1. Title of Degree Program: BS in BOTANY

Program Learning Objectives:
The mission of the BS Botany program is to cultivate a profound understanding of the botanical sciences through exceptional teaching, practical applications and innovative research to contribute meaningfully to scientific advancement, environmental stewardship and the betterment of global community.

2. Program Structure:

Duration	Minimum 4-Years (8-Semesters)		
Admission Requirements:	Students with Pre-Medical / Pre-Engineering combinations in HSSC / A-level with Botany/Biology as an elective subject after 12-years of education.		
Degree Completion Requirements:	General Education	GE	(31 CHs)
	Interdisciplinary	ID	(19 CHs)
	Disciplinary / Major	D	(81 CHs)
	Internship	I	(3 CHs)
	Capstone Project	R	(3 CHs)
			137

3. 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.	Semester	Course Code	Course Title	Credit Hours	Prerequisite
1.	2	URCG-5112	Fables, Wisdom and EPICS	2(2-0)	Nil
2.	4	URCG-5115	The Science of Global Challenges	3(2-1)	Nil
3.	2	URCG-5116	Science of Society-I	2(2-0)	Nil
4.	1	URCG-5118	Functional English	3(3-0)	Nil
5.	3	URCG-5119	Expository Writing	3(3-0)	Nil
6.	2	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
7.	3	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
8.	1	URCG-5105/ URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
9.	3	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
10.	1	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
11.	4	URCG-5124	Entrepreneurship	2(2-0)	Nil
12.	4	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
13.	1-8	URCG-5111	Translation of Holy Quran *	NC	Nil
14.	2	URCG-5127	Seerat of the Holy Prophet (SAW)*	1(1-0)	Nil
GE Courses Credit Hours Total				31	

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

4. Single Major Courses:

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	BOTN-5101	Diversity of Plants	4(3+1)	*Pre-medical with Biology*
2.	BOTN-5102	Plant Systematics, Anatomy and Development	4(3+1)	*Pre-medical with Biology*
3.	BOTN-5103	Cell Biology, Genetics and Evolution	4(3+1)	*Pre-medical with Biology*
4.	BOTN-5104	Plant Physiology and Ecology	4(3+1)	*Pre-medical with Biology*
5.	BOTN-5105	Biodiversity and Conservation	4(3+1)	BOTN-5101
6.	BOTN-5106	Bacteriology and Virology	3(2+1)	BOTN-5101
7.	BOTN-5107	Cell Biology	4(3+1)	BOTN-5103
8.	BOTN-5108	Phycology and Bryology	3(2+1)	BOTN-5101
9.	BOTN-6101	Diversity of Vascular Plants	3(2+1)	BOTN-5101
10.	BOTN-6102	Plant Systematics	3(2+1)	BOTN-5102
11.	BOTN-6103	Mycology and Plant Pathology	3(2+1)	BOTN-5101
12.	BOTN-6104	Plant Ecology-I	3(2+1)	BOTN-5104
13.	BOTN-6105	Plant Physiology-I	3(2+1)	BOTN-5104
14.	BOTN-6106	Genetics-I	3(2+1)	BOTN-5103
15.	BOTN-6107	Plant Biochemistry –I	3(2+1)	BOTN-5103
16.	BOTN-6108	Plant Anatomy	3(2+1)	BOTN-5102
17.	BOTN-6109	Environmental Biology	3(2+1)	BOTN-5105
18.	BOTN-6110	Molecular Biology	3(2+1)	BOTN-5103
19.	BOTN-6111	Plant Biochemistry-II	3(2+1)	BOTN-6107
20.	BOTN-6112	Plant Physiology-II	3(2+1)	BOTN-6105
21.	BOTN-XXX	ELECTIVE-I/Optional paper/Thesis / Research Report	3(2+1)	
22.	BOTN-6113	Genetics-II	3(2+1)	BOTN-6106
23.	BOTN-6114	Plant Ecology-II	3(2+1)	BOTN-6104
24.	BOTN-6115	EthnoBotany	3(2+1)	BOTN-6102
25.	BOTN-XXX	ELECTIVE-II/Optional paper/Thesis/ Research Report	3(2+1)	
Major Courses Credit Hours Total			**81**	

5. Interdisciplinary/Allied courses: minimum 12 credit hours:

Interdisciplinary/Allied courses will be offered after 4th semester

1.	ZOOL-5101	Animal Diversity-I (Invertebrates)	4(3+1)	*FSc with Biology*
2.	ZOOL-5104	Animal Form and Function-II	4(3+1)	*FSc with Biology*
3.	CHEM-5102	Inorganic Chemistry	4(3+1)	*FSc with Chem.*
4.	CHEM-5103	Organic Chemistry	4(3+1)	*FSc with Chem.*
5.	STAT-6134	Biostatistics	3(3+0)	-
Interdisciplinary Courses Credit Hours Total			**19**	

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-6136**	**Field experience/internship**	**3(3-0)**	

6. 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- 6137**	**Capstone project**	**3(3-0)**	

7. List of Optional Papers of BS Botany

Course	Title	Credit Hours	Course	Title	Credit Hours
BOTN-6116	Plant Water Relations	3(2+1)	BOTN-6117	Plant Micro Techniques	3(2+1)
BOTN-6118	Plant Seed Physiology	3(2+1)	BOTN-6119	Palynology	3(2+1)
BOTN-6120	Plant Tissue Culture	3(2+1)	BOTN-6121	Plant Biotechnology	3(2+1)
BOTN-6122	Advanced Environmental Biology	3(2+1)	BOTN-6123	Plant-Conservation Management	3(2+1)
BOTN-6124	Conservation Genetics	3(2+1)	BOTN-6125	Basic Ecological Genetics	3(2+1)
BOTN-6126	Medicinal Plants	3(2+1)	BOTN-6127	Seed Pathology	3(2+1)
BOTN-6128	Biodegradation and Bioremediation	3(2+1)	BOTN-6129	Water Pollution Management	3(2+1)
BOTN-6130	Air Pollution Management Strategies	3(2+1)	BOTN-6131	Conservation Ecology	3(2+1)
BOTN-6132	Plant Stress Physiology	3(2+1)	BOTN-6133	Advanced Plant Anatomy	3(2+1)
BOTN-6134	Seed Production Technology	3(2+1)	BOTN-6135	Research Methodology	3(3+0)

Scheme of Studies BS in *Botany*

Semester-I

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-01	URCG-5118	Functional English	3(3-0)	Nil
GE-02	URCG-5105 URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
GE-03	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
GE-04	URCG-5111	Translation of the Holy Quran – I	NC	Nil
Major-01	BOTN-5101	Diversity of Plants	4(3+1)	*Pre-medical with Biology*
Major-02	BOTN-5102	Plant Systematics, Anatomy and Development/Embryology	4(3+1)	*Pre-medical with Biology*

Semester Total Credit Hours: 16

Semester-II

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-05	URCG-5112	Fables, Wisdom and EPICS	2(2-0)	Nil
GE-06	URCG-5116	Science of Society-I	2(2-0)	Nil
GE-07	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
GE-08	URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)	Nil
Major-03	BOTN-5103	Cell Biology, Genetics and Evolution	4(3+1)	*FSc with Biology*
Major-04	BOTN-5104	Plant Physiology and Ecology	4(3+1)	--

Semester Total Credit Hours: 16

Semester-III

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-09	URCG-5119	Expository Writing	3(3-0)	Nil
GE-10	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
GE-11	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
GE-4	URCQ-5111	Translation of Holy Quran-II	NC	Nil
Major-05	BOTN-5105	Biodiversity and Conservation	4(3+1)	BOTN-5101
Major-06	BOTN-5106	Bacteriology and Virology	3(2+1)	BOTN-5101
ID-01	CHEM-5102	Inorganic Chemistry/ Psychology	4(3+1)	FSc with Chem.

Semester Total Credit Hours: 19

Semester-IV

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-12	URCG-5115	The Science of Global Challenges	3(2-1)	Nil
GE-13	URCG-5124	Entrepreneurship	2(2-0)	Nil
GE-14	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
Major-07	BOTN-5107	Cell Biology	4(3+1)	BOTN-5103
Major-08	BOTN-5108	Phycology and Bryology	3(2+1)	BOTN-5101
ID-02	ZOOL-5101	Animal Diversity-I (Invertebrates)/ Geography	4(3+1)	*FSc with Biology*

Semester Total Credit Hours: 18

Courses (semester I-IV) can be rotated with subject to availability of teacher in that specialized field.

Summer Semester

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Compulsory	BOTN- 6136	Internship	3(3-0)	Completion of minimum 60 credit hours
Internship will be offered after 4th Semester for Fall intake and after 5th Semester for Spring intake Programs in Summer break				

Semester-V

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-4	URCG-5111	Translation of the Holy Quran – III	NC	-
Major-09	BOTN-6101	Diversity of Vascular Plants	3(2+1)	BOTN-5101
Major-10	BOTN-6102	Plant Systematics	3(2+1)	BOTN-5102
Major-11	BOTN-6103	Mycology and Plant Pathology	3(2+1)	BOTN-5101
Major-12	BOTN-6104	Plant Ecology-I	3(2+1)	BOTN-5104
ID-03	CHEM-5103	Organic chemistry/ Psychology	4(3+1)	*FSc with Chemistry*

Semester Total Credit Hours: 16

Semester-VI

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
ID-04	STAT-6134	Biostatistics	3(3+0)	-
Major-13	BOTN-6105	Plant Physiology-I	3(2+1)	BOTN-5104
Major-14	BOTN-6106	Genetics-I	3(2+1)	BOTN-5103
Major-15	BOTN-6107	Plant Biochemistry –I	3(2+1)	BOTN-5103
Major-16	BOTN-6108	Plant Anatomy	3(2+1)	BOTN-5102
ID-04	ZOOL-5104	Animal Form and Function-II/ Geography	4(3+1)	*FSc with Biology*

Semester Total Credit Hours: 19

Semester-VII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
GE-04	URCG-5111	Translation of the Holy Quran – IV	NC	
Major-17	BOTN-6109	Environmental Biology	3(2+1)	BOTN-5105
Major-18	BOTN-6110	Molecular Biology	3(2+1)	*FSc with Chem.*
Major-19	BOTN-6111	Plant Biochemistry-II	3(2+1)	BOTN-6107
Major-20	BOTN-6112	Plant Physiology-II	3(2+1)	BOTN-6105
Major-21	BOTN-XXX	ELECTIVE-I/Optional paper/Thesis/Research Report	3(2+1)	

Semester Total Credit Hours: 15

Semester-VIII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-22	BOTN-6113	Genetics-II	3(2+1)	BOTN-6106
Major-23	BOTN-6114	Plant Ecology-II	3(2+1)	BOTN-6104
Major-24	BOTN-6115	EthnoBotany	3(2+1)	BOTN-6102
Major-25	BOTN-XXX	ELECTIVE-II/Optional paper/ Thesis/ Research Report	3(2+1)	-
Compulsory	BOTN-6137	Capstone Project	3(3+0)	

Semester Total Credit Hours: 15

Degree Program Total: 137

BS in BOTANY
1st Year
1st Semester

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 Contents:

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

URCG-5105	Islamic Studies (Compulsory)	2(2-0)

Course Brief:

Islamic Studies is the academic study of Islam and Islamic culture. Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam; Qur'an and Hadith, history and particular cultural contexts. It majorly comprises the importance of life and that after death. It is one of the best systems of education, which makes an ethically groomed person with the qualities. The basic sources of the Islamic Studies are the Holy Qur'an and Sunnah or Hadith of the Holy Prophet Muhammad (ﷺ).

Course Learning Objectives:

The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It offers opportunities to get fully introductory foundational bases of Islam in fields that include Qur'anic studies, Hadith and Seerah of Prophet Muhammad (ﷺ), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah. The learning of the Qur'an and Sunnah guides the Muslims to live peacefully.

Course Contents:

Introduction to Quranic Studies

1) Basic Concepts of Qur'an
2) History of Quran
3) Uloom-ul-Quran

مطالعہ قرآن (تعارف قرآن ، 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؛ الحشر آیات 18- 20؛ آل عمران آیات 190- 192؛ النحل آیات 12- 14؛ لقمن آیت 20، حم السجدہ آیت 53)

Introduction to Sunnah

1) Introduction of Hadith
2) Legal Status of Hadith
3) History of the compilation of Hadith
4) Kinds of Hadith

حدیث کا تعارف، حدیث کی دینی حیثیت، حفاظت و تدوین حدیث، حدیث کی اقسام
متن، حدیث: 1درج 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-کتا ب وسنت گمراہی سے بچنے کا ذریعہ ہیں4- ارکان اسلام 5- اسلام ، ایمان ، احسان اور قیامت کی نشانیاں، 6-بچوں کی نماز کی تلقین 7- دین کا گہرا فہم اللہ کی خاص عنایت ہے 8- حصول علم، تلاوتِ قرآن اور عمل کی اہمیت و فضیلت، 9 -روز محشرکا محاسبہ، 10- حقوق اللہ کے ساتھ ساتھ حقوق العباد کا لحاظ رکھنا بھی لازم ہے11- حسن خلق کی عظمت اور فحش و بد گوئی کی مذمت 12- دنیا و آخرّت 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

1) Sirah of the Prohet
2) Importance of the Study of Sirah
3) Character building method of the Prophet

(سیرت النبیﷺ(مطالعہ سیرت کی ضرورت و اہمیت ، تعمیر،سیرت و شخصیت کا نبوی منہاج اور عملی نمونے ، اقامت دین کا نبوی طریق کار، اقامتِ دین بعہدِ خلافت راشدہ، میثاق مدینہ ، خطبہ حجۃ الوداع، اخلاقی تعلیمات ، تشکیل اجتماعیت اور اسوہ حسنہ ،قرآن مجید میں سیرت سرور عالم کا بیان، غزواتِ نبوی ﷺ کے مقاصد و حکمتیں)

Islamic Culture & Civilization

1) Basic Concepts of Islamic Culture & Civilization
2) Historical Development of Islamic Culture & Civilization
3) Characteristics of Islamic Culture & Civilization

4) Islamic Culture & Civilization and Contemporary Issues

4. اسلامی تہذیب و تمدن (اسلامی تہذیب کا مفہوم، اسلامی کے عوامل و عناصر، اسلامی تہذیب کی خصوصیات، ، اسلامی تہذیب ، 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، نام ور مسلمان سائنسدان)

Recommend Texts:

a. Hassan, A. (1990). *Principles of Islamic Jurisprudence*. New Dehli: Adam Publishers.
b. Zia-ul-Haq, M. (2001). *Introduction to al-Sharia al-Islamia*. Lahore: Aziz Publication.

Suggested Readings:

1. Hameedullah, M. (1957). *Introduction to Islam*. Lahore: Sh M Ashraf Publisher.
2. Hameedullah, M. (1980). *Emergence of Islam*. New Dehli: Adam Publishers.
3. Hameedullah, M. (1942). *Muslim conduct of State*. Lahore: Sh M Ashraf Publisher.

UQCG-5126	Ethics	2(2+0)

Course Contents:

1. Meaning and Scope of Ethics.
2. Relation of Ethics with:
    (a) Religion
    (b) Science
    (c) Law
3. Historical Development of Morality:
    (a) Instinctive Moral Life.
    (b) Customary Morality.
    (c) Reflective Morality.
    (d) Moral Theories:
    (e) Hedonism (Mill)
    (f) Intuitionism (Butler)
    (g) Kant's Moral Theory.
4. Moral Ethics and Society.
    (a) Freedom and Responsibility.
    (b) Tolerance
    (c) Justice
    (d) Punishment (Theories of Punishment)
5. Moral Teachings of Major Religions:
    (a) Judaism
    (b) Christianity
    (c) Islam
6. Professional Ethics:
    (a) Medical Ethics
    (b) Ethics of Students
    (c) Ethics of Teachers
    (d) Business Ethics

Recommend 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 Readings:

1. Ameer Ali, S. *The Ethics of Islam*. Culcutta: Noor Library Publishers, latest edition
2. 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

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

Course Learning Objectives:

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 Contents:

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 Book:

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

Suggested Books:

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.

