011). A Basic English grammar. Oxford: Oxford University Press.
3. Swales, J. M., & Feak, C. B. (2012). Academic writing for graduate students: Essential tasks and skills (3rd Ed.). Ann Arbor: The University of Michigan Press.
4. Swan, M. (2018). Practical English usage (8th Ed.). Oxford: Oxford University Press.

Suggested Readings:

1. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). Longman grammar of spoken and written English. Harlow Essex: MIT Press.
2. Cresswell, G. (2004). Writing for academic success. London: SAGE.
3. Johnson-Sheehan, R. (2019). Writing today. Don Mills: Pearson.
4. Silvia, P. J. (2019). How to write a lot: A practical guide to productive academic writing. Washington: American Psychological Association.
5. Thomson, A. J., & Martinet, A. V. (1986). A Practical English Grammar. Oxford: Oxford University Press.

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URCG-5123	Applications of Information Communication Technologies (ICT)	3(2-1)

Course Brief:

The course introduces students to information and communication technologies and their application in the workplace. Objectives include basic understanding of computer software, hardware, and associated technologies. How computers can be used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace. Students will get basic understanding of computer software, hardware, and associated technologies. They will also learn how computers are used in the workplace, how communications systems can help to boost productivity, and how the Internet technologies can influence the workplace.

Course Content:

1. Introduction, Overview of Information Technology.
2. Hardware: Computer Systems & Components, Storage Devices.
3. Software: Operating Systems, Programming and Application Software.
4. Databases and Information Systems Networks.
5. File Processing Versus Database Management Systems.
6. Data Communication and Networks.
7. Physical Transmission Media & Wireless Transmission Media.
8. Applications of smart phone and usage.
9. The Internet, Browsers and Search Engines.
10. Websites and their types.
11. Email Collaborative Computing and Social Networking.
12. E-Commerce.
13. IT Security and other issues.
14. Cyber Laws and Ethics of using Social media.
15. Use of Microsoft Office tools (Word, Power Point, Excel) or other similar tools depending on the operating system.
16. Other IT tools/software specific to field of study of the students if any.

Recommended Texts:

1. Discovering Computers 2022: Digital Technology, Data and Devices by Misty E. Vermaat, Susan L. Sebok; 17th Edition.

Suggested Readings:

1. Computing Essentials 2021 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 26th edition.
2. Computers: Understanding Technology by Fuller, Floyd: Larson, Brian: Edition 2018.

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URCG-5115	The Science of Global Challenges	3(2-1)

Course Content:

1. Climate Change
   Global Warming, Natural and Anthropogenic Activities and their impact;
2. Energy
   Renewable and non-renewable energy resources;
3. Water Security
   water scarcity and waste water treatment;
4. Land Degradation
   Salinity, water logging, deforestation, land erosion;
5. Food Security
   Food Security and roll of Biotechnology in food production;
6. Global Health Pandemics
   Infectious diseases, vaccine, development of drug discovery for newly explored diseases

Practical:

1. Preparation of standard solution and their standardizations
2. Soil and Water Analysis

Recommended Texts:

1. Usman, M. (2022). Science of Global Challenges. Ilmi Kitab Khana, Lahore.

Suggested Readings:

1. Thieman, W.J. & Palladino, M.A. (2014). Introduction to biotechnology. Edinburgh Gate UK: Pearson Education Limited.
2. Daugherty, E. (2012). Biotechnology: Science for the New Millennium, 1st Edition, Revised, USA: Paradigm Publication.
3. Karaduman, I. C. (Ed.) (2014) Global Challenges for the world. Obronnosc. Zeszytl Naukowe. Turkey

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Semester – II

BOTN-5103	Fundamentals of Plant Taxonomy	3(2-1)

Course Brief:

The "Plant Classification and Identification" course aims to provide a comprehensive understanding of plant taxonomy, focusing on systematic analysis of plant characteristics for classification and identification. Students will learn about botanical nomenclature, plant parts, and taxonomic techniques essential for distinguishing and categorizing plants. The course also explores various plant families and the application of molecular data in modern taxonomy.

Course Learning Objectives:

The Plant Taxonomy course provides an in-depth understanding of plant classification and identification. It covers the basics of scientific and vernacular names, Linnaeus's binomial system, and classification ranks. Students will learn about plant parts and their descriptions, taxonomic techniques, and the use of molecular data in taxonomy. The course includes practical work, such as collecting and preserving specimens, using and creating keys, and analyzing plant reproductive strategies. Students will also engage in outdoor lab sessions and herbarium preparation, with a focus on identifying and documenting plant families and evolutionary relationships.

Course Content:

1. Introduction to Taxonomy
2. Definition, scope, objectives, basic components, types and phases
3. History of Taxonomy
   - Pre-Linnaean Taxonomy, Linnaean Era, Post Linnaean Taxonomy
4. Systems of Classification
5. Artificial-Carl Linnaeus system, Natural-George Bentham & Joseph Dalton Hooker system, Mechanical system, Phylogenetic-Adolf Engler & Karl Prantl, John Hutchinson systems, Current Systems-Robert F. Thorne, Phylocode.
6. Branches of Taxonomy
   - Numerical taxonomy, Chemotaxonomy, cytotaxonomy, molecular taxonomy
7. Plant Nomenclature
   - Problems with Common names, Binomial nomenclature, International Code of Botanical Nomenclature (ICBN)
8. Plant Characters and their value in Taxonomy
   - Habit, Stems, Hairs, Leaves, Compound and Simple Leaves, Leaf Shapes, Leaf Margins, Leaf Structure, Leaf Arrangements, Leaf Venation, Leaf Modifications, Roots, Root modifications, Flowers, The Inflorescence, Fruits, placentation.
9. Plant Collection and Preservation Techniques
10. HERBARIA - Collecting and Preserving a Plant, Fresh Material, Arranging Plants for Pressing, Pressing Difficult Specimens, The Drying Process, Herbarium Specimens, Photographs, The Problem of Colour, Describing a Plant on Paper, Botanical illustration, Floral Diagrams, Floral Formulae
11. Plant Identification Diagnostic characters, basic aids for plant identification, family wise key identification tools

Lab Outline:

1. Technical description of some plants of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan
2. Preparation of indented and bracketed types of keys
3. Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.
4. Study of variation pattern in different taxa.
5. Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination
6. Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

Recommended Texts:

1. Thomson, S. A., Pyle, R. L., Ahyong, S. T., Alonso-Zarazaga, M., Ammirati, J., Araya, J. F., & Segers, H. (2018). Taxonomy based on science is necessary for global conservation. PLoS biology, 16(3), e2005075.
2. Simpson, M. G. (2019). Plant systematics. Academic press.
3. Pawara, P., Okafor, E., Schomaker, L., & Wiering, M. (2017, September). Data augmentation for plant classification. In International conference on advanced concepts for intelligent vision systems (pp. 615-626). Springer, Cham.

Suggested Readings:

1. Thomson, S. A., Pyle, R. L., Ahyong, S. T., Alonso-Zarazaga, M., Ammirati, J., Araya, J.F., & Segers, H. (2018). Taxonomy based on science is necessary for global conservation. PLoS Biology, 16(3), e2005075.
2. Elhariri, E., El-Bendary, N., & Hassanien, A. E. (2014, December). Plant classification system based on leaf features. In 2014 9th International Conference on Computer Engineering & Systems (ICCES) (pp. 271-276). IEEE.
3. Louhaichi, M. (2018). Group Training Course on Rangelands Plant Terminology & Basic Plant Identification.

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BOTN-5104	Biodiversity & Conservation	3(3-0)

Course Brief:

The depletion of biodiversity is driven by habitat loss, resource overexploitation, climate change, diseases, pollution, and poaching. To address this, governments and organizations emphasize biodiversity conservation, recognizing that humans benefit from biodiversity and must preserve it for future generations. Conservation efforts focus on protection, enhancement, and scientific management of biodiversity to maintain ecological processes and life support systems. The goal is to sustain species variety and ensure ecosystems are used sustainably for both current and future populations.

Course Learning Objectives:

The Biodiversity and Conservation course explores biodiversity definitions, types, and threats like deforestation and pollution. It covers measuring biodiversity through alpha, beta, and gamma diversity, and examines conservation strategies, including in situ and ex situ methods. Students will study biodiversity hotspots, international treaties, and the role of herbariums and botanical gardens. The course also addresses sustainable resource use, ecological services and the Global Biodiversity Information Facility (GBIF).

Course Content:

1. Basic concepts
   - Introduction to biodiversity and its tangible and intangible value
   - Biodiversity hotspots (tropical and coral reef ecosystems)
   - Introduction and levels of biodiversity (Alpha, Beta and Gamma)
   - Biodiversity distribution, importance and Reduction.
   - Major and Current threats to biodiversity
   - Inventorying and monitoring of Biodiversity: baseline data (study)
   - Policies and legislation related to biodiversity loss and conservation
   - Different types of protected areas for biodiversity conservation
   - Understanding opportunities and challenges of biodiversity conservation
2. Cause and depletion of biodiversity
   - Concept of habitat and niche
   - Habitat loss
   - Habitat fragmentation
   - Concept of speciation
   - Loss of existing species

- Origin of new species

3. Species inventory and its utilization
   - Baseline data of biodiversity
   - Use of species inventory in EIA (Environmental Impact Assessment)
   - Preparing species inventory at first level
   - Monitoring of biodiversity
   - Red data books and lists
4. Species extinction
   - How do species become endangered?
   - How species become threatened?
   - Criteria for recognizing different categories of threatened species
   - IUCN threatened species categories
   - Concept of extinct and extant species
   - Extinction of species
   - Theory of mass extinction
5. Species invasion and its impacts on local biodiversity
   - Concept of invasive, alien and native species
   - Species invasion and its major types
   - Intensively invasive species and its out-competing potential for native species
   - Concept of direct and indirection competition of local resources
6. Biodiversity conservation
   - Introduction to conservation, its history, guiding principles, and characteristics
   - In situ conservation – conservation at species and population level
   - Ex situ conservation – conservation in man-made ecosystems, croplands, cities.
   - Reconfirmation assays of existing biodiversity
   - Museums, arboretums, herbarium, zoos
   - Natural parks, sanctuaries, and biosphere reserves
   - Gene bank management and operation
7. Biodiversity conservation – role of masses
   - Public awareness strategies
   - Population explosion role of herbaria and botanical gardens in conservation
   - Legal protection of species and habitats
   - National and international laws and agreements for species and habitat Protection
8. National conservation strategy of Pakistan
   - Major prioritized sites for conservation
   - Priorities in conservation and conservation planning (case studies & exercises)
   - National Conservation Strategy of Pakistan
   - Major protected areas and national parks of Pakistan

Recommended Texts:

1. Baldauf, C. (2020). *Participatory Biodiversity Conservation*: Concepts, Experiences and Perspectives. Springer Publishers. ISBN: 978-3-030-41686-7.
2. Dar, G.H., Khuroo, A.A. (2020). *Biodiversity of the Himalaya: Jammu and Kashmir State*. Springer Publishers. ISBN 978-981-329-174-4.

Suggested Readings:

1. Holl, K.D. (2020). *Primer of Ecological Restoration*. Island Press. ISBN: 9781610919722.
2. Prach, K., Walker, L.R. (2020). *Comparative Plant Succession among Terrestrial Biomes of the World*. Cambridge University Press. ISBN: 9781108561167.
3. Wang, Y. Terrestrial Ecosystems and Biodiversity (2nd Ed.). CRC Press – Taylor & Francis Group. ISBN: 9781138333918

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BOTN-5105	Fundamentals of Genetics & Evolution	3(2-1)

Course Brief:

This course provides a comprehensive introduction to genetics and evolution, covering fundamental concepts in Mendelian genetics, molecular genetics, and evolutionary biology. Students will explore the principles of inheritance, the molecular mechanisms underlying gene expression, and the evolutionary processes that shape genetic diversity in populations. Through laboratory exercises and hands-on activities, students will gain practical experience in genetic analysis and bioinformatics tools.

Course Learning Objectives:

The course on Introduction to Genetics and Evolution provides a comprehensive understanding of key genetic and evolutionary concepts. Students will gain insights into Mendelian genetics, including the laws of inheritance and different types of genetic crosses, as well as sex-linked inheritance. The course covers chromosomal biology and cell division, emphasizing mitosis, meiosis, and chromosomal mutations. Molecular genetics topics include DNA structure, replication, gene expression, and repair mechanisms. Evolutionary principles are explored through natural selection, phylogenetics and systematics, while population genetics focuses on genetic variation, drift, gene flow, and adaptation.

Course Content:

1. Introduction to Genetics and Evolution
2. Mendelian Genetics, Laws of inheritance, Monohybrid and dihybrid crosses, Sex-linked inheritance
3. Chromosomes and Cell Division, Mitosis and meiosis, Chromosomal mutations
4. DNA structure and replication, DNA synthesis and amplification, Transcription and translation, Mutation and repair
5. Evolutionary Principles, Introduction to evolution, Natural selection, Phylogenetics and systematics
6. Population Genetics, Genetic variation and drift, Gene flow and migration, Selection and adaptation
7. Evolutionary Processes, Speciation, Co-evolution, Evolutionary developmental biology (evo-devo)
8. Genomics and Evolution, Genome evolution, Comparative genomics, Evolutionary genomics

Lab Outline:

1. Perform monohybrid and dihybrid crosses in model organisms and
2. Use PCR to amplify DNA sequences and perform DNA sequencing to identify genetic variations.
3. Utilize bioinformatics software to analyze genomic data and compare genomic sequences across species.
4. Conduct phylogenetic analysis using genetic data to construct evolutionary trees and study population genetics through simulation models.

Recommended Texts:

1 Futuyma, D. J., & Kirkpatrick, M. (2017). Evolution (4th Ed.). Sinauer Associates.

2 Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2015). Molecular biology of the cell (6th Ed.). Garland Science.

Suggested Readings

1. Wilson, R. K. (2008). Genomics and evolution. Elsevier.

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URCG-5116	✓	Science of Society-I	2 (2-0)

Course Description:

This course will introduce students with the subject matter of social science, its scope, nature and ways of looking at social phenomenon. It will make the participants acquaintance with the foundations of modern society, state, law, knowledge and selfhood. While retaining a focus on Pakistani state and society, students will encounter theoretical concepts and methods from numerous social science disciplines, including sociology, politics, economics anthropology and psychology and make them learn to think theoretically by drawing on examples and case studies from our own social context. Students

will be introduced to the works of prominent social theorists from both western and non-western contexts. Instruction will include the use of written texts, audio-visual aids and field visits.

Learning Outcomes:

The course has following outcomes: It will

- Introduce student with the nature of human social behavior and foundations of human group life
- Analyze the reciprocal relationship between individuals and society.
- Make student aware with the nature of societies existing in modern world
- Make students familiar with the philosophy of knowledge of social sciences
- Introduce students with the works of prominent theories explain human group behavior
- Help students to understand the foundations of society including culture, socialization, politics and economy
- Introduce students with various dimensions of social inequalities with reference to gender, race, ethnicity and religion
- Make them aware about the understanding of various themes pertains to social science in local context
- Help them recognize the difference between objective identification of empirical facts, and subjective formulation of opinionated arguments

Course Outlines:

1. Introduction to Social Sciences:
   - Social world, Human Social behavior, Foundations of society
   - Evolution of Social sciences
   - Philosophy of Science
   - Scope and nature of social sciences
   - Modernity and social sciences
   - Branches of social science: Sociology, Anthropology, Political Science, Economics.
   - Society and Community, Historical evolution of Society
   - Types of Societies
   - Foraging society, Horticultural society, Pastoralist society
   - Agrarian societies, Industrial society, Postindustrial society
2. Philosophy of Knowledge in social Science and social inquiry
   - Understanding social phenomenon
   - Alternative ways of knowing
   - Science as a source to explore social reality
   - Objectivity, Value-Free research
   - Positivism vs Interpretivism,
   - Qualitative vs Quantitative
3. Culture and Society
   - Idea of Culture, Assumptions of Culture
   - Types, Components, Civilization and culture
   - Individual and culture. Cultural Ethnocentrism, Cultural Relativism
   - Outlook of Pakistani culture
   - Global Flows of culture, Homogeneity, Heterogeneity
4. Social Stratification and Social inequality
   - Dimensions of inequality, Social class
   - Gender, Race, Religion, Ethnicity, Caste
   - Patterns of social stratification in Pakistan
   - Class, caste system in agrarian society
   - Ascription vs Achievement. Meritocracy
   - Global stratification in modern world. Global patterns of inequality
5. Personality, Self and Socialization
   - Concept of self, Personality
   - Nature vs Nurture, Biological vs Social

- Development of Personality
- Socialization as a process, Agents of socialization
- Socialization and self/group identity

6. Gender and Power
   - Understanding Gender; Social construction of Patriarchy
   - Feminism in Historical context, Gender Debates
   - Gender and Development
   - Gender issues in Pakistani society, Women Participation in politics, economy and education
   - Toward a gender sensitive society, Gender mainstreaming
   - Pakistan: State, Society, Economy and Polity
   - Colonialism, colonial legacy, National identity
   - Transformation in Pakistani society: Traditionalism vs Modernism
   - Economy, Informality of Economy, Modern economy and Pakistan
   - Political Economy, Sociology of Economy.

Recommended Books and Reading Material:

1. Giddens, A. (2018). Sociology (11th Ed.). UK: Polity Press.
2. Henslin, J. M. (2018). Essentials of Sociology: A Down-to-Earth Approach. (18th Ed) Pearson Publisher.
3. Macionis, J. J. (2016). Sociology (16th Ed.). New Jersey: Prentice-Hall.
4. Qadeer, M. (2006) Pakistan - Social and Cultural Transformation in a Muslim Nation.
5. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.
6. Systems of Stratification | Boundless Sociology (no date). Available at: https://courses.lumenlearning.com/boundless-sociology/chapter/systems-of-stratification/
7. Jalal, A. (ed.) (1995) 'The colonial legacy in India and Pakistan', in Democracy and Authoritarianism in South Asia: A Comparative and Historical Perspective. Cambridge: Cambridge University Press (Contemporary South Asia)
8. Zaidi, S. A. (2015) Issues in Pakistan's Economy: A Political Economy Perspective. Oxford University Press. Chapter 26
9. Akhtar, A. S. (2017) The Politics of Common Sense: State, Society and Culture in Pakistan. Cambridge: Cambridge University Press.
10. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.

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New

URCG-5121	✓	Tools for Quantitative Reasoning	3(3-0)

Course Brief:

This is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of the modern world. The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative reasoning (I) as its base, this course will enable students further their quantitative. Logical and critical reasoning abilities to complement their specific major field of study.

Course Learning Outcomes:

By the end of the course, student shall have:

1. Understanding of logic and logical reasoning:
2. Understanding the basic quantitative Modeling and Analyses.
3. Logical reasoning skills and abilities to apply them to solve quantitative problems and evaluate arguments;

4. Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools.

Course Content:

1. Logic, Logical and Critical Reasoning:
   - Introduction and importance of logic,
   - Introductive, deductive and abductive approaches of reasoning,
   - Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences,
   - Logical fallacies, Venn Diagrams, Predicates and quantifiers,
   - Quantitative reasoning exercises using logical reasoning concepts and techniques.
2. Mathematical Modeling and Analyses
   - Introduction to deterministic models,
   - Use of linear function for modeling in real-world situations,
   - Modeling with the system of linear equation and linear solutions,
   - Elementary introduction to derivatives in mathematical modeling,
   - Linear and exponential growth and decay models,
   - Quantitative reasoning exercises using mathematical modeling.
3. Statistical Modeling and Analyses
   - Introduction to probabilistic models,
   - Bivariate analysis, scatter plots,
   - Simple linear regression model and correlation analysis,
   - Basics of estimation and confidence interval,
   - Testing of hypothesis (z-test; t-test),
   - Statistical inference in decision making,
   - Quantitative reasoning exercise using statistical modeling.

Recommended Texts :

1. Bennett, J., & Briggs, W. (2019). Using & understanding mathematics: a quantitative reasoning approach. Pearson.
2. Rosen, K. H., & Krithivasan, K. (2012). Discrete mathematics and its applications (Vol. 6). New York: McGraw-Hill

Suggested Readings :

1. Epp, S. S. (1990). Discrete mathematics with applications. Wadsworth Publ. Co.
2. Budnick, F. S., Quinn, S., Bowser, K., & Flaherty, E. H. (1993). Applied mathematics for business, economics, and the social sciences. New York: McGraw-Hill.
3. Bluman, A. (2014). Elementary Statistics: A step by step approach 9e. McGraw Hill.
4. Mann, P. S. (2007). Introductory statistics. John Wiley & Sons.
5. Green, S. W., Wolf, I.k., Stewrat, B. W. (2022). SAT Study Guide Premium. Barrons.

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URCG- 5119	Expository Writing	3(3-0)

Course Brief:

This course prepares undergraduates to become successful writers and readers of English. The course helps students develop their fundamental language skills with a focus on writing so that they can gain the confidence to communicate in oral and written English outside the classroom. The course is divided into five units and takes a Project-based Learning approach. Unit themes target the development of 21st century skills and focus on self-reflection and active community engagement. The course completion will enable the students to develop communication skills as reflective and self-directed learners. They will be able to intellectually engage with different stages of writing process, and develop analytical and problem-solving skills to address various community-specific challenges.

Course Content:

1 Self-Reflection, Introduction to the basics of the writing process , Introduction to the steps of essay writing , Prewriting activities: Brainstorming, listing, clustering and freewriting , Practicing Outlining of the essay

2 Personalized Learning, Learning Process, Learning Styles, Goal Setting and Learning Plan

3 Oral Presentation, Structure and Significance, Content Selection and Slide Presentation, Peer Review

4 Critical Reading Skills, Introducing Authentic Reading (Dawn and non-specialist academic books/texts) , Reading Strategies and Practice: Skimming, scanning, SQW3R, Annotating, Detailed reading and note-taking, Standard Test Practice: TOEFL and IELTS, Model Review Reports and Annotated Bibliographies

5 Community Engagement, Student-led brainstorming on local versus global issues, Identifying research problems , Drafting research questions, Drafting interview/survey questions for community research (in English or L1) , Engaging students in Critical reading, Presenting interview/ survey information, Field work , Writing Community Engagement Project

6 Letter to the Editor, Types of letters, Format and purpose of letter to the editor, Steps in writing letter-to-editor.

Recommended Texts:

1 Bailey, S. (2011). Academic writing: A handbook for international students (3rd ed.). New York: Routledge.

2 Swales, J. M., & Feak, C. B. (2012). Academic writing for graduate students: Essential tasks and skills (3rd ed.). Ann Arbor: The University of Michigan Press.

Suggested Readings

1 Cresswell, G. (2004). Writing for academic success. London: SAGE.

2 Johnson-Sheehan, R. (2019). Writing today. Don Mills: Pearson.

3 Silvia, P. J. (2019). How to write a lot: A practical guide to productive academic writing. Washington: American Psychological Association.

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URCG-5127	✓ Seerat of the Holy Prophet (مطالعہ سیرت النبی صلی اللہ علیہ وسلم)	1(1-0)

Course Brief:

Seerat Un Nabi (ﷺ) is known as the acts of the Prophet according to the teachings of Islam. It contains the history, events, wars, prayers and sayings of the last messenger of Allah. It has been narrated by Hazrat Aisha (RA) that the character of the Messenger of Allah is the Quran.

Course Learning Objectives:

- طلباء کو مطالعہ سیرۃ طیبہ کی ضرورت واہمیت سے آگاہ کرنا
- تعمیر شخصیت میں مطالعہ سیرۃ طیبہ کے کردار کو واضح کرنا
- بعثت نبوی کے موقع پر اقوام عالم کی عمومی صورت حال سے آگاہ کرنا
- رسول اکرم صلی اللہ علیہ وسلم کی مکی اور مدنی زندگی کا اس طرح مطالعہ کروانا کہ طلباء ان واقعات سے نتائج کا استنباط کر سکیں
- طلباء کو عہد نبوی کی معاشرت، سیاست، معیشت سے آگاہ کرنا

Course Content:

S. No.	Title	Description
1.	حضور صلی اللہ علیہ وسلم کے ابتدائی حالات زندگی	۱۔ حضور صلی اللہ علیہ وسلم کا خاندانی حسب ونسب ۲۔ پیدائش اور ابتدائی تربیت ۳۔ لڑکپن اور جوانی کے حالات زندگی
2.	بعثت نبوی کے وقت دنیا کے حالات (۱)	۱۔ بعثت نبوی کے وقت اہم تہذیبیں ۲۔ عرب، مصر، حبشہ، بازنطینی، ساسانی

3.	بعثت نبوی	ا۔ مکی عہد میں دعوت اسلام
4.	بعثت نبوی	ا۔ مدنی عہد میں دعوت اسلام
5.	خصائص النبیؐ	آپؐ بطور پیغامبر امن
6.	خصائص النبیؐ	بحثیت استاد و معلم
7.	خصائص النبیؐ	بحثیت تاجر
8.	خصائص النبیؐ	بحثیت سربراہ ریاست
9.	خصائص النبیؐ	ذاتی محاسن اور عالمگیر اثرات
10.	خصائص النبیؐ	ناموس رسالتؐ
11.	اسوہ حسنہ اور عصر حاضر	غیر مسلموں سے تعلقات
12.	اسوہ حسنہ اور عصر حاضر	اسوہ حسنہ کی روشنی میں گھریلو زندگی
13.	اسوہ حسنہ اور عصر حاضر	مستشرقین اور مطالعہ سیرت
14.	اسوہ حسنہ اور عصر حاضر	وطن سے محبت اور سیرت
15.	اسوہ حسنہ اور عصر حاضر	مستشرقین کے اعتراضات اور ان کے جوابات

نصابی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	ابن ہشام	السیرۃ النبویۃ
2	مولانا شبلی نعمانی، سید سلمان ندوی	سیرۃ النبی صلی اللہ علیہ وسلم
3	قاضی محمد سلیمان سلمان منصور پوری	رحمۃ اللعالمین
4	مولانا سید ابوالحسن علی ندوی	نبی رحمت صلی اللہ علیہ وسلم
5	ڈاکٹر یسین مظہر صدیقی	عہد نبوی کا نظام حکومت
6	ڈاکٹر خالد علوی	انسان کامل ؐ

حوالہ جاتی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	سید ابوالاعلیٰ مودودی	سیرت سرور عالم صلی اللہ علیہ وسلم
2	مولانا صفی الرحمن مبارکپوری	الرحیق المختوم
3	پیر محمد کرم شاہ الازہری	ضیاء النبی صلی اللہ علیہ وسلم
4	ڈاکٹر اکرم الضیاء العمری	السیرۃ النبویۃ الصحیحۃ
5	مولانا عبدالرؤف داناپوری	اصح السیر

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URCG-5128	Pakistan Studies	2 (2-0)

Course Brief:

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical and cultural dimensions. It delves into the diverse landscape, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Course Learning Outcomes:

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

1. Have enhanced knowledge of the geographical, historical and political aspects of Pakistan.
2. Understand the society and cultural of Pakistan.
3. Understand and explain the scio-economics developments in Pakistan.
4. Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Content:

1. Introduction to Pakistan:
   - Geographical location and significance.
   - Historical background: Ancient civilizations in the region.
   - Factors leading to the creation of Pakistan
2. Political History of Pakistan:
   - Formative phase
   - Military interventions and democratic transitions.
3. Geography of Pakistan:
   - Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas.
   - River system: Indus river and its tributaries;
   - Climatic regions of Pakistan.
4. Society and Culture of Pakistan:
   - Socio- cultural diversity.
   - Language and literature of Pakistan.
5. Economics Development of Pakistan:
   - Agriculture and industrial sectors of Pakistan.
   - Economic challenges of Pakistan.
6. Contemporary Issues:
   - Foreign relations of Pakistan.
   - Security challenges: terrorism, extremism, regional conflicts.
   - Environmental problems and sustainable development (SDGs).
   - Media and social change.

