





UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 24th (1/2025) meeting held on 26.08.2025, the Syndicate in its 72nd (4/2025) meeting held on 12.09.2025 has approved the revised curricula of following programs for implementation w.e.f. **Fall 2025**.

- | | | |
|-----|-----------------------------|-------------|
| I. | BS in Zoology | (Annex-'A') |
| II. | Associate Degree in Zoology | (Annex-'B') |


(WAQAR AHMAD)
Additional Registrar (General) 
Dated: 03.12.2025

No. SU/Acad/25/ 1345

Distribution:

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

C.C:

- Dean Faculty of Sciences
- Director, QEC
- Additional Registrar (A & R) *{With the request to forward the notification alongwith curriculum to all Principals of affiliated colleges concerned}*
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File



SCHEME OF STUDIES FOR BS ZOOLOGY

(Applicable from 2025)



**DEPARTMENT OF ZOOLOGY
UNIVERSITY OF SARGODHA
SARGODHA - PAKISTAN**

1. Title of Degree Program: BS Zoology

2. Program Learning Objectives: The Department of Zoology comprises of diverse and enthusiastic faculty member researchers who aim to develop the best possible research environment among the students in the field of Zoology. We train the student in a wide range of basic and applied field of Zoology like Vertebrate and Invertebrate Zoology, Wild fisheries, Paleontology and Zoogeography, Evolution and Systematics, Cell and Molecular Biology, Biochemistry, Plant Genetics, Developmental Biology, Ecology, Toxicology, Microbiology, Vascular Biology, Immunology Integral management, Endocrinology.

3. Program Structure:

Duration	Minimum 4-Years (8-Semesters)		
Admission Requirements:	Students with Pre-Medical / Pre-Engineering combinations in HSSC / A-level with Zoology/Biology as an elective subject after 12-years of education with atleast 45% marks in F.Sc (pre-medical) or equivalent.		
Degree Completion Requirements:	General Education	GE	(35 CHs)
	Interdisciplinary	ID	(24 CHs)
	Disciplinary / Major	D	(72 CHs)
	Internship	I	(3 CHs)
	Capstone Project	R	(3 CHs)
			137

4. General Education (Gen Ed) Requirements: (Mandatory/Core Courses):

The minimum requirement for Gen Ed is 32 credits hours and will be offered in first four semesters only.

Sr. No.	Semester	Course Code	Course Title	Credit Hours	Prerequisite
1.	1	URCG-5129/ URCG-5131	Understanding of Holy Quran-I/ Ethics-I	1(0-1)	Nil
2.	1	URCG-5118	Functional English	3(3-0)	Nil
3.	1	URCG-5105/ URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
4.	1	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
5.	2	URCG-5112	Fables, Wisdom and EPICS	2(2-0)	Nil
6.	2	URCG-5116	Science of Society – I	2(2-0)	Nil
7.	2	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
8.	2	URCG-5127	Seerat of the Holy Prophet (SAW)	1(1-0)	Nil
9.	2	URCG-5128	Pakistan Studies	2(2-0)	Nil
10.	3	URCG-5119	Expository Writing	3(3-0)	Nil
11.	3	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
12.	3	URCG-5122	Ideology & Constitution of Pakistan	2(2-0)	Nil
13.	3	URCG-5130/ URCG-5132	Understanding of Holy Quran-II/ Ethics-II	1(0-1)	URCG-5129/ URCG-5131
14.	4	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
15.	4	URCG-5115	The Science of Global Challenges	3(2-1)	Nil
16.	4	URCG-5124	Entrepreneurship	2(2-0)	Nil
General Education Courses Credit Hours Total				35	

6. Interdisciplinary/Allied courses: minimum 27 credit hours

Sr. No.	Semester	Course Code	Course Title	Credit Hours
1.	2	BOTN-5104	Biodiversity & Conservation	3(3-0)
2.	3	AIDE-5205	Applied Artificial Intelligence	3(2-1)
3.	5	ZOOL-6114	Principles of Biochemistry	3(2-1)
4.	5	ZOOL-6115	Principles of Genetics	3(2-1)
5.	5	ZOOL-6116	Biostatistics	3(3-0)
6.	6	ZOOL-6119	Molecular Biology	3(2-1)
7.	7	ZOOL-6123	Microbiology & Immunology	3(2-1)
8.	8	ZOOL-6124	Computational Biology	3(2-1)
Interdisciplinary Courses Credit Hours				24

7. Field experience/internship: Minimum 03 credit hours:

Lasting 6-8 weeks and ideally scheduled during summer breaks after 5th or 6th semester

1.	ZOOL-6120	Field experience / internship	3(0-3)
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8. Capstone project: Minimum 03 credit hours:

This project, after the seventh semester, requires faculty supervision and evaluation following department guidelines

1.	ZOOL-6125	Capstone project	3(0-3)
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Ull Muehltay
 Chairman
 Department of Zoology
 University of Sargodha, Sargodha

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ANNEXURE I (LIST OF ELECTIVE COURSES)

Course Codes	Course Title	Credits
ZOOL-6126	Aquaculture	3(2-1)
ZOOL-6127	Biodiversity and Wildlife	3(2-1)
ZOOL-6128	Biotechnology	3(2-1)
ZOOL-6129	Comparative Developmental Biology	3(2-1)
ZOOL-6130	Endocrinology	3(2-1)
ZOOL-6131	Economic Entomology	3(2-1)
ZOOL-6132	Environmental Issues	3(2-1)
ZOOL-6133	Fish Physiology and Breeding	3(2-1)
ZOOL-6134	Hematology	3(2-1)
ZOOL-6135	Ichthyology	3(2-1)
ZOOL-6136	Immunology	3(2-1)
ZOOL-6137	Integrated Pest Management	3(2-1)
ZOOL-6138	Microbiology-I	3(2-1)
ZOOL-6139	Microbiology-II	3(2-1)
ZOOL-6140	Molecular and Clinical Endocrinology	3(2-1)
ZOOL-6141	Ornithology	3(2-1)
ZOOL-6142	Physiological Systems and Adaptations	3(2-1)
ZOOL-6143	Physiology of Reproduction	3(2-1)
ZOOL-6144	Principles of Parasitology	3(2-1)
ZOOL-6145	Principles & Kinetics of Toxicology	3(2-1)
ZOOL-6146	Endangered Species Management	3(2-1)
ZOOL-6147	National Parks, Sanctuaries and Wildlife Protected Areas	3(2-1)
ZOOL-6148	Taxidermy	3(2-1)
ZOOL-6149	Conservation Genetics	3(2-1)

Scheme of Studies
BS in Zoology

Semester-I

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-01	ZOOL-5101	Diversity of Invertebrates	3(2-1)	Nil
GE-01	URCG-5129/ URCG-5131	Understanding of Holy Quran – I/ Ethics-I	1(0-1)	Nil
GE-02	URCG-5118	Functional English	3(3-0)	Nil
GE-03	URCG-5105 URCG-5126	Islamic Studies (OR) Ethics for non-Muslim students	2(2-0)	Nil
GE-04	URCG-5123	Applications of Information & Communication Technologies (ICT)	3(2-1)	Nil
Major-02	ZOOL-5105	Animal Form & Function- I (<i>Comparative Anatomy</i>)	3(2-1)	Nil

Semester Total Credit Hours: 15

Semester-II

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-03	ZOOL-5102	Cell Biology	3(2-1)	Nil
Major-04	ZOOL-5103	Diversity of Chordates	3(2-1)	Nil
ID-01	BOTN-5104	Biodiversity & Conservation	3(3-0)	Nil
GE-05	URCG-5112 URCG-5113	Fables, Wisdom Literature and EPICS or Space, Place and Experience	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
GE-09	URCG-5128	Pakistan Studies	2(2-0)	Nil

Semester Total Credit Hours: 19

Semester-III

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-05	ZOOL-5104	Animal Ecology	3(2-1)	Nil
Major-06	ZOOL-5106	Animal Behavior	3(3-0)	Nil
ID-02	AIDE-5205	Applied Artificial Intelligence	3(3-0)	Nil
GE-10	URCG-5119	Expository Writing	3(3-0)	Nil
GE-11	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
GE-12	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
GE-13	URCG-5130 URCG-5132	Understanding of Holy Quran-II*/ Ethics-II	1(0-1)	URCG-5129/ URCG-5131

Semester Total Credit Hours: 18

Semester-IV

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-07	ZOOL-5107	Evolution	3 (3-0)	Nil
Major-08	ZOOL-5108	Animal Form & Function-II (Comparative Physiology)	3(2-1)	ZOOL-5105
Major-09	ZOOL-6109	Entomology	3(2-1)	Nil
Major-10	ZOOL-6110	Developmental Biology	3(2-1)	Nil
GE-14	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
GE-15	URCG-5115	The Science of Global Challenges	3(2-1)	Nil
GE-16	URCG-5124	Entrepreneurship	2(2-0)	Nil

**Semester Total
Credit Hours: 19**

Semester-V

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-11	ZOOL-6111	Fisheries & Aquaculture	3(2-1)	Nil
Major-12	ZOOL-6112	Marine Biology	3(3-0)	Nil
Major-13	ZOOL-6113	Principles of Systematics Zoology	3(2-1)	Nil
ID-03	ZOOL-6114	Principles of Biochemistry	3(2-1)	Nil
ID-04	ZOOL-6115	Principles of Genetics	3(2-1)	Nil
ID-05	ZOOL-6116	Biostatistics	3(3-0)	Nil

Semester Total Credit Hours: 18

Field experience / internship

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
I	ZOOL-6120	Field experience / internship	3(0-3)	Nil

Semester-VI

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-14	ZOOL-6117	Zoogeography & Paleontology	3(2-1)	Nil
Major-15	ZOOL-6118	Research Methodologies & Bioethics	3(3-0)	Nil
Major-16	ZOOL-XXXX	Elective I	3(2-1)	Nil
Major-17	ZOOL-XXXX	Elective II	3(2-1)	Nil
ID-06	ZOOL-6119	Molecular Biology	3(2-1)	Nil

Semester Total Credit Hours: 15

Semester-VII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-18	ZOOL-6121	Wildlife Conservation & Management ✓	3(2-1)	Nil
Major-19	ZOOL-6122	Economic Zoology ✓	3(2-1)	Nil
Major-20	ZOOL-XXXX	Elective – III	3(2-1)	Nil
Major-21	ZOOL-XXXX	Elective – IV	3(2-1)	Nil
ID-07	ZOOL-6123	Microbiology & Immunology ✓	3(2-1)	Nil

Semester Total Credit Hours: 15**Semester-VIII**

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-22	ZOOL-XXXX	Elective – V	3(2-1)	Nil
Major-23	ZOOL-XXXX	Elective – VI	3(2-1)	Nil
Major-24	ZOOL-XXXX	Elective -VII	3(2-1)	Nil
ID-08	ZOOL-6124	Computational Biology ✓	3(2-1)	Nil
R	ZOOL-6125	Capstone ✓	3(0-3)	Nil

Semester Total Credit Hours: 15

Degree Program
Total Credit Hours: 137

Note: Course of Understanding of Holy Quran-I/II should be for Muslim students only

Ali Mubeta
 Chairman
 Department of Zoology
 University of Sargodha, Sargodha

SEMESTER I

Course Code	ZOOL-5101	Course Title	Diversity of Invertebrates	Credit Hours	3(2-1)
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Course Brief:

This course will provide the knowledge of evolutionary/phylogenetic relationship. It imparts the basic taxonomic characteristics and classification of all the invertebrate 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. It delivers information to students about economic and ecological importance of invertebrates. Students will understand invertebrate organismal concepts in laboratory and field.