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

Course Brief:

The Quran is the exact words revealed by Allah SWT to His last Prophet Muhammad (ﷺ). It was memorized by Muhammad (ﷺ) and then dictated to his Companions, and written down by scribes, who cross-checked it during his lifetime. Not one word of the Quran has been changed over the centuries, so that the Quran is in every detail the unique and miraculous text. The Quran is the prime source of Muslim faith and practice. It deals with all the subjects which concern us as human beings: wisdom, doctrine, worship, and law, but its basic theme is the relationship between God and His creatures. At the same time it provides guidelines for proper conduct of individual, society and an equitable holistic system of human life.

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 Contents:

Course Contents:	• 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)

BOTN-5101	Diversity of Plants	4(3+1)

Course Brief:

This course offers an evolutionary survey of the origin and diversification of land plants through geological time. The course will start with the green algae and on how plants may have transitioned from aquatic to the land environment. Land plants that will be discussed include bryophytes, lycophytes, pteridophytes, gymnosperms and angiosperms with emphasis on representative fossil and living taxa. Lectures will emphasize on life histories, anatomical and morphological adaptations, ecology and climate change, extinction, phylogenetics, economic importance, and conservation strategies of representative taxa. Plants are one of the most successful and abundant groups of organisms on earth, comprising the majority of terrestrial biomass, being integral to ecosystem structure, and providing humans with food, shelter, and materials

Course Learning Objectives:

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

Course Contents:

Comparative study of life form, structure, reproduction and economic significance of:

1. Viruses (RNA and DNA types) with special reference to TMV
2. Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with specific reference to bio fertilizers, pathogenicity and industrial importance;
3. Algae (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)
4. Fungi (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus) their implication on crop production and industrial applications.
5. Lichens (Physcia)
6. Bryophytes (Riccia, Anthoceros, Funaria)
7. Pteridophytes: Psilopsida (Psilotum) ,Pteropsida (Marsilea), Sphenopsida (Equisetum) Lycopsida (Selaginella)
8. Gymnosperms (Cycas,Pinus, Ephedra)
9. Angiosperms: Monocot (Poaceae) , Dicot (Solanaceae)

Lab work:

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. Bellinger, E. G., & Sigee, D. C. (2015). *Freshwater Algae*. United States: Wiley Publishers.
2. Prestre, P. G. (2017). *Governing Global Biodiversity: The Evolution and Implementation of the Convention on Biological Diversity*. United Kingdom: Routledge Publishers.

Suggested Readings:

1. Şen, B., & Grillo, O. (2018). *Selected Studies in Biodiversity*. England: Intech Open Publishers.
2. Zotz, G. (2016). *Plants on Plants: The biology of vascular epiphytes*. Germany: Springer-Verlag.
3. Cronk, J. K., & Fennessy, M. S. (2016). *Wetland plants: biology and ecology*. United States: CRC Press, 4. Pullaiah T., Bahadur, B., & Murthy, K. (2015). Plant biodiversity. Germany: Springer-Verlag

BOTN-5102		**Plant Systematics, Anatomy and Development/Embryology**		**4(3+1)**

Course Brief:

Plant systematics is a science that includes and encompasses traditional taxonomy; however, its primary goal is to reconstruct the evolutionary history of plant life. It divides plants into taxonomic groups, using morphological, anatomical, embryological, chromosomal and chemical data. However, the science differs from straight taxonomy in that it expects the plants to evolve, and documents that evolution. Determining phylogeny -the evolutionary history of a particular group; is the primary goal of systematics.

Course Learning Objectives:

To understand: various systems of classification, identification and nomenclature of Angiosperms. Structures and functions of tissues and organs at embryonic level.

Course Contents:

Plant Systematic

1. Introduction to Plant Systematic: aims, objectives and importance.
2. Classification: Brief history of various systems of classification with emphasis on Takhtajan.
3. Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to ICBN/ ICN for plants.
4. Morphology: A detailed account of various morphological characters root, stem, leaf, inflorescence, flower, placentation and fruit types.
5. Diagnostic characters, economic importance and distribution pattern of the following families: Ranunculaceae, Brassicaceae (Cruciferae), Fabaceae (Leguminosae), Rosaceae, Euphorbiaceae, Cucurbitacea, Lamiaceae (Labiatae), Apiaceae (Umbelliferae), Asteraceae (Compositae), Liliaceae (Sen. Lato)

Anatomy

6. Cell wall: structure and chemical composition
7. Concept, structure and function of various tissues like:Parenchyma, Collenchyma Sclerenchyma, Xylem, Phloem, Epidermis (including stomata and trichomes)
8. Meristem: types, stem and root apices
9. Vascular cambium
10. Structure and development of root, stem and leaf.
11. Primary and secondary growth of dicot stem, periderm
12. Characteristics of wood: diffuse porous and ring porous, sap and heart wood, soft and hard wood, annual rings.

Development/Embryology

13. Early development of plant body*: Capsella bursa-pastoris*
14. Structure and development of Anther (microsporogenesis, microgametophyte)
15. Structure and development of Ovule (megasporogenesis, megagametophyte)
16. Endosperm formation
17. Parthenocarpy
18. Polyembryony

Lab outline:

Anatomy and Embryology

a) Study of stomata and epidermis.

b) Tissues of primary body of plant.

c) Study of xylem 3-dimensional plane of wood.

d) T. S of angiosperm stem and leaf.

e) Anatomy of germinating seeds

f) Study of pollens

Taxonomy

g) Identification of families given in syllabus with the help of keys.

h) Technical description of common flowering plants belonging to families mentioned in theory.

i) Field trips shall be undertaken to study and collect local plants.

j) Students shall submit 40 fully identified herbarium specimens.

Recommended Books:

1. Steeves, T.A. and V.K. Sawhney, *Essentials of developmental plant anatomy*. (Oxford University Press, 2017).
2. Spichiger, R. E. *Systematic Botany of flowering plants: a new phytogenetic approach of the angiosperms of the temperate and tropical regions*. (CRC Press, 2019).
3. Hickey, M. and C. King, *The Cambridge Illustrated Glossary of Botanical Terms.*(Cambridge University Press, 2015).
4. Lyons-Sobaski, R.C., W. Sheila and W. Robert. *Plant anatomy*. (Springer-Verlag, 2018).

Suggested Books:

1. Clive A., C.A. Stace and M. J. Crawley, *Alien Plants* (Harper Collins Publishers, 2015).

Hather, J.G., *Archaeological parenchyma*. (Routledge Publishers, 2016).

BOTANY
2nd Semester

URCG-5112	Fables, Wisdom and EPICS	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 Contents:

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. 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.

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.

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

Course Brief:

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

Course Learning Objectives:

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

Course Contents:

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
2. Society and Community, Historical evolution of Society
    - Types of Societies
    - Foraging society, Horticultural society, Pastoralist society
    - Agrarian societies, Industrial society, Postindustrial society
3. 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
4. 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

5. 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

6. 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

7. 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

8. 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 Texts:

1. Giddens, A. (2018). Sociology (11th ed.). UK: Polity Press.
2. Henslin, J. M. (2018). Essentials of Sociology: A Down-to-Earth Approach.(18th Edition) 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.

Suggested Readings:

1. Systems of Stratification | Boundless Sociology (no date). Available at: https://courses.lumenlearning.com/boundless-sociology/chapter/systems-of-stratification/
2. 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)
3. Zaidi, S. A. (2015) Issues in Pakistan's Economy: A Political Economy Perspective. Oxford University Press. Chapter 26
4. Akhtar, A. S. (2017) The Politics of Common Sense: State, Society and Culture in Pakistan. Cambridge: Cambridge University Press.
5. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.

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

Course Brief:

Since ancient times, numbers, quantification, statistics and mathematics has played a central role in scientific and technological development. In the 21st century, Quantitative Reasoning (QR) skills are essential for life as they help to better understand socio-economic, political, health, education, and many other issues, an individual now faces in daily life.

Course Learning Objectives:

The skills acquired by taking this course will help the students to apply QR methods in their daily life and professional activities. This course will also change student's attitude about statistics and mathematics. It will not only polish their QR skills, but also enhance their abilities to apply these skills.

Course Contents:

1. Introduction to quantitative reasoning
2. Overview of contributions of Mathematicians and Statisticians especially Muslim scholars.
3. Types of standard numbers
4. Proportions, rates, ratio and percentages
5. Odds and odds ratio
6. Scale of measurements
7. Number sequence and series
8. Unit analysis as a problem-solving tool
9. Data handling (small and large)
10. Data errors, absolute and relative and their applications
11. Descriptive statistics
12. Rules of counting: multiplication rule, factorial, permutation and combination
13. Probability and its application in real life
14. A graphical perspective through Venn Diagram
15. Financial indicator analysis, and money management (profit, loss, simple and compound interest)
16. Practical scenarios involving algebraic expressions: linear and quadratic

Recommended Texts :

1. Akar, G. K., Zembat, İ. Ö., Arslan, S., & Thompson, P. W. (2023). Quantitative Reasoning in Mathematics and Science Education. 1st Ed., Springer, USA.

2. Peck, R., Olsen, C., & Devore, J. L. (2015). Introduction to statistics and data analysis. 5th Ed., Brooks Cole, USA. 3. Devlin, K. J. (2012). Introduction to mathematical thinking. Palo Alto, CA: Keith Devlin.

Suggested Readings:

1. Triola, M. F., Goodman, W. M., Law, R., & Labute, G. (2006). Elementary statistics. Reading, MA: Pearson/Addison-Wesley.

2. Blitzer, R., & White, J. (2005). Thinking mathematically. Pearson Prentice Hall.

URCG-5127		Seerat of the Holy Prophet		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:

Objectives of the Course	۱۔ طلباء کو مطالعہ سیرۃ طیبہ کی ضرورت واہمیت سے آگاہ کرنا ۲۔ تعمیر شخصیت میں مطالعہ سیرۃ طیبہ کے کردار کو واضح کرنا ۳۔ بعثت نبوی کے موقع پر اقوام عالم کی عمومی صورت حال سے آگاہ کرنا ۴۔ 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 ۵۔ طلباء کو عہد نبوی کی معاشرت، سیاست، معیشت سے آگاہ کرنا

Course Contents:

Course Description

S.No.	Title	Description
1	حضور صلی اللہ علیہ وسلم کے ابتدائی حالاتِ 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	۱۔ مکی عہد میں دعوت اسلام
4	بعثت نبوی	۱۔ مدنی عہد میں دعوت اسلام
5	خصائص النبیؐ	آپؐ بطور پیغامبر امن
6	خصائص النبیؐ	بحثیت استاد ومعلم
7	خصائص النبیؐ	بحثیت تاجر
8	خصائص النبیؐ	بحثیت سربراہ ریاست
9	خصائص النبیؐ	ذاتی محاسن اور عالمگیر اثرات

ناموس رسالت		
غیر مسلموں سے تعلقات		
اسوہ حسنہ کی روشنی میں گھریلو زندگی		
مستشرقین اور مطالعہ سیرت		
وطن سے محبت اور سیرت		
مستشرقین کے اعتراضات اور ان کے جوابات		

10	خصائص النبیؐ	
11	اسوہ حسنہ اور عصر حاضر	
12	اسوہ حسنہ اور عصر حاضر	
13	اسوہ حسنہ اور عصر حاضر	
15	اسوہ حسنہ اور عصر حاضر	
16	اسوہ حسنہ اور عصر حاضر	

نصابی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	ابن ہشام	السیرۃ النبویۃ
2	مولانا شبلی نعمانی، حمید سلمان ندوی	سیرۃ النبی صلی اللہ علیہ وسلم
3	قاضی محمد سلیمان سلمان منصور پوری	رحمۃ للعالمین
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

BOTN-5103		**Cell Biology, Genetics and Evolution**		**4(3+1)**

Course Brief:

Cell biology, genetics and evolution are fundamental to an understanding of the processes of life. In this unit, students will be able examine the structure and function of prokaryotic and eukaryotic cells, including a discussion of the energy flow in photosynthesis, respiration and metabolism. A brief introduction to DNA structure and function from molecular to organism levels and current applications of DNA technology will be studied. This will also enlighten and introduce with classical genetic and evolutionary theory as unifying explanations of life. This course is intended for the student interested in understanding and appreciating common biological topics in the study of the smallest units within biology: molecules and cells. This course will give you a general introduction of cell organelles, cell division and enzymes which are involved in the process of metabolism.Evolution is the process of change in all forms of life over generations, and evolutionary biology is the study of how evolution occurs. Laboratory practicals will investigate enzyme function, cytogenetics and the genetic analysis of populations.

Course Learning Objectives:

To understand:

1. Structure and function of cell.
2. Nature of genetic material and hereditary process
3. Familiarization with evolutionary processes.

Course Contents:

Cell Biology

1. Structure and Function of Bio-molecules (Carbohydrates, Lipids, Proteins, Nucleic Acids)
2. Cell: Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell.
3. Brief description of structure and function of the following cell organelles (Cell wall, Cell membrane, Nucleus, Endoplasmic reticulum, Plastids, Mitochondria, Ribosomes, Dictyosomes, Vacuoles)
4. Reproduction in somatic and embryogenic cell, mitosis, meiosis and cell cycle

Genetics

5. Introduction, scope and brief history of genetics. Mendelian inheritance; Lawsof segregation and independent assortment, back cross, test cross, dominance and incomplete dominance
6. Molecular genetics; DNA replication, nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. lac operon).
7. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and Euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.
8. Evolution: Introduction and theories.

Lab outline:

Cell Biology

1. Study of cell structure using compound microscope and elucidation of ultra structure from electron microphotographs
2. Measurement of cell size.
3. Study of mitosis and meiosis by smear/squash method and from prepared slides.
4. Study of chromosome morphology and variation in chromosome number.
5. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.

Genetics

6. Genetical problems related to transmission and distribution of genetic material.
7. Identification of chromosomes in plant material. Carmine/orcein staining.
8. Determination of blood groups

Recommended Texts:

1. Templeton, N.C. (2015). *Gene and cell therapy* 4th Edition. United Kingdom: Taylor and Francis Publications,
2. Sybille, M., & Shoshan, M. (2015). *Tumor cell metabolism*. United States**:**Springer Publications**.**

Suggested Readings:

1. Verma, P. S., & Agarwal, V. K. (2016). *Cell Biology* (*Cytology*, *Biomolecules and Molecular Biology*). India: S. Chand Publishing.
2. Milo, R., & Phillips, R. (2015). *Cell biology by the numbers.*1st edition. United Kingdom: Taylor and Francis publications.
3. Bradshaw, R., & Stahl, P. (2015). *Encyclopedia of cell biology*. Netherlands: Elsevier Publications.

BOTN-5104		Plant Physiology and Ecology		4(3+1)

Course Brief:

This course is designed to provide students with comprehensive exposure to the subject of plant physiology and ecology and will give know how about physiological adaptation; limiting factors; resources acquisition/allocation; photosynthesis, carbon, energy balance; water use and relations; nutrient relations; linking physiology, stable isotope applications ecophysiology; stress physiology; life history, physiology; evolution of physiological performance; physiology population, community, ecosystem levels. Plant Ecology is the study of the interactions of living things with their environment. It helps to ask questions across four levels of biological organization—organismal, population, community, and ecosystem.

Course Learning Objectives:

To provide comprehensive knowledge of functioning of organs, organelles and biomolecules. To enable the students to assess the effects of various environmental factors on plant growth and development.

Course Contents:

1. **Plant Physiology**
   a) **Water relations:** (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water.Stomatal regulation.
   b) **Mineral nutrition:** Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.
   c) **Photosynthesis:** Introduction, oxygenic and non-oxygenic photosynthesis. Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C_3 and C_4plants.Factors affecting this process. Products of photosynthesis.
   d) **Respiration:** Definition and respiratory substrates. Mechanism of Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic respiration. Energy balance inaerobic and anaerobic respiration, respiratory quotients.
2. **Ecology**
   a) **Introduction:** Aims and applications of ecology.
   b) **Soil:** Physical and Chemical properties of soil (soil formation, texture. pH, EC, organism and organic matter etc.) and their relationships to plants.
   c) **Light and Temperature:** Quality of light, diurnal and seasonal variations. Eco-physiological responses.
   d) **Water:** Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants.
   e) **Wind:** Wind as an ecological factor and its importance.
   f) **Population Ecology:** Introduction. A brief description of seed dispersal and seed bank.
   g) **Community Ecology**. Ecological characteristics of plant community ii. Methods of sampling vegetation (Quadrat and line intercept)iii. Major vegetation types of the local area.
   h) **Ecosystem Ecology**. Definition, types and components of ecosystem. ii. Food chain and Food web.
   i) **Applied Ecology:** Causes, effects and control of water logging and salinity with respect to Pakistan.