Suggested Readings:

1. "Jinnah of Pakistan" by Stanley Wolpert
2. "The sole Spokesman: Jinnah, the Muslim League, and the Demand for Pakistan" by Ayesha Jalal
3. "The struggle for Pakistan" by Ishtiaq Hussain Qureshi
4. "Pakistan, the Formative Phase, 1857-1948" by Khalid B. Sayeed
5. "Pakistan Studies: A Book of Readings" by Sikandar Hayat
6. "Constitutional and Political History of Pakistan" by Hamid Khan
7. "Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sarwar
8. "Pakistan: A Modern History" by Ian Talbot
9. "Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed
10. "Physical Geography of Pakistan" by Umar Jahangir
11. "A Geography of Pakistan: Environment, people, and Economy" by Fazle Karim Khan
12. "Pakistan's Foreign Policy: An Historical Analysis" by S.M. Burke
13. "Separatism in East Pakistan" by Rizwan Ullah Kokab
14. "Being Pakistani: Society, Culture and the Arts" by Raza Rumi
15. "Pakistani's Culture Heritage: Socio-Economic and Technological Aspects" edited by Abdul Jabbar Khan
16. "Language and Politics in Pakistan" by Tariq Rahman
17. Sociology" by Horton and Hunt
18. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring
19. "Economic Development of Pakistan" by Ishrat Husain
20. "Issues in Pakistan's Economy" by S. Zaidi

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Semester - III

BOTN-5106	Phycology & Bryology	3(2-1)

Course Brief:
This course provide basic knowledge about the structure and reproduction of algal and bryophytes and their evolutionary tendencies and to introduce the students with different species of algae and bryophytes, their collection methods, mounting and specimen identification and to enable the students to visualize and understand microscopic differences between algae and bryophytes and their importance. An advanced level course encompassing all the details related to evolution, types, ecology and economic importance of algae. The second half of the course will provide detail information on Introduction and general account of bryophytes, classification, and brief study of Hepaticopsida, Anthoceropsida and Bryopsida.

Course Learning Objectives:
This course aims to understand the classification, morphology and economic importance of Algae and Bryophytes. By the completion of the course, students will be able to understand the structural difference between algae and bryophytes and their evolutionary trends. Students will also collect, identify and prepared stain slides for different specimens of algae and bryophytes. Students make use of this knowledge for the detailed study of algae, bryophytes and their economic importance.

Course Content:
1. Phycology Introduction, general account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.
2. Bryology: Introduction and general account of bryophytes, classification, theories of origin and evolution. Brief study of the classes: Hepaticopsida, Anthoceropsida and Bryopsida.

Lab Outline:
1. Phycology:
   - Collection of fresh water and marine algae.
   - Identification of benthic and planktonic algae
   - Section cutting of thalloid algae
   - Preparation of temporary slides
   - Use of camera lucida/micrographs.
2. Bryology
   - Study of the following genera: *Pellia, Porella, Anthoceros and Polytrichum.*

Recommended Texts:

1. Lee, R. E. (2019). *Phycology* (5th Ed.). England: Cambridge University Press.
2. Bellinger, E., (2015). *Freshwater algae* (2nd Ed.). New Jersey: John Wiley and Sons Ltd.

Suggested Readings:

1. Barsanti, L. & Gualtieri, P. (2014). *Algae: anatomy, biochemistry, and biotechnology* (1st Ed.). Florida: CRC Press, Taylor and Francis Group.
2. Hussain, F. (2016) *Phycology: A text book of algae* (1st Ed.). Lahore: Pak Book Empire

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BOTN-5107	Mycology	3(2-1)

Course Brief:
This course will provide students with basic concepts and identification of fungi, plant pathogens and diseases caused to various important crops. Students will be able to: identify major fungal groups based on morphology (both in the field and in the lab); understand and explain the ecological roles and trophic modes of major fungal groups; use fungal biology resources to understand fungal nomenclature and systematic; demonstrate a broad knowledge of core concepts in Plant Pathology; disease diagnosis and management.

Course Learning Objectives:

The aim of the course is to introduce the students to Mycology and diseases caused by Fungi, to develop an understanding of the diversity of organisms in the Kingdom Fungi. Upon completion of the course the student will be able to: describe the concepts of what constitutes disease in plants. Identify major principles of plant pathology; recognize the etiological agents of disease. Employ methods to diagnose and manage a wide range of plant diseases; describe aspects of integrated pest management; explain the impact of plant disease on human affairs.

Course Content:

1. Introduction: General characters of fungi, Thallus, cell structure and ultra structure of fungi.
2. Reproduction: Asexual and sexual reproduction and reproduction structures, life cycle, haploid, heterokaryotic and diploid states.
3. Fungal Systematics: Classification of fungi into phyla with suitable examples to illustrate somatic structures, life cycle and reproduction of Myxomycota, Chytridiomycota, Zygomycota (Mucorales) Oomycota (Peronosporales), Ascomycota (Erysiphales, Pezizales), Basidiomycota (Agaricales, Polyporales, Uredinales, Ustilaginales) and Deuteromycetes.
4. Symbiotic relationships of fungi with other organisms (lichens and mycorrhiza) and their significance.
5. Importance of fungi in human affairs with special reference to Industry and Agriculture.
6. Field Guides for Mushroom Identification, Mushrooms Demystified, Comprehensive guide to mushroom identification, Visual identification techniques, Common species and their distributions, The Complete Mushroom Hunter
7. Foraging techniques and safety, Seasonal variations and regional differences.

Lab Outline:

1. Basic mycological techniques.
2. Isolation of fungi from soil, water and air using different techniques.
3. Processing and staining of roots for Arbuscular mycorrhizal assessment in roots of crop plants.
4. Isolation and identification of endogonaceous fungi from soil by wet sieving and decanting techniques.
5. Collection, preservation, culturing and identification of mycological specimens with special reference to taxa of agricultural importance; use of keys for their identification.
6. Examination of prepared slides of selected taxa.
7. Field study of Ascomycetous macrofungi, mushrooms, toadstools, rusts, smuts and other pathogenic fungi.
8. Isolation of pathogenic fungi from diseased tissues.
9. Anatomical and microscopic study of lichens.
10. Anatomical study and hyphal systems of Polypores and Agaricales.
11. Identification of various types of Ectomycorrhizae.
12. Study of interaction of fungi in culture.
13. Macroscopic and microscopic examination of common locally available types representing various taxonomic groups.

Recommended Texts:

1. Phillips, M., (2017). Mycorrhizal planet: how symbiotic fungi work with roots to support plant health and build soil fertility(1st ed.). United States:Chelsea Green Publishing Company.
2. Piepenbring, M., (2015). Introduction to mycology in the tropics(1st ed.). America: APS Press, The American Phyto pathological Society.

Suggested Readings:

1. Molecular Markers in Mycology: Diagnostics and Marker Developments by Bhim Pratap Singh (Editor); Vijai Kumar Gupta (Editor) : Publication in 2017.

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BOTN-5108	Plant Anatomy & Embryology	3(2-1)

Course Brief:

This course provides an in-depth study of the structure and chemical composition of plant cell walls, the organization and function of various plant tissues, and the primary and secondary growth processes in plants. It also covers the characteristics of different types of wood and the stages of plant development and embryology, including the development of anthers, ovules, and seeds. Students will gain practical skills in plant tissue analysis, anatomical studies of plant organs, and the identification of plant families through lab work and field trips.

Course Learning Objectives:

The aim of this course is to understand of plant cell wall structure and chemical composition, including the organization and roles of key components. They will explore the concept, structure, and function of various plant tissues, such as parenchyma, collenchyma, sclerenchyma, epidermis, xylem, and phloem, as well as different types of meristems. The course will cover the structure and development of plant organs, focusing on root, stem, and leaf development, including primary and secondary growth in dicots and periderm formation. Additionally, students will examine the characteristics of wood, including diffuse and ring-porous wood, sap and heartwood, softwood and hardwood, and the formation of annual rings. Finally, the course will introduce plant embryology, covering early plant body development, anther and ovule structure, microsporogenesis, megasporogenesis, endosperm formation, parthenocarpy, and polyembryony.

Course Content:

1. Plant Anatomy
   - The Plant Body and its development- Internal Organization, Different Tissue Systems of Primary and Secondary Plant Body. Dermal Tissue System and Modifications, Ground Tissue System and Vascular Tissues System (Origin, Structure, Development, Functional and Evolutionary Specialization).
   - Meristematic Tissues: Classification, Cytohistological Characteristics, Shoot and Root Apices.
   - Leaf, Stem and Roots: Types, Internal Organization, Functions and Development of various Tissues. Anatomical Adaptations of Plants to various Climatic Regimes.
   - Vascular Cambium: Origin, Structure, Seasonal activity and its role in the Secondary Growth of Root and Stem. Wood Anatomy, Abnormal Secondary Growth.
   - Anatomy of Reproductive Parts (Flower, Seed and Fruit).
2. Embryology/Development
   - Flower Morphology and Development, Structure and Development of Anther-Microsporogenesis and Micro gametogenesis, Structure and Development of Ovule-Megasporogenesis and Mega gametogenesis, Embryo Sac Structure, Endosperm Formation, Parthenocarpy, Polyembryony.

Lab Work:

1. Study of Organization of Shoot and Root Meristem,
2. Different Primary and Secondary tissues (Dermal, Ground and Vascular Tissues) of the Plants
3. Study of Parenchyma, Collenchyma, Sclerenchyma, Stomata, Trichomes and Laticifers.
4. Transverse Section of Root, Stem and Leaf of Angiosperms.
5. Study of Primary and Secondary xylem
6. Comparative study of wood structure of Gymnosperms and Angiosperms with the help of prepared slides.
7. Anatomy of Germinating Seeds.
8. Studies of developmental phases of Pollen and Ovule of various Plants

Recommended Books :

1. Bojwani. S.S.. Bhatnagar, S.P. and Dantu, P.K. (2015). *The Embryology of Angiosperms*. Vikas Publishing House.
2. Carrillo-López, A. and Yahia, E.M. (2019). Morphology and Anatomy. *In:* Postharvest Physiology and Biochemistry of Fruits and Vegetables. Woodhead Publishing.
3. Crang, R., Lyons-Sobaski, S. and Wise, R. (2018). *Plant Anatomy: A Concept-Based Approach to the Structure of Seed Plants*. Springer.

Suggested Readings :

1. Gupta, R. and Shukla, K. (2012). Plant Anatomy in relation to Taxonomy. *In; Plant Taxonomy: Past, Present, and Future.* New Delhi, The Energy and Resources Institute, pp. 211-229.
2. Johri, B.M. (2012). *Embryology of Angiosperms*. Springer Science & Business Media.
3. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. (2013). *Comparative Embryology of Angiosperms vol. 1/2* (Vol. 1). Springer Science & Business Media.
4. Lopez, F.B., Barclay, G.F. and Badal, S. (2024). Plant Anatomy and Physiology. *In;* Pharmacognosy. Academic Press.

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URCG-5112	Fables, Wisdom Literature and Epic	2(2-0)

Course Brief:

The three components of the course, including fables, wisdom literature and epic, will enable the learners to explore and understand the classic tradition in literature. Development of personal virtue, a deep Sufi ethic and an unwavering concern for the permanent over the fleeting and the ephemeral are some of the key themes explored in the contents that will develop an intimate connection between literature and life.

Course Learning Objectives:

The course will enable students to explore human experiences, cultivate an appreciation of the past, enrich their capacity to participate in the life of their times, and enable an engagement with other cultures and civilizations, both ancient and modern. But independently of any specific application, the study of these subjects teaches understanding and delight in the highest achievements of humanity.

Course Content:

1. Fables
   - The Fables of Bidpai
   - The Lion and the Bull
   - The Ring-dove
   - The Owls and the Crows
   - Selected poem from Bang-i-Dara
2. Gulistan-e- Sa'di
   - Ten ḥikāyāt from John T. Platts, The Gulistan
3. Epic
   - THE SHĀHNĀMA OF FIRDAUSI

Recommended Texts:

1. John T. P. (1876). The Gulistan; or, Rose Garden of Shaikh Muslihu'd- Dīn Sa'dī of Shīrāz. London: Wm. H. Allen.
2. Chishti, Y.S. (1991). Sharaḥ-i bāng-i darā. Lāhaur: Maktaba-i ta'mīr-i insāniyat

Suggested Readings:

1. Thackston, W. (2000). A Millennium of Classical Persian Poetry. Maryland: Ibex Publishers.
2. Wood, R. (2013). Kalila and Dimna: Fables of Conflict and Intrigue. United Kingdom: Medina Publishing, Limited.

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URCG-5113	Space, Place & Experiences	2(2-0)

Course Learning Objectives:

Architectural structures host the most mundane and ordinary activities as well as elaborate ceremonies to honor religious sentiments or to propitiate political deities. Some structures built for one purpose sometimes end up serving the other in subsequent times. The purpose of this course is to familiarize the learners with the concepts of reading a building to understand human life that existed in and around it during certain historical moments of its existence. Some of the approaches

to study a monument could be the socio-cultural, religious, economic, and political situations of the area where it stands. These angles will not only acquaint you with the different phases of the monument's life but also with the people who commissioned it, occupied or altered it, or tried to destroy it.

Course Content:

1. Learning to engage with a building
   Case Study: Mughal-period mosque, the Begum Shahi/Maryam Zamani
2. Reading a building: History, decorative techniques, location, symbolic significance of motifs, plan/layout
3. Bays and isles, arches, minarets and domes
4. Muqarnas
5. Traditional decorative techniques: munabbat-kārī, parchīn-kārī, kāsha- kārī, āyina- kārī, tāza-kārī
6. Wet-plaster painting known as fresco-buono and dry-plaster painting or fresco-secco
7. Geometric patterns, Islimī or arabesque (stylized vegetal designs) and naturalistic vegetal designs for decorative purposes

Project: Working on historical and anecdotal material of a selected monument

Recommended Texts:

1. Lāl, K. (1884), Tārīkh-i lāhaur (Lāhaur: Būk ṭāk, 2006 [1884]), 127-128.
2. Latif, S.M. (1892), Lahore: Its Historical, Architectural Remains and Antiquities, with an Account of its Modern Institutions. Inhabitants, their Trade, Customs &c. (Lahore: New Imperial Press, 1892), 131-132.
3. Baqir, M. Lahore: Past and Present (Delhi: Low price Publications, 1993 [1952]), 358-359.
4. Quraishī M. A. (1962), "Masājid: 'ahd-i ghaznavī se zamāna-yi ḥāl tak," in Muḥammad Ṭufail ed., Nuqūsh lāhaur nambar: ahd-i ghaznavi se daur-i ḥāzir tak kī tārīkh, 1014 se 1961 tak, Vol. 92 (Special issue 1962), 545-546.
5. Peck, L. (2015), Lahore: The Architectural Heritage (Lahore: Ferozsons, 2015), 80-81.

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URCG-5105	Islamic Studies	2(2-0)

Course Brief:

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam: Qur'aan and Hadith, history-and particular cultural contexts. The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social and anthropology). It offers opportunities to get fully introductory foundational basis of Islam in fields that include Qur'aanic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy and Islamic law, culture and theology through the textual study of Qur'aan and Sunnah.

- To make students understand the relevance and pragmatic significance of Islam in their lives.
- To make learners comprehend the true spirit of Islam with reference to modern world.
- To generate a sense of Islamic principles as a code of living that guarantee the effective solutions to the current challenges of being.
- To provide basic information about Islamic Studies.
- To enhance understanding of the students regarding Islamic Civilization
- To improve students skills to perform prayers and other worships
- To enhance the skill of the students for understanding the issues related to faith and religious life.

Content:

1. Introduction to Qur'anic Studies

   تعارف قرآن مجید

   i. Basic Concepts of Qur'an

   قرآن مجید کا بنیادی تعارف

ii. History of the compilation of Qur'aa — تاریخ جمع و تدوین قرآن مجید

iii. Uloom-ul-Qur'aan — علوم القرآن

مطالعہ قرآن (تعارف قرآن مجید، منتخب آیات کا ترجمہ و تفسیر: سورۃ البقرہ آیات 1-5، 284-286؛ سورۃ الحجرات آیات 1-18؛ سورۃ الفرقان آیات 63-77؛ سورۃ المومنون آیات 1-11؛ سورۃ الاحزاب آیات 6، 21، 32-33، 40، 56-59؛ سورۃ الانعام آیات 151-153؛ سورۃ الصف آیات 1-14؛ سورۃ الحشر آیات 18-20؛ سورۃ آل عمران آیات 190-192؛ سورۃ النحل آیات 12-14؛ سورۃ لقمن آیت 20؛ سورۃ حم السجدہ آیت 53

2. Introduction to Hadith — تعارف حدیث

i. Legal Status of Hadith — حدیث کی قانونی حیثیت

ii. History of the compilation of Hadith — تاریخ جمع و تدوین حدیث

iii. Classifications of Hadith — حدیث کی اقسام

متن حدیث: 1 درج ذیل موضوعات پر احادیث کا مطالعہ

1۔ اعمال کا اجر نیت پر منحصر ہے۔ 2۔ بہترین انسان قرآن کا طالب علم اور اس کا معلم ہے۔ 3۔ کتاب و سنت گمراہی سے بچنے کا ذریعہ ہیں۔ 4۔ ارکان اسلام۔ 5۔ اسلام، ایمان، احسان اور قیامت کی نشانیاں۔ 6۔ بچوں کو نماز کی تلقین۔ 7۔ دین کا گہرا فہم اللہ کی خاص عنایت ہے۔ 8۔ حصول علم، تلاوت قرآن اور عمل کی اہمیت و فضیلت۔ 9۔ روز محشر میں ہونے والا محاسبہ۔ 10۔ حقوق اللہ کے ساتھ ساتھ حقوق العباد کا لحاظ رکھنا بھی لازم ہے۔ 11۔ حسن خلق کی عظمت اور فحش و بدگوئی کی مذمت۔ 12۔ دنیا و آخرت کی بھلائی کی ضامن چار چیزیں۔ 13۔ ہلاک کر دینے والی سات چیزیں۔ 14۔ بے عمل مبلغ کا عبرت ناک انجام۔ 15۔ ہر شخص نگران ہے اور ہر شخص مسئول

3. Sirah of the Prophet (PBUH) — سیرت النبی ﷺ

i. Significance of Seerah Studies — مطالعہ سیرت کی ضرورت و اہمیت

ii. Prophetic principles of Character building — تعمیر سیرت و شخصیت کا نبوی ﷺ منہاج

اقامت دین کا نبوی طریق کار، اقامت دین بعہد خلافت راشدہ مدینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات، تشکیل اجتماعیت اور اسوہ حسنہ، قرآن مجید میں سیرت سرور عالم کا بیان، غزوات نبوی ﷺ کے مقاصد و حکمتیں

4. Islamic Culture & Civilization — اسلامی تہذیب و تمدن

i. Basic Concepts of Islamic Civilization — اسلامی تہذیب کا مفہوم

ii. Historical evaluation of Islamic Civilization — اسلامی تہذیب کا تاریخی ارتقاء

iii. Salient feature of Islamic Civilization — اسلامی تہذیب کی نمایاں خصوصیات

iv. Islamic Civilization and Contemporary Issues — اسلامی تہذیب و تمدن اور معاصر مسائل

اسلامی تہذیب کے عوامل و عناصر، اسلامی تہذیب کے علمی، معاشرتی اور سماجی اثرات، تہذیبوں کے تصادم کے نظریے کا تنقیدی جائزہ، تہذیبی تصادم کے اثرات و نتائج، طبعی، حیاتیاتی اور معاشرتی علوم میں مسلمانوں کا کردار، نامور مسلمان سائنسدان

Recommended Books:

1. Hameed Ullah Muhammad, —Emergence of Islaml , IRI, Islamabad
2. Hameed Ullah Muhammad, —Muslim Conduct of State
3. Hameed Ullah Muhammad, _Introduction to Islam
4. Ahmad Hasan, —Principles of Islamic Jurisprudencel Islamic Research, Institute, International Islamic University, Islamabad (1993).
5. Dr. Muhammad Zia-ul-Haq, —Introduction to Al Sharia Al Islamial. Allama Iqbal Open University, Islamabad (2001)
6. Dr. Muhammad Shahbaz Manj, Teleeemat-e- Islam

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URCG-5126	ETHICS	2(2-0)

Course Content:

1. Meaning and Scope of Ethics.
2. Relation of Ethics with:

- Religion
- Science
- Law

3. Historical Development of Morality:
   - Instinctive Moral Life.
   - Customary Morality.
   - Reflective Morality.
4. Moral Theories:
   - Hedonism (Mill)
   - Intuitionism (Butler)
   - Kant's Moral Theory.
5. Moral Ethics and Society.
   - Freedom and Responsibility.
   - Tolerance
   - Justice
   - Punishment (Theories of Punishment)
6. Moral Teachings of Major Religions:
   - Judaism
   - Christianity
   - Islam
7. Professional Ethics:
   - Medical Ethics
   - Ethics of Students
   - Ethics of Teachers
   - Business Ethics

Recommended Texts:

1. William Lille. An Introduction to Ethics. London Methuen & Co. latest edition.
2. Titus, H.H. Ethics for Today. New York: American Book, latest edition.
3. Hill, Thomas. Ethics in Theory and Practice. N.Y. Thomas Y. Crowel, latest edition

Suggested Reading:

4. Ameer Ali, S. The Ethics of Islam. Culcutta: Noor Library Publishers, latest edition
5. Donaldson, D.M. Studies in Muslim Ethics. London: latest edition.
6. Sayeed, S.M.A.(Tr.) Ta'aruf-e-Akhlaqiat. Karachi: BCC&T, Karachi University of Karachi.

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URCG-5122	Ideology and Constitution of Pakistan	2(2-0)

Course Brief:

This course focuses on ideological background of Pakistan. The course is designed to give a comprehensive insight about the constitutional developments of Pakistan. Starting from the Government of India Act, 1935 till to date, all important events leading to constitutional developments in Pakistan will be the focus of course. Failure of the constitutional machinery and leading constitutional cases on the subject. Moreover, students will study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan. It will also cover the entire Constitution of Pakistan 1973. However, emphasis would be on the fundamental rights, the nature of federalism under the constitution, distribution of powers, the rights and various remedies, the supremacy of parliament and the independence of judiciary

Course Content:

1. Ideology of Pakistan
   Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
   Two Nation Theory and Factors leading to Muslim separatism
2. Constitutional Developments
   Salient Feature of the Government of India Act 1935
   Salient Feature of Indian Independence Act 1947

Objectives Resolution
Salient Feature of the 1956 Constitution
Developments leading to the abrogation of Constitution of 1956
Salient features of the 1962 Constitution
Causes of failure of the Constitution of 1962
Comparative study of significant features of the Constitution of 1956, 1962 and 1973

3. Fundamental rights
4. Principles of policy
5. Federation of Pakistan
   President; Parliament; the Federal Government
6. Provinces
   Governors; Provincial Assemblies; the Provincial Government
7. The Judicature
8. Supreme Court; High Courts; Federal Shariat Courts; Supreme Judicial Council; Administrative Courts and tribunals
9. Islamic Provisions in Constitution
10. Significant Amendments of Constitution of Pakistan 1973

Recommended Books:

1. Constitutional and Political History of Pakistan by Hamid Khan
2. Mahmood, Shaukat and Shaukat, Nadeem. Constitution of the Islamic Republic of Pakistan, 3rd re edn. Lahore: Legal Research Centre, 1996.
3. Munir, Muhammad. Constitution of the Islamic Republic of Pakistan: Being a Commentary on the Constitution of Pakistan, 1973. Lahore, Law Pub., 1975.
4. Rizvi, Syed Shabbar Raza. Constitutional Law of Pakistan: Text, Case Law and Analytical Commentary. 2nd re Edn. Lahore: Vanguard, 2005
5. The Text of the Constitution of the Islamic Republic of Pakistan, 1973 (as amended).
6. Fundamental Laws of Pakistan by A.K. Brohi

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URCG-5111	Translation of Holy Quran-II	Non-credit

Semester / Level:

In some discipline 3rd semester and in some discipline 4th Semester/ ADP Program 2nd Year

Course Learning Objectives:

- Students will come to know about the real nature, significance and relevance of the Islamic beliefs in light of the text of the Holy Quran.
- Students will seek knowledge of translation and transliteration of the Holy Book Quran.
- To familiarize the students with the concept of Ibādah (Its significance, scope and relevance) and its types in Islam.
- Students will learn literal and idiomatic way of translation of the Holy Book.
- Students will learn about the polytheism and its incompatibility in Islam highlighted by the Holy Quran.
- To highlight the significance of learning through using all human faculties provided by the almighty Allah and familiarize the students about condemnation of ignorance mentioned in the Quranic text.
- To develop Awareness among the students about rights and duties of different circles of society in the light of Holy Quran.
- To introduce the students to Quranic Arabic grammar in practical manner.