Course Learning Objectives:

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 and tree diagrams: patterns of organization.
2. Animal-like protists: the protozoa: evolutionary perspective; life within a single plasma membrane, symbiotic lifestyles, Protozoan taxonomy, pseudopodia and amoeboid locomotion; cilia and other pellicular structure, nutrition; genetic control and reproduction; symbiotic ciliates, further phylogenetic consideration.
3. Multicellular and tissue levels of organization: Evolutionary Perspective, Origins of Multicellularity; Animal Origins, Phylum Porifera, Cnidaria, Ctenophora, Characters and Classification, Maintenance functions.
4. The triploblastic and with acoelomate body plan: Phylum Platyhelminthes, Phylum Nematode, Gastrotricha, evolutionary perspective; classification up to class, body plan and functions.
5. Pseudocoelomate body plan: Phylum Aschelminths, evolutionary perspective; general characteristics; classification up to order with external features, feeding and digestive system; other organ system; reproduction and development including Phylum Rotifera, Phylum Nematoda and Phylum Kinorhyncha. some important nematode parasites of human.
6. Phylum Mollusca: evolutionary perspective; relationship to other animals; origin of the coelom; characteristics, classification up to class. the characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods.
7. Phylum Annelida: the metameric body form; evolutionary perspective; relationship to other animals, metamerism and tagmatization, classification up to class. external structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development, Polychaeta, Oligochaeta and Hirudinea, Further phylogenetic consideration.
8. Phylum Arthropoda: evolutionary perspective: classification and relationship to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class.
9. The Hexapods and Myriapods: evolutionary perspective: classification upto class. external structure and locomotion, nutrition and the digestive system, gas exchange, circulation and temperature regulation, nervous and sensory functions, excretion, chemical regulation, reproduction and development in hexapoda, insects' behavior, insect and human.

10. Phylum Echinoderms: evolutionary perspective: relationship to other animals; echinoderm characteristics; classification up to class, maintenance functions, regeneration, reproduction, and development in Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa.
11. Some lesser-known Invertebrates: Lophotrochozoans, Entoprocts, Cycliophores, and Chaetognaths.

Practical

Note: Classification of each member of each phylum upto order with adaptations in relation to habitat of the specimen. Preserved specimen and colored projection slide and CD ROM projection of computer must be used.

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of representatives of Phylum Porifera and prepared slides of spicules of sponges
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of Phylum Echinodermata.
10. Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Planaria of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.
11. Preparation of permanent slide of mouthpart of insects (after dissection).
12. How to make grade-wise series for preparation of temporary and permanent slides.

Recommended Texts:

1. Miller, A. S., & Harley, J. P. (2016 & 2019). *Zoology* (10 & 11) Singapore: McGraw Hill
2. Hickman, C. P., Roberts, L. S., Keen, S. L., Larson, A., P'Anson, H & Eisenhour., D. J. (2009). *Integrated principles of zoology* (14th ed.). Singapore: McGraw-Hill.
3. Hickman, C. Jr., Keen, S., Eisenhour, D., Larson, A., P'Anson, H., (2019). *Integrated principles of zoology* (18th ed.). Singapore: McGraw-Hill.

Suggested Readings:

1. Hickman, C. P., Roberts, L. S., & Larson, A. (2018). *Integrated principles of zoology* th (15 ed.). Singapore: McGraw-Hill.
2. Hickman, C., Jr., Keen, S., Eisenhour, D., Larson, A., P'Anson, H., (2019). *Integrated principles of zoology* (18th ed.). Singapore: McGraw-Hill.
3. Pechenik, J. A. (2015). *Biology of invertebrates* (7th ed.), Singapore: McGraw-Hill

Course Code	URCG-5118	Course Title	Functional English	Credit Hours	3(3-0)
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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. The students would be able to logically add specific details on the topics such as facts, examples and statistical or numerical values.

Course Learning Objectives:

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

Course Code	URCG-5105	Course Title	Islamic Studies	Credit Hours	2(2-0)
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Course Brief:

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. 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 (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'an and Sunnah.

Course Learning Objectives:

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

Course Contents:

Introduction to Qur'anic Studies

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

لعم قرآن (تعارف قرآن، منتخب آیات کا ترجمہ و تفسیر، سورۃ البقرہ آیات 1-5، 482-482، سورۃ الحجرات آیات 1-18، سورۃ الفجر آیات 26-77، سورۃ المؤمنون آیات 1-11، سورۃ الحزاب آیات 2، 41، 64-66، 24، 52-55، سورۃ النعام آیات 151-156، سورۃ الصافات آیات 1-12، نمر آیات 18-44، آل عمران آیات 154-154، النحل آیات 14-12، لقمن 44، حم السجده آیت 65)

Introduction to Sunnah

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

سنت کا تعارف، حدیث کی نبوی حیثیت، حفاظت و تدوین حدیث، حدیث کی اقسام متن، حدیث: درج ذیل موضوعات پر احادیث کا مطالعہ

اعمال کا اجر نیت پر منحصر ہے۔ 4. بہترین انسان قرآن کا طالب علم اور اس کا معلم ہے 6. کتاب و سنت گمراہی سے بچنے کا ذریعہ ہیں 2. ارکان اسلام 5. اسلام، ایمان، احسان اور قیامت نشانیوں، 2 حجروں کی نماز کی تلقین 7. دین کا گہرا فہم ہل کی خاص عنایت ہے 8. حصول علم، تلاوت قرآن اور عمل کی اہمیت و فضیلت، 5 روز محشر کا محاسبہ، 14. حقوق ہل

ہمساتہ حقوق العباد کا لحاظ رکھنا بھی الزم ہے 1. حسن خلق کی عظمت اور فحش و بد گوئی کی مذمت 14. دنیا و آخرت کی بہانگی کی ضمانت چار چیزیں، 16. بانک کر دینے والی ت چیزیں، 12. بے عمل مبلغ کا عبرت ناک انجام 15. ہر شخص زان ہے اور ہر شخص مسئول

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

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ مطالعہ سیرت کی ضرورت و اہمیت، تعمیر سیرت و شخصیت کا نبوی منہاج اور عملی نمونے، اقامت دین کا نبوی طریق کار، اقامت دین بعد خالفت
 ، میناق مدینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات، تشکیل اجتماعیت اور
 ی اللہ 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

مالی 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
 نظریے کا تنقیدی جائزہ، تہذیبی تصادم کے اثرات و
 طبیعی، حیاتیاتی اور معاشرتی علوم میں مسلمانوں کا کردار، نامور مسلمان سائنسدان سوہ حسنہ، قرآن مجید میں سیرت سرور عالم کا بیان، غزوا

Recommended Texts:

1. Hameed ullah Muhammad, —Emergence of Islam, IRI, Islamabad
2. Hameed ullah Muhammad, —Muslim Conduct of State
3. Hameed ullah Muhammad, _Introduction to Islam
4. Ahmad Hasan, —Principles of Islamic Jurisprudence Islamic Research, Institute, International Islamic University, Islamabad (1993)

Suggested Readings:

1. Dr. Muhammad Zia-ul-Haq, —Introduction to Al Sharia Al Islamial Allama Iqbal Open University, Islamabad (2001)
2. Dr. Muhammad Shahbaz Manj, Teleemat-e- Islam

Course Code	URCG-5126	Course Title	ETHICS	Credit Hours	2(2-0)
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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.
4. Moral Theories:
 - (a). Hedonism (Mill) (b). Intuitionism (Butler)
 - (c). Kant's Moral Theory.
5. Moral Ethics and Society.
 - (a). Freedom and Responsibility. (b). Tolerance
 - (c). Justice
 - (d). Punishment (Theories of Punishment)
6. Moral Teachings of Major Religions: a). Judaism
 - b). Christianity c). Islam
7. Professional Ethics:
 - a). Medical Ethics b). Ethics of Students
 - c). Ethics of Teachers d). Business Ethics

Recommended Texts:

1. William Lillie. 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. Calcutta: 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.

Annex - A

URCGI-5129

Model Course Outline for the Course Understanding of Quran – I

Course Title: Understanding of Quran – I

Course Book: Muallim ul Quran (Volume 1, 2 & 3) by Dr Ubaid ur Rahman

Credit Hours: 1 (0-1)

Contact Hours: 5 per week

Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

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

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles), compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath-based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the holy Quran.

Provision of material, content and books:

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

Course Outline:

Weeks	Lectures (1.5 hrs)	Units	Lessons	Assignments/Home Task	Linguistic Notes
1.	1.	1	1-6	Writing the meaning of Quranic words Lesson 1-8	Proper Noun Masculine & Feminine
	2.	1	9-14	Writing the meaning of Quranic words 9-14	Two kinds of plural Concept of (واو) "And" Common Noun
2.	1.	1	15-17	Writing the meaning of Quranic words, phrases & translation of Sentences 15-17	Demonstrative Noun (This & That for Masculine (هذه - هذا) Demonstrative Noun (This & That for Feminine) (هذه - تلك)
	2.	1	18-19 & Revision (Unit 1)	Writing the meaning of Quranic words, phrases & translation of Sentences 17-19 Quiz	Learn for emphasis (لام التوكيد) Superlative Degree like Revision of all Quranic Sentences
3.	1.	Unit 2	1-3	Writing the meaning of Quranic words, phrases & translation of Sentences 1-3	Emphatic Particle ان Preposition "For" (للام) Preposition (لها)
	2.	2	4-6	Writing the meaning of Quranic words, phrases & translation of Sentences 4-6	Preposition (على - من - الى)
4.	1.	2	7-9	Writing the meaning of Quranic words & translation of Sentences 7-9	Preposition (الى) Absolute Negation Particle Exceptive Particle (لا النافية) (لا) (ما النافية) (للبتس)
	2.	2	10-13 & Revision (Unit 2)	Writing the meaning of Quranic words, phrases & translation of Sentences 10-13 Quiz	Subordinating Conjunction (ان), Was (كان), Vocative Particle (يا)