Lab Outline:

1. **Plant Physiology**
   a) Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
   b) Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
   c) Measurement of leaf water potential by the dye method.
   d) Determination of the temperature at which beet root cells lose their permeability.
   e) Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a photometer/cobalt chloride paper method.

f) Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
g) Estimation of oxygen utilized by a respiring plant by Winkler's method.

2. **Ecology**
   a) Determination of physical and chemical characteristics of soil.
   b) Measurements of various population variables
   c) Measurement of vegetation by Quadrat and line intercept methods.
   d) Field trips to ecologically diverse habitats.
   e) Measurements of wind velocity.
   f) Measurement of light and temperature.
   g) Effect of light and temperature on seed germination.

Recommended Books:

1. Keddy, P.A., *Plant Ecology Origins, processes, Consequences,* 2nd Edition. (Cambridge University Press, 2017).
2. Canadell, J.G, S. Diaz, G. Heldmaier, R.B. Jackson, D.F. Levia, E.D. Schulze, U. Sommer and D.A. Wardle, *Ecological Studies*. (Springer, 2019).
3. Taiz, L. and E. Zeiger, *Plant Physiology.*7th Edition. (Sinnauers Publ. Co. Inc. 2019).

Suggested Books:

1. Sharma, H. and P.K Singh, *Laboratory Manual for Bioinstrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology for PG and UG students*.(Excellent Publishing House New Delhi India, 2018).

Jugulam, M., *Biology, Physiology and Molecular Biology of Weeds.*(CRC Press, 2017).

BOTNANY
2nd Year
3rd Semester

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.

Course Learning Objectives:

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 Contents:

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.

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

Course Brief:

The Quantitative Reasoning course incorporates problem solving, critical thinking, and oral and writing communication fluency. Approaches and methods used in the course include choosing and using appropriate mathematical models, the use of data, and the use of real-world applications.

Course Learning Objectives:

This course will prepare the students to apply quantitative reasoning tools more efficiently in their professional and daily life activities. This course will help them to better understand the information in form of numeric, graphs, tables, and functions.

Course Contents:

1. Types of data and its graphical representation (Histogram, Stem and Leaf display, Box Plot, Scatter diagram, Historigam, Bar chart, etc) 2. Solving practical problems using linear and exponential models 3. Population growth models 4. Analytical approach to solve simultaneous equations 5. Inequalities and their application 6. Comparing quantities using analytical tools 7. Logical reasoning and their application in modern age 8. Logical reasoning and decision making 9. Data tendencies via measure of location 10. Variability and Measure of dispersion 11. Measuring relationships via Regression analysis and correlation 12. Statistical inference: sampling techniques, estimation techniques and hypothesis testing for decision and policy making

Recommended Texts:

1. Akar, G. K., Zembat, İ. Ö., Arslan, S., & Thompson, P. W. (2023). Quantitative Reasoning in Mathematics and Science Education. 1st Ed., Springer, USA.
2. Sharma, A. K. (2005). Text book of elementary statistics. Discovery Publishing House.
3. Blitzer, R. (2014). Precalculus, 5th Ed.. Pearson Education, Limited. New York

Suggested Readings:

1. Gupta, S. C., & Kapoor, V. K. (2020). Fundamentals of mathematical statistics. 12th Ed, Sultan Chand & Sons. 2. Aufmann, R. N., Lockwood, J., Nation, R. D., & Clegg, D. K. (2007). Mathematical thinking and quantitative reasoning. Cengage Learning 3. Blitzer, R., & White, J. (2005). Thinking mathematically. Pearson Prentice Hall.

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 Learning Objectives:

This course 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 Contents:

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. 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 Fundamental rights• Principles of policy• Federation of Pakistan• President Parliament The Federal Government Provinces• Governors Provincial Assemblies The Provincial Government The Judicature• Supreme Court High Courts Federal Shariat Courts Supreme Judicial Council Administrative Courts and tribunals Islamic Provisions in Constitution• 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.

Suggested Readings :

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.

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

Course Brief:

- The Quran is the exact words revealed by Allah SWT to His last Prophet Muhammad (ﷺ). It was memorized by Muhammad (ﷺ) and then dictated to his Companions, and written down by scribes, who cross-checked it during his lifetime. Not one word of the Quran has been changed over the centuries, so that the Quran is in every detail the unique and miraculous text. The Quran is the prime source of Muslim faith and practice. It deals with all the subjects which concern us as human beings: wisdom, doctrine, worship, and law, but its basic theme is the relationship between God and His creatures. At the same time it provides guidelines for proper conduct of individual, society and an equitable holistic system of human life.
- **Course Learning Objectives:**
  - Students will come to know about the real nature, significance andrelevanceoftheIslamicbeliefinlightofthetext oftheHolyQuran.
  - Students will seek knowledge of translation and transliteration of theHolyBookQuran.
  - TofamiliarizethestudentswiththeconceptofIbādah(Itssignificance,scopeandrelevance)andits typesin Islam.
  - Students will learn literal and idiomatic way of translation of the HolyBook.
  - StudentswilllearnaboutthepolytheismanditsincompatibilityinIslamhighlightedbythe HolyQuran.
  - Tohighlightthesignificanceoflearningthroughusingallhumanfaculties provided by the almighty Allah and familiarize the studentsaboutcondemnationofignorancementionedintheQuranictext.
  - To develop Awareness among the students about rights and duties ofdifferentcirclesof societyin thelight of HolyQuran.

Course Contents:

- 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 و حمل
  - اولاد کو قتل کرنے کے 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
  - عفو ودرگزر، غصہ پر قابو اور معاف کرنا
  - شعوب و قبائل
  - لوگوں کے بیچ اختلافات
  - حمایت ، نگہبانی

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 ((١٧٧، ٢٣٨، ٣٥، ٢٧٧، ٢١٩، ١١٠، ٣٥، ١٥٣، ٢٣٧، ٢٠١، ٢٨٥، ٣٣، ٢٨٥، ١٥، ١٢٩، ٢٥٣، ٩٨، ٦٢، ١٢٦، ٢٨٥، ٢٥٦، ١٧٧، ١٣٦، ١٨٩، ٢٠٠، ١٨٣، ١٨٣، ٢١٨، ١٥٨، ٢٣١،١٩٩، ٢٢٧، ٢٢٦، ٢٣٧، ٢٢٨، ٢٢٩، ٢٣١، ٢٣٧، ٢٣٥، ٢٣٠ ، ٨٢ ، ١٨٣، ٢٣٣، ١٨٢، ١٦٠، ٨٣) ▪ النساء (٩٥، ٩٢، ٥٩، ١٣٦، ٦٩، ٨٠، ١٣، ٦٩، ٨٦،٨٠، ٣٦، ١٧٦، ١٢، ٣٥، ١٢٨، ٣٣، ١١، ٣، ١٧٦، ٢٣، ٢٥، ١١، ١١، ١٢٨، ١٩١، ٣٥، ٢٠، ٣٥، ١٩١، ٦، ١، ٢٠، ١، ١٦، ١٣٦، ٥٣، ١٢٨، ٨١) ▪ الانعام (٢٢، ١٣٧،١٣،٩٢، ١٥١، ٣٨، ٥٣) ▪ آل عمران (٩٧، ٣٩، ٨٥، ١٢٥، ٨٣، ١٣٣، ١٠١٩) ▪ المائدہ (٥٣، ٢، ٩٢، ١٩،٣٩، ٨٢، ٢، ٥) ▪ الاعراف (٣٥، ١٨٩، ١٨٩) ▪ التوبہ (٢٠، ١٦،٧١) ▪ ہود (١٢) ▪ الزمر (٦) ▪ النور (٥٣، ٢٨،٥٢، ٢٧، ٦٠، ٢٩) ▪ محمد (٣٣) ▪ انفال (٨٢، ٢٠) ▪ الرعد (٣) ▪ الطلاق (٣) ▪ الحج(٥) ▪ ابراہیم ((٢٣،٢٣) ▪ الاسراء (٢٣، ٢٣) ▪ الاحقاف (١٥) ▪ المومنون (٢٧) ▪ العنکبوت (٢٥،٣٨، ٨) ▪ النحل (٢٢) ▪ لقمان (١٥،٣، ١٣) ▪ الاحزاب ((٣٥، ٥٠،٣٨، ٣٩) ▪ الشعراء (٧)

BOTN-5105		**Biodiversity and Conservation**		**4(3+1)**

Course Brief:

Over the years, the depletion of biodiversity has been quite active. This is happening as a result of habitat loss, exploitation of resources, climatic changes, diseases, pollution, poaching of animals etc. In order to correct this scenario, biodiversity conservation has been majorly stressed by governments and social organizations. It must be understood that human beings cherish almost all benefits from the biodiversity. Hence, they should focus on taking proper care associated with the preservation of biodiversity in different forms. It is important because there must be something left for the future generation to look at. We as human beings should curb the degradation as well as the destruction of the habitats, upholding the biodiversity at its prime level. Biodiversity conservation is basically aimed at protection, enhancement and scientific management of the biodiversity. To be precise, manage it at its threshold level and acquire sustainable benefits both for the present and future population. Biodiversity and conservation maintain crucial ecological processes as well as life support systems. It preserves the variety of species and make sustainable exploitation of ecosystems and species.

Course Learning Objectives:

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

Course Contents:

1. Biodiversity: Definition, types and threats.
2. Threats to Biodiversity; deforestation, over grazing, erosion, desertification, ecosystem degradation, bio invasion, pollution and climate change.
3. Biodiversity of Pakistan.
4. Measuring biodiversity: Alpha, Beta and Gamma diversity; Systematic and functional diversity.
5. Ecological services, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of Bio resources).
6. Sustainable and unsustainable use of biological resources.
7. Biodiversity Hot spots of Pakistan and the world.
8. International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar.
9. Conservation strategies; *in situ, ex situ, in vitro* conservation.
10. Conservation *vs* preservation.
11. IUCN categorized protected areas in Pakistan; red listing.
12. Environmental Impact Assessment.
13. Use of herbarium and Botanical Garden in biodiversity and conservation.
14. Concept of pastures and wild life management.
15. Global Biodiversity Information Facility (GBIF).

Lab outline:

1. Inventory of plant biodiversity in various habitats.
2. Field survey for baseline studies and Impact Assessment.
3. Identification of wild plant species used by local communities in different ecosystems.

Recommended Books :

1. Walker, T.,*Plant Conservation: Why it Matters and How it Works*. (Timber Press, 2015).
2. Pellens, P. and P. Grandcolas, *Biodiversity conservation and phylogenetic systematics*. (SIP AG Swetzerland, 2016.)
3. Blackmore, S. and S. Oldfield.*Plant Conservation Science and Practice: The Role of Botanic Gardens.* (Cambridge University press,2017).

Suggested Books:

1. Boenigk, A., S.,Wodniok and E. Glucksman. *Biodiversity and Earth history*. (Springer, 2015). Scherson, R.A, *Phylogenetic Diversity*. (Springer, 2018).

BOTN-5106		Bacteriology and Virology		3(2+1)

Course Brief:

To understand the morphology, structure and economic importance of Viruses and Bacteria.Bacteriology and Virology is a three credit hour course for BS in Botany, which covers the basic principles of Bacteriology and Virology. The course is divided into two main sections corresponding to the type of microorganism studied. The Bacteriology part includes: the historical accounts of microbiology, the bacterial structure, physiology and metabolism, the diversity and classification of bacteria, the various ways to control microorganisms, microbial ecology, food and industrial microbiology and finally an introduction to descriptive epidemiology.

Course Learning Objectives:

The main objectives of the Microbiology course is to establish the basic knowledge on microbes, mostly bacteria and viruses, and their relationships with other organisms, mainly plants and animals. Also included are the biochemical and molecular techniques and strategies used to study, but also to control, these microorganisms. After this course the students will be able to understand various biological and molecular aspects of viruses.

Course Contents:

Viruses

1. General features of viruses, viral architecture, classification, dissemination and replication of single and double - stranded DNA/RNA viruses.
2. Plant viral taxonomy.
3. Virus biology and virus transmission.
4. Molecular biology of plant virus transmission.
5. Symptomatology of virus-infected plants: (external and internal symptoms).
6. Metabolism of virus-infected plants.
7. Resistance to viral infection.
8. Methods in molecular virology.

Bacteria

1. History, characteristics and classification.
2. Evolutionary tendencies in Monera (bacteria, actinomycetes and cyanobacteria)
3. Morphology, genetic recombination, locomotion and reproduction in bacteria
4. Bacterial metabolism (respiration, fermentation, photosynthesis and nitrogen fixation)
5. Importance of bacteria with special reference to application in variousmodern Sciencesspecially agriculture, biotechnology and genetic engineering.
6. Symptoms and control of major bacterial diseases in Pakistan
7. Plant microbe interaction

Lab outline:

1. Viruses: Observation of symptoms of some viral infected plant specimens.
2. Bacteria, Actinomycetes and Cyanobacteria
3. Methods of sterilization of glassware and media etc.
4. Preparation of nutrient medium and inoculation.
5. Preparation of slides for the study of various forms, capsule/slime layer, spores, flagella and Gram-staining.
6. Growth of bacteria, subculturing and identification of bacteria on morphological and biochemical basis (using available techniques).
7. Microscopic study of representative genera of Actinomycetes and Cyanobacteria from fresh collections and prepared slides.

Recommended Texts:

1. Black J. & Black, L. (2017). *Microbiology - Principles and Exploration (*10th ed.). Arlington: John Wiley and Sons, Inc.
2. Willey, J., Sherwood, L. & Woolverton, C. (2017). *Prescott's microbiology* (10th ed.).Kent State: McGraw-Hill Companies, Inc.

Suggested Readings:

1. Mandahar,C. L., (2017). *Plant viruses: structure and replication*(1st ed.). Florida: CRC Press, Taylor & Francis Group Publishers.
2. Arora, A., (2017). *Textbook of microbiology* (5th ed.). India: CBS Publishers and Distributors.
3. Pommerville, J., (2018). *Fundamentals of microbiology*(11thed.). Sudbury: Jones and Bartlet Publishers.

Gaur, R. K, Khurana, K. & Dorokhov, Y. (2018). *Plant viruses: diversity, interaction and management*(1st ed.). Florida: CRC Press, Taylor & Francis Group Publishers.

CHEM-5102		**Inorganic Chemistry**		4(3+1)

Course Brief:

This course covers a range of general topics of inorganic chemistry.It will provide a useful supplement to the advanced courses specified in the department. This course aims to enable the students to achieve the advance knowledge about the key introductory concepts of chemical bonding, acid-base chemistry, and properties of the representative and transition elements, as well as using this knowledge for qualitative and quantitative analysis of inorganic compounds during laboratory work.

Course Learning Objectives:

Learning objectives emphasized in CHEM 5102 involve developing an understanding of basic principles of inorganic chemistry. It develops critical thinking skills enabling students to solve chemistry problems that incorporate their cumulative knowledge. Students learned in class to modern chemistry techniques which give them opportunities to upgrade their knowledge about advanced inorganic concepts. The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and preparation of students for professional positions in chemistry.