Course Content:

- ایمانیات اور عبادات

اللہ پر ایمان، فرشتوں پر ایمان، رسولوں پر ایمان، آسمانی کتابوں پر ایمان، یوم آخرت پر ایمان، تقدیر پر ایمان، نماز، روزہ، زکوۃ، حج، جہاد

- معاشرے کے حقوق
- خاندان کی تکوین
- حق مہر
- رضاعت وحمل
- اولاد کو قتل کرنے کی ممانعت
- شوہر کی نافرمانی
- طلاق
- بیوہ کی عدت کے احکام
- نکاح کا پیغام بھیجنا
- عورت کی وراثت (اس کے شوہر کی طرف سے)
- والدین کے حقوق
- بیویوں اور اولاد کے بیچ عداوت
- خاندان کے حقوق
- مہمان کی عزت
- اجازت طلب کرنے کے اصول
- مجلس کے آداب
- تعاون اور بھائی چارہ
- گروہ بندی
- محبت
- لوگوں کے درمیان صلح
- عفوودرگزر، غصہ پر قابو اور معاف کرنا
- شعوب وقبائل
- لوگوں کے بیچ اختلافات
- حمایت ونگہبانی

Grammar:

- قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)

Details of Chapters and verse Numbers:

- منتخب آیات مع ترجمہ وتجوید
- البقرہ((۱۷۷،۲۳۸،۲۴۵،۲۷۷،۲۱۹،۱۱۰،۴۵،۱۵۳،۲۴۷،۲۰۱،۲۸۵،۳۴،۲۸۵،۱۲۹،۱۵،۲۸۵،۲۵۳،۹۸،۶۲،۱۲۶،۲۸۵،۲۵۶،۱۷۷،۱۳۶، ۱۸۹،۲۰۰،۱۸۴،۱۸۳،۲۱۸،۱۵۸،۲۴۱،۱۹۹،۲۲۷،۲۲۶،۲۳۷،۲۲۸،۲۲۹،۲۳۱،۲۳۷،۲۳۵،۲۳۰،۸۲،۱۸۴،۲۳۳،۱۸۲،۱۶۰،۸۳)
- النساء(۹۵،۹۲،۵۹،۱۳۶،۶۹،۸۰،۱۳،۶۹،۸۶،۸۰،۳۶،۱۲۶،۱۲،۳۵،۱۲۸،۳۴،۱۱،۴،۱۷۶،۲۴،۲۵،۱۱،۱۱،۱۲۸،۱۹۱،۳۵،۲۰،۳۵،۱۹۱،۶،۱، ۲۰،۱،۱۶،۱۴۶،۵۴،۱۲۸،۸۱)
- الانعام(۲۲،۱۳۷،۱۴،۹۲،۱۵۱،۴۸،۵۴)
- آل عمران(۹۷،۳۹،۸۵،۱۲۵،۸۴،۱۴۴،۱۹،۱،۱)
- المائدہ(۵۴،۲،۹۲،۳۹،۱۹،۸۲،۲،۵)
- الاعراف(۳۵،۱۸۹،۱۸۹)
- التوبہ(۲۰،۷۱،۱۶)
- ہود(۱۲)
- الزمر(۶)
- النور(۵۴،۲۸،۵۲،۲۷،۶۰،۲۹)
- محمد(۳۳)
- انفال(۸۲،۲۰)
- الرعد(۳)
- الطلاق(۴)
- الحج(۵)
- ابراہیم((۴۳،۲۳)
- الاسراء(۲۳،۲۴)
- الاحقاف(۱۵)
- المومنون(۲۷)
- العنکبوت(۲۵،۴۸،۸)
- النحل(۲۲)
- لقمان(۱۵،۴،۱۴)
- الاحزاب((۳۵،۵۰،۳۸،۴۹)
- الشعراء(۷)
- الروم(۲۱)
- مریم(۱۴،۲۶)
- المجادلہ(۱۲،۱۱)

Semester - IV

BOTN-5109	Phytogeography	3(2-1)

Course Brief:

This course explores the geographical distribution of plants and the environmental factors influencing their distribution patterns. It covers the principles of phytogeography, including biogeographical regions, plant ecology, and the impact of climate and human activities on plant distribution. The course provides insights into the historical and contemporary aspects of plant distribution, including the role of evolutionary processes and ecological interactions. Practical laboratory work complements the theoretical aspects, focusing on plant distribution mapping, vegetation analysis, and field surveys.

Course Learning Objectives:

Students will explore the definition, scope, and significance of phytogeography, including its historical development and key concepts. They will study the principles of phytogeography, including biogeographical regions, classification, and factors influencing plant distribution such as climate, soil, and topography. The course will cover global plant distribution patterns, endemism, diversity hotspots, and historical and evolutionary aspects of plant distribution. Students will examine major phytogeographical regions (temperate, tropical, arid, and alpine), their characteristics, plant species, and the impact of climate change. Additionally, they will learn methods and techniques for mapping plant distribution, conducting vegetation analysis, and performing field surveys. The course will address human impacts on plant distribution and biodiversity, emphasizing conservation strategies and sustainable management.

Course Content:

1. Introduction to Phytogeography, Definition, scope, and importance of phytogeography, Historical development and key concepts in phytogeography
2. Principles of Phytogeography, Biogeographical regions and their classification, Factors influencing plant distribution: climate, soil, topography, and human activities, Ecological interactions and their impact on plant distribution
3. Plant Distribution Patterns, Global plant distribution patterns and major biomes, Endemism and plant diversity hotspots, Historical and evolutionary aspects of plant distribution
4. Phytogeographical Regions, Major phytogeographical regions: temperate, tropical, arid, and alpine regions, Characteristics and plant species of each region, Impact of climate change on plant distribution
5. Methods and Techniques in Phytogeography, Mapping plant distribution: techniques and tools, Vegetation analysis and classification, Field surveys and data collection
6. Human Impact and Conservation, Effects of human activities on plant distribution and biodiversity, Conservation strategies and sustainable management of plant resources

Lab Outline:

1. Create distribution maps using Q-GIS, Arc GIS and other tools; analyze patterns and their environmental correlations.
2. Study of Global components of living environment.
3. Study of different climatic regions of the world.
4. Measurement of light intensity, temperature and relative humidity under different climatic conditions.
5. Study of climatic conditions and vegetation of coniferous forest,
6. Vegetation and climatic conditions of Heathlands; Grasslands & Deserts.
7. Mangrove and seashore vegetation.
8. Fresh water Plankton, Benthos, Bog & Saline water communities.
9. Marine environment Vegetation.
10. Field work: to study Phytosociology and Impact of climatic factors on plants.

Recommended Texts:

1 Cox, C.B., Moore, P.D. and Ladle, R.J. (2016). *Biogeography: An Ecological and Evolutionary Approach*. John Wiley & Sons.

2 Taylor, E.L., Taylor, T.N. and Krings, M. (2009). Paleobotany: the biology and evolution of fossil plants. Academic Press.

Suggested Reading:

1. Seward, A.C. (2011). *Fossil plants: a text-book for students of botany and geology* (Vol. 4). Cambridge University Press.
2. Von Humboldt, A. and Bonpland, A. (2010). *Essay on the Geography of Plants*. University of Chicago Press.
3. Willis, K.J. and McElwain, J.C. (2014). *The Evolution of Plants*. Oxford University Press, USA.

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BOTN-5110	Principles of Plant Ecology	3(2-1)

Course Brief:

This course examines the role of plants within ecosystems, including their interactions with other organisms and abiotic factors. Students will explore plant life history, functional traits, and demography, alongside ecosystem processes that sustain and regulate environments. Emphasis is placed on understanding plant-to-plant, plant-animal, and broader ecosystem interactions. By the end, students will develop skills in analyzing current theories and applying practical solutions to ecological problems.

Course Learning Objectives:

The aim of the course is to understand the role and interaction of plants with their environment. Plant Ecology is the study of organisms, populations, and communities as they relate to one another and interact in the ecosystems they comprise. In plant ecology, ecosystems are composed of organisms, the communities they comprise, and the non-living aspects of their environment. Ecosystem processes are those that sustain and regulate the environment. Ecological areas of study include topics ranging from the interactions and adaptations of organisms within an ecosystem to the abiotic processes that drive the development of those ecosystems. The course deals with plants life history and functional traits, demography, and interactions between plants, between plants and animals and between plants and the remaining ecosystem. The student can analyze the current theories, methods and interpretations within the field plant ecology, and work independently with practical and theoretical problem solving.

Course Content:

1. Introduction: The seven major autecological factors and their detail. Adaptations in plants in response to ecological factors.
2. The Soil Factor: Definition and importance of soil: Concept of texture and structure; Physical and chemical properties of soil; Soil formation and parent materials; Soil porosity; Organic and inorganic components; Living inhabitants of soil.
3. The Water Factor: Importance of water to plants; Forms of atmospheric moisture; Forms of precipitation and their ecological effects. Soil moisture constants.
4. Light and Temperature Factors: Introduction; Comparison of tropical, temperate and polar regions; Temporal and spatial variations in light and temperature; Role of light and temperature in plant distribution and diversity; Responses and adaptations of plants to light and temperature; Differences in Heliophytes and Sciophytes; Ecological response of plants to warm, chilling and freezing temperatures. Hardening; Ecophysiological responses in plants: Photoperiodism; Thermoperiodism; Cardinal temperatures; Light compensation point; Dormancy; Stratification; Vernalization.
5. The Wind Factor: Formation of wind; Influences of wind on plants; Cushion plants; Shelterbelts.
6. The Fire Factor: Kinds of fire; Plant adaptations related to fire. Fire climax; Practical value of vegetation burning.
7. The Biotic Factor: Biotic influences; Local vegetation; Vegetation of Pakistan; Major Biomes of the world

Lab Outline:

1. Determination of Soil Texture of given soil sample by Hydrometer method
2. Find out the percentage and types of Water Stable Aggregates in a given soil sample by

3. Wet Sieving Technique
4. Determination of Capillary Rise of water in soil of different textures
5. Study the Infiltration and Permeability in soils of different textures
6. Determination of soil moisture constants of given soil sample
7. Determination of Oxidizable Organic Matter Content of soil by Wet Digestion Method
8. Determination of soil water holding capacity of given soil sample
9. Determination of Air Temperature and Relative Humidity in open sunlight/shade at
10. ground level and different heights with a Whirling Psychrometer
11. Determination of Light Intensity in various habitats by using a Lux-Meter
12. Study the different adaptations in Hydrophytes, Xerophytes and Cacti.
13. Study of Heliophytes and Sciophytes
14. Study of Impact of Wind on plants- Cushion plants
15. Preliminary survey to gain information about different local Plant Communities

Recommended Texts:

1. Keddy, P. A., (2017). Plant ecology origins, processes, consequences (2nd Ed.). England: Cambridge University Press.
2. Canadell, J. G., Diaz, S. Heldmaier, G., Jackson, R.B., Levia, D.F., Schulze, E.D., Sommer, U. & Wardle, D. A., (2019). Ecological studies (1st Ed.). New York: Springer.

Suggested Readings:

1. Fath, B., (2018). Encyclopedia of ecology (2nd Ed.). New York: Elsevier.
2. Keddy, P. A., (2018). Wetland ecology: principles and conservation, (2nd Ed.). England: Cambridge University Press.

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BOTN-5111	Principles of Plant Biochemistry	3(2-1)

Course Brief:

Biochemistry is the study of the chemical processes that drive biological systems. Because the field of biochemistry is continually evolving and touches many areas of cell biology, this course also includes an elementary introduction to the study of molecular biology. Biochemistry is both life science and a chemical science - it explores the chemistry of living organisms and the molecular basis for the changes occurring in living cells. It uses the methods of chemistry, "Biochemistry has become the foundation for understanding all biological processes.

Course Learning Objectives:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects. This course gives information to understand the fundamental chemical principles that govern complex biological systems. Biochemistry is the study of the chemical processes that drive biological systems. Biochemistry is both life science and a chemical science - it explores the chemistry of living organisms and the molecular basis for the changes occurring in living cells. At the end of the course students will be unable to get an understanding of fundamental biochemical principles.

Course Content:

1. Introduction to Plant Biochemistry, Definition and scope of plant biochemistry. Importance of structural biochemistry in plant science. Overview of plant cell structure with a focus on biochemical components
2. Introduction to carbohydrates: Occurrence and classification, sugar structures, synthesis of polysaccharides, carbon metabolism in the chloroplast. starch synthesis, Pentose phosphate pathway, carbon export, sucrose synthesis and transport in vascular plants, cellulose synthesis and composition of primary cell walls
3. Introduction to lipids: Occurrence, classification, structure and chemical properties of fatty acids, fatty acid biosynthesis in plants, di and triglycerides, phospholipids, glycolipids, lipids, waxes and sterols.

4. Introduction to Proteins: Aminoacids and their structure. Electrochemical properties and reactions of amino acids. Classification of proteins, primary, secondary, tertiary and quaternary structure of proteins. Protein targeting, protein folding and unfolding. Transport, storage, regulatory and receptor proteins. Protein purification, proteinsequencing. Biological role, plant defense proteins and peptides, defensins and related proteins. Synthesis and functions of non-ribosomal peptides
5. Introduction to Nucleic Acids: General introduction. Purine and pyrimidine bases, nucleosides, nucleotides. Structure and properties of DNA and RNA, types and functions of RNA, nucleic acid metabolism.
6. Introduction to Enzymes: Nature and functions, I.U.E. classification with examples of typical groups, isozymes, ribozymes, abzymes, enzyme specificity, enzyme kinetics, nature of active site and mode of action, allosteric enzymes and feedback mechanism, enzymes with multiple functions mechanisms and evolution. Isoprenoid metabolism, biosynthetic pathways, monoterpenes, sesquiterpenes, phytosterols, diterpenes, Enzymes with multiple functions, mechanisms and evolution.

Lab Outline:

1. Solutions, acids and bases, electrolytes, non-electrolytes, buffers, pH and chemical bonds.
2. To determine the R_f value of monosaccharide's on a paper Chromatogram.
3. To estimate the amount of reducing and non-reducing sugars in plant material titrimetrically/spectrophotometrically.
4. To determine the saponification number of fats.
5. To extract and estimate oil from plant material using soxhlet apparatus.
6. Analysis of various lipids by TLC methods.
7. To estimate soluble proteins by Biuret or Lowry or Dye-binding method.
8. To estimate the amount of total Nitrogen in plant material by Kjeldahl's method.
9. To determine $R_f$value of amino acids on a paper chromatogram.
10. Extraction of Nucleic acids from plant material and their estimation by UV absorption or color reactions.
11. To estimate the catalytic property of enzyme catalase or peroxidase extracted from a plant source.
12. To determine the PKa and isoelectric point of an amino acid.

Recommended Texts:

1. Nelson, D. & Cox, M., (2017). *Lehninger: Principles of Biochemistry* (7th Ed).New York: W.H. Freeman.
2. Heldt, H. & Piechulla, B., (2016). *Plant Biochemistry* (1st Ed.). London: Academic Press.

Suggested Readings:

1. Voet, D., Voet, J. G. & Pratt, C.W., (2015). *Fundamentals of Biochemistry* (5th Ed.). New Jersey: John Wiley and Sons.
2. Mitra, G. N., (2015). *Plants: A biochemical and molecular approach* (1st Ed.).India: Springer.
3. Buchanan, B.B., Gruissem, & W., Jones, R. L., (2015).*Biochemistry and molecular biology of plants*, (2nd Ed.). New Jersey: Wiley.
4. Conn E. E. & Stump, P.K., (2017). *Outlines of Biochemistry* (4th Ed.). New Jersey: John Wiley and Sons Inc.

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BOTN-5112	Fundamentals of Plant Physiology	3(2-1)

Course Brief:

This course provides an introduction to basic principles of plant functions including physical processes occurring in plants, Photosynthesis, Respiration, Pathway of translocation, Gaseous exchange, Mechanism of stomatal regulation and growth and development. The subject here to describe plant physiology-I comprises on harvesting of light by plants and its conversion into a

chemical energy, mechanism of oxygen evolution by plants, cyclic and non-cyclic electron transport chain.

Course Learning Objectives:

This course aims to develop understanding of the relationship of complementary metabolic pathways such as photosynthesis and respiration in energy acquistion and use during plant development and to develop understanding of the environmental influences upon carbon metabolism in plants. Plant physiology deals with all the internal activities of plants.

Course Content:

1. Photosynthesis: General Concepts, Structure of Chloroplast, Organization of the photosynthetic apparatus, Ultra structure and composition of photosystem-I and II, ATP synthase, Mechanism of photosynthesis, light absorption, charge separation and oxidation of water (water oxidizing clock), electron and proton transport through, thylakoid protein-pigment complexes. CO2 fixation mechanism (C3, C4 and CAM plants).
2. Respiration: Glycolysis, Anaerobic and aerobic respiration, The Citric Acid Cycle, Mitochondrial Electron Transport and ATP synthesis, Energetics of Respiration, Glyoxylate cycle.
3. Translocation of photosynthates: Pathway of Translocation, Mechanism of phloem transport; materials translocated through phloem, Phloem loading and unloading, Photosynthate allocation and partitioning.

Lab Outline:

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

Recommended Texts

1. Taiz, L. & Zeiger, E., (2019). Plant physiology (7th Ed.). England: Sinnauers Publ. Co. Inc.
2. Dennis, D. T., Turpin, D. H., Lefebvre, D. D. & Layzell, D. B., (2016). Plant metabolism (6th Ed.). London: Longman Group.

Suggested Readings

1. Mitra, G. N., (2015). Plants: a biochemical and molecular approach (1st Ed.). India: Springer.
2. Buchanan, B., Gruissem, W. & Russell, L., (2015). Biochemistry and molecular biology of Plants (2nd Ed.). New Jersey: John Wiley & Sons.

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URCG-5125	√	Civics and Community Engagement	2(2-0)

Course Description:

The Civics and Community Engagement course is designed to provide students with an understanding of the importance of civic participation, culture and cultural diversity, basic foundations of citizenship, group identities and the role of individuals in creating positive change within their communities. The course aims at developing students' knowledge, skills and attitudes necessary for active and responsible citizenship.

Learning Outcomes:

After completing this course, students will be able to:

- Understand the concepts of civic engagement, community development, and social responsibility.
- Understand rights and responsibilities of citizenship

- Understand cultural diversity in local and global context
- Analyze the significance of civic participation in promoting social justice, equity and democracy.
- Examine the historical and contemporary examples of successful civic and community engagement initiatives.
- Identify and assess community needs, assets, and challenges to develop effective strategies for community improvement.
- Explore the ethical implications and dilemmas associated with civic and community engagement.
- Develop practical skills for effective community organizing, advocacy, and leadership.
- Foster intercultural competence and respect for diversity in community engagement efforts.
- Collaborate with community organizations, stakeholders, and fellow students to design and implement community-based projects.
- Reflect on personal growth and learning through self-assessment and critical analysis of community engagement experiences.

Course Content:

1. Introduction to Civics & Community Engagement ,
   - Overview of the course, Civics & Community Engagement
   - Definition and importance of civics
   - Key concepts in civics: citizenship, democracy, governance, and the rule of law
   - Rights and responsibilities of citizens
2. Citizenship and Community Engagement
   - Introduction to Active Citizenship: Overview of the Ideas, Concepts, Philosophy and Skills
   - Approaches and Methodology for Active Citizenship
3. Identity, Culture, and Social Harmony
   - Concept and Development of Identity, Group identities
   - Components of Culture, Cultural pluralism, Multiculturalism, Cultural Ethnocentrism, Cultural relativism, Understanding cultural diversity, Globalization and Culture, Social Harmony
   - Religious Diversity (Understanding and affirmation of similarities & differences)
   - Understanding Socio-Political Polarization
   - Minorities, Social Inclusion, Affirmative actions
4. Multi-cultural society and inter-cultural dialogue
   - Inter-cultural dialogue (bridging the differences, promoting harmony)
   - Promoting intergroup contact/ Dialogue
   - Significance of diversity and its impact
   - Importance and domains of Inter-cultural dialogue
5. Active Citizen: Locally Active, Globally Connected
   - Importance of active citizenship at national and global level
   - Understanding community
   - Identification of resources (human, natural and others)
   - Utilization of resources for development (community participation)
   - Strategic planning, for development (community linkages and mobilization)
6. Human rights, constitutionalism and citizens' responsibilities
   - Introduction to Human Rights
   - Human rights in constitution of Pakistan
   - Public duties and responsibilities
   - Constitutionalism and democratic process
7. Social Institutions, Social Groups, Formal Organizations and Bureaucracy
   - Types of Groups, Group identities, Organizations
   - Bureaucracy, Weber's model of Bureaucracy
   - Role of political parties, interest groups and non-governmental organizations

8. Civic Engagement Strategies
    - Grassroots organizing and community mobilization
    - Advocacy and lobbying for policy change
    - Volunteerism and service-learning opportunities
9. Social issues/Problems of Pakistan
    - Overview of major social issues of Pakistani society
10. Social Action Project

Recommended Texts:

1. Kennedy. J. K., & Brunold, A. (2016). Regional context and Citizenship education in Asia and Europe. New Yourk: Routledge, Falmer.
2. Henslin, James M. (2018). Essentials of Sociology: A Down to Earth Approach (13th Ed.). New York: Pearson Education
3. Macionis, J. J., & Gerber, M.L. (2020). Sociology. New York: Pearson Education

Reference Books:

1. Glencoe McGraw-Hill. (n.d.). Civics Today: Citizenship, Economics, and Youth.
2. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). Government by the People (16th Ed.). Pearson.
3. Sirianni, C., & Friedland, L. (2005). The Civic Renewal Movement: Community-Building and Democracy in the United States. Kettering Foundation Press.
4. Bloemraad, I. (2006). Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada. University of California Press.
5. Kuyek, J. (2007). Community Organizing: Theory and Practice. Fernwood Publishing.
6. DeKieffer, D. E. (2010). The Citizen's Guide to Lobbying Congress. TheCapitol.Net.
7. Rybacki, K. C., & Rybacki, D. J. (2021). Advocacy and Opposition: An Introduction to Argumentation (8th ed.). Routledge.
8. Kretzmann, J. P., & McKnight, J. L. (1993). Building Communities from the Inside Out: A Path Towards Finding and Mobilizing a Community's Assets. ACTA Publications.
9. Patterson, T. E. (2005). Engaging the Public: How Government and the Media Can Reinvigorate American Democracy. Oxford University Press.
10. Love, N. S., & Mattern, M. (2005). Doing Democracy: Activist Art and Cultural Politics. SUNY Press.

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URCG-5124	✓	Entrepreneurship	2(2-0)

Course Brief:

This course addresses the unique entrepreneurial experience of conceiving, evaluating, creating, managing and potentially selling a business idea. The goal is to provide a solid background with practical application of important concepts applicable to the entrepreneurial environment. Entrepreneurial discussions regarding the key business areas of finance, accounting, marketing and management include the creative aspects of entrepreneurship. The course relies on classroom discussion. participation, the creation of a feasibility plan, and building a business plan to develop a comprehensive strategy for launching and managing a new venture.

Course Learning Objectives

The Entrepreneurship course aims to enhance students' entrepreneurial intentions by fostering their inherent willingness to start a business. Students will gain a deep understanding of the entrepreneurship process and learn effective management strategies through individual and group field assignments. The course emphasizes practical knowledge, providing hands-on experience through assignments and idea pitching to bridge theoretical concepts with real-world applications.

Course Content:

1. Background: What is an Organization, Organizational Resources, Management Functions, Kinds of Managers, Mintzberg's Managerial Roles
2. Forms of Business Ownership: The Sole proprietorship, Partnership, Joint Stock Company
3. Entrepreneurship: The World of the Entrepreneur, what is an entrepreneur? The Benefits of Entrepreneurship, The Potential Drawbacks of Entrepreneurship, Behind the Boom: Feeding the Entrepreneurial Fire.
4. The Challenges of Entrepreneurship: The Cultural Diversity in Entrepreneurship, The Power of "Small" Business, Putting Failure into Perspective, The Ten Deadly Mistakes of Entrepreneurship, How to Avoid the Pitfalls, Idea Discussions & Selection of student Projects, Islamic Ethics of Entrepreneurship.
5. Inside the Entrepreneurial Mind: From Ideas to Reality: Creativity, Innovation, and Entrepreneurship, Creativity – Essential to Survival, Creative Thinking, Barriers to Creativity, How to Enhance Creativity, The Creative Process, Techniques for Improving the Creative Process, Protecting Your Ideas, Idea Discussions & Selection of student Projects.
6. Products and technology, identification opportunities
7. Designing a Competitive Business Model and Building a Solid Strategic Plan: Building a strategic plan, Building a Competitive Advantage, The Strategic Management Process, Formulate strategic options and select the appropriate strategies, Discussion about execution of Students' Project.
8. Conducting a Feasibility Analysis and Crafting a Winning Business Plan: Conducting a Feasibility Analysis, Industry and market feasibility, Porter's five forces model, financial feasibility analysis. Why Develop a Business Plan, The Elements of a Business Plan, What Lenders and Investors Look for in a Business Plan, Making the Business Plan Presentation.
9. Building a Powerful Marketing Plan: Building a Guerrilla Marketing Plan, Pinpointing the Target Market, Determining Customer Needs and Wants through Market Research. Plotting a Guerrilla Marketing Strategy: How to Build a Competitive Edge, Feed Back & Suggestions on Student Project, Islamic Ethics for Entrepreneurial Marketing
10. E-Commerce and the Entrepreneur: Factors to Consider before Launching into E-commerce, Ten Myths of E-Commerce, Strategies for E-Success, Designing a Killer Web Site, Tracking Web Results, Ensuring Web Privacy and Security, Feed Back & Suggestions on Student Project.
11. Pricing Strategies: Three Potent Forces: Image, Competition, and Value, Pricing Strategies and Tactics, Pricing Strategies and Methods for Retailers, The Impact of Credit on Pricing
12. Attracting Venture Capitalist: Projected Financial Statements, Basic Financial Statements, Ratio Analysis, Interpreting Business Ratios, Breakeven Analysis, Feed Back &Suggestions on Student Project,
13. Idea Pitching: Formal presentation, 5-minutes pitch, funding negotiation and launching.