5.	1.	Unit 3	1-2	Writing the meaning of Quranic phrases 1-2	Quranic Adjective Compounds (مبتدأ وموصوف) ✓
	2.	3	3-5	Writing the meaning of Quranic phrases & translation of sentences 3-5	Quranic Possessive Construction (مضاف ومضاف إليه)
6.	1.	3	6-7	Writing the meaning of Quranic phrase translation of sentences. 6-7	Quranic Possessive Construction (مضاف ومضاف إليه)
	2.	3	8-10 & Revision (Unit 3)	Writing the meaning of Quranic phrase & translation of sentences 8-10 Quiz	Active Participle (اسم الفاعل), Passive Participle (اسم المفعول), Dual (مثنى)
7.	1.	Unit 4	1-2	Writing the meaning of Quranic phrase & translation of sentences 1-2	Personal Pronoun He (هو المتصل) Possessive Pronoun His (المتصل)
	2.	4	3-4	Writing the meaning of Quranic phrase & translation of sentences 3-4	Possessive Pronoun with prepositions like في بيته Pronoun "His" with prepositions like له بيته
8.	1.	4	5-8	Writing the meaning of Quranic sentences 5-8	Personal Pronoun You (انت المتصل) Possessive Pronoun Your (المتصل) Possessive Pronoun with prepositions like في بيتك Pronoun "your" with prepositions like لك بيتك
	2.				MKB Form

9.	1.	4	9-12	Writing the meaning of Quranic phrases & sentences 9-12	Personal Pronoun She (هي) (المتصل) Possessive Pronoun Her (ها) (المتصل) Possessive Pronoun with prepositions like لي بها Pronoun "Her" with prepositions like لها
	2.	4	13-16	Writing the meaning of Quranic phrases & sentences 13-16	Personal Pronoun I (أنا) (المتصل) Possessive Pronoun Her (ي) (المتصل) Possessive Pronoun with prepositions like لي التي Pronoun "My" with prepositions like لي
10.	1.	4	17 & Revision Unit 4	Revision of all Quranic sentences of Unit 4 Quiz	Adverb (مثل)
	2.	Unit 5	1-2	Writing the meaning of Quranic phrases & sentences 1-2	Masculine Plural جمع المذكر السالم و جمع المذكر السالم المسروق بحرف الجر
11.	1.	5	3-4	Writing the meaning of Quranic phrases & sentences 3-4	Possessive Construction with Plurals جمع المذكر السالم المسروق بالإنشابة
	2.	5	5-6	Writing the meaning of Quranic phrases, sentences & verses 5-6	Personal Pronoun They (هم) (المتصل) Possessive Pronoun Their (هم) (المتصل)
12.	1.	5	7-8	Writing the meaning of Quranic phrases, sentences & verses 7-8	Possessive Pronoun with prepositions like لي بهم Pronoun "Their" with prepositions like لهم
	2.	5	9-11	Writing the meaning of Quranic phrases, sentences & verses 9-11	Personal Pronoun You (أنتم) (المتصل) Possessive Pronoun Your (كم) (المتصل) Possessive Pronoun with prepositions

13.	1.	5	12-14	Writing the meaning of Quranic phrases & sentences & verses 12-14	like Pronoun "Your" with prepositions like Personal Pronoun We (نحن) Possessive Pronoun Our (المتصل)
	2.	5	15-16	Writing the meaning of Quranic sentences & verses 15-16	Possessive Pronoun with prepositions like Pronoun "Our" with prepositions like
14.	1.	5	17-18	Writing the meaning of Quranic sentences & Verses. 17-18	Demonstrative Pronoun These, Those (هؤلاء - أولئك)
	2.	5	19-23	Writing the meaning of Quranic sentences & Verses 19-23	ما / إنا / إن / (إنا، أين، ما،) (ألم، أن، بل، كان) (ألا، أين، اليوم، يومئذ، سبحانه، ماويلهما، كل، إن، بئس، كلاء، ما أتراك، حسب، أعلم به، مصير، مرجع، دينا) (تبيين)
15.	1.	5	Revision Unit 5	Quiz	
	2.	5	1-3 (till Page 16)	Writing the meaning of Quranic Verbs & Translation of Quranic Sentences & Verses (1-3)	Introduction of Present Tense (الفعل مضارع) & Verbal Sentence (جملة فعلية) Present Tense الفعل المضارع صيغة المفرد يعلم
16.	1.	6	3 (From Page 17) & 4-5	Translation of Quranic Sentences & Verses 3-5	Present Tense الفعل المضارع صيغة المفرد يعلم
	2.	6	6	Translation of Quranic Sentences & Verses	Present Tense الفعل المضارع صيغة الجمع يعلمون

1- Course Description

The Ethics-I course is designed to provide students with a comprehensive understanding of ethical principles, practices, and theories in various societal contexts. Throughout this degree program, students will explore the complexities of ethical theories of semitic and non-semitic religions along with decision-making and develop critical thinking skills to navigate moral dilemmas. This course will also enable the students to interact with others religious identities with respectful, inclusive and holistic approach.

2- Learning Objectives

This course aims to:

1. Introduce students to the fundamental concepts, scope, and importance of ethics.
2. Explore the relationship between law, morality, and social values.
3. Develop a clear understanding of virtuous and immoral ethics and their impact on individual and collective life.
4. Study the role of major religious figures in the moral development of human society and enable students to apply ethical principles for personal development, conflict resolution, and social harmony.

3- Learning Outcomes

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

1. Students will be able to identify and analyze major ethical theories, values, and their scope in social and individual life.
2. Differentiate between law and ethics, and analyze their interrelationship.
3. Identify types of virtuous and immoral ethics and assess their social impacts.
4. Evaluate the ethical teachings of major religions and their relevance in contemporary society.
5. Apply ethical principles to address modern challenges in personal and professional life.

4- Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents**Unit 1: Introduction and Fundamentals of Ethics**

1. Literal and terminological definition of ethics
2. Literal and terminological definition of values
3. Relationship between law and ethics
4. Need, importance, and scope of ethics

Unit 2: Types of Ethics and Their Impact on Society

- Virtuous ethics: concept, types, benefits, and outcomes
- Immoral ethics: concept, types, and harms
- Role of ethics in social refinement and establishment of peace

Unit 3: Virtuous Ethics (Akhlaq-e-Hasanah)

- Concept, need, and importance of virtuous ethics
- Scope of virtuous ethics in the light of religions
- Major virtues in revealed and non-revealed religions
- Impact of virtuous ethics on individual and collective life

Unit 4: Immoral Ethics (Akhlaq-e-Raizilah)

- Concept of immoral ethics
- Social problems caused by immoral ethics
- Practical consequences of immoral ethics
- Major vices in revealed and non-revealed religions

Unit 5: Role of World Religious Figures in Moral Development

- Prophet Moses (AS): introduction, miracles, and role in moral refinement
- Prophet Jesus (AS): introduction, miracles, and role in moral refinement
- Prophet Muhammad (ﷺ): introduction, miracles, and role in moral refinement

Textbook

1. Izutsu, T. (2002). *Ethico-Religious Concepts in the Qur'an*. McGill-Queen's University Press.

Suggested Readings

1. Ger, D. (2005). *Morality: Its Nature and Justification*. Oxford University Press.
2. MacIntyre, A. (2007). *After Virtue: A Study in Moral Theory*. University of Notre Dame Press.
3. Al-Ghazali, Abu Hamid (2001). *The Alchemy of Happiness*. Islamic Texts Society.
4. Maw, S. H. (1994). *The Heart of Islam: Enduring Values for Humanity*. Harper One.
5. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics*. Oxford University Press.
6. Hassan, Z. (2010). *Ethics in Islam: Key Concepts and Contemporary Challenges*. Islamic Research Institute.

Course Code	URCG-5123	Course Title	Applications of Information Communication Technologies (ICT)	Credit Hours	3 (2-1)
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Course Brief:

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

Course Learning Objectives:

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 Texts:

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

Suggested Readings:

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

Course Code	ZOOL-5105	Course Title	Animal Form & Function-I (Comparative Anatomy)	Credit Hours	3(2-1)
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Course Brief:

This course teaches about animal diversity adapted strategically for performance of their similar functions through modification in body parts in past and present times. It imparts understanding of diverse structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous, sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.

Course Learning Objectives:

The course mainly aims to teach the students about animal diversity adapted in different ways for their functions through modifications in body parts, about the diversity in integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory, respiratory, nutritive, excretory, osmoregulatory and reproductive systems according to strategies to survive in their specific conditions. It will also introduce about organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body along with the basic structure of each system that determines its particular function of animal body.

Course Contents:

1. Protection, support, and movement: protection: the integumentary system of invertebrates and vertebrates; movement and support: the skeletal system of invertebrates and vertebrates; movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates
2. Communication I: nerves: neurons: structure and function.
3. Communication II: senses: sensory reception: baroreceptors, chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.
4. Communication III: The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action, Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals
5. Circulation and immunity: internal transport and circulatory systems in invertebrate's characteristics of invertebrate coelomic fluid, hemolymph, and blood cells, transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response.

Practical

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of Labeo (*Labeo rohita*), Frog (*Hoplobatrachus tigerinus*), Varanus (*Varanus bengalensis*), fowl (*Gallus domesticus*) and rabbit (*Oryctolagus cuniculus*).

Note: Exercises of notes on the adaptations of skeletons to their function must be done.

3. Earthworm or leech; cockroach, freshwater mussel, Channa or *Catla catla* or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbit's dissections as per availability.
4. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals)

Recommended Texts:

1. Miller, A. S., & Harley, J. P. (2016 & 2019). *Zoology* (10th & 11th ed). Singapore: McGraw Hill
2. Hickman, C. P., Roberts, L. S., Keen, S. L., Larson, A., Anson, H & Eisenhour, D. J. (2009). *Integrated*

principles of zoology (11 ed.). Singapore: McGrawHill.

Suggested Readings:

1. Hickman, C., Jr., Keen, S., Eisenhour, D., Larson, A., l'Anson, H., (2019). *Integrated principles of zoology* (18 ed.). Singapore: McGraw-Hill.
2. Pechenik, J. A. (2015). *Biology of invertebrates* (7th ed.). Singapore: McGraw-Hill
3. Kent, G. C., & Miller, S. (2001). *Comparative anatomy of vertebrates*. New York: McGraw-Hill.

SEMESTER II

Course Code	ZOOL-5102	Course Title	Cell Biology	Credit Hours	3(2-1)
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Course Brief:

The course aims to impart knowledge about the animal cell and its complex organization and architecture. It enables students to understand various ultra-structural, molecular and functional aspects of the cells. Students will be able to describe and discuss the properties and biological significance of the major classes of molecules found in living organisms and the relationship between molecular structure and biological function, can relate how cell movement and cell-cell communication occur and discuss mechanisms of signal transduction and the lab work will provide platform to become familiar with various cell types through techniques of slide preparation.

Course Learning Objectives:

Understanding of microscopy to study cell structure and cellular compartmentalization will be provided to learners. Main emphasis of course is to develop familiarity with structure and function of cells at the molecular level, including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells.

Course Contents:

1. Introduction to prokaryotic and eukaryotic cells: plasma membrane, its chemical composition structure and functions of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.
2. Cytoskeleton: microfilaments, microtubules, intermediate filaments.
3. Cytoplasmic Organelles: Membrane system, structural and functional commonalities.
4. Ultrastructure, chemical composition and functions of endoplasmic reticulum and their role in protein synthesis and drug metabolism, golgi apparatus its role in synthesis of glycoprotein,
5. Mitochondrial respiration and its significance as semi- autonomous organelle;
6. Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, glyoxysome with reference to glyoxylic acid cycle.
7. Nucleus: chromatin, heterochromatin, euchromatin, chromosome structure, coiling and nucleosome during different phases of cell cycle.