Course Contents:

1. Periodic Table and Periodicity of Properties: Modern Periodic Table, Group trends and periodic properties, Atomic & ionic radii, ionization potentials, electron affinities and electronegativities; Redox potential, electrochemical series and its applications. Corrosion and electroplating.
2. Acid Base Equilibria: Acids and bases, relative strengths of acids, pH, pKa, pKb. Hard and soft acid & Bases. SHAB Principle & its application. Buffers, types buffer, Preparation, Buffer capacity and applications of buffers. Indicators: (Acid-base, Redox, Adsorption), Solubility product, Common ion effect and its applications.
3. Chemical Bonding: Nature of a bond, hybridization, Valence Bond Theory (VBT), The Concept of Resonance, Molecular Orbital Theory (MOT), Valence Shell Electron Pair Repulsion (VSEPR) theory. Special types of bonds such as Metallic bonds, Hydrogen Bonding, Bent bond, Ion-dipole-dipole bond, ion induced-dipole bond.
4. Chemistry of p-Block Elements: Introduction to p-block elements (Group trends in p-block elements with reference to, atomic sizes & chemical reactivities). Boranes& Boride; aluminium halides, hydrides & Alums; Silicates (Structural aspects, classifications and applications); silicones (Structural aspects, classifications and applications),Germanes; phosphazenes, Phosphides, Oxoacids of Phosphorous; Oxoacids& salts of sulphur; Noble gases (compounds of Xe, Kr, Ra; bonding and applications).Production of pure silicon chips for solar energy cells.
5. Chemistry of d-Block Elements: Electronic configuration. Characteristics. Nomenclature. Nature of bonding in coordination compounds: Werner's theory, VBT, MOT and CFT for coordination compounds. Isomerism in coordination compounds. Chelates: Classification and applications. Applications of coordination compounds (Medicinal, Industrial, Agricultural).
6. Separation Techniques: General introduction and Applications (Solvent extraction and Chromatographic techniques such as paper, Ion exchange and Column).
7. Introduction to Analytical Techniques in Inorganic Chemistry: Introduction to spectroscopic Techniques: Principle, brief instrumentation, sample handling and applications (Flame emission, Atomic Absorption, IR & UV/Vis).
8. Chemical Industries: Metallurgy of Al, Cr and U, fertilizers (Urea & Phosphate fertilizers) Cement and Sugar.

Lab outline:

1. Qualitative Analysis; four radicals (cations and anions) for salt mixture.
2. Chromatographic separation of cations

3. Determination of total hardness of water using EDTA.
4. Estimation of manganese (II) using EDTA.
5. Estimation of copper (Iodometrically).
6. Determination of thiosulphate ion (lodometrically).
7. Determination of ferricyanide using KI solution.
8. Determination of chloride by Volhard's and Mohr's methods.
9. Estimation of chloride ions using adsorption (Fluorescein) indicator.
10. Estimation of bromide ions using adsorption (Eosin) indicator.
11. Estimation of percentage of ferrous ions in the Mohr's salt using $KMnO_4$.
12. Percentage determination of ferric ions in ferric alum using $KMnO_4$ solution.
13. Determination of purity of commercial potassium oxalate using $KMnO_4$ solution.
14. Estimation of ferrous ions using $K_2Cr_2O_7$ solution.

Recommended Texts:

1. Graham, H., & Man, H. (2000). *Chemistry in Context* 5th Edition. Thomas Nelson Ltd. U.K.
2. Philp, M. (1996). *Advance Chemistry*. Cambridge Low Price Edition, U.K.
3. David, H. (2000). *Modern Analytical Chemistry*. McGraw Hill, NY.

Suggested Readings:

4. Graham, H., & Man, H. (2000). *Chemistry in Context* 5th Edition. Thomas Nelson Ltd. U.K.
5. Philp, M. (1996). *Advance Chemistry*. Cambridge Low Price Edition, U.K.
6. David, H. (2000). *Modern Analytical Chemistry*. McGraw Hill, NY.

BOTANY
4th Semester

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

Course Contents:

1**. Climate Change** i.e., Global Warming, Natural and Anthropogenic Activities and their impact; Energy i.e., Renewable and non-renewable energy resources.

2. Water Security i.e., water scarcity and waste water treatment; Land Degradation i.e., salinity, water logging, deforestation, land erosion.

3. Food Security and roll of Biotechnology in food production; Global Health Pandemics i.e. 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 Text:

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

Suggested Books :

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

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:

To enhance the 'entrepreneurial intentions' of the students by improving their natural willingness to start a business. To understand the process of entrepreneurship and learn the ways to manage it by working individually in the class and in the form of groups outside the class to conduct field assignments. To educate the students about the practical underpinnings of the entrepreneurship with the aid of practical assignments and idea pitching.

Course Contents:

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 ECommerce, 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.

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

Course Brief:

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.

Course Learning Objectives:

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.

Course Contents:

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

Citizenship and Community Engagement

- Introduction to Active Citizenship: Overview of the Ideas, Concepts, Philosophy and Skills
- Approaches and Methodology for Active Citizenship

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

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

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)

Human rights, constitutionalism and citizens' responsibilities

- Introduction to Human Rights
- Human rights in constitution of Pakistan

- Public duties and responsibilities
- Constitutionalism and democratic process

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

Civic Engagement Strategies

- Grassroots organizing and community mobilization
- Advocacy and lobbying for policy change
- Volunteerism and service-learning opportunities

Social issues/Problems of Pakistan

- Overview of major social issues of Pakistani society

Social Action Project

Recommended Books:

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

Suggested Readings:

1. Bloemraad, I. (2006). Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada. University of California Press.

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.

BOTN-5107		Cell Biology		4(3+1)

Course Brief:

Cell biology is the study of cell structure and function, and it revolves around the concept that the cell is the fundamental unit of life. Focusing on the cell permits a detailed understanding of the tissues and organisms that cells compose. It is the study of cell with respect to its anatomy and physiology. It provide understanding of about cell which act as fundamental unit of life. It focusing on cell combine form tissues, organ and organism. Research in cell biology is interconnected to other fields such as genetics, molecular genetics, biochemistry, molecular biology, medical microbiology, immunology, and cytochemistry.

Course Learning Objectives:

This course aims to understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation. To know about the cell division; how and when it takes place. To know about the cancer, causes types and possible preventive measures.

Course Contents:

1. Introduction of prokaryotes and eukaryote cell, Animal and Plant cell structure.
2. Brief description of ultra-structure and functions of plant cell organelles.
3. End membranous systems.
4. Cell cycle and cell division; meiosis in sexual reproduction in plants.
5. Cellular metabolism and enzymes.
6. Cellular respiration and photosynthesis.
7. Biological information flow; transcription and translation.
8. Informational molecules; carbohydrates proteins and nucleic acids.
9. Cytoskeleton in cell cycle and mitosis.
10. Extra cellular matrix; various types of extra cellular matrix proteins; elastic fibronectin, glycoprotein, collagen, dyneinand motor proteins.
11. Vesicular trafficking, cell migration, cell adhesion, cancer growth factors, disorders in cell cycle, apoptosis and gap junction.

Lab Outline:

1. Study of mitosis and meiosis in onion root tip and pollen grains
2. Study of cell organelles in plant cell by compound microscope
3. Measurement of cell size
4. Separation of different sized DNA fragments on agarose gel.
5. Study of chromosomes morphology and variation in chromosomes number.
6. Counting of prokaryotic cells (bacteria) and blood cells by using haemocytometer.
7. Extraction and estimation of carbohydrates, proteins and DNA from plant sources.

Recommended Texts:

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.

Suggested Readings:

1. Templeton, N. S., (2015). *Gene and cell therapy* (4th ed.). London: Taylor and Francis publications.
2. Sybille, M. & Maria, S., (2015). *Tumor cell metabolism* (1st ed.).New York: Springer Publications.

Bradshaw, R. & Stahl, P., (2015). *Encyclopedia of cell biology* (1st ed.). New York: Elsevier publications.

BOTN-5108		Phycology and 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 Contents:

1. Phycology Introduction, general account, evolution, classification, biochemistry, ecology and economic importance of the following divisions of algae: vChlorophyta, 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:

Phycology:

1. Collection of fresh water and marine algae.
2. Identification of benthic and planktonic algae
3. Section cutting of thalloid algae
4. Preparation of temporary slides
5. Use of camera lucida/micrographs.

Bryology

6. 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.

ZOOL-5101	Animal Diversity-I (Invertebrates)	4(3+1)

Course Brief:

This course will provide the knowledge of evolutionary/phylogenetic relationship. It imparts the basic taxonomic characteristics and classification of all the in vertebrate phyla. This includes more than 95% of all of the described species of animals and far more than 99% of all of the individual animals on the planet. The central theme running throughout this course will be phylogeny. It provides understanding of body organization, mode of feeding, digestion, reproduction and development of invertebrates.

Course Learning Objectives:

It delivers information to students about economic and ecological importance of invertebrates. Students will understand invertebrate organismal concepts in laboratory and field. The primary objectives for the laboratory section of this course includes; introduction of structure, function and behavior of selected invertebrate types through the observation of both living and preserved specimens, to reinforce basic laboratory skills of students like microscopy, dissection and careful observation, to provide students with the ability to recognize the major groups of invertebrate and to increasing understanding of the methods of investigating animal evolution.

Course Contents:

1. Introduction: classification of organisms, evolutionary relationships
2. Animal-like Protists: the Protozoa
3. Multicellular and tissue levels of organization: evolutionary perspective, origins of multicellularity; 4. Animal origins, Phylum Porifera, Cnidaria, Ctenophora 5. The triploblastic acoelomate body plan: Phylum Platyhelminthes, Phylum Nematode, gastrotricha 6. Pseudocoelomate body plan: Phylum Aaschelminths, Phylum Rotifera, Phylum Nematoda and Phylum kinorhyncha. Some important nematode parasites of humans 7. Phylum Mollusca, Annelida, Arthropoda,(the hexapods and myriapods), Phylum Echinodermata 8. Some lesser known invertebrates: lophorates, entoprocts, cycliophores, and cheatognaths

Lab work:

1. Study of representatives of phylum Protista, Porifera and prepared slides of spicules of sponges 2. Study of principal representatives of classes of phylum Coelenterate, Platyhelminthes, rotifer, nematode, Mollusca, Annelida, Arthropoda, Echinodermata 3. Preparation of permanent mount of obelia, hydra, proglottid, parapodia, insect mouthparts

Recommended Texts:

1. Miller, A. S., & Harley, J. B. (1999, 2002, 2007, 2009, 2012 & 2016). Zoology (4th, 5th, 6th, 7th , 8 th, 9th, 10thed.). Singapore: McGraw Hill. 2. Hickman, C. P., Roberts, L. C., & Larson, A. (2018). Integrated principles of zoology (15thed.). Singapore: McGraw-Hill.

Suggested Readings:

1. Pechenik, J. A. (2015). Biology of invertebrates (7thed.). Singapore: McGraw-Hill 2. Kent, G. C., & Miller, S. (2001). Comparative anatomy of vertebrates. New York: McGraw-Hill.

Botany
3rd Year
5th Semester

URCG-5111		**Translation of the Holy Quran – III**		**Non-credit**

Course Brief:

- The Quran is the exact words revealed by Allah SWT to His last Prophet Muhammad (ﷺ). It was memorized by Muhammad (ﷺ) and then dictated to his Companions, and written down by scribes, who cross-checked it during his lifetime. Not one word of the Quran has been changed over the centuries, so that the Quran is in every detail the unique and miraculous text. The Quran is the prime source of Muslim faith and practice. It deals with all the subjects which concern us as human beings: wisdom, doctrine, worship, and law, but its basic theme is the relationship between God and His creatures. At the same time it provides guidelines for proper conduct of individual, society and an equitable holistic system of human life.

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 Contents:

Course Contents:	○ اخلاق (تعارف،ضرورت وابمیت ،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 و انکساری • نگاہ اور آوازکو 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 و لعب • 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 وتجوید ▪ البقرہ (۱۱۲، ۲۳۵، ۸۳، ۱۸۲، ۱۷۲، ۱۵۲، ۱۷۲، ۵۲، ۱۵۳، ۱۷۷، ۲۵۰، ۱۲۵، ۲۲۲، ۲۷، ۷۷، ۱۸۲، ۱۳۸، ۱۸۷، ۱۰۹، ۲۶۳، ۲۶۳، ۲۶۲، ۲۱۲، ۶۷، ۲۳۱، ۱۰، ۳۳، ۱۲۳، ۲۵۸، ۲۷، ۷۱، ۸۳، ۲۲۶، ۱۹۵، ۷۶) ▪ آل عمران (۱۵۳، ۱۳، ۲۳، ۱۸۵، ۱۳۲، ۱۳۸، ۱۳۳، ۱۳۵، ۱۷، ۲۰۰، ۱۲۵، ۱۳۳، ۱۱۳، ۱۰۳، ۱۰۳، ۲۶، ۷۸، ۱۳۱، ۱۳۷، ۱۵۹) ▪ النساء (۱۳۵، ۲۳، ۲۲، ۱۰۸، ۱۰۷، ۱۰۵، ۵۳، ۲۰، ۲۷، ۱۷۳، ۳۶، ۲۵، ۲۳، ۳۷، ۵۷، ۲۳) ▪ المائدۃ (۵۸، ۵۷، ۹۳، ۱۳، ۶، ۳۱، ۱۹) ▪ النحل (۱۲۶، ۹۰، ۱۰۵، ۱۱۳، ۳۰، ۱۲۶، ۱۲۵) ▪ الرعد (۲۵، ۲۰، ۲۳، ۲۲، ۶) ▪ الاعراف (۳۱، ۶۶، ۵۱، ۱۳۶، ۳۰، ۳، ۲۰، ۱۳۳، ۱۹۹، ۹۵، ۸۱) ▪ القصص (۵۳، ۸۳) ▪ فصلت (۳۳) ▪ الانعام (۳۲، ۷۰، ۷۰، ۱۳۰، ۱۵۵، ۱۶۰) ▪ النمل (۹۰، ۳۶) ▪ الحج (۳۰، ۵۸، ۶۰، ۸۸، ۷۷) ▪ الحجرات (۹، ۱۱، ۶، ۱۱، ۳، ۱۲، ۱۵، ۱۰) ▪ الاحزاب (۲۳، ۵۰، ۵۸، ۵۸، ۵۲، ۵۵، ۵۹، ۳۵، ۲۳، ۳۵) ▪ الحشر (۹) ▪ طہ (۷۲) ▪ الانعام (۱۶۳، ۱۳۱، ۱۱۶، ۱۵۱، ۶۳، ۱۲۷) ▪ ق (۳۳) ▪ الانفال (۲۷، ۳۶، 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) ▪ الاسرا ء(۳۷، ۱۱۰، ۵، ۳۷) ▪ المزمل (۱۸) ▪ المدثر (۶، ۴) ▪ المدثر (۴۳) ▪ فاطر (۳۲) ▪ الفتح (۲۹) ▪ البلد (۱۷) ▪ الزمر (۳، ۱۰) ▪ الحجر (۸۵) ▪ النجم (۳۱) ▪ الرحمٰن (۶۰) ▪ ھود (۸، ۱۰۲، ۳) ▪ الکہف (۲، ۵۶) ▪ الشوری (۳۷) ▪ غافر (۲۸، ۲۷) ▪ الحدید (۲۰، ۲۰) ▪ مریم (۵۹) ▪ النازعات (۳۱) ▪ التوبہ (۶۵، ۶۴، ۷۷) ▪ الھمزہ (۱)

BOTN-6101		**Diversity of Vascular Plants**		**3(2+1)**

Course Brief:

This course provides a comparative study of pteridophytes, gymnosperms and angiosperms, integrating form, function and ecology. This course is designed to introduce students to the major lineages of vascular plants, including the ferns, gymnosperms and flowering plants; to enable the students to understand and appreciate the biology and evolution of plant architecture; to examine the evolutionary origins of plants and the impacts humans have had on plant evolution and diversity; to explore the methods of fossilization and its importance in biology; to get a broad overview of Pteridophytes, Gymnosperms and Angiosperms; to have a good overview of the general morphology, sexual reproduction and diversity of the different divisions of vascular plants; to emphasize appropriate science skills, in lab, including experimental observation, and illustration in various groups of vascular plants.

Course Learning Objectives:

Students will be able to: recognize the major groups of vascular plants; differentiate them by their principal characters, and understand their phylogenetic relationships; utilize the knowledge in developing strategies for their higher studies conservation of the plants and sustainable utilization of these natural resources.

Course Contents:

1. Pteridophytes Introduction, origin, history, features and a generalized life cycle. Methods of fossilization, types of fossils, geological time scale and importance of paleobotany. 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.
4. Angiosperms: Origin, general characteristics, importance, and life cycle of angiosperms.
5. Palynology:

a) An introduction to Neopalynology and Paleopalynology, its applications in botany, geology, archaeology, criminology, medicines, honey, oil and gas exploration.
b) Basic information about the nomenclature, morphology and classification of living and fossil pollen and spores.