Recommended Texts:

1. Scarborough, N. M. (2011). Essentials of entrepreneurship and small business management. Publishing as Prentice Hall, One Lake Street, Upper Saddle River, New Jersey 07458..

Suggested Readings:

1. Burstiner, I. (1989). Small business handbook. Prentice Hall Press.

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Semester V

BOTN-6101	Advanced Plant Ecology	3(2-1)

Course Brief:

Plant ecology course deals with the study of the main environmental factors affecting the Earth's major vegetation types: tropical forests, tropical savannas, arid regions (deserts), Mediterranean ecosystems, temperate forest ecosystems, temperate grasslands, coniferous forests, tundra. The student can analyze the current theories, methods and interpretations within the field plant ecology, and work independently with practical and theoretical problem solving with respect to plant responses in terms of functional traits, life history, demography and ecosystem interactions in different ecosystems.

Course Learning Objectives:

The course aims to provide comprehensive knowledge of population, community, ecosystem ecology and its relevance to mankind. The course covers plant ecology on advanced level. The main objectives for this course in plant ecology are to provide a broad overview of the field of plant ecology, gives students a fundamental appreciation of the local boreal forest and tundra floras and ecosystems, provide an overview of the Earth's major biomes.

Course Content:

1. Population Ecology a. Population structure and plant demography: Seed dispersal, seed bank, seed dormancy, recruitment and demography b. Life history pattern and resource allocation: Density dependent and density independent factors, resource allocation, reproductive effort, seed size versus seed weight, population genetics and evolution
2. Community Ecology: Historical development of community ecology, community concepts and attributes, methods of sampling of plant communities, ecological succession, community soil-relationship, local vegetation, vegetation of Pakistan and major formation types of the world
3. Ecosystem Ecology: Ecological concepts of ecosystem, boundaries of ecosystem. Compartmentalization and system concepts, energy flow in ecosystem, biogeochemical cycles: water carbon and nitrogen case studies.

Lab Outline:

1. Study of Seed dispersal pattern of local populations.
2. Study of community attributes. Sampling of vegetation including by Quadrat, plotless, transect methods.
3. Field trip to study of different communities located in different ecological regions of Pakistan.
4. Study of Physical and Chemical properties of Soil.
5. Correlation of soil properties with vegetation type.

Recommended Texts:

1. West, P. W., (2015). Tree and forest measurement (1st Ed.). Switzerland: Springer International Publishing AG.
2. Osborne, P. L., (2017). Tropical ecosystems and ecological concepts (2nd Ed.).England: Cambridge University Press.

Suggested Readings:

1. Perera, A. H., Peterson, U., Pastur, G.M. & Iverson, L. R., (2018). Ecosystem services from forest landscapes: broadscale considerations (1st Ed.).New York: Springer International Publishing AG.
2. Mabberly, D. J. (2017). Mabberly's, plant book: a portable dictionary of plants their uses and classification (1st Ed.). England: Cambridge University Press.
3. Osaki, M. & Tsuji, N., (2016). Tropical Peat Land Ecosystems (1st Ed.).Berlin: Springer Verlag.

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BOTN-6102	Advanced Plant Biochemistry	3(2-1)

Course Brief:

This course provides an advanced introduction to the fundamental processes of plant metabolism. This course gives information on how protein structure and function derived from the constituent amino acids, and the features of structural and globular proteins. It describes the basic principles governing the rate of enzyme catalysed reactions and the forms of inhibition of enzyme-catalysed reactions. The course describes the major pathways of carbohydrate, lipid and amino metabolism and gives information on how energy is stored and released through them.

Course Learning Objectives:

By the end of this course, students will be equipped to understand plant biochemistry, including the structure and function of biomolecules and their roles in biochemical processes. The students will be able to demonstrate familiarity and competence with the practical skills and techniques used in biochemical research and analysis. This will include experimental planning, the preparation of reagents and use of basic instrumentation (spectrophotometers, centrifuges, chromatographic apparatus etc.), the collection of biochemical data and its presentation, and most importantly, the analysis and interpretation of the outcomes of biochemical investigations.

Course Content:

1. Bioenergetics: Energy, laws about energy changes, oxidation and reduction in living systems.
2. Metabolism: Biosynthesis, degradation and regulation of sucrose and starch. Breakdown of fats with special reference to beta-oxidation and its energy balance, biosynthesis of fats. Replication of DNA, reverse transcription, biosynthesis of DNA and RNA. Components of protein synthesis, genetic code, protein synthesis: initiation, elongation and termination.
3. Plant Secondary Metabolites Alkaloids: Occurrence, physiological effects, chemical nature with special reference to solanine, nicotine, morphine, theine and caffeine. Aflatoxins, their nature and role. Terpenoids: Classification monoterpenes, sesquiterpenes, diterpenes, triterpenes, tetraterpenes, polyterpenes and their chemical constitution and biosynthesis.
4. Plant growth regulators ['hormones']auxin, cytokinines, ABA, brassinosteroids, jasmonic acid, salicylic acid, NO, carbohydrates, peptides, with emphasis on structures and pathways that regulate inter- and intra-cellular signaling
5. Vitamins: General properties and role in metabolism.

Lab Outline:

1. Separation of soluble proteins by polyacrylamide gel (PAGE) electrophoresis.
2. Separation of nucleic acids by gel electrophoresis.
3. To estimate the amount of vitamin C in a plant organ (orange, apple juice).
4. To determine potential alkaloids in plants.
5. To estimate terpenoids in plants.

Recommended Texts:

1. Nelson, D., & Cox, M. , (2017). *Lehninger: principles of biochemistry* (7th Ed.). London: W.H. Freeman.Heldt. H., & Piechulla, B., (2016). *Plant Biochemistry*. London: Academic Press.

Suggested Readings:

1. Voet, D., Voet, J. G. & Pratt, C. W. (2015). *Fundamentals of biochemistry* (1st Ed.). New Jersey: John Wiley and Sons.
2. Heldt, H. W., (2015). *Plant biochemistry* (5th Ed.). Cambridge: Academic Press.
3. Buchanan, B. B, Gruissem, W. &. Jones, R.L., (2015). *Biochemistry and molecular biology of plants* (2nd Ed.). New Jersey: Wiley.
4. Conn, E.E. & P.K. (2017). Stump, o*utlines of biochemistry* (1st Ed.). New Jersey: John Wiley and Sons Inc.

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BOTN-6103	Advanced Plant Physiology	3(2-1)

Course Brief:

Plants are immobile in nature; they want to fulfill all their requirements of their life without moving from one place to another place. Plant physiology helps to study a wide range of processes and functions that plants use to live and survive, including respiration, metabolism, transpiration, plant hormones, environmental response and transport processes. It is also very important to know the functions of a living organism or any of its parts. They also have help in agriculture fields, medicine, food production and textiles. This course examines life processes of plants such as signal transduction, different types of hormones (old group of hormones and newly discovered hormones) their synthesis, mode of action and beneficial effects. It also gives information about mechanisms and different forces involve in uptake of water, role of water potential, minerals nutrition, their physiological role and deficiency symptoms in plants. This course also introduces photoperiodism, vernalization and assimilation of nutrients.

Course Learning Objectives:

The aim of the course is to give comprehensive and advanced knowledge about growth regulators, mechanism of water uptake and role of essential nutrients in plant metabolism. To give it comprehensive and advance knowledge of growth regulators, mechanism of water uptake and role of essential nutrients in plant metabolism

Course Content:

1. Plant Growth Regulators: Major natural hormones and their synthetic analogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action and transport. Physiological effects of auxin, gibberellins, cytokinin's, abscisic acid, ethylene, polyamines, brassinosteriods, jasmonates, and salicylic acid.
2. Water Relations: The soil -plant -atmosphere continuum - an overview. Structure of water. Physico-chemical properties of water. Water in the soil and its potential. Water in cell components. Absorption of water in plants (pathways and driving forces, aquaporins, their structure and types).Cell water relations terminology. Hofler diagram - analysis of change in turgor, water and osmotic potential with changes in cell volume. Modulus of elasticity coefficient; Hydraulic conductivity. Osmoregulation, methods for measurement of water, osmotic and turgor potentials- pressure chamber, psychrometry, pressure probe and pressure volume curve
3. Plant Mineral Nutrition: Inorganic composition of plant and soil. Absorption of mineral nutrients through roots, mycorrhizae. Effect of soil pH on nutrient availability. Ion traffic into root. The nature of membrane carriers, channels and electrogenic pumps. Passive and active (primary and secondary) transports and their energetics. Essential and beneficial elements, their functions and deficiency symptoms in plants. Fertilizers and their significance in agriculture.
4. Phytochromes: Discovery of phytochromes and cryptochromes, physical and chemical properties of phytochromes, distribution of phytochromes among species, cells and tissues and their role in biological processes. Phytochromes and gene expression.
5. Control of Flowering: Autonomous versus environmental regulation. Circadian rhythms. Classification of plants according to photoperiodic reaction, photoperiodic induction, locus of photoperiodic reaction and dark periods in photoperiodism. Role of photoperiodism in flowering, biochemical signaling involved in flowering, vernalization and its effect on flowering. Floral meristem and floral organ development, floral organ identity genes and the ABC model.
6. Signal transduction in prokaryotes and eukaryotes.
7. Dormancy; definition and causes of seed dormancy; methods of breaking seed dormancy; types and physiological process of seed germination.
8. Plant Movements; Tropic movement-phototropism, gravitropism and their mechanism. Nastic movements.

Lab Outline:

1. To investigate the preferential absorption of ions by corn seedlings and potato slices.
2. To determine the osmotic potential of massive tissue by freezing point depression method or by an osmometer.
3. To investigate water potential of a plant tissue by dye method and water potential apparatus.
4. Determination of K uptake by excised roots.
5. Measurement of stomatal index and conductance.
6. Qualitative determination of K content in Guard cells by Sodium cobalt nitrite method.

Recommended Texts:

1. Taiz, L. & Zeiger, E., (2019). *Plant* physiology (7th Ed.). England: Sinnauers Publ. Co. Inc.
2. Dennis, D. T., Turpin, D. H., Lefebvre, D. D. & Layzell, D. B., (2016). *Plant Metabolism* (6th Ed.).London: Longman Group.

Suggested Readings:

1. Mitra, G.N., (2015). *Plants: a biochemical and molecular approach* (1st Ed.). India: Springer.
2. Buchanan, B., Wilhelm, G. & Russell, L., (2015). *Biochemistry and molecular biology of plants* (1st Ed.).New Jersey: John Wiley & Sons.
3. Hopkins. W.B., (2017). *Introduction to plant physiology* (5th Ed.). New Jersey: John Wiley and Sons.

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BOTN-6104	Microbial Botany	3(2-1)

Course Brief:

Microbial Botany explores the complex interactions between microorganisms and plants, focusing on the role of microbes in plant health and disease, as well as their ecological and economic importance. This course covers the diversity of plant-associated microbes, including bacteria, fungi, and viruses, and their impact on plant physiology and development. Students will learn about microbial interactions with plants, plant-pathogen dynamics, and the use of microorganisms in agriculture and biotechnology. The course includes practical laboratory work to study microbial techniques and plant-microbe interactions.

Course Learning Objectives:

By the end of this course, students will be able to understand the diversity and taxonomy of microorganisms associated with plants, including bacteria, fungi, and viruses. They will analyze plant-microbe interactions, covering symbiotic relationships, pathogenic mechanisms, and the impact of microbes on plant health. Students will also learn to identify and classify plant pathogens, understanding their effects on plant physiology and crop production. Practical skills will be developed through the application of laboratory techniques to isolate, identify, and study plant-associated microorganisms. Additionally, students will evaluate the role of microbes in agriculture and biotechnology, including their use in biocontrol and soil health management. Finally, they will develop strategies for managing plant diseases caused by microorganisms, incorporating integrated pest management and sustainable practices.

Course Content:

1. Introduction to Microbial Botany, Overview of microbial botany ,Importance of plant-microbe interactions
2. Diversity of Plant-Associated Microbes, Bacteria: Classification, morphology and roles, Fungi: Classification, structure and functions, Viruses: Structure, taxonomy and effects on plants
3. Microbial Interactions with Plants ,Symbiotic relationships (e.g., mycorrhizae, nitrogen-fixing bacteria), Pathogenic interactions and disease mechanisms
4. Plant Pathogens, Identification and classification of plant pathogens, Mechanisms of pathogenicity and disease development
5. Microbial Techniques in Botany, Isolation and identification of plant-associated microorganisms, Techniques for studying microbial interactions

6. Microbial Impact on Plant Health, Effects of microbes on plant growth and development, Role of microbes in soil health and fertility
7. Disease Management and Biocontrol ,Integrated pest management strategies, Use of beneficial microbes for disease control and soil improvement
8. Applications in Agriculture and Biotechnology, Role of microbes in sustainable agriculture, Biotechnological applications of plant-associated microorganisms.

Lab Outline:

1. Perform isolation techniques to extract plant-associated bacteria, fungi, and viruses, and use staining and culturing methods for their identification.
2. Observe and document interactions between plants and microbes using microscopy and growth assays.
3. Identify plant pathogens and analyze their impact on plant health using infection assays and molecular techniques.
4. Apply PCR, ELISA, and gel electrophoresis to study microbial properties and interactions.
5. Develop and evaluate strategies for managing plant diseases, including biocontrol methods and sustainable practices.

Recommended Texts:

1. Adhya, T., Mishra, B. B., & Annapurna, K. (Eds.). (2018). *Advances in soil microbiology: Recent trends and future prospects (Vol. 2): Soil-microbe-plant interaction*. Springer.
2. Saxena, S. (2015). *Applied microbiology*. Springer

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BOTN-6105	Pteridophytes & Gymnosperms	3(2-1)

Course Brief:

This course provides an in-depth exploration of Pteridophytes and Gymnosperms, covering their general characteristics, classification, evolutionary significance, and economic importance. It also delves into the field of Palaeobotany, examining fossilized plants to understand historical plant evolution. Students will study various Pteridophyte and Gymnosperm groups, their reproductive mechanisms, and their significance in both historical and modern contexts.

Course Learning Objectives:

By the end of this course, students will have a comprehensive understanding of Pteridophyte diversity, including their general characteristics, classification, and reproductive mechanisms. They will be able to identify and characterize major Pteridophyte groups such as Psilopsida, Lycopsida, Sphenopsida, and Pteropsida. Students will analyze the features of Gymnosperms, including their general characteristics, classification, evolutionary trends, and their relationships with Angiosperms and Pteridophytes. They will also describe the structure, classification, and economic importance of key Gymnosperm groups like Cycadopsida, Coniferopsida, and Gnetopsida. Additionally, students will gain insights into Palaeobotany, explaining fossilization processes, the geological time scale, and the significance of fossil Pteridophytes and Gymnosperms in the context of plant evolution.

Course Content:

1. Pteridophytes Introduction, origin, history, features and a generalized life cycle. First vascular plant Rhyniophyta e.g. Cooksonia. General characters, classification, affinities and comparative account of evolutionary trends of the following phyla: Psilopsida (Psilotum), Lycopsida (Lycopodium, Selaginella), Sphenopsida (Equisetum), Pteropsida (Ophioglossum, Dryopteris and Marsilea).
2. Origin and Evolution of seed habit.
3. Gymnosperms: Geological history, origin, distribution, morphology, anatomy, classification and affinities of Cycadofillicales, Bennettitales, Ginkgoales, Cycadales, Coniferales and Gnetales. Distribution of gymnosperms in Pakistan. Economic importance of gymnosperms.

Lab Outline:

1. To study the morphological and reproductive features of available genera.

2. Study trips to different parts of Pakistan for the collection and identification of important pteridophytes, gymnosperms and angiosperms.
3. Study of pollen morphology
4. Examine and identify reproductive structures and understand their evolutionary adaptations.
5. Examine fossil specimens of Pteridophytes and Gymnosperms.

Recommended Texts :

1. Maarten J., Christenhusz, M., & Michael F., (2017). Chase, plants of the world: an illustrated encyclopedia of vascular plants (1st Ed.). United States: Kew publishing.
2. Maarten J., Christenhusz, M., Michael F. & Byng, J.W. (2018). The global flora: a practical flora to vascular plant species of the world (1st Ed.). Bradford: Plant Gateway Limited.

Suggested Readings :

1. Hobohm, C., (2016). Endomism in vascular plants (1st Ed.). New York: Columbia University Press.
2. Bowcutt, F. & Hamman, S., (2016). Vascular plants of the south sound prairies (1st Ed.). Washington: Evergreen State College Greener Bookstore.

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BOTN-6106	Biostatistics	3(2-1)

Course Brief:

To produce students, that has applicable knowledge about statistics, which they apply in different fields of study. Course aimed at providing students with a formal treatment of biological data. The course explores the basic concepts of Biostatistics and its applications.

Course Learning Objectives:

The goal is to provide students, to the community with high skills to play the major role in statistics by using the knowledge of biological variables and their analysis. The course is heavily oriented with tools for analyzing biological data through statistical methods with practical applications.

Course Content:

1. Definition of biostatistics, viz-a-viz the type of variables and observations in biological.
2. Health and medical sciences, uniqueness in terms of behavior of variables their domain and units.
3. Categorical, numerical and censored data. Populations, target populations and samples.
4. Role of sampling in Biostatistics, size of samples of various types of studies, Proportions, rates and ratios; incidence, prevalence odds.
5. Distributional Behavior of biological variables (Binomial, Poisson and Normal), Role of transformation for analysis of biological variables.
6. Probit and Logit transformation and their analysis, p values, its importance and role.
7. Confidence interval in simple and composite hypothesis testing.

Lab Outline:

1. Introduction to following Statistical Softwares, Installation and Setup, Basic Operations (Data Import/Export & How to load data sets into each software), Statistical Analysis, Advanced Analysis, Visualization, Reporting and Output.
2. Practice using following different software's
3. SPSS (Statistical Package for the Social Sciences)
4. R (R programming language)
5. SAS (Statistical Analysis System)
6. Stata
7. Minitab
8. MATLAB
9. JMP
10. PSPP
11. Excel (with Analysis ToolPak)
12. Statistica
13. EViews

14. Systat
15. Gretl
16. XLSTAT
17. IBM Amos (for Structural Equation Modeling)
18. GraphPad Prism
19. SciPy (Python)
20. Orange
21. KNIME
22. MedCalc

Recommended Texts:

1. Zar, J.(2000). "Bostatistical Analysis" 5th Edition John Wiley & Sons.
2. Shoukri, M. M & Pause, C. A (1998). "Statistical Methods for Health Sciences". 2nd Ed, CRC Press, Florida.

Suggested Books:

1. Dainel, W.W. (1996). "Biostatistics: A Foundation for the Health Sciences". 6th Edition, John Wiley New York.
2. Diggle, J.P. Liang, Kung-Yee and Zegar, S.L (1996)."Analysis of Longitudinal Data", Clarendon Press, Oxford.

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URCG-5111	Translation of Holy Quran-III	Non-credit

Semester / Level:
In some discipline 5th semester and in some discipline 6th Semester/ BS (5th Semester intake) 1st/2nd

Course Learning Objectives:

- To introduce ethics and highlight its importance, need and relevance for individual and collective life.
- To illuminate the students with the Quranic norms of Morality i.e. truthfulness, patience, gratitude, modesty, forgiving, hospitality etc.
- To familiarize the students with immoral values like falsify, arrogance, immodesty, extravagance, backbiting etc.
- To inculcate ethical and moral values in our youth.
- To develop a balanced dynamic and wholesome personality.
- To introduce the students to Quranic Arabic grammar in practical manner.

Course Content:

- اخلاق (تعارف، ضرورت واہمیت، اقسام، معنویت)

اخلاق حسنہ:

- برائی کو نیکی سے مٹانا
- نیکی کے کاموں میں مسابقت
- لوگوں کے درمیان صلح
- عدل وانصاف
- سچائی
- ایثار
- سلیم قلب
- مہمان نوازی
- لغویات سے اعراض

- عاجزی وانکساری
- نگاہ اور آواز کو پست رکھنا
- چال میں میانہ روی
- شرمگاہوں کی حفاظت
- صبر
- شکر
- امور میں میانہ روی

اخلاق سئیہ:

- ظلم اور زیادتی
- غرور و تکبر
- نفسانی خواہشات کی پیروی
- بدگمانی
- جھوٹ
- چغلی اور تہمت
- تمسخر اور شیخی خوری
- لہو ولعب
- برے ناموں سے پکارنا
- احسان جتانا اور تکلیف دینا
- فضول خرچی اور حد سے بڑھنا
- حسد اور تنگ دل
- بے پردگی

Grammar:

- قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)

Details of Chapters and verse Numbers:

- منتخب آیات مع ترجمہ و تجوید
  - البقرہ (۱۱۲، ۲۴۵، ۸۳، ۱۸۲، ۱۷۲، ۱۵۲، ۱۷۲، ۵۲، ۱۵۳، ۱۷۷، ۲۵۰، ۱۲۵، ۲۲۲، ۲۷، ۷۷، ۱۸۲، ۱۴۸، ۱۸۷، ۱۰۹، ۲۶۴، ۲۶۳، ۲۶۲، ۲۱۲، ۶۷، ۲۳۱، ۱۰، ۳۴، ۱۲۴، ۲۵۸، ۷۱، ۲۷، ۸۳، ۲۲۶، ۱۹۵، ۷۶)
  - آل عمران (۱۵۴، ۱۴، ۲۴، ۱۸۵، ۱۳۲، ۱۴۸، ۱۳۴، ۱۴۵، ۱۷، ۲۰۰، ۱۲۵، ۱۳۳، ۱۱۴، ۱۰۴، ۱۰۴، ۲۶، ۷۸، ۱۴۱، ۱۴۷، ۱۵۹)
  - النساء (۱۳۵، ۲۳، ۲۲، ۱۰۸، ۱۰۷، ۱۰۵، ۵۴، ۲۰، ۲۷، ۱۷۳، ۳۶، ۲۵، ۲۴، ۴۷، ۵۷، ۲۴)
  - المائدۃ (۵۸، ۵۷، ۹۳، ۱۳، ۶، ۴۱، ۱۹)
  - النحل (۱۲۶، ۹۰، ۱۰۵، ۱۱۳، ۳۰، ۱۲۶، ۱۲۵)
  - الرعد (۲۵، ۲۰، ۲۴، ۲۲، ۶)
  - الاعراف (۳۱، ۶۶، ۵۱، ۱۳۶، ۴۰، ۴، ۲۰، ۱۴۴، ۱۹۹، ۹۵، ۸۱)
  - القصص (۵۴، ۸۴)
  - فصلت (۳۴)
  - الانعام (۳۲، ۷۰، ۷۰، ۱۳۰، ۱۵۵، ۱۶۰)
  - النمل (۹۰، ۴۶)

- الحج(۳۰،۵۸،۶۰،۸۸،۷۷)
- الحجرات(۹،۱۱،۶،۱۱،۳،۱۲،۱۵،۱۰)
- الاحزاب(۲۳،۵۰،۵۸،۵۸،۵۲،۵۵،۵۹،۳۵،۲۴،۳۵)
- الحشر(۹)
- طٰہٰ(۷۲)
- الانعام(۱۶۴،۱۴۱،۱۱۶،۱۵۱،۶۳،۱۲۷)
- ق(۳۴)
- الانفال(۲۷،۴۶،۶۱)
- الفتح(۱۵)
- یونس(۱۰،۱۹،۱۲،۶۶،۲۲،۲۲)
- الفرقان(۶۳،۲۱،۶۷،۶۳)
- النور(۲۳،۶،۴،۳۰،۳۱،۳۳،۳۳،۶۱،۳۱،۲۲)
- لقمان(۶،۳۳،۱۹،۳۲،۱۸)
- الاسراء(۳۷،۱۱۰،۵،۳۷)
- المزمل(۱۸)
- المدثر(۶،۴)
- المدثر(۷۴)
- فاطر(۳۲)
- الفتح(۲۹)
- البلد(۱۷)
- الزمر(۳،۱۰)
- الحجر(۸۵)
- النجم(۳۱)
- الرحمٰن(۶۰)
- ھود(۸،۱۰۲،۳)
- الکہف(۲،۵۶)
- الشوریٰ(۳۷)
- غافر(۲۸،۲۷)
- الحدید(۲۰،۲۰)
- مریم(۵۹)
- النازعات(۴۱)
- التوبہ(۶۵،۶۴،۷۷)
- الھمزہ(۱)

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Semester VI

BOTN-6107	Systematics of Angiosperms	3(2-1)

Course Brief:

This course provides an in-depth study of angiosperm taxonomy and systematic botany, focusing on the identification, classification, and evolutionary relationships of flowering plants. Students will explore the principles and methodologies used in the classification of angiosperms, including the study of key plant families, morphological features, and the application of modern techniques in plant systematics. Emphasis will be placed on understanding the diversity of angiosperms, their ecological roles, and their significance in human life.