Practical

1. Preparation of whole mount.
2. Preparation of human blood smear and identification of Leucocytes.
3. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).
4. Squash preparation of onion root tip for mitotic stages
5. Mounting of polytene chromosome (*Drosophila/Chironomous.*) Demonstration.
6. Cultural and staining of bacteria.

Recommended Texts:

1. Cooper, G. M., & Adams, K. (2022). *The cell: A molecular approach* (9th ed.). Massachusetts: Sinauer Associates.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M., & Amon, A. (2021). *Molecular cell biology* (9th ed.). New York: W. H. Freeman.
3. Karp, G., Iwasa, J., & Marshall, W. (2020). *Karp's cell and molecular biology: concepts and experiments* (9th ed.). New Jersey: John Wiley and Sons.

Suggested Readings:

1. De-Robertis, E. D. (2014). *Cell and molecular biology* (8th ed.). New York: Lea & Febiger.
2. Alberts, B., Hopkin, H., Johnson, A., Morgan, D., Walter, P., & Heald, R. (2023). *Essential cell Biology* (6th ed.). New York: W. W. Norton & Company.
3. Hofmann, A., & Clokie, S. (2018). *Wilson and Walker's principles and techniques of Biochemistry and molecular biology* (8th ed.). Cambridge: Cambridge University Press.

Course Code	ZOOL-5103	Course Title	Diversity of Chordates	Credit Hours	3(2-1)
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Course Brief:

This course will enable students to understand the taxonomic characteristics of protochordates and chordates. It provides knowledge about the phylogenetic relationships of protochordates and various classes of chordates. Students will understand the phylogenetic relations, physiological adaptations, behavior and diversity of Pisces, amphibians, reptiles and mammals and able to analyze the process of micro evolution within chordates. After this course the students will understand what the chordates are, can recognize different categories of chordates, understands the level of organization in chordate subphylum, can comprehend the general characters of chordates and know about the origin and evolutionary relationship in different subphylum of chordates.

Course Learning Objectives:

Upon successful completion of this subject students will be able to describe unique characters of urochordates, cephalochordates and fishes, can recognize difference in life functions of urochordates and fishes, will understand the ecological role of different groups of chordates and understand the diversity of chordates. Identification of the morphological and anatomical structure for the major groups of vertebrates from an evolutionary point of view will be discussed.

Course Contents:

1. Protochordates: classification of protochordates. Structure, anatomy and organ systems of acorn worms, urochordates and cephalochordates, reproduction; life histories and metamorphosis of protochordates. phylogenetic relationships.
2. Fishes: vertebrate success in water. Phylogenetic relationships of Pisces. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli. Locomotor adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).
3. Amphibians: The first terrestrial vertebrates. Characteristics of amphibian's Phylogenetic relationships. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura. Structure and locomotor adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.
4. Reptiles: The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodylia. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development of chelonia, squamata, Rhynchocephalia and crocodylian. Further phylogenetic considerations
5. Birds: Classification, feathers, flight and endothermy. Phylogenetic relationships; ancient birds and the evolution of flight. Diversity of modern birds. Adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development. Migration and navigation.
6. Mammals: Classification, Specialized teeth, endothermy, hair and viviparity. Diversity of mammals. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

Practical

1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
2. Visit to PMNH for the study of diversity of chordates.

Recommended Texts:

1. Miller, A. S., & Harley, J. P. (2016 & 2019). *Zoology* (10 & 11 ed.). Singapore: McGraw Hill.
2. Hickman, C. P., Roberts, L. S., Keen, S. L., Larson, A., P'Anson, H & Eisenhour., D. J. (2009). *Integrated principles of zoology* (14 ed.). Singapore: McGraw-Hill.
3. Hickman, C., Jr., Keen, S., Eisenhour, D., Larson, A. & P'Anson, H., (2019). *Integrated principles of zoology* (18 ed.). Singapore: McGraw-Hill.

Suggested Readings:

1. Hickman, C. P., Roberts, L. S., & Larson, A. (2018). *Integrated principles of zoology* (15 ed.). Singapore: McGraw-Hill.
2. Hickman, C., Jr., Keen, S., Eisenhour, D., Larson, A. & P'Anson, H., (2019). *Integrated principles of th zoology* (18ed.). Singapore: McGraw-Hill.
3. Peckenik, J. A. (2015). *Biology of Invertebrates*. 7 Ed Singapore: McGraw-Hill.

Course Code	BOTN-5104	Course Title	Biodiversity & Conservation	Credit Hours	3(3-0)
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Course Brief:

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

Course Learning Objectives:

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

Course Contents:

1. Basic concepts • Introduction to biodiversity and its tangible and intangible value • Biodiversity hotspots (tropical and coral reef ecosystems) • Introduction and levels of biodiversity (Alpha, Beta and Gamma) • Biodiversity distribution, importance and Reduction. • Major and Current threats to biodiversity • Inventorying and monitoring of Biodiversity: baseline data (study Policies and legislation related to biodiversity loss and conservation • Different types of protected areas for biodiversity conservation • Understanding opportunities and challenges of biodiversity conservation
2. Cause and depletion of biodiversity • Concept of habitat and niche • Habitat loss • Habitat fragmentation • Concept of speciation • Loss of existing species • Origin of new species
3. Species inventory and its utilization • Baseline data of biodiversity • Use of species inventory in EIA (Environmental Impact Assessment) • Preparing species inventory at first level • Monitoring of biodiversity • Red data books and lists
4. Species extinction • How do species become endangered? • How species become threatened? • Criteria for recognizing different categories of threatened species • IUCN threatened species categories • Concept of extinct and extant species • Extinction species • Theory of mass extinction
5. Species invasion and its impacts on local biodiversity • Concept of invasive, alien and native species • Species invasion and major types • Intensively invasive species and its out-competing potential for native species • Concept of direct and indirect competition of local resources
6. Biodiversity conservation • Introduction to conservation, its history, guiding principles, and characteristics • In situ conservation – conservation at species and population level • Ex situ conservation – conservation in man-made ecosystems, croplands, cities, Reconfirmation assays of existing biodiversity • Museums, arboretums, herbarium, zoos • Natural parks, sanctuaries, and biosphere reserves • Gene bank management and operation
7. Biodiversity conservation – role of masses • Public awareness strategies • Population explosion role of herbaria and botanic gardens in conservation • Legal protection of species and habitats • National and international laws and agreements for species and habitat Protection
8. National conservation strategy of Pakistan • Major prioritized sites for conservation • Priorities in conservation and conservation planning (case studies & exercises) • National Conservation Strategy of Pakistan • Major protected areas and national parks in Pakistan

Recommended Texts:

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

Suggested Readings:

1. Holl, K.D. (2020). Primer of Ecological Restoration. Island Press. ISBN: 9781610919722.

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

Course Code	URCG-5112	Course Title	Fables, Wisdom and EPICS	Credit Hours	2(2-0)
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Course Brief:

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. 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.

Course Learning Objectives:

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 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 hikāyāt from John T. Platts, *The Gulistan*
3. Epic
 - THE SHĀHNĀMA OF FIRDAUSI

Recommended Texts:

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

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

Course Code	URCG-5116	Course Title	Science of Society-I	Credit Hours	2 (2-0)
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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. While retaining a focus on Pakistani state and society, students will encounter theoretical concepts and methods from numerous social science disciplines, including sociology, politics, economics anthropology and psychology and make them learn to think theoretically by drawing on examples and case studies from our own social context. Students will be introduced to the works of prominent social theorists from both western and non-western contexts. Instruction will include the use of written texts, audio-visual aids and field visits.

Course Learning Objectives:

The course has following outcomes: It will

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

Course 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

Society and Community, Historical evolution of Society

- Types of Societies
- Foraging society, Horticultural society, Pastoralist society
- Agrarian societies, Industrial society, Postindustrial society

2. Philosophy of Knowledge in social Science and social inquiry

- Understanding social phenomenon
- Alternative ways of knowing
- Science as a source to explore social reality
- Objectivity, Value-Free research
- Positivism vs Interpretivism
- Qualitative vs Quantitative

3. Culture and Society

- Idea of Culture, Assumptions of Culture
 - Types, Components, Civilization and culture
 - Individual and culture. Cultural Ethnocentrism, Cultural Relativism
 - Outlook of Pakistani culture
 - Global Flows of culture, Homogeneity, Heterogeneity
- 4. Social Stratification and Social inequality**
- Dimensions of inequality, Social class
 - Gender, Race, Religion, Ethnicity, Caste
 - Patterns of social stratification in Pakistan
 - Class, caste system in agrarian society
 - Ascription vs Achievement, Meritocracy
 - Global stratification in modern world, Global patterns of inequality
- 5. Personality, Self and Socialization**
- Concept of self, Personality
 - Nature vs Nurture, Biological vs Social
 - Development of Personality
 - Socialization as a process, Agents of socialization
 - Socialization and self/group identity
- 6. Gender and Power**
- Understanding Gender
 - Social construction of Patriarchy
 - Feminism in Historical context, Gender Debates
 - Gender and Development
 - Gender issues in Pakistani society, Women Participation in politics, economy and education
 - Toward a gender sensitive society, Gender mainstreaming



Pakistan: State, Society, Economy and Polity

- Colonialism, colonial legacy, National identity
- Transformation in Pakistani society: Traditionalism vs Modernism
- Economy, Informality of Economy, Modern economy and Pakistan
- Political Economy, Sociology of Economy

Recommended 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.

General Education Cluster: Quantitative Reasoning

UACG-5120

Exploring Quantitative Skills

3(3-0)

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

Course Learning Outcomes

By the end of this course, students shall have:

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

Contents

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

Recommended Texts

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

Suggested Readings

1. Zaslav, E. (2020). *Quantitative reasoning: thinking in numbers*. Cambridge, Cambridge University Press.
2. de Mesquita, E. B., & Fowler, A. (2021). *Thinking clearly with data: A guide to quantitative reasoning and analysis*. New Jersey, Princeton University Press.
3. Bennett, J., & Briggs, W. (2019). *Using & understanding mathematics: a quantitative reasoning approach*. Pearson.
4. Rosen, K. H., & Krithivasan, K. (2012). *Discrete mathematics and its applications* (Vol. 6). New York: McGraw-Hill.
5. Chatfield, C. (2018). *Statistics for technology: a course in applied statistics*. Routledge.
6. Lock, R. H., Lock, P. F., Morgan, K. L., Lock, E. F., & Lock, D. F. (2020). *Statistics: Unlocking the power of data*. New Jersey, John Wiley & Sons.