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

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 Books:

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 .

BOTN-6102		Plant Systematics		3(2+1)

Course Brief:

The aim of the course is to know floral composition/system of classification focusing on identification, classification, and description nomenclature and flora writings monographs. An introduction to the goals and methods of plant systematics, and a survey of the diversity of vascular plants, including ferns, conifers, flowering plants, and related groups. Plant systematics is the study of flowering plant diversity. Lectures cover the processes of plant reproduction and evolution, patterns of plant diversity and biogeography, and the methods used to analyze and interpret these patterns and processes. The laboratory presents a survey of the vascular plants with a focus on major plant families, emphasizing prominent groups in natural habitats and in cultivation. Through the lectures, laboratory exercises, walks and readings students will learn: how to describe and classify plant diversity; the major features and evolutionary origins of vascular plants. What causes selection on, and variation in, plant characteristics;A "Vocabulary" of plant description; identification of plants using dichotomous keys; recognition of important angiosperm families; gain some knowledge of the local spring flora Learn where your food plants come from.

Course Learning Objectives:

To know floral composition/system of classification focusing on identification, classification, description nomenclature and flora writings monographs.

Course Contents:

1. Introduction: Importance and relationship with other sciences, Phases of plant taxonomy. Origin and radiation of angiosperm, their probable ancestors, when, where and how did the angiosperms evolve; the earliest fossil records of angiosperms.
2. Concept of Species: What is a species? Taxonomic species, Biological species, Micro and macro species, Species aggregate. Infra specific categories.
3. Speciation: Mechanism of speciation, Mutation and hybridization, Geographical isolation, Reproductive isolation, Gradual and abrupt.
4. Variation: Types of variation, continuous and discontinuous variation, Clinalvariation.
5. Systematics and Gene ecology / Biosystematics: Introduction and importance, Methodology of conducting biosystematics studies, various biosystematics categories such as ecophene, ecotype, ecospecies, coenospecies and comparium.
6. Taxonomic Evidence: Importance and types of taxonomic evidences: anatomical, cytological, chemical, molecular, palynological, geographical and embryological.
7. Nomenclature: Important rules of Botanical nomenclature including effective and valid publication, typification, principles of priority and its limitations, author citation, rank of main taxonomic categories, conditions for rejecting names.
8. Classification: Why classification is necessary? Importance of predictive value. Brief history, Different systems of classification with at least one example of each (Linnaeus, Bentham and Hooker, Engler and Prantle, Bessey, Cronquist, Takhtajan and Dahlgren).
9. Brief introduction of Numerical taxonomy**.**
10. General characteristics, distribution, evolutionary trends, phyletic relationships and economic importance of the following families of angiosperm:
    Apiaceae (Umbelliferae), Arecaceae (Palmae), Asclepiadaceae,Asteraceae (Compositae), Boraginaceae,Brassicaceae (Cruciferae),Caryophyllaceae, Chenopodiaceous,Convolvulaceae, Cucurbitaceae,Cyperaceae, Euphorbiacea, Fabaceae (Leguminosae), Lamiaceae (Labiatae), Liliaceae, Magnoliaceae, Malvaceae, Myrtaceae, Orchidaceae, Papaveraceae, Ranunculaceae, Rosaceae, Salicaceae, Scrophulariaceae

Lab Outline:

1. Technical description of 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. Simpson, M., (2019). *Plant systematics* (3rd ed.). New York: Elsevier.
2. Novikov, A. & Barabasz-Krasny, B., (2015). *Modern plant systematic* (1st ed.).Ukrainian:Liga-Press.

Suggested Readings:

1. Hoorn, C., Perrigo, A. & Antonelli, A., (2018). *Mountains, climate and biodiversity* (1st ed.). New Jersey: Wiley-Blackwell.
2. Shipunov, A., (2018). *Introduction to botany* (1st ed.). North Dakota: Minot State University Publications.

BOTN-6103		**Mycology and Plant Pathology**		**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 Contents:

Mycology

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.

Pathology

6. Introduction and classification of plant diseases.
7. Symptoms, causes and development of plant diseases
8. Loss assessment and disease control
9. Epidemiology and disease forecast
10. 5.Important diseases of crop plants and fruit trees in Pakistan caused by fungi, e.g.
11. damping off, mildews, rusts, smuts, dieback, red rot of sugarcane etc.
12. Systemic resistance: Induced systematic resistance (ISR), Acquired Systematic resistance (ASR).

Lab Outline :

1. Mycology: General characters and morphology of fungi. Study of unicellular and mycelial forms with septate and aseptate hyphae. Distinguishing characters of different phyla: study of suitable examples. Study of asexual and sexual reproductive structures in different groups of fungi. Study of some common examples of saprophytic, parasitic and air-borne fungi belonging to different phyla.
2. Pathology: Identification of major plant pathogens under lab and field conditions, cultural studies of some important plant pathogenic fungi, application of Koch's postulates for confirmation of pathogencity. Demonstration of control measures through chemotherapeutants.

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 Phytopathological Society

BOTN-6104		Plant Ecology-I		3(2+1)

Course Brief:

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. The four main levels of study in plant ecology are the organism, population, community, and ecosystem. 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 covers plant ecology on advanced level. 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 Learning Objectives:

To understand the role and interaction of plants with their environment

Course Contents:

1. Introduction: History and recent developments in ecology.
2. Soil: Nature and properties of soil (physical and chemical), water in the soil-plant-atmosphere continuum, the ionic environment and plant ionic relations, nutrient cycling. Physiology and ecology of N, S, P and K nutrition. Heavy metals (brief description), salt and drought stress and osmoregulation.
3. Light and temperature: Nature of light, factors affecting the variation in light and temperature, responses of plants to light and temperature, adaptation to temperature extremes,
4. Carbon dioxide: Stomatal responses, water loss and CO_2assimilation rates of plants in contrasting environments. Ecophysiological effects of changing atmospheric CO_2concentration. Functional significance of different pathways of CO_2 fixation. Productivity: response of photosynthesis to environmental factors, C and N balance.
5. Water: Water as an environmental factor, role of water in the growth, adaptation and distribution of plants, water status in soil, water and stomatal regulation, transpiration of leaves and canopies.
6. Oxygen deficiency: Energy metabolism of plants under oxygen deficiency, morph-anatomical changes during oxygen deficiency, post-anoxic stress
7. Wind as an ecological factor.
8. Fire as an ecological factor.
9. Carbon credit

Lab Outline:

1. Determination of physico-chemical properties of soil and water.
2. Measurements of light and temperature under different ecological conditions.
3. Measurements of wind velocity.
4. Measurement of CO_2 and O_2 concentration of air and water.
5. Effect of light, temperature, moisture, salinity and soil type on germination and growth of plants.
6. Measurement of ions, stomatal conductance, osmotic potential, water potential, xylem. pressure potential, leaf area and rate of CO_2 exchange in plants in relation to various environmental conditions.

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*(2nded.). New York: Elsevier.
2. Keddy, P. A., (2018). *Wetland ecology: principles and conservation,* (2nded.).England: Cambridge University Press.

CHEM-5103		Organic Chemistry		4(3+1)

Course Brief:

The students will acquire knowledge about the basic concepts of organic chemistry, chemistry of hydrocarbons, functional groups and the mechanism of organic reactions. It will be useful for the qualitative analysis and synthesis of organic compound. Understanding and knowledge of new and advanced field of organic and also significances the importance of application of advanced techniques. This course is a foundation course for Organic Chemistry major courses of higher semester. The main objectives emphasized in this course involve developing an understanding of basic principles of organic chemistry. It develop critical thinking skills enabling students to solve general chemistry problems that incorporate their cumulative knowledge. Students learned in class to advanced organic chemistry concepts which give them opportunities to upgrade their knowledge about advanced organic concepts.

Course Learning Objectives:

The essence of this course is to develop study skills that students need to succeed in university-level chemistry courses and preparation of students for professional positions in the field of synthesis chemistry.

Course Contents:

1. Basic concepts: atomic, molecular and hybrid orbitals: multiple localized and delocalized bonds, . 2. Introduction to spectroscopy with special reference to the infrared, ultraviolet/visible spectroscopy. 3. Hydrocarbons: classification of hydrocarbons. Nomenclature. Methods of preparation, 4. Stereoisomerism: conformational analysis of ethane and butane. Optical isomerism, optical activity, 5. Alkyl halide: nomenclature, method of preparation and chemical reaction 6. The hydroxyl group and ether: nature of hydroxyl group in phenol and alcohol. 7. Alcohol: classification and nomenclature, preparation method and chemical reaction 8. Ether: preparation and reactions. 9. The carbonyl group: nature and its reactivity, nomenclature of aldehyde and ketone, Carboxylic acid acid anhydrides, acid halides, acid amides, esters including glycerides. Introduction to amino acid. 10. Nitrogen compounds: amines; classification, nomenclature, preparation and chemical reactions, .

Lab outline:

1. Qualitative organic analysis; systematic identification of organic compounds containing group like COOH, OH, NH2, C=O.
2. 2. Purification techniques viz solvent extraction distillation and recrystallization, etc. 3. Preparation of simple organic compounds viz, Ethyl benzoate, benzoic acid, tribromophenol, aspirin, nitrobenzene.

Recommended Texts:

1. Younas, M. (2006). Organic Spectroscopy. A. H. Publisher, Lahore.
2. Solomons, T.W.G. (2016).Fundamentals of Organic Chemistry. 12th edition Wiley, New York.
3. Vogel, A. I. (1996). A Text Book of Practical Organic Chemistry. Prentice Hall.

Suggested Reading:

1. Kemp, W. (1990). Organic Spectroscopy. Macmillan, London.
2. Chughtai, F. A. (1995). Organic Reactions, Majid Book Depot. Lahore/Faisalabad.
3. Streitwieser, A., Heathcock, C., and Kosower, E.M. (2017). Introduction to Organic Chemistry. 4 th edition Macmillan, NY.

Botany
3rd Year
Semester 6th

STAT-6134		**Biostatistics**		**3(3+0)**

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 Contents:
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.

Recommended Books:

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 Edition , 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

BOTN-6105		**Plant Physiology-I**		**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. This also gives information about dark reaction, C3, C4 cycle, mechanisms of photosynthesis in CAM plants and phloem transport.

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 (e.g. with respect to alternative fixation pathways, photoinhibition, and photorespiration). Plant physiology deals with all the internal activities of plants.

Course Contents:

1. Photosynthesis: History of photosynthesis, nature and units of light, determination of oxygenic and an oxygenic photosynthesis, various pigments and photosynthetic activity, ultra structure and composition of photo system-I and II, absorption and action spectra of different pigments, mechanism of photosynthesis - light absorption, charge separation or oxidation of water (water oxidizing clock), electron and proton transport through thylakoid protein-pigment complexes. Photophosphorylation and its mechanism, CO_2 reduction(dark reactions) - C_3 pathway and photorespiration, regulation of C_3 pathway, C_4 pathway and its different forms, C_3-C_4 intermediates, CAM pathway.
2. Respiration: Synthesis of hexose sugars from reserve carbohydrates, mechanism of respiration- glycolysis, differences between cytosolic and chloroplastidicglycolysis, oxidative decarboxylation, Krebs cycle, regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation, aerobic and anaerobic respiration. Energetics of respiration, pentose phosphate pathway, glyoxylatecycle, cyanide resistant respiration.
3. Translocation of Food: Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.
4. Leaves and Atmosphere: Gaseous exchange, mechanism of stomata regulation, factors affecting stomatal regulation.
5. Assimilation of Nitrogen, Sulphur and Phosphorus: The nitrogen cycle, nitrogen fixation, pathways of assimilation of nitrate and ammonium ions, assimilation of Sulphur and phosphorus.

Lab Outline:

1. To determine the volume of CO_2 evolved during respiration by plant material.
2. To determine the amount of O_2 used by respiring water plant by Winkler Method.
3. Separation of chloroplast pigments on column chromatogram and their quantificationby spectrophotometer.
4. To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
5. To categorize C_3 and C_4 plants through their anatomical and physiological characters.
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., Gruissem, W. & Russell, L., (2015). *Biochemistry and molecular biology of Plants* (2nd ed.). New Jersey: John Wiley & Sons.

BOTN-6106		**Genetics-I**		**3(2+1)**

Course Brief:

This course provides the basic biology to understand all of these issues better, tries to clarify some misconceptions, and tries to prepare students for future, more advanced coursework in Genetics. Genetics is the study of how genes bring about characteristics, or traits, in living things and how those characteristics are inherited.

Course Learning Objectives:

The aim of the course is to learn and apply concepts of modern transmission and molecular genetics. The objectives of the are: to identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes; to solve transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes; to accurately diagram and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes. This course discusses the principles of genetics with application to the study of biological function at the level of molecules, cells, and multicellular organisms, including humans.

Course Contents:

1. Extensions of Mendelian Analysis: Variations on dominance, multiple alleles, lethal alleles, several genes affecting the same character, penetrance and expressivity.
2. Linkage I:Basic eukaryotic chromosome mapping : The discovery of linkage, recombination, linkage symbolism, linkage of genes on the X chromosome, linkage maps, three-point testcross, interference, linkage mapping by recombination in humans,
3. Linkage II: Special eukaryotic chromosome mapping techniques: Accurate calculation of large map distances, analysis of single meiosis, mitotic segregation and recombination, mapping human chromosomes.
4. Recombination in Bacteria and their Viruses: Bacterial chromosome, bacterial conjugation, bacterial recombination and mapping the *E. Coli* chromosome, bacterial transformation, bacteriophage genetics, transduction, mapping of bacterial chromosomes, bacterial gene transfer.
5. The Structure of DNA: DNA: The genetic material, DNA replication in eukaryotes, DNA and the gene.
6. The Nature of Gene: How genes work, gene-protein relationships, genetic observations explained by enzyme structure, genetic fine structure, mutational sites, complementation.
7. DNA Function: Transcription, translation, the genetic code, protein synthesis, universality of genetic information transfer, eukaryotic RNA.
8. The Extranuclear Genome: Variegation in leaves of higher plants, cytoplasmic inheritance in fungi, extranuclear genes in chlamydomonas, mitochrondrialgenes in yeast, extragenomic plasmids in eukaryotes.
9. Developmental Genetics: Gene Regulation and Differentiation, Crown gall disease in plants, cancer as a developmental genetic disease.
10. Population Genetics: Gene frequencies, conservation of gene frequencies, equilibrium, Hardy-Weinberg law, factors affecting gene equilibrium.

Lab Outline:

Arrangement of genetic material:

1. Linkage and recombination.
2. Gene mapping in diploid.
3. Recombination in Fungi.
4. Recombination in bacteria.
5. Recombination in viruses.

Population Genetics:

6. Gene frequencies and equilibrium.
7. Changes in gene frequencies,
8. Blood group and Rh-factor
9. Drosophila
10. Culture technique

11. Salivary gland chromosome
12. FungalGenetics: *Saccharomyces* culture techniques and study.
13. Studies on variation in maize ear size and colour variation
14. Bacterial Genetics.
15. Bacterial cultural techniques, Gram staining (*E. coli, B. Subtilis*)
16. Transformation.
17. Conjugation.

Recommended Texts:

1. Klug, W. S., Cummings, M. R. Spencer, C. A. Palladino, M. A. & Killian, D. (2018). *Concepts of genetics* (12th ed.).New York: Pearson Publishers.
2. Klug, W. S., Cummings, M. R., Spencer, C. A. & Palladino, M. A., (2016). *Concepts of genetics*(11th ed.). New York: Pearson Publishers.

Suggested Readings:

1. Grotewold, E., Chappell, J. & Kellogg, E. A., (2015). *Plant genes, genomes and genetics* (1st ed.). New Jersey: Willey Blackwell.
2. Carey, N., (2016). *The epigenetics revolution* (2nd ed.).UK: Publisher Icon *Books* Ltd.

BOTN-6107		**Plant Biochemistry -I**		**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. Its aim is to understand the fundamental chemical principles that govern complex biological systems. At the end of the course students will be enable to understand; An understanding of fundamental biochemical principles, such as the structure/function of biomolecules. An understanding of metabolic pathways and the regulation of biological & biochemical processes.