Course Learning Objectives:

By the end of this course, students will be skilled in identifying and classifying angiosperms using morphological and anatomical features. They will understand plant taxonomy principles, apply modern systematic techniques like molecular phylogenetics and interpret floral morphology. Additionally, students will analyze angiosperm diversity, assess its ecological significance, and conduct and present taxonomic research.

Course Content:

1. Introduction
   - Brief history; aims and fundamental components; Alpha taxonomy, omega-taxonomy, keys, taxonomic literature, Botanical nomenclature; principles and rules; taxonomic ranks; type concept, principle of priority.
   - Concept of Species
   - Speciation: Mechanism of speciation, Mutation and hybridization.
   - Variation: Types of variation, continuous and discontinuous variation, Clinal variation.
2. Classification of Angiosperms
   - Salient features of the systems, proposed by Bentham and Hooker and Engler & Prantl. Attribution of different systems of classification; orders:
   - Magnoliales, Centospermae, Tubiflorae, Amentiferae, Helobiales and Glumiflorae.
3. Modern Techniques for the Identification of Plants
   - Major, contributions of cytology,
   - phytochemistry and taximetrics to taxonomy,
   - Molecular techniques, DNA barcoding
4. Origin and Evolution of Angiosperms
   - Origin and Evolution of Angiosperms;
   - Angiosperms Phylogeny;
   - Age and Place of origin, Biphyletic origin, Theories of origin;
   - Origin of Monocots and Evolutionary lines of Angiosperms.
5. Angiosperm Phylogeny Group
   - Phylogenetic relationships among different groups of angiosperms, Development of APG system, Principle of APG system, details of latest APG system, Magnoliids (Magnoliales);
   - Monocots (Asparagales); Commelinids (Poales); Fabids (Malphigiales);
   - Malvids (Caryophyllales);
   - Lamiids (Gentianales);
   - Campanulids (Asterales)
6. Diagnostic Characters of Selected Families of Monocotyledons
   - Liliaceae - lily family, Xanthorrhoeaceae- grass-trees, mat-rushes.
   - Amaryllidaceae- amaryllis family. Iridaceae - iris family., Orchidaceae-orchid family,
   - Centrolepidaceae, Poaceae (Gramineae) – grasses, Cyperaceae
7. Diagnostic Characters of Selected Families of Dicotyledons
   - MYRTACEAE - myrtle family, eucalypts, bottlebrushes, tea-trees.
   - RUTACEAE - rue family, citrus, boronias, correas.
   - ASTERACEAE - (compositae) daisy family.
   - EPACRIDACEAE - heath family.

- PROTEACEAE - protea family, banksias, grevilleas, hakeas.
- CASUARINACEAE - she-oaks.
- RHAMNACEAE - buckthorn family

8. Taxonomic Techniques
   The advantages of using keys and their limitations, The rules when making a key, Rules When Writing Couplets

Lab Outline:

1. Technical description of some plants of the local flora and their identification up to species level with the help of a regional/Flora of Pakistan
2. Preparation of indented and bracketed types of keys
3. Preparation of permanent slides of pollen grains by acetolysis method and study of different pollen characters.
4. Study of variation pattern in different taxa.
5. Submission of properly mounted and fully identified hundred herbarium specimens at the time of examination
6. Field trips shall be undertaken to study and collect plants from different ecological zones of Pakistan.

Recommended Texts:

1. Thomson, S. A., Pyle, R. L., Ahyong, S. T., Alonso-Zarazaga, M., Ammirati, J., Araya, J.F., & Segers, H. (2018). Taxonomy based on science is necessary for global conservation. PLoS Biology, 16(3), e2005075.
2. Simpson, M. G. (2019). Plant systematics. Academic press.
3. Pawara, P., Okafor, E., Schomaker, L., & Wiering, M. (2017, September). Data augmentation for plant classification. In International conference on advanced concepts for intelligent vision systems (pp. 615-626). Springer, Cham.

Suggested Reading:

1. Thomson, S. A., Pyle, R. L., Ahyong, S. T., Alonso-Zarazaga, M., Ammirati, J., Araya, J. F., & Segers, H. (2018). Taxonomy based on science is necessary for global conservation. PLoS biology, 16(3), e2005075.
2. Elhariri, E., El-Bendary, N., & Hassanien, A. E. (2014, December). Plant classification system based on leaf features. In 2014 9th International Conference on Computer Engineering & Systems (ICCES) (pp. 271-276). IEEE.
3. Louhaichi, M. (2018). Group Training Course on Rangelands Plant Terminology & Basic Plant Identification.

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BOTN-6108	Plant Pathology	3(2-1)

Course Brief:

This course provides a comprehensive understanding of plant diseases, their causes, and management strategies. It covers the scope, history, and importance of plant pathology, focusing on fungi, bacteria, viruses, and nematodes as disease agents. Students will learn to identify and diagnose plant diseases through various techniques, understand the disease cycle and epidemiology, and explore different methods of disease management, including cultural, chemical, and biological control. The course also addresses plant disease resistance and its genetic basis. Practical lab work will enhance students' diagnostic and management skills through hands-on experience with various pathogens and control methods.

Course Learning Objectives:

By the end of this course, students will be able to define the scope and historical development of plant pathology, identify and describe pathogens including fungi, bacteria, viruses, and nematodes, and apply diagnostic techniques to recognize plant disease symptoms. They will understand disease cycles and epidemiology, implement management strategies, and explain genetic resistance while performing practical laboratory work on plant disease diagnosis and management.

Course Content:

1. Introduction to Plant Pathology, Definition, scope, and importance of plant pathology, History and development of plant pathology
2. Causes of Plant Diseases, Fungi: morphology, taxonomy, and pathogenicity, Bacteria: morphology, taxonomy, and pathogenicity, Viruses: structure, taxonomy, and pathogenicity, Nematodes: morphology, taxonomy, and pathogenicity
3. Symptoms and Diagnosis of Plant Diseases, Types of symptoms: visual, biochemical, and molecular, Diagnostic techniques: visual, laboratory, and molecular,
4. Disease Cycle and Epidemiology, Disease cycle: infection, colonization, reproduction, and dissemination, Epidemiology: disease spread, disease forecasting, and disease monitoring
5. Disease Management, Cultural control: sanitation, irrigation, and pruning, Chemical control: fungicides, bactericides, and nematicides, Biological control: bio fungicides, biopesticides, and biological agents, Integrated disease management (IDM)
6. Plant Disease Resistance i.e. Rust, smut, Blight, root rot, mosaic viruses, mildews, Canker Breeding for resistance, Genetic basis of resistance

Lab Outline:

1. Collect and identify fungal, bacterial, viral, and nematode pathogens from infected plant samples,
2. Prepare and examine slides of pathogens under a microscope
3. Apply visual, biochemical, and molecular techniques to diagnose plant diseases, Use laboratory equipment for pathogen isolation and identification.
4. Observe and document different stages of the disease cycle (infection, colonization, reproduction, and dissemination) in controlled environments.
5. Implement cultural control practices such as sanitation, irrigation, and pruning in a greenhouse setting, Apply chemical control methods using fungicides, bactericides, and nematicides on infected plants.
6. Explore biological control methods by using biofungicides and biopesticides.
7. Study plant resistance mechanisms and conduct experiments on breeding for disease resistance.

Recommended Text:

1. Agrios, G. N. (2005). *Plant pathology* (5th d.). Elsevier Academic Press.
2. Lucas, J. A. (2020). *Plant pathology: A concise introduction* (2nd ed.). Wiley-Blackwell.

Suggested Readings:

1. Brown, A., & Smith, H. (2014). *Benson's microbiological applications: Laboratory manual in general microbiology* (13th Ed.). McGraw-Hill Education.

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BOTN-6109	Molecular Genetics	3(2-1)

Course Brief:

This course introduces the principles of molecular genetics in both prokaryotic and eukaryotic organisms. It covers gene organization, regulation of transcription and translation, and techniques in recombinant DNA technology. The course also explores bioinformatics applications in gene and genome analyses and the biotechnological applications of molecular genetics.

Course Learning Objectives:

The course aims to provide a thorough understanding of the organization and regulation of genetic information in both prokaryotic and eukaryotic organisms. Students will gain familiarity with various recombinant DNA technology techniques and their diverse applications, enabling them to manipulate and study genetic material effectively. Additionally, the course emphasizes the integration of bioinformatics tools with laboratory-based experiments to analyze and interpret genetic data. By applying molecular genetics knowledge, students will be equipped to address problems encountered in both basic and applied research, developing practical solutions for common challenges in the field of molecular genetics.

Course Content:

1. Introduction to Molecular Genetics, Definition and Scope of Molecular Genetics, Historical Perspective and Key Discoveries, Central Dogma of Molecular Biology
2. Gene Organization, Prokaryotic Gene Organization, Structure of Prokaryotic Genes, Operons and Gene Clusters, Eukaryotic Gene Organization, Structure of Eukaryotic Genes, Introns, Exons, and Splicing ,Chromatin Structure and Epigenetics
3. Regulation of Transcription and Translation, Regulation in Prokaryotes, Promoters, Operators, and Repressors, Operon Models (e.g., lac operon and tryptophan operon, gene attenuation)
4. Regulation in Eukaryotes, Transcription Factors and Enhancers, RNA Processing and Export, Post-Transcriptional Regulation, Regulation of Translation, Mechanisms of Translation Initiation, Regulation by Small RNAs
5. Proteins, basic features alpha helix and beta secondary structure, protein purification, protein folding and sequencing
6. DNA hybridization and Types e.g. southern blotting, FISH, In situ hybridization, DNA microarray, Recombinant DNA Technology, Basic Techniques, DNA Cloning and Restriction Enzymes, Vector Systems (Plasmids, Viral Vectors) ,
7. DNA libraries, construction, screening and application
8. Advanced Techniques, CRISPR/Cas9 and Genome Editing
9. Genetic Change-Gene Mutation: The molecular basis of gene mutations, spontaneous mutations. Induced mutations, Mutagens and carcinogens. Biological repair mechanisms.
10. Genetic Change-Recombination: General homologous recombination, the holiday model, Enzymatic mechanism of recombination. Site-specific recombination, recombination regarding chromosomal rearrangements.
11. Bioinformatics - Applications in genetics and genome analysis.
12. Bioethics: Moral, Religious and ethical concerns
13. Gene Therapy and Genetic Disorders, Recombinant Protein Production (Insulin, Vaccines), GMOs and Crop Improvement, Plant and Animal Gene Editing,
14. Molecular markers: Introduction, Dominant, Co-dominant markers system, RFLP, AFLP, SNPs.
15. Introduction to Human and Plant Genome Project

Lab Outline:

1. Learn aseptic techniques and lab safety protocols, including PPE use and waste disposal.
2. Isolate and purify DNA from various sources and assess quality using spectrophotometry.
3. Prepare agarose gels and perform gel electrophoresis to visualize DNA fragments.
4. Set up and run PCR to amplify DNA sequences and analyze results with gel electrophoresis.
5. Perform DNA cloning, transform bacterial cells with plasmid DNA, and screen for successful transformants.
6. Express recombinant proteins in different systems, purify using affinity chromatography, and analyze with SDS-PAGE and Western blotting.
7. Use bioinformatics tools for sequence analysis, gene prediction, and genomic data interpretation.
8. Apply CRISPR/Cas9 for gene editing, screen edited genes, and troubleshoot common issues.

Recommended Texts:

1. Nelson, D., & Cox, M., (2017). Lehninger: principles of biochemistry (7th Ed.). London: W.H. Freeman Macmillan Learning.
2. Lodish, H., Berk, A., Kaiser, C., Krieger, M. & Bretscher, A., (2016). Molecular Cell Biology (8th Ed.). London: W.H. Freeman-Macmillan Learning.

Suggested Readings:

1. Venkat, B., Sahijram, R. & Murthy, K., (2015).Plant biology and biotechnology (1st Ed.).Berlin: Springers Verlag. Clark, D., Pazdernik. N. & McGehee, M., (2019). Molecular Biology (1st Ed.). Amsterdam: Elsevier Inc.

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BOTN-6110	Sustainable Development Goals	3(3-0)

Course Brief:

This course explores the intersection of Botany and the United Nations' Sustainable Development Goals (SDGs). Students will gain a deep understanding of how botanical research and practices can contribute to achieving the SDGs, with a focus on sustainable agriculture, biodiversity conservation, climate action, and ecosystem management. The course will cover the scientific, ethical, and practical aspects of using botanical knowledge to address global challenges.

Course Learning Objectives:

By the end of this course, students will have a solid understanding of the key concepts of Sustainable Development Goals (SDGs) and their relevance to botany. They will be able to analyze the vital role plants and ecosystems play in achieving sustainable development, particularly in addressing challenges like food security, biodiversity loss, and climate change. Students will apply their botanical knowledge to these global issues and gain experience in developing and presenting case studies that highlight how botany contributes to SDGs. Additionally, they will critically evaluate existing policies and practices related to sustainability, considering their impact on botanical sciences and broader ecological systems.

Course Content:

1. Introduction to Sustainable Development and SDGs, Overview of Sustainable Development. United Nations 2030 Agenda and the 17 SDGs Relevance of SDGs to Botany. Global and local case studies in SDGs
2. No Poverty, The role of sustainable agriculture in poverty reduction, Development of drought-resistant and high-yield crops, Empowering smallholder farmers through botanical innovations ,Case studies on poverty alleviation through plant-based industries
3. Zero Hunger ,Contribution of plants to global food security, Crop diversity, genetic resources, and food sovereignty, Sustainable agricultural practices: agroecology, organic farming, Biofortification of crops to combat malnutrition, Innovative plant-based solutions for reducing hunger
4. Good Health and Well-being ,Medicinal plants and their role in traditional and modern medicine ,Nutraceuticals and functional foods derived from plants, Botanical approaches to improving nutrition and public health ,Plants in mental health: therapeutic gardens and horticultural therapy
5. Quality Education, Importance of botanical education in promoting sustainability, Development of educational programs focused on plant sciences, Integrating botany into community education for sustainable practices ,Promoting awareness of plant diversity and conservation
6. Gender Equality, Empowering women in agricultural sectors and plant sciences, Gender-responsive agricultural practices and policies ,Women's role in the conservation of plant biodiversity, Case studies on female-led botanical research and farming initiatives
7. Clean Water and Sanitation ,Role of plants in water purification and management ,Wetlands, riparian buffers and phytoremediation techniques ,Sustainable irrigation practices in agriculture, Impact of agriculture on water quality and solutions to mitigate pollution
8. Affordable and Clean Energy ,Bioenergy crops and their role in sustainable energy production ,Development of plant-based alternatives to fossil fuels ,Algae and other plants in renewable energy technologies ,Impact of biofuel production on food security and the environment
9. Decent Work and Economic Growth ,Creation of sustainable livelihoods through plant-based industries, Economic benefits of biodiversity conservation, Role of botanical gardens and nurseries in local economies ,Innovations in plant biotechnology that drive economic growth
10. Industry, Innovation, and Infrastructure, Innovations in plant biotechnology for sustainable industry ,Green infrastructure development using plant systems, Role of botany in sustainable industrial practices, Plant-based materials and bioplastics as alternatives to conventional products
11. Reduced Inequalities, Access to botanical resources and agricultural technologies, Addressing inequalities in plant-based research and development ,Role of botany in improving food security in marginalized communities, Policies and practices that promote equitable distribution of plant resources

12. Sustainable Cities and Communities, Urban greening initiatives and their impact on community well-being, Role of plants in air quality improvement and urban biodiversity, Green roofs, walls, and urban forests as sustainable city infrastructure, Case studies on integrating plant systems in urban planning
13. Responsible Consumption and Production, Sustainable harvesting and agricultural practices, Role of plants in promoting a circular economy and reducing waste, Conservation of plant genetic resources and traditional knowledge, Plant-based products and their contribution to sustainable consumption
14. Climate Action, Impact of climate change on plant life and ecosystems, Role of forests and plant-based ecosystems in carbon sequestration, Development of climate-resilient crops and adaptation strategies, Reforestation and afforestation initiatives to combat climate change
15. Life Below Water, Importance of marine plants, such as seagrasses and algae, in aquatic ecosystems, Conservation and restoration of coastal and marine plant habitats, Role of plants in maintaining healthy aquatic environments, Impact of climate change on marine plants and strategies for mitigation
16. Life on Land, Conservation of terrestrial ecosystems and plant biodiversity, Restoration of degraded landscapes and reforestation efforts ,Protection of endangered plant species and habitats, Ecosystem services provided by plants and their role in maintaining biodiversity
17. Peace, Justice and Strong Institutions, Role of plants in fostering peace and stability through resource management, Protection of indigenous plant knowledge and equitable access to resources, Botany in legal frameworks: patents, biopiracy and conservation laws, case studies on community-led conservation efforts and their impact on peace
18. Partnerships for the Goals, Importance of cross-disciplinary approaches in botanical research, International cooperation and collaboration in plant sciences, Role of botanical institutions in promoting global partnerships, Case studies on successful partnerships that leverage botany for sustainability

Recommended Texts:

1. "Transforming our world: the 2030 Agenda for Sustainable Development." United Nations, 2015.
2. "The State of the World's Biodiversity for Food and Agriculture." FAO, 2019.
3. "Climate Change and Plants: Biodiversity, Growth and Interactions." Edited by T.J. Flowers and F. R. Scarlett. Oxford University Press, 2018.
4. "Conservation Biology for All." Edited by Navjot S. Sodhi and Paul R. Ehrlich. Oxford University Press, 2010.
5. "Botany in a Day: The Patterns Method of Plant Identification." By Thomas J. Elpel. Hops Press, 2013.
6. "Phytoremediation: Role of Aquatic Plants in Environmental Clean-Up." Edited by Bhupinder Dhir. Springer, 2014.IPCC Reports on Climate Change and Ecosystems.

Suggested Reading:

1. "Plant Biotechnology for Sustainable Production of Energy and Co-products." Edited by Peter N. Mascia, John Scheffran, and Jack M. Widholm. Springer, 2010.
2. "The Role of Biodiversity in Climate Change Mitigation." By WBGU (German Advisory Council on Global Change). WBGU, 2020.
3. "Biodiversity and Ecosystem Services: Scaling Up Business Solutions." WBCSD, 2020.

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BOTN-6111	Artificial Intelligence (AI) in Botany	3(3-0)

Course Brief:

This course is designed to introduce MPhil Botany students to the foundational concepts of Artificial Intelligence (AI) with a strong emphasis on its practical applications in the field of botany. Recognizing that students may have limited experience with AI and advanced computing, the course will focus on how AI can be utilized to enhance botanical research, such as plant disease detection,

environmental monitoring, and genomic analysis, with minimal emphasis on the technical complexities of AI.

Course Learning Objectives:

By the end of this course, students will have a solid understanding of core artificial intelligence concepts and their relevance to botanical research. They will explore and identify various applications of AI in plant science, including predictive modeling, image analysis, and environmental monitoring. Students will develop practical skills in using AI tools to analyze and interpret botanical data, enabling them to apply these techniques to real-world research projects. Through hands-on experience, they will solve complex problems and enhance their research outcomes in plant science.

Course Content:

1. Introduction to AI and Its Relevance to Botany, Basics of Machine Learning in Botany, Understanding supervised and unsupervised learning, Examples of machine learning applications in plant science.
2. Data Collection and Preprocessing in Botanical Studies, Techniques for collecting and preparing botanical data. , Overview of data preprocessing relevant to plant science.
3. Introduction to Predictive Modeling in Botany, Basic concepts of predictive modeling in the context of plant growth and disease prediction. , Application examples of predictive models in botany.
4. Neural Networks and Deep Learning for Plant Sciences, Introduction to neural networks with a focus on plant image analysis and phenotype prediction. Case studies of deep learning in plant science.
5. AI in Plant Genomics and Phenotyping, Role of AI in analyzing plant genomes and high-throughput phenotyping. , Applications in gene prediction and trait analysis.
6. AI Techniques for Plant Image Analysis, Techniques for analyzing plant images using AI, including disease detection, Practical applications in botanical research.
7. AI in Environmental Monitoring and Conservation, Applications of AI in tracking environmental changes, Case studies on AI in environmental monitoring related to botany.,
8. Ethical Considerations in AI Applications in Botany, Discussion on the ethical use of AI in botanical research. Challenges such as data privacy and bias in AI-driven studies.

Recommended Texts:

1. "Artificial Intelligence: A Guide for Thinking Humans" by Melanie Mitchell
2. "Machine Learning for Absolute Beginners" by Oliver Theobald
3. "Python Crash Course" by Eric Matthes (only selected chapters relevant to data analysis)

Suggested Readings:

1. "Deep Learning with Python" by François Chollet (Chapters focused on practical applications)
2. "AI Ethics" by Mark Coeckelbergh (Chapters on ethical considerations in science)

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Semester VII

BOTN-6112	Analytical Techniques in Botany	3(1-2)

Course Brief:

This course provides an in-depth understanding of various analytical techniques utilized in plant sciences. Objectives of the subject are: To expose the students to different techniques that can be used to study different biological processes and to provide information about the chemical composition of biomass, characterize its properties, and determine the concentration of both org.

Course Learning Objectives:

Upon completing the course, students will have a solid understanding of laboratory instruments, techniques, and proper lab etiquette, including good laboratory practices essential for effective and safe laboratory work. They will also develop proficiency in various microscopic techniques, gaining hands-on experience with different types of microscopy to enhance their analytical skills and contribute to their overall competence in a laboratory setting.

Course Content:

1. Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze-fracture, freeze etching.
2. Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation, marker enzyme
3. Radio labelling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, and safety guidelines.
4. Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography
5. Blotting techniques: Southern blotting, Northern blotting, Western blotting
6. Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR, and ESR spectroscopy, Molecular structure determination using X-ray diffraction, NMR, and different types of mass spectrometry.
7. Characterization of proteins and nucleic acids: Isolation and purification of RNA, DNA (genomic and plasmid), and proteins, different separation methods. Analysis of RNA, DNA, and proteins by PAGE, SDS-PAGE, and two-dimensional gel electrophoresis, PCR

Lab Outline:

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Separating sugars by thin layer chromatography.
3. Separating amino acids by paper chromatography.
4. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
5. Preparation of permanent slides (double staining).
6. Analysis of proteins and nucleic acids using AGE, PAGE, SDS-PAGE, and two-dimensional gel electrophoresis.
7. Isolation and purification of RNA, DNA, and proteins
8. Quantitative and qualitative analysis of isolated biomolecules
9. Safe handling and usage of radioisotopes in biological experiments
10. Detection and measurement of radioactive materials in biological samples

Recommended Texts:

1. Upadhyay, Updhyay and Nath (2009) Biophysical Chemistry: Principles and Techniques, Himalaya Publishing House, Mumbai.
2. Analytical Techniques in Plant Sciences, by Dr. San. K. Nath, Mahaveer Publication. 2022.

Suggested Reading:

1. Practical Manual on Plant Molecular Biology and Analytical Techniques, Dr. S. Girija, AkiNik Publications, 2020

BOTN-6113	Field Botany	3(2-1)

Course Brief:

Field Botany is designed to provide students with hands-on experience in identifying, classifying, and understanding the ecological roles of plants in various habitats. This course combines classroom instruction with extensive fieldwork to explore plant diversity, structure, and function in natural settings. Students will learn techniques for plant collection, documentation, and analysis, as well as gain insight into plant ecology and conservation.

Course Learning Objectives:

By the end of this course, students will be equipped to identify and classify a broad spectrum of plant species in their natural habitats using botanical keys and guides. They will gain a comprehensive understanding of the ecological roles and adaptations of plants across diverse environments and will be proficient in conducting systematic vegetation surveys to document plant communities accurately. Students will also develop skills in applying field techniques for the collection and preservation of plant specimens. Additionally, they will analyze how environmental factors influence plant distribution and health and will have the capability to develop and present a research project based on field observations and data.

Course Content:

1. Introduction to Field Botany, Definition and scope of field botany, Importance of field studies in botany
2. Plant Identification and Classification, Botanical nomenclature and taxonomy, Use of field guides and botanical keys, Identification of common plant families
3. Vegetation Analysis, Methods for vegetation sampling (quadrats, transects), Documentation and analysis of plant communities, Use of Geographic Information Systems (GIS) in vegetation studies
4. Plant Ecology and Adaptations, Ecological roles of plants in different habitats, Adaptations to biotic and abiotic stressors, Plant interactions with other organisms
5. Field Techniques and Specimen Collection, Techniques for collecting and preserving plant specimens, Herbarium practices and specimen documentation, Ethical considerations in fieldwork
6. Environmental Impact and Conservation, Human impacts on plant diversity and ecosystems, Conservation strategies and sustainable management of plant resources, Case studies on plant conservation efforts
7. Identification, Cultivation and Preservation of Mushrooms-Techniques and limitations in cultivation.
8. Collection and Identification of various diseases of plants by Protozoans, Bacteria, Viruses, Nematodes and Fungi.
9. Field Survey of Biogeographic regions and knowledge of various Plant Communities, Plant Community Structure and Classification; Studying Ecosystems and ecological Food Chains, Overview of Major Habitat Types: Forests, Grasslands, Deserts, Wetlands, and Coastal Areas, Soil Structure and Soil Texture Classification.
10. Biodiversity Hotspots and Endemic Species in Pakistan.
11. Field Survey of Phytogeographic Regions in Pakistan.

Lab/Field Outline:

1. Conduct field trips to diverse habitats to collect and identify plant species. Utilize botanical keys and guides to document and classify collected specimens.
2. Perform systematic vegetation surveys using quadrats and transects. Analyze plant communities and their correlation with environmental factors.
3. Collect and preserve plant specimens for herbarium use. Document and label specimens according to standard herbarium practices.
4. Design and execute a research project focused on a specific aspect of field botany. Present findings through a detailed written report.
5. Analyze case studies related to plant ecology and conservation. Engage in discussions about the implications of field research and its applications.