مطالعہ سیرت النبی صلی اللہ علیہ وسلم Secret of the Holy Prophet

Course Code

URCG-5127

Title	Description
Semester	
Nature of Course	
No. of C. Hrs.	1(1-0)
Total Teaching weeks	18
Objectives of the Course	<p>۱۔ طلبہ کو خداوند پر اطیب کی ضرورت اور اہمیت سے آگاہ کرنا</p> <p>۲۔ حقیر شخصیت میں مطالعہ سیرت اطیب کے کردار کو واضح کرنا</p> <p>۳۔ بعثت نبوی کے موقع پر اقوام عالم کی موسیٰ صورت میں سے آگاہ کرنا</p> <p>۴۔ رسول اکرم صلی اللہ علیہ وسلم کی دورانی زندگی کا اس طرح مطالعہ کرنا کہ طلبہ اس انجمن سے دلچسپی اور استفادہ کر سکیں</p> <p>۵۔ طلبہ کو محمد نبوی کی معاشرت، سیاست، معاشرت سے آگاہ کرنا</p>

Course Description

S.No.	Title	Description
1	مختصر صلی اللہ علیہ وسلم کے ابتدائی حالات زندگی	۱۔ مختصر صلی اللہ علیہ وسلم کا ابتدائی سبب و نسب ۲۔ ہجرت اور ابتدائی نبوت ۳۔ لوگوں اور جنوں کے حالات زندگی
2	بعثت نبوی کے وقت و حالات (۱)	۱۔ بعثت نبوی کے وقت اہم جہتیں ۲۔ عرب، مصر، ہند، چینی، اسرائیلی
3	بعثت نبوی	۱۔ نبی محمد صلی اللہ علیہ وسلم کی آمد اسلام
4	بعثت نبوی	۱۔ نبی محمد صلی اللہ علیہ وسلم کی آمد اسلام
5	خصائص النبی	آپ کے گھور پیمانہ پر اس
6	خصائص النبی	بعثت اور معلم
7	خصائص النبی	بعثت اور
8	خصائص النبی	بعثت اور سیاست
9	خصائص النبی	ذاتی عیاشی اور معاشرتی اثرات

10	نصائح التبت	ناموس رسالت
11	اسودت اور عصر حاضر	غیر مسلموں سے تعلقات
12	اسودت اور عصر حاضر	اسودت کی روشنی میں گھریلو زندگی
13	اسودت اور عصر حاضر	سنتز قین اور مظاہرہ حیرت
15	اسودت اور عصر حاضر	دعوت سے محبت اور حیرت
16	اسودت اور عصر حاضر	سنتز قین کے التزامات اور ان کے جرائم

نصائح التبت

نمبر شمار	نام مولف	نام کتاب
1	ابن ہاشم	السيرة النبوية
2	مولانا شبلی نعمانی، سید سلمان ندوی	میر تقی علی علیہ السلام
3	ڈاکٹر محمد سلیمان سلطان منصور پوری	رسول اللہ صلی اللہ علیہ وسلم
4	مولانا سید ابراہیم حسن علی ندوی	نبی رحمت صلی اللہ علیہ وسلم
5	ڈاکٹر یحییٰ عظیم صدیقی	مہد نبوی لاہنگام حکومت
6	آغا خرمشاہ ندوی	انسان کامل

حوالہ جاتی کتب

نمبر شمار	نام مولف	نام کتاب
1	سید ابوالاعلیٰ مودودی	حیرت سرور عالم صلی اللہ علیہ وسلم
2	مولانا امجد علی اراکین مہدی پوری	ارحیق الختوم
3	پروفیسر محمد کرم شاہان زہری	فیضان الہی صلی اللہ علیہ وسلم
4	ڈاکٹر اکرم انصاری امری	السيرة النبوية الصحيحة
5	مولانا عبدالرؤف دانا پوری	اصح الہی

Course Code	URCG-5128	Course Title	Pakistan Studies	Credit Hours	2(2-0)
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Course Brief:

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

COURSE LEARNING OUTCOMES

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

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

SYLLABUS

1. Introduction to Pakistan:

Geographical location and significance.

Historical background: Ancient civilizations in the region. Factors leading to the creation of Pakistan.

2. Political History of Pakistan:

Formative phase.

Military interventions and democratic transitions.

3. Geography of Pakistan:

Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas. River systems: Indus River and its tributaries.

Climatic regions of Pakistan.

4. Society and Culture of Pakistan:

Socio-cultural diversity.

Languages and literature of Pakistan.

5. Economic Development of Pakistan:

Agriculture and industrial sectors of Pakistan. Economic challenges of Pakistan.

6. Contemporary Issues:

Foreign relations of Pakistan.

Security challenges: terrorism, extremism, and regional conflicts.
sustainable development (SDGs).

Environmental problems and

Media and social change.

SUGGESTED INSTRUCTIONAL / READING MATERIALS

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

SEMESTER III

Course Code	ZOOL-5104	Course Title	Animal Ecology	Credit Hours	3(2-1)
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Course Brief:

This course will enable students to understand about habitat, ecology, ecosystems and environmental threats. Students will learn about the rehabilitation of destroyed ecosystems. They will also be capable to learn methods to protect and safe environment. The students will be literate about the biogeochemical cycles, applied ecology, population ecology, community ecology and global ecosystems. Upon successful completion of the course students will develop an appreciation of the modern scope of scientific inquiry in the field of Ecology, become familiar with the variety of ways that organisms interact with both the physical and the biological environment and develop an understanding of the differences in the structure and function of different types of ecosystems.

Course Learning Objectives:

Moreover, this subject imparts knowledge to compare the relationships among organisms, including predation, parasitism, competition, commensalism, and mutualism. The students will also able to explain the general distribution of life in aquatic systems as a function of chemistry, geography, light, depth, salinity, and temperature.

Course Contents:

1. Energy: Basic concepts of and types of ecology, laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.
2. Biogeochemical cycle: nitrogen, phosphorus, sulphur, water, carbon and nutrient.
3. Limiting factors: basic concepts, temperature, soil, water, humidity, light and fire.
4. Global ecosystems: atmosphere, hydrosphere, lithosphere and ecosphere, an overview of ecosystem with special reference to ecological niche, basic concepts and types, major ecosystem of world, forest, grassland, desert, tundra and agricultural ecosystems. marine, estuarine, freshwater and wetlands
5. Population ecology: basic population characters, growth and growth curves, population dynamics and regulations.
6. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions
7. Applied Ecology: Resources and their ecological management; mineral, agricultural desalination, weather modification, forest and range management, landscape and land use
8. Pollution: definition, types, water, air, land and noise, sources and management.
9. Radiation ecology: global environmental changes (ozone depletion, acid rain, greenhouse effect and global warming, koyota protocol, radioactivity leakage, environmental laws).
10. Exotic and Invasive Species: desertification, deforestation, exotic and invasive species

Practical

1. Population Sampling Techniques (quadrant, line transect, point count, focal scan and capture and recapture method).
2. Study of different Ecosystems (fresh water, terrestrial, marine/mountain/ desert).
3. Ecological notes.
4. Measurements of physical factors of different ecosystems.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.

9. Experimental design and approaches in ecological research; writing a research project
10. Development of an ecological management plan of some selected area

Recommended Texts:

1. Molles, M. C. (2005). *Ecology: concepts and applications* (6thed.). New York: McGraw Hill.
2. Cox, C. B., & Morre, D. (2000). *Biogeography: an ecological and evolutionary approach* (6thed.). London: Life Sciences King's College.
3. Morrison, M.L., Brennan, L.A., Marcot, B.G., Block, W.M., & McKelvey, K.S. (2020). *Foundations for advancing animal ecology (wildlife management and conservation)*. Maryland: John Hopkins University Press.

Suggested Readings:

2. Dondson, S. I., Allen, T. F. N., Carpenter, S. R., Ives, A., Jeanne, R. L., Kitchell, J. F., Langston, N. E., & Turner, M. G. (1998). *Ecology*. Oxford: Oxford Univ. Press.
3. Chapman, J. L., & Reiss, M. J. (1997). *Ecology: principles and applications*. Cambridge: Cambridge University Press.
4. Cambridge University Press.
5. Odum, E. P. (2005). *Fundamentals of ecology* (5th ed.) Philadelphia: W.B. Saunders

Course Code	ZOOL-5106	Course Title	Animal Behavior	Credit Hours	3(3-0)
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Course Brief:

This course will give the baseline information about animal behavior and associate the likely role of external and internal stimuli on various animals during the day, season and year. It also relates daily behavioral rhythms in diurnal and nocturnal periodicities and predicts and anticipates variety of animal actions (costs and benefits) as assessed by innate and learned behavioral displays. The unifying theme of this course will be evolution by means of natural and sexual selection

Course Learning Objectives:

It includes the scientific study of the mechanistic and evolutionary causes of animal behavior, including communication, foraging and anti-predator behavior, spatial behavior, mating behavior, parental care, and social behaviors. After successful completion of this course, students should be capable of understand and identify behaviors in a variety of taxa, can competently discuss the evolutionary origins of various behaviors and can design and implementing experiments to test hypotheses relating to animal behavior.

Course Contents:

1. Introduction: behavior and its types, proximate and ultimate causes of behavior.
2. Development of behavior: Impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses, physiology of behavior in changed environments.
3. Hormones and behavior in animals. Innate behavior and innate releasing mechanisms; built in programmed performance by offspring to that of parents. Innate behavior of three spines stickle back fish. Learned behavior and its mechanisms: quick learners' vs. slow learners.
4. Concept of animal cognition: key to understand and develop multiple behavioral choices, Ecological and genetics to maintain animal behavior, concept of territoriality and defense in animals.
5. Circadian rhythms and concept of bio-rhythmicity in animals.
6. Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities.
7. Costs and benefit ratios in behavior; successful foragers and winners of predator-prey relationships. Altruism and parental sacrifice to nurture the young.
8. Competition for resources; survival of the most suitable individuals; evolutionary arms races in behavior.
9. Social organization in animals and concept of group living; benefits and losses, Aggression, appeasement and selfish individuals. Social organization in insects and mammals.
10. Communication in animals: visual, bioacoustic, electrical, chemical and tactile.
11. Various types of chemical signals in animal's behavior and their importance in ecosystems.

Recommended Texts:

1. Dugatkin, L. A. (2020). *Principles of animal behavior* (4th ed.). University of Chicago Press.
2. Rubenstein, D. (2022). *Animal Behavior* (12th ed.) Oxford University Press

Suggested Readings:

1. Rubenstein, D., & Alcock, J. (2019). *Animal behavior, an evolutionary approach* (11th ed.). New York, Oxford, Oxford University Press.
2. Goodenough, J., McGuire, B., & Wallace, R.A. (2009). *Perspective on animal behavior*. New York: John Wiley & Sons.
3. Scott, G. (2009). *Essential Animal Behavior*. Wiley-Blackwell publishers

Course Code	AIDE-5205	Course Title	Applied Artificial Intelligence	Credit Hours	3(3-0)
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Course Title: Applied Artificial Intelligence

Level: Undergraduate (Non-Computing Discipline)
 Credit Hours: 3 (Theory + 1 Substantive Project)
 AIDE-5205

Introduction
 Artificial Intelligence (AI) is rapidly transforming industries and reshaping the way people work, think, and make decisions. This course introduces non-computing students to the practical applications of AI in their respective fields. Without requiring prior programming knowledge, the course emphasizes conceptual understanding, critical thought, and problem-solving skills to understand AI tools. It builds AI literacy for responsible use and critical thinking in AI-driven environments.