Course Contents:

1. Introduction to photosynthetic organisms, Bioenergetics and overview of photosynthesis, Photosynthesis: The Light Reaction Photo systems, ATP Synthesis, CO_2 Fixation, RuBisCo and enzyme kinetics, C_3-Cycle, C_4-Cycle, Regulation of photosynthesis
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*, (2nded.). New Jersey:Wiley.
4. Conn E. E. & Stump, P.K., (2017). *Outlines of biochemistry*(4th ed.). New Jersey:John Wiley and Sons Inc.

BOTN-6108		Plant Anatomy		3(2+1)

Course Brief:

It emphasis on flowering plants. Identify the anatomy and morphology (cells, tissues, and tissue systems) of a given plant root. Also, emphasis on flowering plants. Explain primary growth, initiation of lateral meristems, and secondary growth in roots using appropriate terminology. Explain how the structural features of leaves and roots and their components (such as wood and cork) confer qualities that are useful to people. Compare and Contrast the structure of stem and roots.

Course Learning Objectives:

The aim of the course is to provide the students understanding about anatomical features of vascular plants. To provide students with skills necessary to section and stain fresh plant material in preparation for study of plant anatomy. To train students in the proper use of the compound light microscope and to give them experience in interpreting images that they see through the microscope in terms of how plant structure is related to function. To provide students with skills in modern microscopic digital image capture, processing and analysis techniques useful in plant anatomical studies. To instill in students an appreciation for the complexity of tissue organization that exists within plant bodies that allow plants to develop and live as integrated organisms in diverse environments. Identify the parts of a leaf and distinguish between compound and simple leaves. Identify the anatomy and morphology (cells, tissues, and tissue systems) of a given plant leaf.

Course Contents:

1. The plant body and its development: Fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body.
2. Meristematic tissues: classification, cytohistological characteristics, initials and their derivatives.
3. Apical meristem: Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices.
4. Leaf: types, origin, internal organization, development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
5. Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions: additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.
6. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
7. Anatomy of Reproductive parts: Flower, Seed, Fruit
8. Economic aspects of applied plant anatomy.
9. Anatomical adaptations.
10. Molecular markers in tree species used for wood identification.

Lab Outline:

1. Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures.
2. Study of abnormal/unusual secondary growth.
3. Peel and ground sectioning and maceration of fossil material.
4. Comparative study of wood structure of gymnosperms and angiosperms with the help of prepared slides.

Recommended Texts:

1. Crang, R., Lyons-Sobaski, S. & Wise, R., (2018). *Plant anatomy: a concept-based approach to the structure of seed plants*(1st ed.). Switzerland: Springer.

2. Schweingruber, F. H. & Borner, A., (2018). *The plant stem: a microscopic aspect*(1st ed.). Switzerland: Springer.

Suggested Readings:

1. Hacke, U. G., (2015). *Functional and ecological xylem anatomy* (2nd ed.). New York: Springer International Publishing.
2. Steeves, T.A. & Sawhney, V.K., (2018). *Essentials of developmental plant anatomy* (1st ed.).England: Oxford University Press.

ZOOL-5104		**Animal Form and Function-II**		**4(3+1)**

Course Brief:

This course will enable students to understand the diverse forms adapted to perform the same
This course will enable students to understand the diversity in animal form and function adapted according to the modified environmental conditions. Students will also be provided understanding about the need of emergence of diversity of forms for the performance of similar function in variable conditions. It also demonstrates that a form is successfully adapted to perform a function successfully according to its own environment.

Course Learning Objectives:

Upon successful completion of course students will have knowledge about nutrition and digestion process among animal groups, temperature regulation strategies adapted by animals and different modes of reproduction in several groups for their successful stay on planet. The practical section will let them to study the excretory system in invertebrate and vertebrate model animals, can study nutritive canal in an invertebrate and a vertebrate animals through dissection and will be able to study the male and female reproductive system of an invertebrate and a vertebrate animal model with familiarity of major differences in them.

Course Contents:

1. Nutrition and Digestion: Evolution; the metabolic fates of nutrients in heterotrophs; diversity in digestive structures of invertebrates,
2. Mammalian digestive system: gastrointestinal motility, digestion; pancreas, liver and gallbladder
3. Temperature and body fluid regulation: homeostasis and temperature regulation in invertebrates
4. Temperature regulation in fishes, amphibians, reptiles, birds and mammals;
5. Control of water and solutes in fishes, amphibians, reptiles, birds and mammals
6. Invertebrate and vertebrate: excretory systems
7. Reproduction and development: asexual and sexual reproduction in invertebrates;
8. Sexual reproduction in various vertebrate classes; human male and female reproductive system,
9. Prenatal development, birth, placenta; milk production and lactation in human.

Lab outline:

1. Study of excretory system in an invertebrate and a vertebrate representative (Model).
2. Study of digestive system in invertebrate and a vertebrate representative (Dissection).
3. Dissection and study of male and female reproductive system in vertebrates and invertebrates.

Recommended Texts:

1. Pechenik, J. A. (2013). *Biology of invertebrates* (4th ed.). Singapore: McGraw-Hill.
2. Hickman, C. P., Roberts, L. S., & Larson, A. (2004). *Integrated principles of zoology* (11th ed.). Singapore: McGraw-Hill.

Suggested Readings:

1. Campbell, N. A. (2002). *Biology* (6th ed.). California: Benjamin Cummings.
2. Kent, G. C., & Miller, S. (2001). *Comparative anatomy of vertebrates*. New York: McGraw-Hill.
3. Hickman, C. P. & Kats, H. L. (2000). *Laboratory studies in integrated principles of zoology*. Singapore: McGraw-Hill.

BOTANY
4th Year
7th Semester

URCG-5111		**Translation of the Holy Quran – IV**		**Non-Credit**

Course Brief:

The Quran is the exact words revealed by Allah SWT to His last Prophet Muhammad (ﷺ). It was memorized by Muhammad (ﷺ) and then dictated to his Companions, and written down by scribes, who cross-checked it during his lifetime. Not one word of the Quran has been changed over the centuries, so that the Quran is in every detail the unique and miraculous text. The Quran is the prime source of Muslim faith and practice. It deals with all the subjects which concern us as human beings: wisdom, doctrine, worship, and law, but its basic theme is the relationship between God and His creatures. At the same time it provides guidelines for proper conduct of individual, society and an equitable holistic system of human life.

Course Learning Objectives:

To familiarize the students with commandments of trade and inheritance. mentioned in the Quranic text (with the help of Urdu translation). To introduce the students to scientific facts and miracles of the Holy Qura 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 Contents:

Course Contents:	○ 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: • تخلیقِ کائنات • اجرامِ 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 وتجوید ▪ البقرہ (٢٦١، ٢٢١٥، ٢٦٥، ٢١٩، ٢٦٣، ٢٧٥، ١٨، ٢٦٥، ١٧٧، ٢٦٥، ١٦، ٢٧٥، ٢٨٢، ٢٦٢، ٢٧٣، ٢٧١، ٨٣، ١٧٧، ٢١٥، ٢٧٦، ٢٧٨، ١٦، ٢٧، ٢٢٣، ٢٩، ٢٥٥، ١٦٣، ٢٦٦، ١٦٣، ١٦٣، ٥٠، ٦٠، ١٦٣، ٥٧، ٢١٠، ١٩، ٢٦، ٧١، ٩٢، ٩٣) ▪ آل عمران (١١٧، ١٣٣، ١٣٠، ١٩٠، ٢٧، ٥٩) ▪ النساء (٢٩، ٢، ٢٩، ١٦١) ▪ المائدہ (٨٩، ٩٥، ٧٥، ٦٩، ٦٠) ▪ التوبہ (٩٨، ٢٣، ٦٩، ٢٣، ٢٣، ٦٠، ٣) ▪ الاعراف (١٧٢، ١٨٥، ٥٧، ٥٨، ١٦٣، ١٦٣، ١٦٠، ٣٠، ١٣٣، ١٧٦، ١٦٦) ▪ الرعد (١٧، ٣) ▪ الطور (٣٣) ▪ الانعام (٥٩، ٦٣، ١٣١، ١٣٦، ٣٨) ▪ الانفال (٢٨، ٣٦، ٣١)

▪ الكهف (٥١، ١٠٩، ٣٧، ٣٢، ٣٥، ١٧، ٣٥) ▪ الجاثيه (٥) ▪ فاطر (٢٧، ١٢، ١٣) ▪ العنكبوت (٢٠، ٦٣، ٣١) ▪ الروم (٥٠) ▪ الاسراء (٧٠، ٩٩) ▪ الرعد (٢) ▪ السبا(١٠، ٣، ٢٢) ▪ يونس (٨٨، ١٠١، ٢٣، ٢٣، ٥، ٢٢) ▪ يوسف (٩٣، ١٣) ▪ الفرقان (٦٢، ٥٣) ▪ لقمان (٢٩، ١٦) ▪ طه (١١٣، ٥٣) ▪ النحل (٧٥، ١١، ٦١، ٣٩، ٧٩، ٦٨، ٦٨، ١١٥، ٨، ٨) ▪ النمل (٦٣، ٦٣، ٨٨، ٦٠، ٨٢، ١٦، ١٧، ١٨) ▪ السجده (٢٧) ▪ الحديد (٦) ▪ هود (٣٣، ٦) ▪ يسين (٣٧، ٣١) ▪ الروم (٣٩، ٣٩، ٥٠، ١٩، ٢٣، ٣٦) ▪ فصلت (٣٩، ٣٩)	
▪ الحج (٦١، ٦٥، ٢٢، ٧٣) ▪ الحجر (١٩، ٢٢) ▪ الانبياء (٣١، ٣٠، ٣٧) ▪ الزاريات (٣٧) ▪ الزلزله (١) ▪ القصص (٧٦، ٧٩، ٨٠، ٨١، ٨٢) ▪ النور (٣٧، ٢٢، ٢٢، ٣٠، ٣٥، ٣٣) ▪ الجمعه (١١، ٦٢، ١٠، ١١، ٥) ▪ القمر (٧) ▪ الواقعه (٦٩) ▪ الفاطر (٢٠، ١٣) ▪ الملک (١٩) ▪ الصف (١٠) ▪ الجن (١٣) ▪ الشورىٰ (٢٨) ▪ الزخرف (١١) ▪ الفيل (١)	

BOTN-6109		**Environmental Biology**		**3(2+1)**

Course Brief:

Environmental Biology encompasses varied themes such as energy flow biosphere & biomes, carbon trading and other biogeochemical cycling, greenhouse gas emissions, water resource management, land degradation and rehabilitation, flora and fauna, habitat destruction, deforestation, energy and mineral depletion, air and water pollution, soil erosion, and groundwater contamination. This course provides insight into of the basic science of environmental biology and ecological theory. Environmental Biology helps in recognition of environmental problems such as climate change, global warming, ozone layer depletion, acid rains as well.

Course Learning Objectives:

The aim of the course is to provide updated knowledge of environmental problems and sustainable environmental management. This course enables students to develop strong expertise in contemporaneous themes in ecological research, develop critical thinking and to discuss about advanced topics in population, community and ecosystem ecology as well as in biodiversity research.

Course Contents:

1. Environment: Introduction, scope and pressure.
2. Pollution: Definition, classification and impact on habitats.
3. Air pollution: Sources and effect of various pollutants (inorganic, organic).on plants, prevention, control and remediation. Smog, photochemical smog. Acid rain: Theory of acid rain, adverse effects of acid rains. Chlorofluorocarbons and its effects.
4. Water pollution: Major sources of water pollution and its impact on vegetation, prevention, control, remediation, eutrophication and thermal pollution.
5. Sediments pollution: Fungicide, pesticides, herbicide, major sources of soilpollution and its impact. Prevention, control, remediation, heavy metalpollution. tanneries, hospital waste. Treatments of sewage, sludge, and polluted waters.
6. Noise pollution.
7. Radiation pollution (including nuclear radiation): Measurement, classification and effects, principle of radiation protection, waste disposal
8. Forest: Importance, deforestation, desertification and conservation.
9. Ozone layer:Formation, Mechanism of depletion, Effects of ozone depletion
10. Greenhouse effect and global warming: Causes and impacts.
11. Human population explosion: Impact on environment.
12. Environment impact assessment: Industrial urban, civil developments.
13. National conservation strategy: Brief review of major environmental problems of Pakistan and their solutions.
14. Sustainable environmental management.
15. Wetlands and sanctuaries protection: The pressures, problems and solutions.
16. Range management: Types of rangelands, potential threats, sustainable management.
17. Aerobiology: Pollen allergy and dust allergy.

Lab Outline:

1. Examination of industrial waste water and Municipal sewage and sludge for: Total dissolved solids, pH and EC, BOD/COD, Chlorides, carbonate, and Nitrates.
2. Examination of water samples forms different sites for the presence and diversity of organisms.
3. Effect of air pollutants on plants.
4. Visits to environmentally compromised sites and evolution of remediation

Recommended Texts:

1. Ren, H. & Zhang, X., (2019). *High-risk pollutants in wastewater* (1st ed.). Amsterdam: Elsevier Publishing Company.
2. Nriagu, J., (2019). *Encyclopedia of environmental health*(2nd 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. Fisher, M., (2018). *Environmental biology*(1st ed.).Medford: Open Oregon Press Book Publishing Company.

BOTN-6110		**Molecular Biology**		**3(2+1)**

Course Brief:

Molecular biology is a specialized branch, the study of the chemistry of molecules which are specifically connected to living processes. Of particular importance to molecular biology are the nucleic acids (DNA and RNA) and the proteins which are constructed using the genetic instructions encoded in those molecules. As a result, molecular biology techniques are at the forefront of most cutting edge scientific research. In this project you will investigate a number of commonly used molecular biology techniques involving DNA. The molecules which form the basis of life provide scientists with a more predictable and mechanistic tool for scientists to study. Working with whole organisms (or even just whole cells) can be unpredictable, with the outcome of experiments relying on the interaction of thousands of molecular pathways and external factors. Molecular biology provides scientists with a toolkit with which they may "tinker" with the way life works. They may use them to determine the function of single genes or proteins, and find out what would happen if that gene or protein was absent or faulty. Molecular biology is used to examine when and why certain genes are switched "on" or "off".

Course Learning Objectives:

To disseminate the knowledge of molecular basis of life

Course Contents:

1. Nucleic Acids: DNA-circular and superhelical DNA, renaturation, hybridization, sequencing of nucleic acids, synthesis of DNA, Central Dogma
2. Proteins: Basic features of protein molecules, folding of polypeptide chain, α-helical and β-secondary structures, protein purification and sequencing.
3. Transcription: Enzymatic synthesis of RNA, transcriptional signals. Translation: The genetic code, the Wobbling, polycistronic and monocistronic RNA, overlapping genes.
4. Gene regulation in Eukaryotes: Differences in genetic organization and prokaryotes and eukaryotes. Regulation of transcription, initiation, regulation of RNA processing, regulation of nucleocytoplasmic mRNA transport, regulation of mRNA stability, regulation of translation, regulation of protein activity.
5. Plant Genomics: Transcriptomics; DNA libraries, their construction, screening and application. Microarray of gene technology and its application in functional genomics.
6. Proteomics: Structural and functional proteomics, methods to study proteomics Metabolomics; methods to study metabolomics; importance and application of metabolomics
7. Bioinformatics and Computational Biology. Levels, scope, potential and industrial application of bioinformatics and computational biology, docking.

Lab Outline:

Following techniques will be used for the isolation and analysis of different components:

1. Extraction of RNA, DNA and proteins.
2. Electrophoreses: One and two dimensional
3. Purification of proteins, RNA and DNA.
4. Amplification using PCR.
5. Northern, Western and Southern Blotting.

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*(8thed.). 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.

BOTN-6111		Plant Biochemistry-II		3(2+1)

Course Brief:

This course provides an advanced introduction to the fundamental processes of plant metabolism. Topics will include protein structure and function, mechanisms and control of enzyme action, the biochemistry of carbohydrate, fat and protein metabolism, energy generation and ruminant specific biochemistry. Explain how protein structure and function is derived from the constituent amino acids, and compare the features of structural and globular proteins. Describe the basic principles governing the rate of enzyme catalysed reactions and the forms of inhibition of enzyme-catalysed reactions. Describe the major pathways of carbohydrate, lipid and amino metabolism and demonstrate how energy is stored and released through them. 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 Learning Objectives:

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

Course Contents:

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.
2. 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.