Recommended Texts:

1. Meffe, G. K., Carroll, C. R., & Knight, M. L. (2006). *Principles of conservation biology* (3rd Ed.). Sinauer Associates.
2. Hollingsworth, P. M., Harris, D. J., & Martin, S. W. (2005). *Plant conservation: A manual of techniques*. Oxford University Press.

Suggested Readings:

1. Frey, C. J. H. G. M., & Gray, H. A. S. M. J. (2010). *Practical field ecology: A project guide*. John Wiley & Sons.
2. Saunders, R. S. (2022). *The plant lover's field guide to understanding botany*. Timber Press

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BOTN- 6114	Forensic Botany	3(2-1)

Course Brief:

A forensic botanist looks to plant life to gain information regarding possible crimes. Leaves, seeds and pollen found either on a body or at the scene of a crime can offer valuable information regarding the timescales of a crime and if the body has been moved between two or more different locations. The forensic palynology can often produce specific findings of location of death, decomposition and time of year. The knowledge of systematics leads to identification of evidence at crime scene. The morphological and anatomical study revels in collection of samples from crime scene and it's in vitro analysis. It leads to proper submission of evidence in court of law. The aim of this course is to provide students with an overview of a variety of topics within the area of forensic sciences including crime scene investigation, forensic photography, digital forensics, fingerprinting, court and police organizational structures and forensic DNA analysis. Topics to be covered also include identification of the deceased and disaster victim identification structures.

Course Learning Objectives:

By the end of this course, students will be proficient in forensic botany, including plant and non-plant identification, evidence collection, and habitat analysis. They will understand legal implications, DNA analysis, and microscopy in forensic contexts. Additionally, they will gain skills in dendrochronology, palynology, and forensic phycology for comprehensive forensic investigations.

Course Content:

1. Introduction to forensic botany: Legal plant definition; Botanical evidence in legal investigations, alibis, timing, gravesite growth, stomach contents.
2. Types of plants and non-plant groups studied by botanists, basic plant characteristics for forensic investigators, plant habits and dispersal mechanisms.
3. Initial crime scene notation: Stepwise methods for the collection of botanical evidence; proper documentation and handling techniques.
4. Habitat documentation: Methods for recording and analyzing habitat characteristics; importance of detailed environmental context in forensic investigations.
5. The common law: Legal framework and its implications for forensic botany; relevant case law and legal precedents.
6. DNA analysis in forensic botany: Types of samples and collection methods for DNA analysis; uses of genetic data in forensic investigations; genotyping methods; finding a laboratory for analysis.
7. Microscopes and microscopic botanical structures: Relevance of microscopic analysis in forensic botany; importance of reference collections for microscopic analysis.
8. Dendrochronology: Basics of tree-ring dating and its forensic applications; case study: The Lindbergh case; recommended further reading.
9. Palynology: Analysis of fossil and modern pollen grains, spores, and related structures; applications in forensic investigations.
10. Forensic phycology (algal evidence): Finding and collaborating with an algal botanist; identification and analysis of algae in forensic investigations; collection and processing techniques for algal evidence in forensic cases.

11. Forensic Mycology, Forensic mycology: definition and fields of applicability, Fungi and thermochronology: case studies, Methods of sampling fungi at a crime scene (outdoor or indoor) environment, Fungal spores are important micro-traces since, like other palynomorphs, Forensic mycology use to relate the scene to the defendant by analyzing fungal biota at the crime scene.
12. Forensic Ecology & its application, what is forensic ecology? Role of forensic ecology in criminal cases, Plant ecology (growth patterns of vegetation) useful in estimating time of death.
13. Forensic Limnology & its application, what is forensic limnology? Aquatic plants (e.g., algae, diatoms) have been useful; To link suspects to a crime scene ,To establish that drowning occurred in freshwater ,Can be used for identification purposes

Lab Outline:

1. Identification of various Plant parts (macro and micro fragments) in the laboratory through various techniques (hand lens, light microscopy etc.)
2. Identification of different Fabric(s) by various means
3. Recovery of Plant Debris including palynomorphs (e.g. pollen and spores) from fabrics, leather and other items such as ornaments, jewelry etc.
4. Coprolite analysis for Forensic use
5. Gut analysis to isolate Plant particles
6. Extraction and Identification of Phytoparticles from different relevant Body parts, using established forensic protocols

Recommended Texts

1. Miller, M.T. & Massey, P. (2018). The crime scene: a visual guide. Amsterdam: Elsevier Science.
2. Triv, S., Rehman, H., Saggu, S., Panneerselvam, C. & Ghosh, S.K. (2018). DNA barcoding and molecular phylogeny. Switzerland: Springer.

Suggested Readings

1. Primorac, D. & Schan field, M. (2015). Forensic DNA applications: an interdisciplinary perspective. Boca Raton, Florida: CRC Press.
2. Clifton, J. (2018). Forensic science. Connecticut, USA: Larsen and Keller Education.

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BOTN-6115	Scientific Inquiry & Research Methods	3(2-1)

Course Brief:

This course offers a thorough exploration of scientific inquiry and research methodologies, equipping students with essential skills for conducting robust scientific research. It begins with an introduction to scientific inquiry, detailing the scientific method, types of research, and key research characteristics. Students will delve into research ethics, learning about ethical principles, informed consent, and handling dilemmas. The course covers research design and methodology, including hypothesis formulation, various research designs, and sampling techniques. It also addresses data collection methods for both quantitative and qualitative research, as well as instrument development and validation. Further, students will learn to analyze and interpret data using statistical methods and software, write comprehensive research reports, and effectively present and disseminate their findings.

Course Learning Objectives:

By the end of this course, students will be equipped with a comprehensive understanding of scientific inquiry, research design, and methodology. They will master ethical considerations in research, develop and validate measurement instruments, and apply both quantitative and qualitative data collection methods. Additionally, students will gain proficiency in data analysis and interpretation, write structured research reports, and effectively present and disseminate their findings.

Course Content:

1. Introduction to Scientific Inquiry, Definition and importance, The scientific method: steps and processes ,Characteristics of scientific research, Types of Scientific Research, Basic vs.

applied research, Qualitative vs. quantitative research, Descriptive, experimental, and correlational research

2. Ethics in Scientific Research, Ethical principles and guidelines ,Informed consent and confidentiality ,Handling ethical dilemmas
3. Research Design and Methodology, Identifying research problems, Constructing clear and testable hypotheses, Operational definitions of variables ,Research Designs, Experimental designs (e.g., randomized controlled trials), Quasi-experimental designs, Non-experimental designs (e.g., case studies, surveys)
4. Sampling Techniques, Probability and non-probability sampling, Sample size determination, Sampling bias and error
5. Data Collection Methods, Quantitative Data Collection, Surveys and questionnaires, Structured interviews, Observational methods, Qualitative Data Collection, Unstructured and semi-structured interviews, Focus groups, Ethnography and participant observation
6. Instrument Development and Validation, designing reliable and valid measurement instruments, Pilot testing, Ensuring reliability and validity
7. Data Analysis and Interpretation, Descriptive statistics (mean, median, mode, standard deviation), Inferential statistics (t-tests, ANOVA, regression analysis), Using statistical software (e.g., SPSS, R), Qualitative Data Analysis, Coding and thematic analysis ,Content analysis ,Narrative analysis ,Interpreting Results Drawing conclusions from data ,Discussing findings in the context of the literature ,Identifying limitations and implications
8. Writing a Research Report, Structure of a research paper (abstract, introduction, methods, results, discussion, conclusion), Proper citation and referencing (APA, MLA, Chicago styles), Avoiding plagiarism
9. Presenting Research Findings, preparing effective oral presentations, Designing and presenting research posters, Using visual aids and technology in presentations
10. Publication and Dissemination, submitting to academic journals, Peer review process, Communicating research to the public and stakeholders

Lab Outline:

1. Learn to use SPSS and R for data entry, management, and basic statistical analyses to interpret research results."
2. Use of spectrophotometers and balances for accurate measurement and data collection in experimental research."
3. Perform basic statistical tests and interpret results to validate research hypotheses and draw conclusions."
4. Plan and execute qualitative data collection through interviews and focus groups, analyzing data to extract meaningful insights."

Recommended Texts:

1. Youdeowei, A.. Stapleton, P., Obubo, R. (2012). Scientific Writing for Agricultural Research Scientists - A Training Resource Manual. Wageningen, The Netherlands: CTA.
2. Chasan-Taber, L. (2014). Writing Dissertation and Grant Proposals. CRC Press, USA.
3. Oster, S., Cordo, P. (2015). Successful Grant Proposals in Science, Technology, and Medicine A Guide to Writing the Narrative. Cambridge University Press, Cambridge, UK.

Suggested Readings:

1. Creswell, J. W. (2018). Research design: Qualitative, Quantitative and Mixed methods approaches. 5th Ed. Thousand Oaks, CA: Sage.
2. Leedy, P. (2004). Practical Research: Planning and Design (8th Edition), Jeanne Ellis Ormrod.

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URCG-5111	Translation of Holy Quran-IV	Non-Credit

Semester / Level:
In some discipline 7th semester and in some discipline 8th Semester/ BS (5th Semester intake) 3rd / 4th

Course Learning Objectives:

- To familiarize the students with commandments of trade and inheritance mentioned in the Quranic text (with the help of Urdu translation).
- Students
- To introduce the students to scientific facts and miracles of the Holy Quran and Quranic stress on deep study of Allah's explored universe.
- To motivate the students for reading and exploring the last Holy Book revealed by Almighty Allah.
- Through memorization students will develop their relation with last revelation.

Course Content:

- تجارت اور وراثت:
  - مال کی تقسیم
  - نادان کا مال
  - عوام الناس کا مال
  - عورتوں کا مال
  - یتیموں کا مال
  - کفار کا مال
  - جائز مال
  - معاہدے
  - رہن
  - قرض
- سائنسی حقائق:
  - تخلیق کائنات
  - اجرام فلکی
  - شجر و حجر
  - زمین و آسمان کے اسرار
  - ہوائیں اور طوفان
  - بہائم اور مویشی
  - حشرات الارض
  - پہاڑ اور سمندر

Grammar:

- قرآنی عربی گرامر کے اصول اور انکے اطلاقات (متن قرآنی پر اطلاق سے توضیحات)

Details of Chapters and verse Numbers:

- منتخب آیات مع ترجمہ و تجوید
  - البقرہ(۲۶۱،۲۱۹،۲۶۵،۲۲۵،۲۶۴،۲۷۵،۱۸،۲۶۵،۱۷۷،۲۶۵،۱۶،۲۷۵،۲۸۲،۲۶۲،۲۷۴،۲۷۱،۸۳،۱۷۷،۲۱۵،۲۷۶،۲۷۸،۱۶،
    ۲۷،۲۲۳،۲۹،۲۵۵،۱۶۴،۲۶۶،۱۶۴،۱۶۴،۶۰،۵۰،۱۶۴،۵۷،۲۱۰،۱۹،۲۶،۷۱،۹۲،۹۳)
  - آل عمران(۱۱۷،۱۳۴،۱۳۰،۱۹۰،۲۷،۵۹)
  - النساء(۲۹،۲،۲۹،۱۶۱)
  - المائدہ(۸۹،۹۵،۷۵،۶۹،۶۰)

- التوبہ(۹۸،۲۴،۶۹،۲۴،۲۴،۶۰،۴)
- الاعراف(۱۷۲،۱۸۵،۵۷،۵۸،۱۶۳،۱۶۰،۴۰،۱۳۳،۱۷۶،۱۶۶)
- الرعد(۱۷،۴)
- الطور(۴۴)
- الانعام(۵۹،۶۳،۱۴۱،۱۴۶،۳۸)
- الانفال(۲۸،۳۶،۴۱)
- الکہف(۵۱،۱۰۹،۴۷،۳۲،۴۵،۱۷،۴۵)
- الجاثیہ(۵)
- فاطر(۲۷،۱۲،۱۳)
- العنکبوت(۲۰،۶۳،۴۱)
- الروم(۵۰)
- الاسراء(۷۰،۹۹)
- الرعد(۲)
- السبا(۱۰،۳،۳۲)
- یونس(۸۸،۱۰۱،۲۴،۲۴،۵،۲۲)
- یوسف(۹۴،۱۴)
- الفرقان(۶۲،۵۳)
- لقمان(۲۹،۱۶)
- طہٰ(۱۱۴،۵۳)
- النحل(۷۵،۱۱،۶۱،۴۹،۷۹،۶۸،۶۸،۱۱۵،۸،۸)
- النمل(۶۴،۶۴،۸۸،۶۰،۸۲،۱۶،۱۷،۱۸)
- السجدہ(۲۷)
- الحدید(۶)
- ھود(۴۳،۶)
- یسین(۳۷،۴۱)
- الروم(۳۹،۳۹،۵۰،۱۹،۲۴،۴۶)
- فصلت(۳۹،۳۹)
- الحج(۶۱،۶۵،۲۲،۷۳)
- الحجر(۱۹،۲۲)
- الانبیاء(۳۱،۳۰،۴۷)
- الزاریات(۴۷)
- الزلزل(۱)
- القصص(۷۶،۷۹،۸۰،۸۱،۸۲)
- النور(۳۷،۲۲،۴۰،۴۵،۴۳)
- الجمعہ(۱۱،۱۰،۶۲،۱۱،۵)

- القمر(۷)
- الواقعہ(۶۹)
- الفاطر(۲۰،۱۳)
- الملک(۱۹)
- الصف(۱۰)
- الجن(۱۳)
- الشوریٰ(۲۸)
- الزخرف(۱۱)
- الفیل(۱)

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Semester VIII

BOTN-6116	Plant Biotechnology	3(2-1)

Course Brief:

This course offers an in-depth exploration of plant biotechnology, beginning with the fundamentals of gene regulation and the various tools and enzymes used for DNA manipulation. Students will be introduced to the principles of gene editing and the use of cloning and expression vectors to manipulate plant genomes.

Course Learning Objectives:

By the end of this course, students will understand plant biotechnology fundamentals, including gene regulation, DNA manipulation tools, and fermentation biotechnology. They will gain proficiency in plant tissue culture, biosynthesis of secondary metabolites, and their roles in ecological interactions. Students will also explore commercial applications such as amino acid and antibiotic production, along with recombinant DNA technology.

Course Content:

1. Introduction and history of Plant Biotechnology, Importance of biotechnology in plant improvements.
2. Plant growth and development under in vitro conditions, plant cell and tissue culture, cloning and somatic cell genetics, Embryo rescue, haploid culture, protoplast culture, Virus free plants developments, Soma clonal variations as breeding tool, conventional and biotechnology supported plant breeding,
3. Recombinant DNA technology, Gene cloning, Plant transformation; *Agrobacterium*-mediated transformation, Gene gun method of transformation, Chloroplast transformation, Genes for yield and quality improvement,
4. Incorporation of novel gene for tolerance against biotic and abiotic stresses; Gene for insect and disease resistance, herbicide resistant plants,
5. Biosafety concerns and bioethics on GM crops. practical application of transgenic plant technology for plant health, human/animal health and nutrition, biosafety aspects of transgenic plants

Lab Outline:

1. Stock preparations.
2. Sterile techniques.
3. Media preparations.
4. Explant isolation and culture.
5. Plasmid-DNA isolation and culture.
6. Agrobacterium culture growth.
7. Transformation by co-cultivation method.
8. Selection of transformants.

9. Screening of transformants.
10. DNA and protein isolation.
11. Biochemical analysis of transgenic plants.
12. Molecular analysis of transgenic plants.

Recommended Texts:

1. Nelson, D. & Cox. M. (2017). Lehninger: principles of biochemistry. W.H. Freeman-Macmillan Learning.
2. Lodish, H., Berk, A., Kaiser, C., Krieger, M. & Bretscher, A. (2016).Molecular cell biology. (8th ed.). New York: W.H. Freeman-Macmillan Learning.

Suggested Readings:

1. Venkat, B., Sahijram, R. & Murthy, K. (2015). Plant biology and biotechnology. Singapore: Springer-Verlag
2. Clark, D., Pazdernik, N. & McGehee, M. (2019). Molecular biology: Amsterdam Elsevier Inc

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BOTN-6117	Economic & Industrial Botany	3(3-0)

Course Brief :

This course provides a comprehensive exploration of the critical role plants play in human society and their diverse applications. Students will examine plant structure and function and delve into the historical and contemporary significance of plants in fulfilling human needs for food, clothing, shelter, and energy. Topics include major food crops, the environmental impact of modern agriculture, the role of genetically modified plants, and the health implications of plant-derived substances. The course also covers plants used in beverages, spices, fibers, and medicinal applications, along with the economic impact of problem plants and the role of plants in phytoremediation and conservation efforts. Through lectures, discussions, and hands-on laboratory exercises, students will gain an understanding of the multifaceted relationships between plants and human society.

Course Learning Objectives:

By the end of this course, students will gain a thorough understanding of the vital roles plants play in human needs, from food and clothing to energy and medicinal uses. They will explore the historical and modern significance of major plant-based resources, including carbohydrates, proteins, and fats, as well as the impact of caffeine and alcohol. The course will also cover plant fibers, medicinal plants, and the economic effects of problem plants. Additionally, students will examine plant-based fuels, ornamental plants, and conservation efforts such as phytoremediation and seed banks.

Course Content:

1. Plants as a source of carbohydrate, lipids, vitamins, protein and minerals etc.
2. Large scale production of plant using tissue culture technology
3. Off season greenhouse vegetable production systems
4. Fruit processing and preservation
5. Ornamental plants
6. Nursery production
7. Horticultural and Ornamental Plants
8. Vegetative propagation of plants
9. Medicinal Plants: Historical and modern uses of herbs and plant extracts
10. Plant as source of food and fodder
11. Plant fuels, coal oil, peat, moss, biodiesel, ethanol,
12. Plant fermentation biotechnology
13. Phytoremediation for soil conservation and improvement
14. Invitro and in vivo plant conservation
15. Economic impact of plant problems, Weeds, invasive species, allergies, poisonous plants,
16. Pharmacognosy: Tea, coffee, chocolate, terpenoids, alkaloids, saponins

Lab Online:

1. Identify and analyze major food crops and their roles in human diets.
2. Explore the characteristics and controversies surrounding GM plants.
3. Study plants that supply essential nutrients.
4. Measure caffeine content in beverages and alcohol in various plant-based products.
5. Identify and analyze the properties of various spices and herbs.
6. Explore the use of plant fibers in textiles and other products.
7. Study the historical and modern uses of medicinal plants.

Recommended Texts:

1. Kochhar, S.L. (2016). Economic botany. Cambridge, UK: Cambridge University Press.
2. Wiersema, J.H. & León, B. (2016).World economic plants: a standard reference. Florida: CRC Press.

Suggested Readings:

1. Bagetta, G., Cosentino, M., Corasanitiand, M.T. and Sakurada, S. (2016). Herbal medicines: development & validation of plant-derived medicines for human health. Florida: CRC Press.
2. Pandey, B.P. (2016). Economic botany. New Delhi: S Chand & Company Pvt. Ltd.

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BOTN-6118	Evolutionary Trends in Plants	3(2-1)

Course Brief :

This course explores the major evolutionary trends in the plant kingdom, tracing the development of plant diversity from simple to complex forms. Students will examine the structural, functional, and reproductive adaptations that have allowed plants to colonize a wide range of environments. The course will cover key events in plant evolution, including the origin of land plants, the diversification of vascular plants, the evolution of seed plants, and the rise of angiosperms. Emphasis will be placed on understanding the evolutionary processes and mechanisms that drive plant diversity and adaptation.

Course Learning Objectives:

By the end of this course, students will understand the major evolutionary milestones in plant history and analyze how structural and functional adaptations have enabled plants to thrive in various environments. They will explore the evolutionary relationships among different plant groups and evaluate the significance of key innovations such as vascular tissues, seeds, and flowers. Additionally, students will develop critical thinking skills through the analysis of fossil records, phylogenetic studies, and comparative morphology.

Course Content:

1. Introduction to Plant Evolution, Overview of plant evolution, Origin of life and early photosynthetic organisms, Fossil record and methods of studying plant evolution. The Origin of Land Plants, Transition from aquatic to terrestrial life, Adaptations to land: cuticle, stomata, and structural support, Early land plants: Bryophytes
2. Evolution of Vascular Plants, Development of vascular tissues (xylem and phloem), The rise of pteridophytes (ferns and allies), Significance of lignin and secondary growth, Seedless Vascular Plants, Diversity and life cycles of lycophytes and ferns, Adaptations for spore dispersal ,Ecological roles of seedless vascular plants
3. Evolution of Seed Plants, Origin and significance of seeds, Gymnosperms: characteristics and diversity, Adaptations for reproduction without water, Gymnosperms: Cycads and Ginkgo, Morphology and reproduction of cycads, Ginkgo biloba: a living fossil, Evolutionary significance and conservation
4. Gymnosperms: Conifers and Gnetophytes, Diversity and adaptations of conifers, Unique features of Gnetophytes, Ecological and economic importance. Origin and Evolution of Angiosperms, The "abominable mystery" of angiosperm origins ,Characteristics and innovations of flowering plants, Fossil evidence and molecular data
5. Angiosperm Diversity and Classification, Major angiosperm clades (monocots and eudicots), Floral diversity and pollination strategies ,Coevolution with pollinators

6. Evolution of Plant Reproductive Strategies, Asexual vs. sexual reproduction, Evolution of flowers and fruits ,Seed dispersal mechanisms
7. Evolution of Plant Developmental Processes, Genetic and molecular basis of plant development, Evolution of leaves, stems, and roots, Heterospory and the evolution of seed habit
8. Plant Evolution in Changing Environments, Adaptations to diverse habitats (deserts, wetlands, etc.), Role of climate change in plant evolution.
9. Plant-Fungi and Plant-Microbe Interactions, Mycorrhizal associations and their evolutionary significance, Symbiotic nitrogen fixation, Plant defense mechanisms against pathogens
10. Evolution of Secondary Metabolites, Role of secondary metabolites in plant evolution, Evolutionary significance of alkaloids, terpenes, and phenolics, Human use of plant secondary metabolites
11. Phylogenetics and Plant Evolution, Methods of phylogenetic analysis, Constructing and interpreting phylogenetic trees, Molecular evidence and its role in understanding plant evolution
12. Future Directions in Plant Evolution Research, Emerging technologies and their applications, Conservation of plant diversity, Impact of human activities on plant evolution

Lab Outline:

1. Free hand section cutting, staining and permanent / temporary mounting of the representative specimens mentioned in the theory portion.
2. Study of Different types of Rocks (Igneous, Sedimentary, Metamorphic).
3. Different techniques involved in studying fossils and age determination.
4. Isolation of Palynomorphs through Maceration from samples of Mesozoic and Paleozoic Rocks of Pakistan.
5. Study of different types of Placentation in different flowers.
6. Study of different types of Embryo Sacs in Angiosperms.
7. Field Study Tour (mandatory) to the Lesser / Higher Himalayas to collect and identify specimens as given in the syllabus. Rock samples from various stratigraphically measured geological Formations shall be collected to isolate Palynomorphs of Seed Ferns, Gymnosperms and Angiosperms mentioned in the theory section. Detailed Field Report will be submitted by pupils at the time of practical examination carrying separate marks apart from Practical Note Book.
8. Free hand drawings (or Camera Lucida) of isolated and properly identified Palynomorphs along with the brief morphological description.

Recommended Texts:

1. Wang, X. (2018). The Dawn Angiosperms: Uncovering the Origin of Flowering Plants, Second Edition, Springer, p. 407.
2. Niklas, K. J. (2016). Plant Evolution: an introduction to the history of life. Chicago; London: The University of Chicago Press, 2016. 566 pp.
3. Taylor, E. L., Taylor T. N. and Krings, M. (2009). Biology and Evolution of Fossil plants. Princeten Hall, New York. 1252 pp.

Suggested Readings:

1. Traverse (2007). Paleopalynology. Unwin Hyman Ltd. 813 pp.
2. Stussey, T.F. (2009) Plant Taxonomy: The Systematic Evolution of Comparative Data. Columbia University Press, New York
3. Simpson, M.G. (2019) Plant Systematics. Elsevier Pub Simpson, M. (2010). Evolution and Diversity of Vascular Plants. 10.1016/B978-0-12-374380-0.50004-X.

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BOTN- 6138	Capstone Project	3(3-0)

Course Brief:

The course provides with a comprehensive foundation in project planning, experimental design, and reporting. How To formulate research questions, create detailed project proposals, and address ethical

considerations. They will develop skills in designing and conducting experiments, analyzing data, and preparing research reports. Additionally, students will gain experience in delivering presentations and reflecting on their research outcomes.

Course Learning Objectives:

By the end of this course, students will be adept at defining research questions and objectives, writing comprehensive project proposals, and addressing ethical considerations in project planning and proposal development. They will have the skills to design and execute experiments, conduct laboratory work, and analyze data using appropriate methods. Additionally, students will be proficient in preparing detailed research reports and delivering effective presentations to share their findings and reflect on their research experience.

Course Content:

1. Project Planning and Proposal Development, Students will define their research questions and objectives, write a project proposal, and address ethical considerations.
2. Experimental Design and Execution, Students will design experiments, conduct laboratory work, and analyze data using appropriate methods.
3. 3. Reporting and Presentation, Students will prepare a research report and create and deliver presentations to share their findings and reflect on their work.

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Elective/Optional Courses

BOTN- 6119	Plant Seed Physiology	3(2-1)

Course Brief:

This course comprehensively provides the details of physiology of seed development and maturation. It is science and technology that is applied in the seed industry and includes biotech, crop improvement, as well as courses in seed production and conditioning. This course provides students with core graduate level management and leadership skills enabling them to better serve seed and agricultural biotechnology businesses and regulatory agencies in an increasingly complex industry. This program emphasizes seed production, handling, and use; seed physiology and technology; plant breeding, and plant biotechnology. This course is designed to help students integrate and better understand crop growth, development and yield from a perspective of whole plant physiology.