Course Objectives

This course aims to provide students with a foundational understanding of artificial intelligence and its transformative potential across various business disciplines. Students will learn about real-world AI applications, ethical considerations, and how to leverage basic AI tools and techniques relevant to their disciplines. The course encourages interdisciplinary exploration and empowers students to become informed participants in AI-driven decision-making processes.

Learning Outcomes

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

- Explain the basic concepts and history of AI and distinguish it from related technologies.
- Identify and interpret AI applications relevant to their disciplines.
- Evaluate the ethical, social, and economic implications of AI systems.
- Use simple AI-based tools and platforms to solve discipline-specific problems.
- Recognize AI-based opportunities or solutions in real-world scenarios related to their fields.

Course Syllabus (Week-wise Breakdown)

Weeks 1-2: Introduction to AI

- What is Artificial Intelligence?
- History, evolution, and key milestones.
- Types of AI (Narrow, General, Super AI)
- AI vs. Machine Learning vs. Deep Learning

Weeks 3-4: Foundations of AI and Machine Learning

- Supervised, Unsupervised, and Reinforcement Learning

- Common algorithms (focus on linear regression, classification, clustering)
- Concept of overfitting and its prevention
- AI vs. Data: correlation vs. causation and differences

Weeks 5-6: AI Tools & Platforms (No Code or Low Code)

- Hands-on with tools like:
 - Google Teachable Machine
 - IBM Watson Studio
 - Microsoft Azure ML
 - Curvy AI, Grammarly AI, etc.
- Data visualization and interpretation

Weeks 7-8: AI Ethics and Social Impacts

- AI bias and fairness
- Data privacy concerns
- Legal, societal, and ethical dimensions
- Case studies of AI misuse and responsible AI

Weeks 9-10: Natural Language Processing & Generative AI

- What is NLP? Where is it used?
- Introduction to ChatGPT, translation tools, and text summarization
- Content generation (images, text, videos (Sora, etc.), etc.)

Weeks 11-12: AI in Industry & Interdisciplinary Projects

- How AI is transforming jobs and industries
- AI and creativity: human-AI collaboration
- Interdisciplinary group projects (student-led)

Weeks 13-14: Discipline-Specific AI Applications

Overview, assistance or data and resources per group

Discipline-Specific Applications

Discipline	Relevant Applications
Business & Economics	AI in customer insights, predictive analytics, fraud detection, marketing optimization
Education	Intelligent tutoring systems, personalized learning platforms, automated grading
Engineering	Predictive maintenance, smart systems, optimization, AI in CAD and robotics
Discipline	Relevant Applications
Health Sciences	Diagnostic tools, symptom checkers, AI in medical imaging, public health forecasting
Social Sciences & Humanities	AI in social media analysis, digital humanities, ethics, linguistics
Arts & Design	Generative art, AI-assisted design, music generation, creative writing tools
Psychology/Behavior	AI in behavioral prediction, sentiment analysis, social media analysis
Agricultural Sciences	AI in weather prediction, yield optimization, disease detection

Recommended Books (Latest Editions & Recent References)

- Ng, A. (2024). *AI for everyone: How to use it, how to manage it, and how to make it work for you*. New York: Wiley.
- Elmahdi, M. (2023). *Artificial intelligence: A guide for thinking humans* (Updated ed.). New York: Wiley.
- Global a critical overview of AI's current capabilities and limitations, potential for societal benefits.
- Shoemaker, J. (2023). *How to think like a computer: 100 ways to think like a computer and why it's making the world a better place*. New York: NY: No Starch Press.
- Smith, P. D. (2022). *AI for business: A practical guide for managers, small business owners, and entrepreneurs*. Boca Raton, FL: Packt Publishing.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. Cambridge, MA: MIT Press.
- Yuan, M., & Wang, X. (2022). *Applied artificial intelligence: A practical guide for applying AI in real business environments with case studies and actionable advice*.

Course Code	URCG- 5119	Course Title	Expository Writing	Credit Hours	3 (3-0)
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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 selfreflection and active community engagement.

Course Learning Objectives:

The course completion will enable the students to develop communication skills as reflective and selfdirected 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.

General Education Cluster: Quantitative Reasoning

URCG-5T21

Tools for Quantitative Reasoning

3(3-0)

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

Course Learning Outcomes

By the end of the course, student shall have:

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

Contents

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

Recommended Texts

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

Suggested Readings

1. Epp, S. S. (1990). *Discrete mathematics with applications*. Wadsworth Publ. Co.
2. Budnick, F. S., Quinn, S., Bowser, K., & Flaherty, F. H. (1993). *Applied mathematics for business, economics, and the social sciences*. New York: McGraw-Hill.
3. Bluman, A. (2014). *Elementary Statistics: A step by step approach*. McGraw-Hill.
4. Mann, P. S. (2007). *Introductory statistics*. John Wiley & Sons.
5. Babones, S. (2013). *Applied statistical modeling*. (No Title).
6. Green, S. W., Wolf, L. K., Stewart, B. W. (2022). *SAT Study Guide Premium*. Barron's.

Model Course Outline for the Course Understanding of Quran – II

Course Title: Understanding of Quran – II
 Course Book: Muallim ul Quran (Volume 3, 4 & 5) by Dr Ubaid ur Rahman
 Credit Hours: 1 (0-1)
 Contact Hours: 3 per week
 Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

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

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

Provision of material, content and books:

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

Course Outline:

Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	6	6	Understanding & Translation of Verses	Present Tense سورة جمع مذكر مخاطب ملك يعززون
	2.	6	7-8	Understanding & Translation of Verses	Present Tense سورة جمع مذكر مخاطب ملك يعززون
2.	1.	6	9-10	Understanding & Translation of Verses	Present Tense سورة مفرد مذكر مخاطب (امرؤ) وجمع مذكر مخاطب (امرؤون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense سورة جمع مذكر مخاطب (امرؤون)

سبقة المتكلم (أحد)					
3.	1.	6	13	Understanding & Translation of Verses	Present Tense سبقة جمع المتكلم (تعدد)
	2.	6	14-15	Understanding & Translation of Verses	Negative Imperative سبقة المفرد وسبقة الجمع , لا تكبد , لا تكبدوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar mozwal (مستتر مؤنث)
	2.	6	18-19	Understanding & Translation of Verses	Laam uttafaal (لام التعليل) & Laam ul hood (لام الجحود)
5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice
	2.	6	Revision (Unit 6)	Quiz	
6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tense سبقة المفرد للثاني
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense سبقة المفرد للثاني
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense سبقة المفرد للثاني
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense سبقة المفرد للثاني
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense سبقة المفرد للثاني
	2.	MID-TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense سبقة الجمع للثاني جديرا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense سبقة الجمع للثاني جديرا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense سبقة الجمع للثاني جديرا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense سبقة الجمع للثاني جديرا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense سبقة الجمع للمتكلم جديرا

	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense سنة الجمع المتكلم عهدنا
2.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense سنة الجمع المتكلم عهدنا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense سنة الجمع المتكلم عهدنا
3.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense سنة الجمع المتكلم عهدنا
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense سنة الجمع المتكلم عهدنا
4.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense سنة المتكلم و المتكلم عهدنا
	2.	7	7	Understanding & Translation of Verses	Past Tense سنة المتكلم للمتكلم عهدنا
5.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول المتكلم
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول الجمع
6.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر المفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر الجمع

Ethics II

URCG-513

1. Course Description

The course *Ethics II* is designed to provide students with a deeper understanding of ethical principles and practices from Jewish, Christian, Islamic, Hindu, Buddhist, Sikh, Confucian, and Jain ethical traditions. Students will engage in reasoning, decision-making, tolerance, and peacebuilding. The course emphasizes moral growth towards ethical living and interfaith engagement.

2. Learning Objectives

The course objectives are to:

1. Understand the fundamental principles and theories of ethics.
2. Introduce the ethical and moral teachings of Judaism, Christianity, Islam, and Hinduism.
3. Explore the ethical teachings of non-Semitic religions such as Buddhism, Sikhism, Confucianism, and Jainism.
4. Develop critical thinking skills to evaluate ethical arguments and theories.
5. Promote ethical leadership and interfaith harmony.

3. Learning Outcomes

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

1. Identify and analyze major ethical theories and teachings from world religions.
2. Understand the role of religions in improving moral values and social behavior.
3. Demonstrate ethical decision-making in various personal and professional contexts.
4. Recognize the impact of ethical decisions on individuals, communities, and society.
5. Apply skills of ethical leadership, including communication, conflict resolution, and inclusive engagement.

4. Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Title: ~~Ethics II (For Non-Muslim Students)~~ Course Code: ~~URCG-5130~~

Course Contents

Unit 1: Ethical Teachings of Semitic Religions

- Judaism and its ethical teachings
- Christianity and its ethical teachings
- Islam and its ethical teachings

Unit 2: Ethical Teachings of Non-Semitic Religions

- Hinduism and its ethical teachings
- Sikhism and Buddhism: ethical values and practices
- Confucian and Jain ethical traditions

Unit 3: Professional Ethics

- Ethics for students and teachers
- Ethics in doctor-patient relationships
- Ethics in trader-customer interactions

Unit 4: Concept and Significance of Tolerance

- Definition, need, and importance of tolerance
- Teachings of Semitic religions on tolerance and their contemporary relevance
- Teachings of non-Semitic religions on tolerance and their contemporary relevance

Unit 5: Foundational Values and Ethics for Peacebuilding in Society

- Respect for sacred scriptures, personalities, places of worship, and religious symbols
- Promotion of tolerance and broadmindedness
- Encouragement of dialogue and harmony
- Benevolence towards humanity
- Establishment of justice and fairness
- Patience, forbearance, and forgiveness

Textbook

- Kidder, R. M. (2009). *How Good People Make Tough Choices: Resolving the Dilemmas of Ethical Living*. Harper.

Suggested Readings

1. Barash, D. P., & Webel, C. P. (2014). *Peace and Conflict Studies*. Sage.
2. Smart, N. (1998). *The World's Religions*. Cambridge University Press.
3. Mohr, S. H. (2003). *The Heart of Islam: Enduring Values for Humanity*. HarperOne.
4. Sharma, A. (2006). *Hindu Ethics: Purity, Abortion, and Euthanasia*. SUNY Press.
5. Harvey, P. (2000). *An Introduction to Buddhist Ethics: Foundations, Values and Issues*. Cambridge University Press.
6. Coward, H., & Parkinson, J. (2013). *A Cross-Cultural Dialogue on Ethical Leadership*. Willard Laurier University Press.

Course Code	URCG-5122	Course Title	Ideology and Constitution of Pakistan	Credit Hours	2(2-0)
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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.

Course Learning Objectives:

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 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 Judiciary**

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 Texts:

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:

1. Rizvi, Syed Shabbar Raza. Constitutional Law of Pakistan: Text, Case Law and Analytical Commentary. 2nd re edn. Lahore: Vanguard, 2005.
2. The Text of the Constitution of the Islamic Republic of Pakistan, 1973 (as amended).

SEMESTER IV

Course Code	ZOOL-5107	Course Title	Evolution	Credit Hours	3(3-0)
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Course Brief:

The course aims to provide extensive knowledge about origin of life and concepts about forces responsible for evolutionary changes. This course will also provide information about origin, classification and evolution of fauna. The students will be able to understand classification, philosophy of nomenclature, species concepts, phylogenetic inference and evolutionary perspectives of biodiversity.