BOTN-6112		**Plant Physiology-II**		**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 process 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 mechanism 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 advance 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 Contents:

1. Plant Growth Regulators: Major natural hormones and their syntheticanalogues. Bioassay, structure, biosynthesis, receptors, signal transduction and mode of action and transport. Physiological effects of auxin, gibberellins, cytokinins, abscisicacid, 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 itspotentials. Water in cell components. Absorption of water in plants (pathways and drivingforces, aquaporins, their structure and types).Cell water relations terminology. Hoflerdiagram - 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. Phytochromesand 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. Nasticmovements.

Lab Outline:

1. To investigate the preferential absorption of ions by corn seedlings and potato slices.
2. To determine 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.

BOTANY
8th Semester

BOTN-6113		**Genetics-II**		**3(2+1)**

Course Brief:

Recombinant DNA technology has revolutionized our ability to investigate the genomes of diverse species and has led to the modern revolution in genomics. Modern genetic techniques are playing an emerging role in agriculture, health, medicine, foods, disease diagnosis and therapy. Genetic technology is developing faster than the policies, laws, and conventions that govern its use. The course aims to develop students' problem solving skills and to introduce them recombination of genetic material at molecular levels with emphasis on introduction to biotechnology and genomics. It also provides information to extend their knowledge about different Mechanisms of Genetic Change and to help them thinking in an analytical way. The objectives of learning of this course includes: to introduce recombinant DNA technology and to elaborate application of recombinant DNA.

Course Learning Objectives:

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

Course Contents:

1. Recombinant DNA: Recombinant DNA Technology Introduction, basic techniques, PCR and Rt PCR, Restriction enzymes, Plasmids, Bacteriophages as tools, the formation of recombinant DNA, recombinant DNA technology, site directed mutagenesis, DNA sequencing.
2. Application of Recombinant DNA: Applications of recombinant DNA technology using prokaryotes, recombinant DNA technology in eukaryotes: An overview, transgenic yeast, transgenic plants, transgenic animals, screening for genetic diseases, identifying disease genes, DNA typing, gene therapy, genetically modified organisms and apprehensions.
3. Mechanisms of Genetic Change I: Gene Mutation: The molecular basis of gene mutations, spontaneous mutations, induced mutations, reversion analysis mutagens and carcinogens, biological repair mechanisms.
4. Mechanisms of Genetic Change II: Recombination: General homologous recombination, the Holiday model, enzymatic mechanism of recombination, site-specific recombination, recombination and chromosomal rearrangements.
5. Mechanisms of Genetic Change III: Transposable Genetic Elements: Insertion sequences, transposons, rearrangements mediated by transposable elements, review of transposable elements in prokaryotes, controlling elements in maize.
6. Human Genome Project: Strategies and application, achievement and future prospects.
7. Plant Genome Projects: Arabidopsis, achievement and future prospects. Other plant genome projects
8. Bioinformatics: Application of computational tests to the analysis of genome and their gene products
9. Bioethics: Moral, religious and ethical concerns

Lab Outline:

Problems relating to the theory

1. Isolation and separation of DNA and protein on gel electrophoresis: Bacterial chromosome, Plasmid DNA(mini-preps), Plant DNA, Protein.
2. DNA Amplification by PCR

Recommended Texts:

1. Stevens, T. & Newman, S., (2019). *Biotech juggernaut: hope, hype, and hidden agendas of entrepreneurial bioscience*(1st ed.).Philadelphia: Routledge.
2. Shukla, P., (2018). *Applied microbiology and engineering: an interdisciplinary approach*(1st ed.).London:

Academic Press.

Suggested Readings:

1. Se-Kwon, K., (2015). *Handbook of marine biotechnology*(1st ed.). New York: Springer Publications.
2. Venkat, B., Sahijramand, R. & Murthy, K., (2015). *Plant biology and biotechnology* (2nd ed.). New York: Springer Publications.
3. Watson, J., Berry, A. & Davies, K., (2017). *DNA: the story of the genetic revolution* (1st ed.). New York: Knopf Doubleday Publishing Group

BOTN-6114		Plant Ecology-II		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. Also give brief account about plant adaptations. 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 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 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 Contents:

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* (1sted.). England: Cambridge University Press.
3. Osaki, M. & Tsuji, N., (2016). *Tropical peat land ecosystems*(1st ed.).Berlin: Springer Verlag.

BOTN-6115		Ethnobotany		3(2+1)

Course Brief:

Ethnobotany is the scientific study of interactions between human cultures and plants/plant environments (the interrelationships between people and plants). This course examines many different levels and types of interactions between people and plants. The course offers exciting insights into groups of economically important plants such as grasses, legumes, and staples, and how plants serve as a source of useful natural products. The course provides important examples on the economic importance of plants, and how the study of plants with a focus on medicine, health, and nutrition can shape the future careers of students.

Course Learning Objectives:

The goal of this course is to introduce students to the fascinating world of the relationships between people and plants. The course offers a unique and multidisciplinary approach that includes plant structure and function, plant diversity, the origins of agriculture, and the uses of plants by peoples around the world. As plants are important to people, the course focuses on how plants affect human health, nutrition and well-being, interact with other organisms, and provide critical support to biodiversity. The course also offers important views on how people damage plants and their habitats, and how the reversion of this trend is important to secure the future of humankind.

Course Contents:

1. Definition-Scope. History of ethnomedicinal plants. Traditional Medicinal systems:
2. Ayurvedha, Siddha, Unani and Naturopathy.
3. Definition of Drug-
   Classification of natural drugs, alphabetical, morphological, pharmacological, chemical and chemo taxon omical.
4. Traditional and Folklore medicines. Native medicine. Major tribes of the Sargodha region and their ethnobotanical and ethno-biological heritage.
5. Ethno Medicines. Ethnobotany and conservation of plants with special reference to Pakistan –mythology and conservation of ecosystems, conservation of selected plant species: sacred grove, forestry and unique ecosystems and their ethnobiological values, plants and animals in art, tradition and ethnography: Ethnobotanical field methods.
6. Pharmacognosy: Definition and scope,drug adulteration,drug evaluation;chemical evaluation, physical evaluation and biological evaluation.
7. Phytochemical investigations, standardization and quality control of herbal drugs.
8. Cultivation, collection and preparation of natural drugs. Macroscopic characters: physical andorganoleptic characters, therapeutical and pharmaceutical uses of the local ethnomedicinal plans: Commercial value.

Lab outline:

1. Ethnobotanical survey of various places
2. Preparation of herbarium sheets of ethnobotanicalplants.
3. Phytochemical analysis of ethnobotanicalplants.
4. HPLC of selected plant extracts.

Recommended Texts:

1. Rafael, L., Casas, A., & Jose, B. (2016). *Ethnobotany of mexico*. USA: Springer publisher.
2. Albuquerque, A., Paulino, U., Alves, N., & Romeu, R. (2016). *Introduction to ethnobiology*. USA: Springer publishers.

Suggested Readings:

1. Rainer, B. (2017). *Ethnobotanyof the Caucasus*. USA: Springer Publisher.
2. Schmidt, B. M., Diana, M., & Cheng, K. (2017). *Ethnobotany: a phytochemical perspective*. New Jersey: Wiley publishers.
3. Pullaiah, T., Murthy K., & Bahadur, B. (2017). *Ethnobotany of India.* UK: Taylor and Francis Publishers.

Optional Courses

BOTN-6116		**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 Contents:

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, anti-transpirants.
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 transpirationof 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.

BOTN-6117		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 scale 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.Microtechnique 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 Contents:

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, stainsand staining techniques, Camera Lucida types, principles and their uses.
5. Micrometry

Lab outline:

Preparation of hand sections, maceration and clearing

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

BOTN-6118		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 Contents:

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 outline:

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.

BOTN-6119		**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 neopalynology 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 Contents:

1. An introduction to Neopalynology 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 Magnolid 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.

BOTN-6120		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 Contents:

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.

BOTN-6121		**Plant Biotechnology**		**3(2+1)**

Course Brief:

This course explores the use of biotechnology to both generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation. There is an emphasis on the molecular mechanisms directing plant gene expression under diverse environmental and developmental stimuli.

Course Learning Objectives:

The aim of the course is to introduce students to genetic engineering, cloning strategies, PCR and genetic markers and applications of plant biotechnology, to provide updated knowledge of environmental problems and sustainable environmental management through treatment technologies such as phytoremediation. The objective of the course is to give students new knowledge and widening of the knowledge acquired in other course by handling of classical and modern plant biotechnology processes, including breeding of healthy plants, plants with improved characteristics and plants for biomolecule production. This course enhances the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical and agricultural applications.

Course Contents:

1. Biotechnology: Definition, history, scope and significance. Principles and applications of genetic recombinant technology in medicine, agriculture, veterinary and food industry. Production of biotechnological products – food SCP(algae, yeast, mushroom).
2. Biofertilizers, biofuel, biopesticides, biogas production, waste and sewage management, effective microorganisms.
3. Enzyme biotechnology: Sources and production of commercially importantenzymes. cellulase, amylase, pectinases, proteinases. Immobilization of enzymes and its applications.
4. Amplification of genes by PCR, cDNA and construction of cDNA libraries.
5. Blotting techniques (Southern, northern and western blotting) nonradioactive probe DNAdiagnostics (RF LP, AFLP and RAPD). DNA sequencing.
6. Recombinant DNA technology-gene transfer in plants. Vectors – types, plasmids (PBR 322, PBR 327), cosmid insertion vectors, replacement vectors, shuttle vectors and high expression vectors.
7. Strategies for development of transgenicplants, specificandnon-specific methodsofgene transfer, organization of Ti plasmid in Agrobacterium tumifaciens-Ti plasmid mediated gene transfer. DNA transfer by particle bombardment, micro and macro injection methods –lipofection-electroporation. Gene cloning in E. *coli.* isolation of DNA – insertion of DNA – use of linkers and adapters, transformation, uptake of DNA by host cell, selection of clones, identification of recombinants, insertional inactivation.
8. Plant tissue culture: Concept of totipotency-organization of tissue culture laboratory. Sterilization methods-callus induction, subculture and maintenance. Organogenesis, anther culture and production of haploids, somatic embryogenesis-isolation, culture and fusion of protoplasts-cybrids, micro-propagation,encapsulatedseeds.

Lab outline:

1. Extraction and estimation of plant DNA.
2. Basic biotechnology techniques
3. Preparation of different types of standard tissue culture media.
4. Establishment of aseptic cultures following appropriate sterilization procedures using seeds.
5. Preparation of culture medium (MS, N&N, SH, B5), sterilization and inoculation.
6. Demonstration of Agarose gel electrophoresis.
7. Encapsulation of seeds/embryos in calcium alginate.

8. Visits of Biotechnology labs at NIBGI, Faisalabad, AARI, Faisalabad and School of Biological Sciences Lahore, Center of Excellence in Molecular Biology, Lahore: National institute for Genomics and Advance Biotechnology (NIGAB)

Recommended Texts:

1. Abdin, M.Z., Kiran,U.Kamaluddinand, A. &Ali, M.A.(2017). *Plant biotechnology: principles and applications*(1st ed.).New York: Springer.
2. Kumar, S., Kumar, R., & Pandey, A. (2019). *Current developments in biotechnology and bioengineering: waste treatment processes for energy generation*(1st ed.).Amsterdam: Elsevier .
3. Gahlawat, S. K., Salar, R.K., Siwach, P.,Duhan, J. S.,Kumar, S., &Kaur, P. (2017).*Plant biotechnology: recent advancements and developments*(1st ed.).New York: Springer.

Suggested Readings:

1. Smith, R. H., (2013). *Plant tissue culture: techniques and experiments* (3rd ed.).Cambridge:Academic Press.
2. Stewart, N., (2017). *Plant biotechnology and genetics: Principles, Techniques, and Applications*(2nd ed.).New Jersey: Wiley Online Liberar.

BOTN-6122		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 Contents:

1. *E*nvironment: Introduction, scope, pressure.
2. Pollution: Definition, classification and impact on habitats
3. Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, and remediation. Smog, photochemical smog.
4. Acid rain: Theory of acid rain, Adverse effects of acid rains, chlorofluorocarbons and its effects.
5. Water pollution: Major sources of water pollution and its impact on vegetation, prevention, control remediation, eutrophication, and thermal pollution.
6. Sediments pollution: Fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control, remediation, heavy metal pollution, tanneries, hospital waste. Treatments of sewage, sludge, and polluted waters.
7. Noise pollution.
8. Radiation pollution (including nuclear radiation): Measurement, classification and effects, principle of radiation protection, waste disposal.
9. Forest: Importance, deforestation, desertification and conservation.
10. Ozone layer:Formation, Mechanism of depletion, Effects of ozone depletion
11. Greenhouse effect and global warming: Causes and impacts.
12. Human population explosion: impact on environment.
13. Impact assessment: Industrial urban, civil developments.
14. National conservation strategy: Brief review of major problems of Pakistan and their solutions.
15. Sustainable Environmental management.
16. Wetlands and sanctuaries protection: The pressures, problems and solutions.
17. Range management: Types of rangelands, potential threats, sustainable management.
18. Aerobiology: Pollen allergy and dust allergy.
19. Physical conditions and availability of resources: Introduction, environment conditions, effect of condition, animal responses, microorganisms, plant resources and animal resources.
20. Applied issues in conservation: Sustainability, forming of monoculture and pest control.
21. Role of natural resources in conservation: Types of resources (renewable and non-renewable), wild life management, species conservation, conservation of habitat, introduction of exotic species, natural parks, forest resources, soil and water resources, food and agriculture resources.

Lab outline:

1. Examination of industrial waste water and Municipal sewage and sludge for: Total dissolved solids, pH and EC, BOD/COD, Chlorides, carbonate, and Nitrates
2. Examination of water samples forms different sites for the presence and diversity of organisms.
3. Effect of air pollutants on plants.
4. Visits to environmentally compromised sites and evolution of remediation methods.
5. Visits to disturbed ecosystems
6. Survey of different important species for conservation.
7. Visits to different sanctuaries.

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.

BOTN-6123		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.

BOTN-6124		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 Contents:

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.

BOTN-6125		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 Contents:

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.

BOTN-6126		**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 (hydrodistillation, solvent extraction, and quality control), assessment of dried botanicals, and quality assessment and sensory analysis of essential oils.

Course Contents:

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.

BOTN-6127		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 Contents:

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.

BOTN-6128		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, 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.
4. Das, S. (2018). *Microbial biodegradation and bioremediation, reprint ed*. Amsterdam: Elsevier Science Publishing Co Inc.

BOTN-6129		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 Contents:

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 and 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.

BOTN-6130		**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 behaviour 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 Contents:

1. Nature and classification of pollutants, sources and effects of pollutants on plant growth viz; fluoride, Sulphur dioxide (SO_2), 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.* United Kingdom: 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.

BOTN-6131		**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 Contents:

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.

BOTN-6132		**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 Contents:

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). 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.

BOTN-6133		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 Contents:

1. The plant body and its development: fundamental parts of the plant body, internal organization, different tissue systems of primary and secondary body.
2. Meristematic tissues: classification, cytohistological characteristics, initials and their derivatives.
3. Apical meristem: Delimitation, different growth zones, evolution of the concept of apical organization. Shoot and root apices.
4. Leaf: types, origin, internal organization, development of different tissues with special reference to mesophyll, venation, bundle-sheaths and bundle-sheath extensions. Enlargement of epidermal cells.
5. Vascular cambium: Origin, structure, storied and non-storied cell types, types of divisions: additive and multiplicative; cytoplasmic characteristics, seasonal activity and its role in the secondary growth of root and stem. Abnormal secondary growth.
6. Origin, structure, development, functional and evolutionary specialization of the following tissues: Epidermis and epidermal emergences, Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem with special emphasis on different types of woods, Periderm.
7. Secretory tissues: Laticifers (classification, distribution, development, structural characteristics, functions) and Resin Canals.
8. Anatomy of reproductive parts: Flower, Seed, Fruit
9. Economic aspects of applied plant anatomy.
10. Anatomical adaptations.
11. Molecular markers in tree species used for wood identification.