Course Learning Objectives:

In this course, students will gain an overview of plant seeds physiological processes that are necessary to understand how plants operate and interact with their environment. The course is useful to understand and interpret agronomic phenomena contributing to crop yield. It also offers an opportunity to survey contemporary aspects of crop physiology with emphasis on recent research progress in related fields.

Course Content:

1. Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.
2. Seed germination Types of germination, factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration. breakdown of stored reserves in seeds, mobilization and interconversion pathways.
3. Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy.
4. Seed viability and longevity, pre-and post-harvest factors affecting seed viability; seed ageing; physiology of seed deterioration; lipid peroxidation and other viability theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.
5. Seed vigour and its concept, vigour test methods, factors affecting seed vigor, physiological basis of seed vigour in relation to crop performance and yield. Seed, invigoration and its physiological and molecular control.

Lab Ouline:

1. Proximate analysis of chemical composition of seed;
2. Different types of seed germination and evaluation,
3. Methods for breaking seed dormancy
4. Seed vigor test
5. Accelerated aging test
6. Priming and invigoration treatment for improving germination and vigor

Recommended Texts:

1. Agrawal, P. K. & Sherry, R. J., (2018).Techniques in seed science and technology (3rd Ed.).New Delhi: Brillion Publishing.
2. Baskin, C. C., & Baskin, J. M., (2014). Seeds: ecology, biogeography and evolution of dormancy and germination (1st Ed.).Cambridge: Academic Press.

Suggested Readings:

1. Taiz, L. & Zeiger, E., (2019). Plant Physiology (7th Ed.). England: Sinnauers Publ. Co. Inc.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. & Layzell, D.B., (2016). Plant Metabolism (6th Ed.).London: Longman Group.
3. Arnold, R. B. & Sanchez, R., (2004). Handbook of Seed Physiology (3rd Ed.).New York: The Haworth Press, Inc.

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BOTN- 6120	Palynology	3(2-1)

Course Brief:

Specifically, palynologists look at such factors as abundance of pollen and its occurrence in preserved samples. In the research of plants and their origins, palynologists have an important foothold in the study of past environmental systems, or paleoenvironments. The course teaches the practical procedures used and will be taught through instruction within a laboratory environment. This course gives information about spores and pollens of preserved species samples, which in turn can reveal many details about different ecosystems, especially marine environments. With palynology, one can determine such environmental characteristics as water depth, temperature, and salinity. This is important in learning more about past wildlife and how it has evolved.

Course Learning Objectives:

This course aims to introduce students to neo palynology and paleopalynology and its applications in botany, geology, archaeology, criminology, medicines, honey, oil and gas exploration. It also provide the students information about the nomenclature, morphology and classification of living and fossil pollen, and spores. The objective of the course is to disseminate information on palynology samples and preparation techniques that avoid the use of acids. Palynology is a particular study within the realm of ecology that deals with the pollen and spores of plant species.

Course Content:

1. An introduction to Neo palynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey, oil and gas exploration.
2. Basic information about the nomenclature, morphology and classification of living and fossil pollen, and spores; Morphology and functional significance of spores and pollen,
3. Palynomorphs of the Paleozoic, Palynomorphs of the Mesozoic, mega and microspores.
4. Gymnosperm pollen-major types through time, diagnostic features of angiosperm pollen and the early fossil record,
5. Anita group and Magnoliids pollen, monocot pollen, lower Eudicot pollen types, selected Rosid pollen types, selected Asterid pollen types.
6. Applications: forensics, honey, paleo environment, case histories. Fagales, geometrically bizarre and fun pollen types.

Lab Outline:

1. Microscopic Study of Spores and Pollen, Herbarium sheets.
2. Acetolysis.
3. Slide preparation, temporary and permanent slides of spores and pollen

4. Photomicrography, HF safety training, maceration and dissolution, gravity separation, counting techniques.

Recommended Texts:

1. Slam, H., (2016). Aerobiology: the toxicology of airborne pathogens and toxins (1st Ed.).London: Royal Society of Chemistry.
2. Burge, H. & Muilenberg, M., (2018). Aerobiology (1st Ed.). Florida: CRC Press.

Suggested Readings:

1. Bhattacharya, K.,(2015). A text book of palynology (1st Ed.). New Delhi: New Century Publication
2. Beaudoin, A.B. & Head, M.J., (2017).The palynology and micropalaeontology of boundaries (1st Ed.).London: Geological Society.
3. Alfred, T., (2018). Paleopalynology (2nd Ed.). New York: Springer.

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BOTN- 6121	Plant Tissue Culture	3(2-1)

Course Brief:

Plant tissue culture is used widely in the plant sciences, forestry, and in horticulture. Applications include: The commercial production of plants used as potting, landscape, and florist subjects, which uses meristem and shoot culture to produce large numbers of identical individuals.

Course Learning Objectives:

The aim of the course is to know about concept of cellular totipotency, differentiation and de-differentiation and various tissue culture methods / techniques for the production pathogen-free plants and explicit the role of plant tissue culture in crop improvement. Plant tissue culture broadly refers to the an in vitro cultivation of plants, seeds and various parts of the plants (organs, embryos, tissues, single cells, protoplasts).With the advances made in the tissue culture technology, it is now possible to regenerate species of any plant in the laboratory. In this process the growth medium or culture solution is very important as, it is used for growing plant tissue because it contains various plant nutrients in the form of 'jelly' known as agar and plant hormones which are necessary for the growth of plant.

Course Content:

1. Plant Tissue Culture-An introduction
2. Cellular totipotency, differentiation and de-differentiation
3. Selection of a suitable explant material in different plant groups
4. Initiation and maintenance of callus cultures
5. Organogenesis
6. Somatic embryogenesis
7. Micropropagation
8. Role of somaclonal variation in crop improvement
9. Cell suspension cultures
10. Isolation, purification and culture of plant protoplasts
11. Role of plant protoplasts in crop improvement
12. Production of pathogen-free plants using tissue culture techniques.

Lab Outline:

1. An introduction to a Plant Tissue Culture lab.
2. Laboratory facilities and their use.
3. Aseptic techniques.
4. Preparation and use of Stock solutions.
5. Media composition and preparation protocols.
6. Preparation of selected media, pouring and sterilization.
7. Procurement, preparation and sterilization of explants.
8. Initiation and maintenance of callus cultures and regeneration studies in selected species.

9. Culture initiation and maintenance for Micropropagation of selected species.

Recommended Texts:

1. Umesha, S., (2019). Plant Biotechnology (1st Ed.).Philadelphia: Francis and Taylor Group.
2. Dixon, R.A. & Gonzalcs, F.A., (2017). Plant Cell Cultures. A Practical Approach (2nd Ed.). England: Oxford University Press.

Suggested Readings:

1. Loyola-Vargas, V.M. & Ochoa-Alejo, N., (2016). Somatic embryogenesis: Fundamental Aspects and Applications (1st Ed.). Switzerland: Springer International Publishing.
2. Kumar, S., Mishra, S. & Mishra, A.P., (2016). Plant Tissue Culture: Theory and Techniques (2nd Ed.).England: Scientific Publishers.

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BOTN-6122	Seed Production Technology	3(2-1)

Course Brief:

The course is designed to enhance the students' knowledge of seed production and the key roles of bees and other insect pollinators, how to manage seed crops from agronomic, quality control, and genetic integrity standpoints, and how to meet new challenges through seed production research. Seed is the product of fertilized ovule that consists of embryo, seed coat, and cotyledon (s). In terms of seed technology, any part of the plant body which is used for commercial multiplication of crop is called seed. To make the available good quality seeds to the farmers, seed certification is necessary, which is a scientifically designed process. In our country seed certification is linked with notification of kind/variety. Only those varieties are eligible for certification, which are released and notified under Seeds Act. Seed testing is required to achieve the objectives for minimizing the risks of planting low quality seeds and the primary aim of the seed testing is to obtain accurate and reproducible results regarding the quality status of the seed samples submitted to the seed testing laboratories. After analyzing seed from each aspect i.e. disease, productivity and germination it is produced in bulk amount and brought to the market.

Course Learning Objectives:

This course provides information about modern concept of quality and seed management, introduction to seed industry of Pakistan, legislation under seed (Amendment). Act-2015 and comparative study of various seed management systems in the world.

Course Content:

1. Reproductive process in plants. Definition of seed and planting material. Anatomy and chemistry of seed. Introduction to seed industry of Pakistan. Variety development, registration and maintains system.
2. Modern concept of quality and seed management. Production of early generation seed. Seed generation system from pre-basic to basic and certified. Seed quality system, legislation under seed (Amendment). Act2015, crop inspection, seed testing, seed processing and storage.
3. Production of true to type disease free fruit nursery plant, hybrid seed production, establishment, planning and management of seed business. seed marketing and prices network.
4. Comparative study of various seed management systems in the world.

Lab Outline:

1. Lay out of seed adaptability and demonstration plot.
2. Visit to seed production plot and seed testing Laboratory to know the physical and analytical purity of seed lot,
3. Variety purity identification by using electrophoresis and DNA fingure printing techniques.
4. Assessment of seed viability and planting value by using tetrazolium test and vigor test.
5. Visit to variety breeding institute, seed farm and seed processing plant and seed storage.
6. An assignment/Mini project to assess the profit and loss of seed production entrepreneur.

Recommended Texts:

1. Bhutta, A. R. (2010). Introduction Seed Pathology. Pakistan: HSC.
2. Khare, D., & Shale, M. S. (2014). Seed technology (2nd Ed.) USA: Scientific Publisher.
3. Singh, S. (2014). Seed Testing. Pakistan: Gene Tech Book.

Suggested Readings:

1. Hussain, A., & Bhutta, A. R. (2016). Seed Industry in Pakistan. Islamabad: FSC&RD/PSF.
2. Shagufta, S. (2012). Seed science & seed technology. India: APH Publisher.
3. Chakarborty, S. (2013). Plant Molecular Genetics. USA: Scientific Publisher.

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BOTN- 6123	Advanced Environmental Biology	3(2-1)

Course Brief:

This course introduces the student to the fundamentals of environmental biology: the structure and biota of several aquatic and terrestrial ecosystems, including Vermont ecosystems. It includes spatial and temporal changes in ecosystems and species; critical observation and interpretation of landscapes; and communication skills, critical thinking, and teamwork. The student investigates why species occupy specific habitats. Environmental Biology is the study of living organisms in relation to their environment. It is emerged from the fields of natural history and medicine during the Enlightenment. Today it provides an integrated, quantitative, and interdisciplinary approach to the study of environmental systems. Environmental biology incorporates more of the pure sciences for understanding human relationships, perceptions and policies towards the environment.

Course Learning Objectives:

The aim of the course is to provide updated knowledge of environmental problems and sustainable environmental management, to familiarize the students with national conservation strategy and role of natural resources in conservation diversity of nature and importance of biodiversity for survival and proper functioning of ecosystems.

Course Content:

1. Environmental problems, their causes, and sustainability & Environmental history.
2. Science Systems, Matter and Energy, Energy Conversions, Thermodynamics, Basic Chemistry (acids, bases, salts), Niches, Interactions, Succession
3. Biogeography: Weather, Climate, Biomes & Biodiversity
4. Population Dynamics, Carrying Capacity, and Conservation Biology and Evolution of a Species
5. The Human Population: Growth, Demography
6. Global Problems, Energy Resources, Human Health
7. Air, Water soil and their pollution
8. Food Resources, Pesticides and Pest Control,
9. Land Management and Diversity
10. Economics, Politics, and Ethics

Lab Outline:

1. Water Characterization, Alkalinity and Buffering Capacity of Water,
2. Examination of industrial waste water and Municipal sewage and sludge for: Total dissolved solids, pH and EC, BOD/COD, Chlorides, carbonate, and Nitrates,
3. Visits to environmentally compromised sites, disturbed ecosystems, different sanctuaries
4. Survey of different important species for conservation.

Recommended Texts:

1. Fisher, M., (2018). Environmental biology (1st Ed.). Medford: Open Oregon Press Book Publishing Company.
2. Ren, H. & Zhang, X., (2019). High-risk pollutants in wastewater (1st Ed.). Amsterdam: Elsevier Publishing Company.

Suggested Readings:

1. Sivasubramanian, V., (2016). Environmental sustainability using green technologies (1st Ed.). Florida: CRC Press Taylor and Francis Group.
2. Calver, M., Lymbery, A. McComband, J. & Bamford, M. (2018). Environmental Biology (1st Ed.). England: Cambridge University Press.
3. Nriagu, J., (2019). Encyclopedia of Environmental Health (2nd Ed.).Amsterdam: Elsevier Publishing Company.

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BOTN-6124	Plant-Conservation Management	3(2-1)

Course Brief:

The course provides a thorough introduction to the essential aspects of plant conservation including an overview of threats to the world's plant diversity, conservation genetics, conservation assessments and ways to minimize biodiversity loss. It includes an introduction to international legislations, politics and humans' role, both as threats and conservers of plant diversity. The course has a tropical focus and requires basic knowledge in plant biology at university level. This class will review the causes of plant species decline, the biological factors associated with small populations at both the ecological and genetic level, the current practices of population monitoring and management for conservation in both in-situ and ex-situ environments and the possibility of reintroduction.

Course Learning Objectives:

The aim of the course is to provide updated knowledge of plant conservation, conservation in practice and conservation techniques for sustainable ecosystem management, to familiarize the students with threats to plant communities and its impact on population dynamics and economic development. Plants are the base for virtually all other life on Earth however humans appropriate approximately 1/3 to 1/2 of all plant productivity.

Course Contents:

1. Plant Conservation: Introduction, philosophy, origin, scope, objectives. Definitions
2. Understanding of Conservation: Biodiversity (types). Species (number), advantages of conservation (food, drugs and medicine
3. Extinction of Plant Species: Natural causes of Extinction. Anthropogenic (man-made) extinction, habitat destruction, Invasive species. Pollution, over harvesting, commercial products and life specimen, introduced species, predator and pest control, threats to species, over exploitation, introduced species, genetic problems in small population, risks reviews and dynamics of small population
4. Threats to Communities: Chains of extinctions, emergence of new species from old. Functional integrity in relation to fragment size
5. Conservation in Practice: Endangered species management and biodiversity protection, categorization of plant species, endangered species law. Bunting and fishing laws, the endangered species act, recovery plans, captive breeding and management plans, types of conservation (Ex-situ conservation), protected areas, conservation towards restoration of ecology, healthy approach to save biodiversity, saving rare species in the wild, habitat protection, private land and land critical habitat. Reauthorizing the endangered species.
6. Conservation Techniques: Parks and natural preserves, trouble in our parks and management. New parks establishment. Wildlife in parks, wilderness areas, wildlife refuges, refuge management, world conservation strategy.
7. Conservation and Economic Development: Indigenous communities and biosphere reserves, International wildlife preserves. Transboundary peace parks, preserving functional ecosystem and landscapes, landscape dynamics, size and design of nature preserves, wetland conservation.

Lab Outline:

1. Visit to Botanical garden. Governor House, Lahore

2. Visit to Bagh-e-Jinnah Lahore
3. Visit to Soon Valley, Pakistan
4. Visit to Botanical Garden, University of Agriculture. Faisalabad

Recommended Texts:

1. Ortega-Rubio, A., (2018). Mexican Natural Resources Management and Biodiversity Conservation (1st Ed.). New York: Springer Publication.
2. Blackmore, S., (2018). Best plant conservation practices to support species survival in the wild (3rd Ed.). Amsterdam: Center for Plant Conservation.

Suggested Readings:

1. Walker, T., (2015). Plant conservation: why it matters and how it works (5th Ed.). Portland: Timber Press.
2. Blackmore, S. & Oldfield, S. (2017). Plant conservation science and practice: the role of botanic gardens (1st Ed.). England: Cambridge University Press.

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BOTN- 6125	Conservation Genetics	3(2-1)

Course Brief:

The key genetic analyses employed in conservation genetics studies will be described and their technical and theoretical limitations discussed, as will their considerable power to inform key conservation decisions. It is becoming increasingly apparent that measures of genetic diversity should be included in our assessment of species health and future viability, to make the best decisions for their protection and management. As genetic techniques become more sophisticated and reliable, our use of them to support species conservation has similarly increased.

Course Learning Objectives:

The aim of the course is to provide updated knowledge of conservation genetics, scope of conservation genetics, values of biodiversity and loss of biodiversity, to familiarize the students with conservation techniques and genetic tools, genetic markers for assessing biodiversity. This course will introduce the principles and applications of conservation genetics, from assessing the genetic health of individuals and whole populations to deciding on species and sub-species divisions.

Course Content:

1. Introduction to plant conservation genetics, scope of conservation genetics, values of biodiversity and loss of biodiversity, Hardy-Weinberg principle, genetic drift, effective population size, population subdivision, quantitative genetics, molecular phylogenetics.
2. Genetic tools for conservation, genetic markers, inbreeding coefficients, conservation issue, met population and fragmentation, evolutionary significant units, conservation breeding.
3. Types of conservation: Forest conservation, wild plant conservation, invasive species study and control, medicinal plant conservation,
4. Conservation methods/techniques/management.
5. Natural and human-caused factors that cause plant species to be rare or imperiled and the genetic and ecological implications of rarity in plant species, conservation strategy for a rare or imperiled plant species, and applications of ecological and population genetics principles to evaluate the long-term viability of such a plant species with and without conservation measures.

Lab Outline:

1. Extraction of DNA from plant material by using CTAB method.
2. Molecular markers: SSR, Intron-polymorphisms, CAPS, AFLP, RAPD etc.
3. Analysis of morphological and molecular diversity in different cultivars/varieties of a crop plant.
4. QTL mapping (Theoretical using available data) 5. Field trips to the location of rare or threatened plant populations.

Recommended Texts:

1. Ortega-Rubio, A., (2018). Mexican natural resources management and biodiversity conservation (1st Ed.). New York: Springer publication.
2. Blackmore, S., (2018). Best plant conservation practices to support species survival in the wild (3rd Ed.). Amsterdam: Center for Plant Conservation.

Suggested Readings:

1. Walker, T., (2015). Plant conservation: why it matters and how it works (5th Ed.). Portland: Timber Press.
2. Blackmore, S. & Oldfield, S. (2017). Plant conservation science and practice: the role of botanic gardens (1st Ed.). England: Cambridge University Press.

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BOTN-6126	Basic Ecological Genetics	3(2-1)

Course Brief

This course elucidates the role of genetic techniques, genetic markers to assess the genetic diversity within and among the population. This course also provides an insight into gene flow and mating system and importance of biological and environmental factors on gene flow.

Course Learning Objectives:

The aim of this course is to provide the basics of the genetic component in functioning, development and sustainability of ecosystems with the main focus on forests and the associated communities. Sustainable development and biodiversity as well as increased impact of biotechnology became important present-day challenges and the basics of interaction between genetics and environment are needed to solve these problems. After completing the course students should obtain the basics of ecological genetics on one hand and breeding and biotechnology on another hand. This knowledge will allow the students to efficiently cope with the ecological problems connected with genetics to proceed with well-balanced approach to simultaneously maintain the ecological stability and economical benefit.

Course Content:

1. Ecological genetics. What is ecological genetics? Why study ecological genetics.
2. Markers and sampling in ecological genetics Introduction, methods of data generation, principles of sampling within and among population.
3. Genetic diversity and differentiation. Introduction, factors influencing diversity and differentiation, The Hardy Weinberg Equilibrium, genetic diversity, genetic differentiation, genetic distance, statistical approaches, use of genetic diversity statistics.
4. Gene flow and mating system. Introduction, Factors governing gene flow. Considerations for measuring gene flow, measuring gene flow -indirect estimates, measuring gene flow - direct estimates. The importance of biological and environmental factors on gene flow.
5. Intraspecific phylogenies and phylogeography. Introduction, homology, gene trees and species trees, tree form and building, tree interpretation, organelles versus nuclear intraspecific phylogenies.
6. Speciation and hybridization. Introduction, species, speciation, hybridization, analysis of speciation and hybridization.

Lab Outline:

1. Extraction of DNA from plant material.
2. Separation of DNA by gel electrophoreses.
3. Gene amplification through PCR
4. Graphical representation of speciation and hybridization data by UPGMA
5. DNA sequencing.

Recommended Texts:

1. Daniel, L., & Cochrane, H. B. (2017). Genetics: analysis of genes and genomes 9th Edition. USA: Jones & Bartlett Learning.
2. Turnpenny, P. D., & Ellard, S. (2016). Emery's Elements of Medical Genetics. Amsterdam: Elsevier.

Suggested Readings:

1. Pierce, B.A. (2017). Genetics: a conceptual approach. 6th Edition. USA: W. H. Freeman.
2. Klug, W. S., Michael, R. Cummings, R. Spencer, C. A. Palladino, M. A. & Killian, D. (2018). Concepts of genetics. UK: Pearson.
3. Lewis, R., (2017). Human genetics.12th Edition. USA: McGraw Hill Publication.

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BOTN- 6127	Medicinal Plants	3(2-1)

Course Brief:

The course topics will be taught from the perspective of how different cultures utilize medicinal plants. Students will learn how different cultures perceive diseases and then utilize plants to treat them. Currently medicinal plant usage is quite common, but how that use of medicinal plants is perceived depends on the society where they are used. The latter part of the course focuses on how societies in developed countries perceive, use and regulate plant medicines or herbal supplements. Finally, because all plants with bioactive compounds can't always be regulated, throughout the course students will learn how to evaluate claims made of specific plants and herbal supplements and will learn where to find reliable information about those plants and products. Use of plants for medicinal and other purposes; poisonous plants, cross-cultural aspects, chemistry and biological significance of natural products, and natural products from higher plants in modern medicine are discussed.

Course Learning Objectives:

The overall objective of this course is to improve students understanding of the uses and effects of medicinal plants, including herbal supplements, on people and their cultures or societies. This will focus on natural products extraction (hydro-distillation, solvent extraction, and quality control), assessment of dried botanicals, and quality assessment and sensory analysis of essential oils.

Course Content:

1. History of Medicinal plants. Traditional Medicinal systems: Ayurvedha, Siddha, Unani and Naturopathy. Cultivation, therapeutically and pharmaceutical uses of selected medicinal plants of Sargodha region. Historical account of medicinal plants in Pakistan. Establishment of medicinal plant gardens.
2. Definition of Drug-Classification of natural drugs: alphabetical, morphological, pharmacological and chemical .traditional and folklore medicine-native medicine drugs from leaves, flower, fruits and seeds, roots, bark (Cinchona) and wood (Ephedra)
3. Pharmacognosy-Definition and scope, drug adulteration, drug evaluation, chemical evaluation and biological evaluation of drugs, phytochemical investigations-quality control of herbal drugs.

Lab Outline:

1. Ethnomedicinal survey of various places
2. Preparation of herbarium sheets of ethnomedicinal plants.
3. Phytochemical analysis of ethnomedicinal plants.
4. HPLC of selected plant extracts

Recommended Texts:

1. Akos, M. (2015). Medicinal and Aromatic Plants of the World: USA: Springer publishers.
2. Tránsito, M., L. Luengo and C. Máñez(2015). Medicinal plants at home: NYC: Skyhorse Publishers.

Suggested Readings:

1. Krochmal, A., R.S. Walters and R.M. Doughty (2016). A guide to medicinal plants of Appalachia: NYC: Amazon publishers.
2. Kumar, A. (2016). Handbook of medicinal plants. NYC: Amazon publishers.
3. Da, H., J. Xiao, G. Pei and G. Xiao (2015). Medicinal plants. (1st Ed.)Amsterdam: Elsevier Publsihers.

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BOTN-6128	Seed Pathology	3(2-1)

Course Brief:

Seed pathology involves the study and management of diseases affecting seed production and utilization, as well as disease management practices applied to seeds. International seed trade has been affected significantly by changing phytosanitary regulations, not always based on science. This course deals with the History, economic importance, dynamic of transmission of plant pathogens, methodology and control measures of seed borne diseases. Seed pathology as a subdisipline of plant pathology is relatively new. Recent developments in the area of seed pathology technology allow for more ecofriendly seed treatments and more reliable seed health testing. Due to economics and new interest in environmental issues, research into the viability of biological seed treatments is becoming more common.

Course Learning Objectives:

The use of sophisticated DNA amplification technologies allows for the detection of seedborne pathogens that might go undetected using more conventional means. For the farmers seeds are not produced and collected in appropriate scientific technology rather these are the portions of grain cash crop harvested for their consumptions. However, the seed organizations in the country are still not so aware of the impact of unhealthy seeds which affect directly or indirectly the crop productivity and sustainable food security in the country.

Course Content:

1. Emergence of seed pathology as an independent discipline and its significance.
2. Morphological and anatomical studies of healthy and infected seed and planting material by using molecular techniques.
3. Effect of seed borne disease on seed viability and planting value. Histopathological study of infected seed, transmission of seed borne pathogens and their establishment in host and then to seed.
4. Mycotoxicological problems induce by seed borne pathogens and their health hazards. Identification of economical important seed borne disease and their post-harvest losses in agriculture and horticulture crops. Seed health technology and seed health certification system for production of disease free seed and inspection of seed consignments during export import and testing of germplasm material.
5. Concept of GMO in management of seed borne disease. Management of commercial scale production of disease free forest nursery and fruit plant certification. Seed and planting material national health standard under the seed (Amendment) Act-2015.Bioterrorism, SPS measures and international obligations.

Lab Outline:

1. Collection of seed samples as per ISTA rules,
2. Isolation of pathogen, identification and preservation of culture.
3. Histopathology of healthy and infected seed.
4. Effect of different chemicals and antagonistic microorganisms on seed borne pathogens and seed germination.
5. Field crop inspection for disease assessment.
6. Visit to seed health testing lab, seed processing plants and seed storage.

Recommended Texts:

1. Bhutta, A R. (2010). Introductory seed pathology. Pakistan: HEC.
2. Ahmed, S. (2009). Plant Disease Management for Sustainable Agriculture. India: Daya Publishing House.