Course Learning Objectives:

The students will be able to understand the basic principles of evolution and systematics, and the inference of evolutionary patterns in the major animal groups. Students will be able to demonstrate evolutionary implications of animal diversity, nature and origin to life, Systematic Zoology, microtaxonomy and taxonomic categories. The practical section will enable the students to preserve invertebrate species and classify them up to class level, how to identify animal by the help of key and how to make keys of different types for identification of animals

Course Contents:

1. Theories of Evolution: theories to explain diversity of life– modern synthetic theory, Factors initiating elementary evolutionary changes (micro-evolution) and change of gene frequencies. Mutation pressure, selection pressure, immigration and crossbreeding, genetic drift.
2. Role of isolation in evolution: factors of large evolutionary changes (macroevolution). Concepts of allometry, orthogenesis, adaptive radiation.
3. Modern concept of Natural Selection: levels of selection, selection patterns, some examples of Natural Selection.
4. Impacts of Natural Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry, sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory and recapitulation theory

Recommended Texts:

1. Strickberger's Evolution Hall, B.K. & Hallgrímsson, B. (2013). *Jones & Barrett Publishers*.
2. Ridley, M. (2004). Evolution. Blackwell Scientific Publications.
3. Freeman, S.& Herron, J. C. (2014). Evolutionary analysis, 5th ed. Pearson Prentice Hall.

Suggested Readings:

1. Moody, P.A. (1989). Introduction to Evolution, Harper and Row, Publishers, New York Systematics

Course Code	ZOOL-5108	Course Title	Animal Form & Function-II (Comparative Physiology)	Credit Hours	3(2-1)
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Course Brief:

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 like temperature regulation adequately and 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 adapted by 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 invertebrate and 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 of nutrition; the metabolic fates of nutrients in heterotrophs; digestion, Animal strategies for getting and using food, diversity in digestive structures of invertebrates., The mammalian digestive system; gastrointestinal motility and its control, Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.
2. Temperature and body fluid regulation: homeostasis and temperature regulation; the impact of temperature on animal life; heat gains and losses; some solutions to temperature fluctuations;
3. Temperature regulation in invertebrates, fishes, amphibians, reptiles, birds and mammals; heat production in birds and mammals, control of water and solutes (osmoregulation and excretion); invertebrate and vertebrate
4. Excretory systems; how vertebrates achieve osmoregulation; vertebrate kidney variations; mechanism in metanephric kidney functions.
5. Reproduction and development: asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction, sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes; the human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function; the human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.

Practical

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

Note: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used to develop better understanding among students.

Recommended Texts:

1. Miller, A. S., & Harley, J. P. (2016 & 2019). *Zoology* (10 & 11 ed.). Singapore: McGraw Hill.
2. Hickman, C., Jr., Keen, S., Eisenhour, D., Larson, A., l'Anson, H., (2019). *Integrated principles of zoology* (18 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. Pechenik, J. A. (2015). *Biology of invertebrates* (7th ed.). Singapore: McGraw-Hill

Course Code	ZOOL-6109	Course Title	Entomology	Credit Hours	3(2-1)
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Course Brief:

The course is designed to impart knowledge to students about morphology and body parts of the insects. The objective of the entomology undergraduate is to provide students with a broadly-based education in the science and practice of entomology. After this course, students can demonstrate an understanding of insect identification, structure, and function. It includes general characteristics of insects, relationship with other arthropods and evolutionary study of insects splitting up into different evolutionary lines.

Course Learning Objectives:

This subject also imparts knowledge about ecology of insects by learning carrying capacity, food chains, predation and competition, diapause insect population and community studies and insect communication. The practical section will enable the students to prepare permanent slides, distinguish the several body parts (antennae, mouth parts, wings, legs, terminal segments and genitalia) of insects; can study the different systems, especially digestive, reproductive of the insect and be able to address complex problems facing entomology.

Course Contents:

1. General characteristics of insects and their classification
2. Hard parts: general segmentation, tagmatosis and organization.
3. Cuticle: colors of insects, cuticular outgrowths and appendages sclerotization.
4. Head: cephalization, sclerites, modifications.
5. Antennae: different modes of ingestion and types of mouth parts.
6. Neck: sclerites, thorax: sclerites: legs, their different modifications and functions.
7. Wings: origin; development and basal attachments, main veins and their branches 8. Abdomen: secondary appendages and external genitalia, 9. Flight; types of flight.
10. Soft parts: muscular system; basic structure, types of muscles
11. Sense organs: sound and light producing organs.
12. Nutritive requirements: fat body, exocrine and endocrine glands
13. Reproduction: reproductive organs and different types of reproduction in insects,
14. Development: embryology up to dorsal closure, different types of metamorphosis, apolysis and ecdysis and the role of endocrine secretions.
15. Ecology: insect population and community studies, insect communication.

Practical

1. Preparation of permanent slides.
2. All the hard parts (antennae, mouth parts, wings, legs, terminal segments and genitalia).
3. Different systems, especially digestive, reproductive of the following insects.
4. American cockroach, gryllus, grasshopper, housefly, butterfly, mosquito, any common beetle.
5. Red cotton bug.
6. Wasp and honey bee.
7. Sympathetic nervous system of cockroach and gryllus.
8. Salivary glands of cockroach, red cotton bug and honey bee.

Recommended Texts:

1. Richards, O. W., & Davies, R. G. (1977). *Imm's general textbook of entomology* (Vol. 1; 10 ed.).

London: Chapman & hall.

2. Chapman, R. F. (2013). *The insects: structure and function* (5th ed.). Cambridge: Cambridge University Press.
3. Wigglesworth, V. B. (2012). *The principles of insect physiology*. London: Springer Science & Business Media.

Suggested Readings:

1. Tembhare, D. B. (2002). *Modern entomology*. Dehli: Himalaya Publishing House.
2. Henderson, P. A., & Southood, T. R. E. (2016). *Ecological methods*. London: Wiley Blackwell.
3. Peterson, P. G. (2018). *Elements of insect ecology*. London: Ed- Tech Press.

Course Code	ZOOL-6110	Course Title	Developmental Biology	Credit Hours	3(2-1)
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Course Brief:

The course aims to provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development; impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction. It provides understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. Students will learn how developmental biology is having a significant impact on our understanding of evolution and modern medicine, including the treatment of birth defects, infertility and cancer in humans.

Course Learning Objectives:

The students will be able to understand and compare basic principles of embryology through understanding the developmental patterns with help of morphology and anatomy of embryos of different vertebrates. The practical section will enable them to go through the structure of gametes of animals (like. frog, fish and mammal), to study of fertilization, early development of frog/fish through induced spawning under laboratory conditions and to know about the dactylography and its uses in developmental biology.

Course Contents:

1. Introduction: History and Basic Concepts of developmental biology, Principal features of developmental biology and embryology with special emphasis on vertebrate models, origin of sexual reproduction, developmental patterns
2. Spermatogenesis: Mammalian spermatogenesis as model for all vertebrates, Spermiogenesis or (spermateliosis), The role of Sertoli and Leydig cells in spermatogenesis, Hormonal control of spermatogenesis
3. Primates menstrual cycle
4. Oogenesis: mechanism of oogenesis among various classes of vertebrates, vitellogenesis hormonal control of vitellogenesis and oogenesis
5. Fertilization: external & internal fertilization, species-specific recognition of sperm and egg, fusion of male and female gametes
6. Polyspermy: slow and fast blocks to polyspermy, activation of egg metabolism
7. *IN VITRO* Fertilization (IVF): history, steps and advantages of IVF, disadvantages and risk factors
8. Cleavage & blastulation, patterns of embryonic cleavage and blastulation among different vertebrate classes, mechanism of cleavage
9. Gastrulation: fate maps, gastrulation in amphibians, birds and mammals
10. Early vertebrate development
11. Neurulation, ectoderm, mesoderm and endoderm formation
12. Placenta and extraembryonic membranes
13. Cellular basis of morphogenesis: differential cell affinity, cell adhesion molecules,
14. Organogenesis, Mechanism of teratogenesis
15. Aging and regeneration in vertebrates

Practical

1. Study of the structure of gametes in some representative cases, i.e. frog, fish and mammal.
2. Hen's egg internal and external structural details.
3. Microscopic analysis of hen's egg yolk, albumin and shell membranes.
4. Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.

5. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
6. Study of developmental stages of nematodes through microscopic analysis of animal dung.
7. Semen analysis.
8. Dactylography and its uses in developmental biology.

Recommended Texts:

1. Gilbert, S. F., & Barresi, M. J. F. (2020). *Developmental Biology* (11th ed.). Oxford: Oxford University Press, Incorporated.
2. Dale, L., & Slack, J. M. W. (2021). *Essential Developmental Biology*. Wiley: United Kingdom.

Suggested Readings:

1. Carlson, B. M. (2023). *Human Embryology and Developmental Biology*. Elsevier Health Sciences: United States.
2. Micheal, J. F., & Scott, F.G. (2019). *Developmental Biology*. United States: MJP Publisher.
3. Carlson B. M. (2014). *Human Embryology and Developmental Biology* (5th ed.). Elsevier/Saunders: United States.

Course Code	URCG-5125	Course Title	Civics and Community Engagement	Credit Hours	2(2-0)
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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.
- Examine the historical and contemporary examples of successful civic and community engagement initiatives.
- Identify and assess community needs, assets, and challenges to develop effective strategies for community improvement.
- Explore the ethical implications and dilemmas associated with civic and community engagement.
- Develop practical skills for effective community organizing, advocacy, and leadership.
- Foster intercultural competence and respect for diversity in community engagement efforts.
- Collaborate with community organizations, stakeholders, and fellow students to design and implement community-based projects.

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 Texts:

1. Kennedy, J. K., & Brunold, A. (2016). Regional context and Citizenship education in Asia and Europe. New York: 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. Glencoe McGraw-Hill. (n.d.). Civics Today: Citizenship, Economics, and Youth.
2. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). Government by the People (16th ed.). Pearson.
3. Sirianni, C., & Friedland, L. (2005). The Civic Renewal Movement: Community-Building and Democracy in the United States. Kettering Foundation Press.
4. Bloemraad, I. (2006). Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada. University of California Press.
5. Kuyek, J. (2007). Community Organizing: Theory and Practice. Fernwood Publishing.
6. DeKieffer, D. E. (2010). The Citizen's Guide to Lobbying Congress. TheCapitol.Net. 7. Rybacki, K. C., & Rybacki, D. J. (2021). Advocacy and Opposition: An Introduction to Argumentation (8th ed.). Routledge.
8. Kretzmann, J. P., & McKnight, J. L. (1993). Building Communities from the Inside Out: A Path Towards Finding and Mobilizing a Community's Assets. ACTA Publications.
9. Patterson, T. E. (2005). Engaging the Public: How Government and the Media Can Reinvigorate American Democracy. Oxford University Press.
10. Love, N. S., & Mattern, M. (2005). Doing Democracy: Activist Art and Cultural Politics.