Lab outline:

1. Study of organization of shoot and root meristem, different primary and secondary tissues from the living and preserved material in macerates and sections, hairs, glands and other secondary structures.
2. Study of abnormal/unusual secondary growth.
3. Peel and ground sectioning and maceration of fossil material.
4. Comparative study of wood structure of gymnosperms and angiosperms with the help of prepared slides.

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.

BOTN-6134		**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 Contents:

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). Act-2015, 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.

BOTN-6135		**Research Methodology**		**3(3+0)**

Course Brief:

The course introduces the language of research, ethical principles and challenges, and the elements of the research process within quantitative, qualitative, and mixed methods approaches. Participants will use these theoretical underpinnings to begin to critically review literature relevant to their field or interests and determine how research findings are useful in forming their understanding of their work, social, local and global environment.

Course Learning Objectives:

This course aims to know about research methods, research process, research design, development of skills for writing the research paper and knowledge about the major theoretical and philosophical underpinnings of research. The primary objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. This course will provide an opportunity for participants to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches.

Course Contents:

1. Research Methods: Planning research, various methods, analyzing results, giving reports etc
2. Research Process: Formulating research questions; sampling (probability and no probability.
3. Measurements: Surveys, scaling, qualitative, unobtrusive.
4. Research Design; Experimental and quasi-experimental, data analysis
5. Writing the Research Paper, the major theoretical and philosophical underpinnings of research including; the idea of validity in research, reliability of measures; and ethics.

Recommended Texts:

1. Leedy, P. & Ormrod, J.A., (2019). *Practical research: planning and design*(12th ed.).New York: Pearson Publishers.
2. Creswell, J. & Creswell, D., (2018). *Research design: qualitative, quantitative, and mixed methods approaches* (5th ed.). New York: SAGE Publishers.

Suggested Readings:

1. Merriam, S. & Tisdell, E., (2015). *Qualitative research: a guide to design and implementation*(4th ed.). New Jersey: John Wiley & Sons Incorporation .
2. Booth, W., Colomb, G., Williams, J. Bizup, J.& Gerald, W.F., (2016). *The Crafts of Research* (4th ed.). Chicago: University of Chicago Press.
3. Flick, U., (2017). *Introducing research methodology: a beginner's guide to doing a research project* (1st ed.).New York: SAGE Publishers.

PSYC-5101		Introduction to Psychology		3(3+0)

Course Brief:

The course is designed to be an introduction to the science and profession of psychology. The course will assist the student in developing a foundation of basic knowledge to pursue further studies in specific areas of psychology—introduction to general psychology as the science of the human mind and behaviour. The course will examine the different models upon which modern psychology has been built, along with the history and origins of psychology.

Course Learning Objectives:

The course will survey introductory topics such as learning, memory, sensation and perception, personality, lifespan development, the physiological basis of behaviour, stress, health, psychological disorders, social psychology, and research methods. Students explore the key figures, diverse theoretical perspectives, and research findings that have shaped some of the major areas of contemporary psychology. This course also examines the research methods psychologists use across these areas to study the origins and variations in human behaviour.

Course Contents:

1. Introduction to Psychology: Nature and Application of Psychology with particular reference to Pakistan 2. Research Enterprise in Psychology (A brief sketch): Goals of Scientific Enterprise; Steps in Scientific Investigation; Advantages of Scientific Approach; types of research.
3. Biological Basis of Behavior: Communication in the Nervous System; Organization of the Nervous System; Brain Research Method
4. Sensation and Perception : Psychophysics: Basic Concepts and Issues: Our senses of Sight: The Visual System: Our Senses of Hearing: The Auditory System: Our Senses of Touch: Sensory Systems in the Skin: The other Senses: The Kinesthetic System & The Vestibular System
5. Motivation and Emotion. The Motivation of Hunger and Eating; Affiliation: Theories of Emotion (James Lange Theory & Cannon-Bard Theory; Schachter's Two Factor Theory & Evolutionary Theories of Emotion)
6. Learning: Definition of Learning; Types of Learning (Classical Conditioning &. Operant Conditioning) 7. Human Memory: Encoding: Storage: Retrieval; Forgetting: When Memory Lapses; In Search of Memory Trace: The Physiology of Memory; Are There Multiple Memory Systems?
8. Language, Thinking & Decision making: The Cognitive revolution In Psychology; Language: Turning Thoughts into Words; Problem-Solving: In Search of Solutions; Decision Making: Choices and Chances 9. 9 Personality: Theory, Research, and Assessment: The Nature of Personality; Psychodynamic Perspectives; Behavioral Perspectives; Humanistic Perspectives; Biological Perspectives; Contemporary Empirical Approaches to Personality Traits; Culture and Personality

Recommended Text:

1 Weiten, W. (2017). Psychology: Themes and variations (10th ed.). Boston: Cengage Learning.
2 Kalat, J. W. (2013). Introduction to psychology (10th ed.). New Delhi: Cengage Learning.
3 Nolen-Hoeksema, S., Hilgard, E. R. (2014). Atkinson & Hilgard's introduction to psychology (16th ed.). New Delhi: Cengage Learning.

Suggested Readings:

1 Plotnik, R., & Kouyoumdjian, H. (2013). Introduction to psychology (10th ed.). Boston: Cengage Learning.
2 Flanagan, C., Berry, D., Jarvis, M., & Liddle, R. (2015). AQA psychology. Cheltenham: Illuminate Publishing.

PSYC-5105		Experimental Psychology		3(3+0)

Course Brief:

This course provides students with a coherent overview of classic and contemporary data on the nature of experimental psychology. Experimental psychology is an applied research course for psychology majors. Basic research methods and terminology are presented and practised in the classroom, and then the same basic research principles are practised and applied in a laboratory setting.

Course Learning Objectives:

This course Introduces research methods employed in studying the cognitive and social determinants of thinking and decision-making. Students gain experience in conducting research, including designing simple experiments, observation and preference elicitation techniques; analysing behavioural data, considering validity, reliability, and research ethics; and preparing written and oral reports. Students will learn how to plan, conduct, and analyze their experimental research and how to communicate the results of their research to others. This course will enable students to familiarise themselves with the critical evaluation of experimental data and their relations to current models of the human psyche.

Course Contents:

1 Introduction: Development of Experimental Psychology
2 Psychophysics: Importance of Psychophysics; Absolute & Differential Thresholds; Psychophysical Methods; Theory of signal detection
3 Learning: Simple Learning and Conditioning; Classical versus instrumental conditioning; Basic factors in learning and performance; Role of reinforcement in learning; Contemporary theories of Learning; Transfer of training
4 Memory: Theories of Memory; Compartments of Memory; The storage and retrieval process; Transplantation of Memory; Memory Experiments; Mnemonics: ways of improving memory (Devices Mnemonics)
5 Thinking and Problem-Solving: Nature of Thinking; Concept formation; Imageless thought Controversy; Set and attitude as factors in Thinking; Creative Thinking; Theories of Thinking
6 Practical Work: Ten experiments out of the following list shall be performed by the students:
7 Meaningful vs. Nonsense Learning;
8 Retroactive Inhibition
9 Simple Reaction Time; Judgment of Time
10 Transfer of Training: Whole vs Part Learning
11 Trial Position Effect under Massed and Distributed Practice
12 Retention for Complete and Interrupted Task
13 Mapping Cutaneous Sense Spot
14 Mental Fatigue; Negative After Image
15 Thermal Adaptation

Recommended Text:

1 Martin, D. W. (2008). Doing psychology experiments. Belmont, CA: Thomson-Wadsworth.
2 Postman, L., & Egan J. P. (2001). Experimental psychology. New Delhi: Kalyan Publishers.
3 Stevens, S. S. (2002). Handbook of experimental psychology (3rd ed.). London: John Wiley& sons.

Suggested Readings:

1 Galotti, K. M. (2004). Cognitive psychology in and out of laboratory (3rd ed.). Belmont, CA:Vicki Knight.
Robert, J. S., & Karin, S. (2016). Cognitive psychology (7th ed.). Boston: Cengage Learning.

PSYC- 5106		Social Psychology		3(3+0)

Course Brief:

This course offers to review theory and research in social psychology and to apply its major principles to situations encountered in everyday life. This course will also help familiarise you with social psychology by discussing classic topics of study and experiments that have defined the field. You will be able to recognize and evaluate social, cultural, spiritual, and other types of diversity and discuss scientific research methods commonly used to investigate social psychological phenomena. You will think critically about the merits of research findings, theories, and conclusions and gain an informed perspective on how social situations influence behaviour in everyday settings.

Course Learning Objectives:

It will discuss the relevance of social psychological research for understanding human social behavior and apply that knowledge to one's personal growth and development. It will also demonstrate the utility of applying social psychological theory and research to real-world problems and issues for the benefit of society.

Course Contents:

1 The Field of Social Psychology: Introduction, Current trends and future scope Conducting research in social psychology
2 Self-Presentation and Social Perception: Non-verbal Behaviour, Attribution, Impression Management
3 Social Cognition: Schemas, Heuristics, Affect and Cognition
4 Behaviour and Attitudes, Cognition & attitude
5 Aspects of Social Identity: The self: Nature of the self, Self-concept, Social diversity, Self- esteem; Self-focusing, Self Monitoring, Self Efficacy; Gender: Maleness or femaleness
6 Social Influence: Conformity, Compliance, Obedience
7 Pro-social Behavior
8 Aggression /hurting others,
9 Prejudice and Discrimination
10 Interacting with others: Interpersonal Attraction - need, characteristics of other situations and problems; Intimacy — Parent-child
11 Group Influence
12 Facilitation, Social loafing; Coordination in groups; Cooperation or conflict;
13 Leadership
14 Role of Media in Social Psychology: Perception, Persuasion, Propaganda, Portrayal of Role Models & Media and Agent of change
15 Social Psychology in action
16 A war against terrorism, Safety issues, and the role of media in society Note: Each student shall prepare a report on any one issue concerning humanity e. g. i) Stereotypes ii) Health, iii) Law

Recommended Text:

1 Branscombe, N. R., & Baron, R. A. (2017). Social psychology (14th ed.). Canada: Pearson education.
2 DeLamater, J. D., & Myers, D. J., & Collett, J. L. (2015). Social psychology (8th ed.). New York: Westview Press.

Suggested Readings:

1 Crisp, R. J. & Turner, R. N. (2014) Essential social psychology (3rd ed.). New York: SAGE Publications Ltd.
2 Myers, D. G. & Twenge, J. (2019). Social psychology (13th ed.). New York: McGraw- Hil

GEOG - 5102		Physical Geography		3(3-0)

Course Brief:

This course provides an opportunity for understanding part of the complex physical and biological environment in which human beings live. It introduces basic processes that influence the characteristics and spatial relationships of climate, water cycle and vegetation. The first part of the course examines the interactions of solar energy with the Earth's atmosphere and surface, and how atmospheric circulation, precipitation, and weather systems are generated. The second part of the course covers the cycling of water and other Earth resources within the living zone - the biosphere. It focuses on how these cycles, together with the flows of energy, influence the nature and distribution of ecosystems and vegetation.

Course Learning Objectives:

Throughout the course, students look at patterns of human activity that are in response to and have an effect upon environmental processes, and are asked to observe and interpret aspects of their local environment in light of what they have learned.

Course Contents:

1. Definition, scope and major branches
2. Realms of the physical environment
3. Lithosphere
4. Internal structure of earth
5. Rocks–origin, formation and types: Igneous, Sedimentary and Metamorphic Rocks
6. Plate tectonics, mountain building forces.
7. Geomorphic processes – endogenic and exogenic processes and their resultant landforms
8. Earthquakes and volcanic activity, folding and faulting
9. Weathering, mass wasting, cycle of erosion, erosion and deposition
10. Landforms produced by running water, ground water, wind and glaciers
11. Atmosphere
12. Composition and structure of atmosphere
13. Atmospheric temperature and pressure, global circulation
14. Atmospheric moisture and precipitation
15. Air masses and fronts
16. Cyclones and other disturbances
17. Hydrosphere
18. Hydrological cycle
19. Ocean composition, temperature and salinity of ocean water
20. Movements of the ocean water; waves, currents and tides
21. Biosphere

Recommended Texts:

1. Strahler, A. (2013). *Introduction to physical geography*. New York: John Wiley & Sons.
2. Thornbury, W. D. (2004). *Principles of geomorphology*. New Jersey: John Willy &Sons.

Suggested Readings:

1. Strahlar, A. N., & Strahlar, A. H. (2004). *Physical environment.* New York: John Wiley & Sons.
2. Stringer, E. T. (2004). *Modern physical geography*. New York: John Wiley & Sons.

GEOG– 5103		Human Geography		3(3-0)

Course Brief:

This course provides an introduction to Human Geography. The major thrust is on the study of human societies in their relation to the habitat or environment. Dealing with the spatial distribution of societies, human geography covers a very wide field or its scope is enormous. It embraces the study of human races; the growth, distribution and density of populations of the various parts of the world, their demographic attributes and migration patterns; and physical and cultural differences between human groups and economic activities. It also covers the relationship between man and his natural environment, and the way in which his activities are distributed. Human geography also takes into account the mosaic of culture, language, religion, customs and traditions; types and patterns of rural settlements, the site, size, growth and functions of urban settlements, and the functional classification of towns.

Course Learning Objectives:

The study of spatial distribution of economic activities, industries, trade, and modes of transportations and communications as influenced by the physical environment are also the important topics of human geography.

Course Contents:

1. Introduction
2. Definition, scope and branches
3. Basic approaches
4. Population and its characteristics and population distribution
5. Population structure and composition
6. Population dynamics (fertility, mortality, migration etc.)
7. Economic activities
8. Agriculture, mining, forestry, animal husbandry and poultry
9. Industries: cottage, light and heavy
10. Trade, transport and services
11. Tourism
12. Settlements
13. Theories of human settlement
14. Types of settlements

Recommended Texts:

1. Ahmed, Q. S. (2001). *Fundamentals of human geography*. Karachi: Royal Book Company.
2. Becker, A. & Secker. (2002). *Human geography: culture, society, and space.* , New Jersey: John Wiley and Sons.

Suggested Readings:

1. Benko, G. & Shorhmay. (2004). *Human geography: a history for the 21st century.* London: Hodder Arnold.
2. Blij, H. J. D. (2002).*Human geography: culture, society, and space*. New Jersey. John Wiley and Sons.
3. Cloke, P. & Crang, P. (2005). *Introducing human geographies*, (2nd ed.). London: Hodder Arnold.

GEOG- 5106		**Surveying**		**3(2+1)**

Course Brief:

Surveying is the science of measuring and recording distances, angles, heights and sizes on the earth's surface to obtain data from which accurate plans and maps is made. It is the art and science of determining the position of natural and artificial features on, above the earth's surface or establishing such point and representing this information on paper plans, as figures, tables or computer based map. The basic concerns regarding a survey are spaces and locations within them. Survey essentially takes note of specific point locations for later reference. Surveying has been essential elements in the planning and execution of nearly every form of construction.

Course Learning Objectives:

One of the main functions of surveying is to acquire data on the shape and position of features on the ground, and to somehow delineate this information on maps, plans and drawings so as to make this data useful for other observers/users. These maps and plans can range from simple drawings in terms of sketches through to plans and maps, all based on some fundamentals of graphical communication

Course Contents:

1. Introduction
2. Instrumental survey and records
3. Surveying using the following instruments
4. Chain survey
5. Plane Table
6. Prismatic Compass
7. Determination of heights and slopes with Abney Level
8. Contouring by Indian Clinometer

Recommended Texts:

1. Singh, G. (2009). *Map work and practical geography*. New Delhi: Vikas Publishing House Pvt. Ltd.
2. Singh, L. & Raghu, N. S. (2000) *Map work and practical geography*. New Delhi: Kalyani publishers.

Suggested Readings:

1. Khan, M. Z. A. (1998). *Text Book of Practical Geography*. Delhi: Concept Publishing Company.
2. Bygott, J. (1952). *An introduction to mapwork and practical geography*. London: University Tutorial Press.
3. Bygott, J. (1955). *Mapwork and practical geography*. London: University Tutorial Press.