Suggested Readings:

1. Agarwal,V. K. (2014). Management of Seed Borne Disease. India: Agrobios.
2. Agrios, G. N. (2005). Plant Pathology. United States: Academic Press. Sharma, R.C., & Sharma, J. N. (2011). Integrated plant disease management. United States: Scientific Publishers.

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BOTN-6129	Biodegradation and Bioremediation	3(2-1)

Course Brief:

This course will present the basic principles of chemical and biological degradation of toxic chemicals, and familiarize the students with the application of the remedial technologies in natural environments. Topics covered will include: 1) occurrence and ecological significance of toxic organic chemicals, 2) chemistry of contaminants, kinetics and mechanisms of degradation (chemical and biological), and 3) current technologies of bioremediation of contaminated soils and water. Bio/remediation as an option to treat contaminated soils and ground water. Advantages and disadvantages of bioremediation compared to non-biological processes. Biodegradation of specific contaminants (e.g. diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and poly-aromatic hydrocarbons) will be studied in detail. The investigation component of this course consists of learning how to do appropriate laboratory and field experiments to obtain data on microbial degradation of an organic pollutant to be able to calculate bioremediation design parameters such as mass and delivery rate requirements of electron acceptors and nutrients and degradation rates in reactor and non-reactor based systems; and to be aware of limitations of these calculations.

Course Learning Objectives:

To provide updated knowledge of environmental problems and sustainable environmental management through environmental laws, treatment technologies which include traditional and modern microbial techniques especially explicating the role of bacteria biodegradation and bioremediation.

Course Contents

1. The environment and pollution: Introduction, environmental laws.
2. Treatment technologies: Traditional approaches to pollution control, Bio-treatment technologies for pollution control.
3. Biocatalyst selection and genetic modification: Enrichment and screening strategies, Design of enrichment strategies relating to the environmental source, Microbiological techniques for enrichment and selection, Genetic approach,
4. The carbon cycle and xenobiotic compounds, Biodegradation and microbial technologies by microorganisms, Acclimation, Detoxification, Activation, Sorption, Bioavailability, Sequestering and complexing, co-metabolism, Environmental effects, Effects of metals and radionuclide on environment, Metal and radionuclide microbial treatment, Biotechnology for metal and radionuclide removal and recovery, Recalcitrant molecules

Lab Outline:

1. Isolation of bacteria from oil wastes, polluted water from industries and sewage.
2. Spray plate technique for testing the degradation ability of bacteria for different aromatic hydrocarbons.
3. Bioremediation from culture by metal resistant bacteria.

Recommended Texts:

1. Kaushik. G. (2015). Applied environmental biotechnology: present scenario and future trends. Singapore: Springer Verlag.
2. Crawford, R.L. (2009). Bioremediation principle and applications. UK: Cambridge University Press.
3. Singh, H. (2006). Mycoremediation: Fungal Bioremediation. New Jersey: Wiley-Interscience.

Suggested Readings:

1. Chang, W. (2017). Biodegradation and bioremediation. USA: Syrawood Publishing House.
2. Sangeetha, J., Thangadurai, D., Muniswamy D., & Abdullah, M.A. (2016). Environmental biotechnology: biodegradation, bioremediation, and bioconversion of xenobiotics for sustainable development. USA: Apple Academic Press.
3. Das, S. (2018). Microbial biodegradation and bioremediation, reprint ed. Amsterdam: Elsevier Science Publishing Co Inc.

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BOTN-6130	Water Pollution Management	3(2-1)

Course Brief:

This course provides an overview of engineering approaches to protecting water quality with an emphasis on water treatment unit operations. It covers a wide range of topics, including water characterization parameters and designing systems to treat municipal and industrial wastewater, as well as the legislative framework. Water Pollution management and strategies is offered to students to let students know basic knowledge and control technologies of water pollution, so that they can solve problems on water treatment. An understanding of the physical, chemical and biological processes involved during contamination of water is essential if society is going to effectively monitor and control the effects of pollution using modern technology and engineering practices. A huge range of pollutants may be released into the aquatic environment during everyday domestic, leisure, industrial and commercial activities and many of these contaminants are potentially harmful to human health and the environment.

Course Learning Objectives:

In this course, we will focus on the origins, pathways and consequences of anthropogenic pollutants in the environment as well as discussing the various approaches to pollution control and remediation. At the end students will learn about the causes and harms of water pollution and their possible methods to remove the pollutants and contaminants.

Course Content:

1. Water pollution: Sources, types and their impacts; Pollution problems of groundwater resources, sources of contamination, management issues; Pollutants - sewage, pesticides, oils, metals, radioactive wastes, biomedical wastes, etc. Common transport processes of pollutants in the aquatic environment; dispersal of pollutants; Algal blooms and their management, Methods of pollution surveys; Waste disposal and water quality criteria used in different parts of world national and international standards; ISO-14000(EMS), EIA, Management strategies'
2. Wastewaters - classification and characteristics of sewage and industrial effluents; treatment methods for water and waste water; Principles of aeration, chlorination, ozonation and U.V. irradiation; Waste recycling and utilization in aquaculture; Design and construction of water filtration devices; aerobic and anaerobic treatment of wastewater; Wastes from fish processing units and their treatment; solid waste management; removal of nitrogen and phosphorus from waste water; Role of aquatic macrophytes in treatment of waste water.

Lab Outline:

1. Determination of DO, BOD and COD of water.
2. Determination of total dissolved solids (TDS) of ground and surface water.
3. Estimation of amount of phosphate, sulphate, nitrate, nitrite, iron and magnesium and calcium in the ground and surface water.
4. Estimation of Ca, Mg, organic matter and phosphates in soil.
5. Collection and preservation of waste water samples; Physicochemical analysis of wastewater total dissolved and suspended solids, color, odor, DO, BOD, COD, H_2S, NH_3–N, NO_2-N, NO_3-N, PO_4-P, CH_4, heavy metals and pesticides.
6. Use of algae for organic waste treatment.
7. Visit to sewage treatment plants, fish processing units and other industries.

Recommended Texts:

1. Chakraborty, D., & Mukhopadhyay, K. (2016). Water pollution and abatement policy in India: a study from an economic perspective,(1st Ed.)USA: Springer.
2. McMillan, S. (2018). Water pollution: types, causes and management strategies. USA: Syrawood Publishing House.

Suggested Readings:

1. Kneese, A.V. (2015). Water pollution: economics aspects and research needs. London, United Kingdom.
2. Rose, M., & Mendoza, O.(2016). Water pollution & treatment. Canada:Arcler Education Inc
3. Humaira, Q., Bhat, R.A., Mehmood, M.A., & Dar, G.H. (2019). Fresh water pollution dynamics and remediation,(1sted.)Berlin: Springer Verlag.

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BOTN-6131	Air Pollution Management Strategies	3(2-1)

Course Brief:

This course provides skills and information on how to monitor air pollution and increase public awareness, how to develop emission inventories and track progress, how to assess the benefits of air quality improvement, how to select control strategies that are most effective and will describe regulatory approaches that have been most effective elsewhere.

Course Learning Objectives:

In this course, students will learn effects of air pollutants on human beings, materials and the environment, what their sources are, and their physical and chemical behavior in the atmosphere. This will introduce the nature of our atmosphere, its composition and meteorology, air pollutant emissions, air pollution chemistry and climate change / carbon management, together with the practical measures used to limit emissions from sources ranging from power stations to vehicles and the legislative and policy framework used by national and local authorities to enforce air quality objectives. Successful air quality management programs can reduce emissions that lead to air pollution while simultaneously providing other development benefits that accrue locally as well as globally. Benefits can include improved public health, energy savings, economic development, agricultural benefits and reduced emissions of greenhouse gases and other short-lived climate pollution.

Course Content:

1. Nature and classification of pollutants, sources and effects of pollutants on plant growth viz; fluoride, Sulphur dioxide (SO2), ozone, PAN - smog, ammonia, chlorine, ethylene, dusts etc., nature, causes, prevention and control of air pollution (vehicular pollution and industrial chimney wastes).
2. Air Pollution Sources: Origin, dispersion and impact on human, crops and forest of Particulates, Sulphur oxides, Nitrogen oxides & volatile organic compounds, carbon monoxide, carbon dioxide, Smog and PAN, MTBE (methyl tertiary butyl ether) and CFCs (chlorofluorocarbons),
3. Basic principles of air pollution management, ambient concentrations of air pollutants and trace gases, national environmental policies, implementation of policies and organization of management agencies, national air monitoring programme, effects of air pollution on human health, air quality criteria and case study, emergency preparedness, safety planning and management, vehicular pollution, monitoring and abatement technologies.
4. Air pollution control equipments, objectives and types of control equipments, efficiency of separating devices, control of particulate emission settlers, cyclones, filters, scrubbers and esps. Control of sulphur dioxide from lean and rich waste gases (recovery of sulphur and sulphuric acid).Control of NOx through absorption and other newer methods; control of vehicular emission (catalytic conversion devices); Indoor air pollution and its control.
5. Hazardous air pollutants and their management. Biological abatement of air pollution, scope of green belt development, economical aspect of air pollution abatement technologies.

Lab Outline:

1. Estimation of foliar dust deposition in samples collected from sites exposed to air pollution.
2. Determination of settled particulate matter in air.
3. Biomonitoring of heavy metals in the environment.
4. Mapping of vegetation of selected region by using Remote sensing data.
5. Field visits to industrial areas for on-spot biodiversity assessment and to prepare status report.

Recommended Texts:

1. Vallero, D. A. (2014). Fundamentals of air pollution. Cambridge: Academic Press.
2. Vallero, D. A. (2019). Air pollution calculations: quantifying pollutant formation, transport, transformation, fate and risks. USA: Elsevier.

Suggested Readings:

1. Guardia, M.D.L., & SergioA. (2016). The quality of air: Volume 73. UK: Oxford Press.
2. Smedley, T. (2019). Clearing the air: the beginning and the end of air pollution. UK: Bloomsbury Sigma.
3. Tiwary, A., & Williams, I. (2018). Air pollution: measurement, modelling and mitigation. (4th Ed.) USA: CRC Press.

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BOTN-6132	Conservation Ecology	3(2-1)

Course Brief:

Conservation ecology is the branch of ecology and evolutionary biology that deals with the preservation and management of biodiversity and natural resources. It is a discipline that is emerging rapidly as a result of the accelerating deterioration of natural systems and the worldwide epidemic of species extinctions. Its goal is to find ways to conserve species, habitats, landscapes, and ecosystems as quickly, as efficiently, and as economically as possible. Conservation, study of the loss of Earth's biological diversity and the ways this loss can be prevented. Biological diversity or biodiversity includes its ecosystems, species, populations, and genes.

Course Learning Objectives:

This course will help the students to learn about the work of conservation biologists and study of ecosystems can help with conserving the world's biodiversity. Students will explore the impact of wind farms on populations of seabirds, and understand how the use of advanced techniques can be used to study different populations. It will also enable the students to know that how ecosystems are influenced by human activity and will explore the reasons behind the bee decline across the world, and examine fish species in tropical seas to see at first-hand how climate change damages coral reefs.

Course Content:

1. Introduction to conservation ecology, history, importance of edaphic factors in conservation. Importance of topographic factors, biotic factors.
2. Ecosystem: Physical conditions and availability of resources.
3. Applied issues in conservation: Role of natural resources in conservation ecology.
4. Types of natural resources (renewable m non-renewable), wildlife management, species preservation, conservation of habitat, introduction of exotic species, natural parks, forests resources, soil and water resources, food and agriculture resources.

Lab Outline:

1. Visits to different disturbed ecosystem
2. Survey of different important species for conservation
3. Visit to different sanctuaries

Recommended Texts:

1. Schowalter T. D. (2016). Plant Ecology: An Ecosystem Approach. United States: Academic Press.
2. Ent, A., Repin, R., Sagau, J., & Wong, K. (2015). Plant Diversity and Ecology of outcrops in Malaysia. United States: Springer.

Suggested Readings:

1. Real, L. (2017). Ecological genetics. United States: Princeton University Press.
2. Kobori, H., Dicikinson, L. D., Washintani, I., Sakurai, R., & Amano, T. (2016). A new approach to plant ecology and conservation. United States: Springer.
3. Baer, H., & Singer, M. (2016). Global warming and the political ecology of plants health. United Kingdom: Rautledge Publishers.

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BOTN-6133	Plant Stress Physiology	3(2-1)

Course Brief:

This course will provide an understanding of the unique features of plant cells and a general grounding on plant physiology and growth. In addition it will provide a brief introduction to the various physiological, molecular, and biochemical mechanisms plants use to respond to environmental stresses like extreme temperature, drought, salt, and pathogens. Any external factor that negatively influences plant growth, productivity, reproductive capacity, or survival is considered as a stress. Plants have to face different type of stresses and develop possible mechanism to compensate the effect of stress. In this course the students are expected to; learn the major principles of plant physiology and the crucial processes behind it (e.g. water and nutrient transport, photosynthesis, key regulatory hormones); gain understanding on the interaction between plants and the environment, become

familiar with basic methodologies employed in these fields and to develop the skills to read relevant literature, to follow research seminars in these fields and to critically assess the presented information. This course will also allow the students to learn about the molecular mechanism of the plant to overcome /minimize the plant stress which affects the plant basic processes.

Course Learning Objectives:

This course elucidates the general theory and various causes, types and aspects of stress in plants. This course also provides an insight into Acclimation and plant responses to stress at multiple levels of integration - from the molecule to the whole plant.

Course Content:

1. The history of stress research, general theory of stress.
2. Stress at plants at sub-cellular, cellular, organ.
3. Stress factors, classification of biotic, abiotic factors, methods of measurement
4. Signal transduction, molecular biological foundations of anti-stress reaction
5. Stress proteins, antioxidants - anti-stress response mechanisms
6. Stress lack / excess of available water (mechanisms to avoid stress)
7. Stress of substrate salinity, osmotic stress
8. Stress caused by toxic and foreign substances
9. Stress caused by cold, frost
10. Thermal stress (heat effects of physical, chemical, molecular and biological)
11. Radiation stress (regularly, classification, mechanisms of formation, mechanisms for protection)
12. Acclimation / adaptation to stress in extreme environments (deep oceanic waters, submarine volcanic eruptions, oceanic coastal areas, an extremely toxic habitats, alpine and polar regions, and desert biomes, extra-terrestrial systems).
13. Plant responses to stress at multiple levels of integration - from the molecule to the whole plant. Global issues related to environment and plant stresses. Use of the primary scientific literature as a basis for the in-depth study of plant responses to environmental stress

Lab Outline:

1. Determination of water potential by pressure chamber
2. Determination of osmotic potential by osmometer
3. Investigation of osmolytes from plants growing under stress conditions
4. Estimation of antioxidant activity in plants under stress conditions

Recommended Texts:

1. Mitra, G.N. (2015). Plants: A Biochemical and Molecular Approach. India: Springer.
2. Jugulam, M. (2017). Biology, physiology and molecular biology of weeds. United States: CRC Press.

Suggested Readings:

1. Taiz, L., & Zeiger, E. (2019). Plant physiology.7th Edition. Unites States: Sinnauers Publ. Co. Inc.
2. Taiz, L., & Zeiger, E. (2018). Fundamental of plant physiology. Unites States: Sinnauers Publ. Co. Inc.
3. Buchanan, B., Gruissem, W., & Russell, L. (2015). Biochemistry and molecular biology of plants. Jones. United States: John Wiley & Sons.
4. Dennis, D. T., Turpin, D. H., Lefebvre, D. D., & Layzell D. B. (2016). Plant metabolism. (6thed.) England: Longman Group.

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BOTN-6134	Advanced Plant Anatomy	3(2-1)

Course Brief:

Plant anatomy is the study of the internal structure of plants. It plays a key role in understanding how plants function and is an essential component of much research. This course focuses on plants and provides with comprehensive, updated information about the organization, development, structure and function of plant cells, tissues and organs. The Plant Anatomy course will combine theory and

practical so that participants can develop a sound understanding of the structure and function of plants. This subject has a vital role and helps to understand the internal organization of the plant.

Course Learning Objectives:

It will enable the students to learn about the internal organization of the tissues and their types and when or where these specific types of tissues arise and perform specific function. The following learning outcomes are expected to be achieved through the study of this course i.e. Understand basic concepts and terminology in plant anatomy and various structures of seed plants in relation to their development, function and evolution, Explain how knowledge of plant anatomy is connected to our everyday life and practices in agriculture and forestry etc.

Course Content:

1. Different types of Meristems: Organization of shoot and root apical meristems; Differentiation of primary and secondary plant body: Epidermis, Stomatal ontogeny, Cuticle and epidermal appendages; Secretory structures, Reproductive plant anatomy: Floral vasculature.
2. Secondary Xylem: Axial and ray system, Growth layers, Reaction wood, Gymnosperm wood, Angiosperm wood, Differentiation in secondary xylem, Strength of wood in relation to structure
3. Dendrochronology (Sap wood, Heart wood, Tension wood, Grain and Knot in wood) Healing of wounds, Secondary thickening growth in Monocots. More about Dendrochronology.
4. Stem: Tissue systems, Leaf traces, Leaf gaps, Branch traces and branch gaps, Vascular bundles, Concept of stele delimitation of vascular region, Endodermis, Pericycle, Origin of vascular cambium, Common forms of secondary growth
5. Anomalous Secondary Growth: Secondary growth in monocots, Grafting and wound healing
6. Types of Stems: Conifer. Woody dicotyledons, Dicotyledonous vine, Herbaceous, Dicotyledons, Herbaceous monocotyledons Crowns anatomy.
7. Leaf: Histology of angiosperm, Leaf, Mesophyll, Bulliform cell, Vascular system, Bundle sheaths, Supporting structure, Secretary structures, Petiole, Histology of gymnosperm leaf, Development of leaf, Growth of leaf lamina, Monocotyledonous leaf, Development of vascular tissues, Abscission of leaves. Anatomy of the node
8. Root: Concept, Origin, Morphology, Primary structure, Root cap, Vascular cylinder, Development of histogens, Primary and secondary growth, Development of lateral roots, Development of adventitious roots, Development of buds on roots, Structure in relation to function. Root-Shoot Transition: Secretary structures, Glands, Nectaries, Hydathodes,
9. Internal secretary structures, Laticifers. Root Apex: Root Apex in lower vascular plants, Gymnosperms, Angiosperms; Dicots and monocots, Coleorhizae.
10. Theories of structural development and differentiation (Stem and Root)
11. Flower: Concept, Structure, Vascular system. Different parts, Sepals, Petals, Stamen, Carpel, Ovule, Organogenesis, Histogenesis, Abscission, Structure of peduncle Petiole and Pedicle Anatomy, Resin canal in Plants
12. Anatomy of Reproductive parts: Seed, Grain, Fruit
13. Applied plant anatomy: Brief idea on the application of anatomical studies in climatology, Pharmacognosy, Forensic science, Archaeology and taxonomy.
14. Anatomical adaptations Molecular markers in tree species used for wood identification

Lab Outline:

1. Study of Tissues from the Living and Preserved Material of Stems, Roots and leaves.
2. Study of trichomes, sclereids, tracheid's, vessels and sieve tube elements.
3. Study of laticifers, oil glands, resin canals, cystolith and crystals.
4. Study of different types of stomata (monocots and dicots).
5. Anatomy of bark and lenticels
6. Nodal anatomy: Study of unilocular, trilocular, multiacinar.
7. TS, TLS and RLS of woody

Recommended Texts:

1. Clive, A., Stace, C.A., & Crawley, M. J. (2015). *Alien* plants. United States: Harper Collins Publishers.
2. Hather, J.G. (2016). *Archaeological Parenchyma*. United Kingdom: Routledge Publishers.

Suggested Readings:

1. Steeves, T. A., & Sawhney, V. K. (2017). Essentials of developmental plant anatomy. United Kingdom: Oxford University Press.
2. Spichiger, R.E. (2019). Systematic Botany of flowering plants: A new phytogenetic approach of the angiosperms of the temperate and tropical regions. United States: CRC Press.
3. Cleal, C. J., & Thomas, B. A. (2019). Introduction to plant fossils. United Kingdom: Cambridge University Press.
4. Richard, C., Wise, L. S., & Robert, W. (2018). Plant anatomy. Germany: Springer-Verlag.

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BOTN- 6135	Plant Water Relations	3(2-1)

Course Brief:

The term "Cell water relations" describes plant water status in a cell, individual organ (leaf, internode, flower) or whole plant level, furthering our understanding of basic plant growth and development, and plant response to the environment. After completion of this course, the students will be able to understand water and nutrient movement in soil and plant and adaptation of plants to adverse soil water conditions. This course will focus on instruments and techniques used to quantify water balance and status in plants in the field.

Course Learning Objectives:

The aim of the course is to overview comprehensively the soil-plant-atmosphere continuum for the maintenance of vital physiological functions and mechanisms in plants and to upgrade the concept about source sink relationships in translocation of solutes in plants. To familiarize graduate students with some of the tools necessary to measure plant water relations parameters in the field. Emphasis will be on water potential measurements with Scholander pressure chambers, leaf gas exchange measurements with potometers and infrared gas analysers, and xylem sap flux measurements with heat dissipation probes. Water is the major component of living cells and constitutes more than 90% of protoplasm by volume and weight. Mechanisms of water and nutrient movement in soils and plants, and their relationships with plant growth are discussed.

Course Content:

1. The soil-plant-atmosphere continuum - an overview.
2. Structure of water. Physico-chemical properties of water. Water in the soil and its potentials. Water in cell components. Absorption of water in plants (pathways and driving forces, aquaporins, their structure and types).
3. Cell water relations terminology. Hoflerdiagram - analysis of change in turgor, water and osmotic potential with changes in cell volume.
4. Modulus of elasticity coefficient; Hydraulic conductivity.
5. Osmoregulation, methods for measurement of water, osmotic and turgor potentials- pressure chamber, psychrometry, pressure probe and pressure volume curve, stomatal physiology, transpiration flux, antitranspirants.
6. Source sink relationships in translocation of solutes. Mineral nutrition: Hydroponics prospects and problems,
7. Nutrient solutions, chelating agents. Mineral ion uptake passive and active uptake and transport
8. Nernst equation, Donnan's potential, role of H- ATPase as a carrier, co transport.

Lab Outline:

1. Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
2. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
3. Measurement of leaf water potential by the dye method.
4. Determination of the temperature at which beet root cells lose their permeability.

5. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a potometer/cobalt chloride paper method.
6. To regulate stomatal opening by light of different colors and pH.

Recommended Texts:

1. Taiz, L. & Zeiger, E., (2019). Plant physiology (7th Ed.). England: Sinnauers Publ. Co. Inc.
2. Dennis, D. T., Turpin, D. H., Lefebvre, D. D. & Layzell, D. B., (2016). Plant Metabolism (6th Ed.).London: Longman Group.

Suggested Readings:

1. Mitra, G. N., (2015). Plants: a Biochemical and Molecular approach (1st Ed.).India: Springer
2. Buchanan, B., Wilhelm, G. &Russell, L. (2015). Biochemistry and molecular biology of plants(1st ed.). New Jersey: John Wiley & Sons.
3. Willey, N., (2016). Environmental plant physiology (1st Ed.). New York: Garland Science.
4. Taiz, L. & Zeiger, E., (2018). Fundamental of Plant Physiology (1st Ed.).England: Sinnauers Publ. Co. Inc.

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BOTN-6136	Plant Micro Techniques	3(2-1)

Course Brief:

This course provides information for managing the techniques of microscopic slides making, microscopic measurements and methods of identification of some organic compounds in plant cells. Microteaching is a highly individualized training device. Microteaching is an experiment in the field of teacher education which has been incorporated in the practice teaching schedule. Microteaching is micro in the sense that it scales down the complexities of real teaching. Microteaching advocates the choice and practice of one skill at a time. After finishing this course, students should be able to make temporary microscopic slides, using different cutting techniques and permanent microscopic slides using paraffin method.

Course Learning Objectives:

The aim of the course is to elucidate the importance of light microscopy and other special techniques maceration and staining to study plant sections, and to make students able to use microtome and camera Lucida .Micro technique an important experimental science that has led and continues to lead a great service for each branch of the life sciences: microbiology, genetics, embryology, morphology and science, also plays an important role in the development of medical studies of human anatomy. This includes knowledge of the preparations microscopic plant sample.

Course Content:

1. Light microscopy–optical principle, resolution, magnification, aberration. Phase contrast microscopy Dark field illumination.
2. Electron microscope (TEM &SEM), principle and preparation techniques. Special techniques maceration; squashes, smears, whole mount and clearing techniques.
3. Micro technique steps fixation and fixatives, dehydration, clearing, infiltration, embedding, block making and sectioning.
4. Microtome's types, principles and operating mechanisms, stains and staining techniques, Camera Lucida types, principles and their uses.
5. Micrometry

Lab Outline:

1. Preparation of hand sections, maceration and clearing
2. Temporary and permanent mounting of whole specimens and Sections using different types of mountants.
3. Calibration of microscope and micrometry
4. Microtomy and microtome sectioning
5. Examination of different cell and tissue types with help of techniques
6. Study of structure of (primary and or secondary) leaf, root, stem and floral parts (including fruit).
7. Examination of vascular cambium and study of its activity.

8. Examination of structure and identification of Wood of some common trees such as Dalbergia sissoo, Acacia arabica. etc

Recommended Texts:

1. Yeung, E. C. T., Stasolla, C., Sumner, M. J.& Huang, B. Q., (2015). Plant micro-techniques and protocols (1st Ed.).New York: Springer.
2. Richard, C., Sobaski, L., Wise, S.& Robert, S., (2018). Plant Anatomy (1st Ed.).New York: Springer.

Suggested Readings:

1. Back, C. B., (2010). An introduction to plant structure and development: plant anatomy for the twenty-first century (2nd Ed.).England: Cambridge University Press.
2. Maiti, R., (2012). Crop plant anatomy (15th Ed.). England: CABI.
3. Steeves, T. A. & Sawhney, K. V., (2017). Essentials of developmental plant anatomy (1st Ed.). England: Oxford University Press