Course Code	URCG-5115	Course Title	The Science of Global Challenges	Credit Hours	3(2-1)
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Course Brief:

Natural sciences enable an understanding and appreciation of the physical and the natural world through observation and experimentation. The program of studies introduces students to theoretical analyses, experimental methods, and problem solving. The study of physics, chemistry, geology, biology, and ecology helps develop critical faculties for evaluating natural phenomena and expert opinion.

Course Learning Objectives:

The course shall enable the students to practice application of Scientific Method in the natural sciences. It will also teach the students to appreciate the beauty of the natural and physical worlds often hidden from casual observation but which, once revealed, lends richness to everyday life.

Course Contents:

1. **Climate Change** i.e., Global Warming, Natural and Anthropogenic Activities and their impact
2. **Energy** i.e., Renewable and non-renewable energy resources
3. **Water Security** i.e., water scarcity and waste water treatment
4. **Land Degradation** i.e., salinity, water logging, deforestation, land erosion; **Food Security** and roll of Biotechnology in food production
5. **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 Texts:

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

Suggested Readings:

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

Course Code	URCG-5124	Course Title	Entrepreneurship	Credit Hours	2(2-0)
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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:

1. To enhance the 'entrepreneurial intentions' of the students by improving their natural willingness to start a business.
2. 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.
3. 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 E- Commerce, Ten Myths of E-Commerce, Strategies for E-Success, designing a Killer Web Site, Tracking Web Results, Ensuring Web Privacy and Security, Feed Back & Suggestions on Student Project.
11. **Pricing Strategies:** Three Potent Forces: Image, Competition, and Value, Pricing Strategies and Tactics, Pricing Strategies and Methods for Retailers, The Impact of Credit on Pricing
12. **Attracting Venture Capitalist:** Projected Financial Statements, Basic Financial Statements, Ratio Analysis, Interpreting Business Ratios, Breakeven Analysis, Feed Back & Suggestions on Student Project,

13. **Idea Pitching:** Formal presentation, 5-minutes pitch, funding negotiation and launching.

Recommended Texts:

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

Suggested Readings:

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

Semester V

Course Code	ZOOL-6111	Course Title	Fisheries & Aquaculture	and	Credit Hours	3(2-1)
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Course Brief:

This course focuses on disseminating the history, needs and importance of fisheries and aquaculture. Moreover, it elaborates the basic components of pond fish culture and improves knowledge about local fish species, including culturable fishes, and their biology. It also imparts knowledge regarding fish gears and post-harvest techniques.

Course Learning Objectives:

Declining fish populations, marine pollution and destruction of important coastal ecosystems has introduced increasing uncertainty in important fisheries worldwide, threatening economic security and food security in many parts of the world. These challenges are further complicated by the changes in the ocean caused by climate change, which may extend the range of some fisheries while dramatically reducing the sustainability of other fisheries.

Course Contents:

1. Introduction to fisheries and aquaculture, national and international trends
2. Fish morphology and diversity in size and shape
3. Distribution of fishes in Pakistan, commercial fishes, marine and freshwater
4. Fish diseases: viral, bacterial, fungal and parasitic
5. Fish habitat, ecology and extant of distribution, water quality parameters (abiotic: temperature, light, salinity, pH, turbidity, etc.) and their effects on fish health and production
6. Biotic parameters (plankton, insects, aquatic vegetation etc.) of ponds, lakes, rivers and impacts on fish growth.
7. Induced breeding
8. Fish enemies and their control: insects, fishes, amphibians, reptiles, birds and mammals
9. Fishing gears, fishing techniques, fishing communities
10. Fish preservation, processing transportation and marketing

Practical

1. Morphological characters of a typical fish
2. Species identification, fin formula, key to identification of commercial fishes
3. Dissection of common fish to study its various systems
4. Visit to a fish hatchery
5. Introduction to artificial feed ingredient

Recommended Texts:

1. Sharma, O.P. (2009). *Handbook of Fisheries and Aquaculture*. Agrotech Publishing Academy, Udaipur, New Delhi, India.
2. Stickney, R.R. (2009). *Aquaculture: An Introductory Text*. CABI Publishing, London, UK.

Suggested Readings:

1. Pillay, T.V.R., & Kutty, M.N. (2005). *Aquaculture: Principles and Practices*. Blackwell Science Limited. New York.
2. Ali, S.S. (1999). *An Introduction to Freshwater Fishery Biology*. University Grants Commission, H-9 Islamabad.

Course Code	ZOOL-6112	Course Title	Marine Biology	Credit Hours	3(3-0)
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Course Brief:

To introduce basic concepts of oceanography, biodiversity, ecology and evolution as they pertain to marine coastal environments. To learn through theoretical and practical exercises how environmental and biological factors interact to sustain near-shore ecosystems. To acquire field skills to study marine near-shore environments. To improve discussion, analytical, presentation and writing skills.

Course Outline:

1. Biodiversity of different shore types such as rocky, sandy, muddy, rocky-sandy, rocky-muddy and sandy-muddy shores *etc.*
2. Seaweeds and Mangroves
3. Interaction of biological factors to sustain near-shore ecosystems
4. Coral reef systems, physiological and behavioural adaptations that enable organisms to live in a particular environment
5. Basic ecological principles, marine conservation, metapopulations-dynamics, adaptation to climate change, and conservation genetics

Recommended Books:

1. Bertness, Gaines and Hay, Marine Community Ecology. Sinauer Associates, Inc. ISBN 0-87893-057-4.
2. Human, The Reef Set: Reef Fish, Reef Creature and Reef Coral (3 Volumes). New World Publications, Inc. ISBN 1-878348-32-9.
3. Kaplan, Coral Reefs. Peterson Field Guide. Houghton Mifflin Company. ISBN 0-618-00211-1.
4. Kaplan, Southeastern and Caribbean Seashores. Peterson Field Guide. Houghton Mifflin Company. ISBN-13 978-0-395-97516-9.
5. Morrissey and Sumich, Biology of Marine Life. 9th edition. Jones and Bartlett Publishers.
6. Trujillo and Thurman, Essentials of Oceanography, 10 edn. Prentice Hall. ISBN-13: 9780321668127.
7. Wisheart, A Photographic Atlas of Marine Biology. Morton Publishing Company. ISBN: 9780895827852.
8. Earle, S. A. (2021). National Geographic Ocean: A Global Odyssey. National Geographic. ISBN 9781426221927.
9. DK. (2020). *Oceanology: The secrets of the sea revealed*. DK Publishing. ISBN 9780744020502.

Course Code	ZOOL-6113	Course Title	Principles of Systematic Zoology	Credit Hours	3(2-1)
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Course Brief:

This course introduces the principles and practices of animal taxonomy and systematics. It covers the historical development, key terminologies, species concepts, and taxonomic procedures, including classification, naming, and identification methods. Emphasis is placed on the application of phylogenetics and cladistics in modern taxonomy, as well as the rules of zoological nomenclature. The course prepares students for careers in systematics and related biological sciences.

Course Learning Objectives:

The students will be able to understand the basic principles of systematics, microtaxonomy and taxonomic categories. The practical section will enable the students to preserve invertebrate species and classify them up to class level, how to identify animal by the help of key and how to make keys of different types for identification of animals

Course Contents:

1. Importance and applications of systematics: Taxonomy in Animal science, systematics as a profession and its future perspectives.
2. History of taxonomy: systematics, basic terminology of systematics, theories of biological classifications.
3. Taxonomic characters: Kinds and weightage, micro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Species concept.
4. Typological species concept: Nominalist species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation
5. Taxonomic procedures, taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.
6. Formation of specific names, brief concept of cladistics, phylogenetics. Theory and practice of cladistics and phylogenetic systematics.
7. Systematics publications: International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

Practical

1. Collection, preservation and identification of common species with the help of keys.
2. Preparation of keys for the identification of specimens.
3. Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.

Recommended Texts:

1. I.Mayer , E. Principles of Systematic Zoology. (1994). McGraw Hill, New York.
2. Andrew V. Z. Brower & Randall T. Schuh. (2021). Biological Systematics: Principles and Applications (3rd ed.) Oxford Academic Books.

Suggested Readings:

1. Wiley, E. O. & Lieberman, B. S. (2011). Phylogenetics: Theory and practice of phylogenetic systematics. (2nd ed), Wiley-Blackwell.
2. Kapoor, V.C. (2001). Principles and practices of animal Taxonomy. Science Publishers, 2nd ed

Course Code	ZOOL-6114	Course Title	Principles of	Credit Hours	3(2-1)
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Course Brief:

The course aims to provide in-depth knowledge about the polymerized organic compounds of life. It will develop an understanding about the dynamism in life as it proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It enables students to know how organisms harvest energy for growth and duplication. This course will help students to understand the principles of bioenergetics and the dietary requirements of man and animals. It will also provide knowledge of metabolism of dietary and endogenous carbohydrate, lipid, and protein as well as the principles and major mechanisms of metabolic control and molecular signaling by hormones

Course Learning Objectives:

This course help students with a basic understanding of the principles of bioenergetics and enzyme catalysis, understand the chemical nature of biological macromolecules, their three- dimensional construction, and the principles of molecular recognition and demonstrates understanding of the molecular machinery of living cells in the students.

Course Contents:

1. Amino acids, peptides and proteins: Standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, Cytochrome C; Proteins: level of structural organization, example of structural and functional proteins.
2. Enzymes: Introduction; important characteristics of enzymes; immobilized enzymes; How enzymes work; example of enzymatic reaction; enzyme kinetics, enzyme rate of reaction and substrate concentration, how pH and temperature effect on enzyme activity.
3. Classification, types, important characteristics and structure of carbohydrates; cyclic structure of monosaccharides; cyanohydrin formation; disaccharides their types structure and function;
4. Polysaccharides, storage and structural types; structure and major functions of polysaccharides.
5. Lipids: Fatty acids, their types and major characteristics; storage lipids, acylglycerols; waxes;
6. Structural lipids in membranes; Major functions of lipids; lipoproteins, their types and major functions.
7. Vitamins and cofactors: Occurrence, structure and biochemical function of vitamins B complex group.
8. Metabolism: Detailed description of glycolysis and catabolism of other hexoses; regulation and bioenergetics of glycolysis. Anabolic role of glycolysis; fate of pyruvate under aerobic and anaerobic conditions, lactate, acetyl CoA and ethanol formation; alcoholic fermentation; gluconeogenesis, its regulation and significance in the tissues; feeder pathways in glycolysis; utilization of other carbohydrates in glycolysis phosphorolysis and starch; regulation of glycogen metabolism.
9. Citric acid (TCA) cycle: conversion of pyruvate to acetyl CoA, pyruvate dehydrogenase, a multi-enzyme complex; detailed description of citric acid cycle; bioenergetics and conservation of energy produced in the cycle. Anabolic or biosynthetic role of citric acid cycle intermediates; replenishing or anaplerotic reactions and their role; regulation of citric acid cycle; Electron transport and its components, oxidative phosphorylation, chemiosmotic theory, ATP synthesis, uncouple electron transport and heat generation.
10. Lipid metabolism: oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis of triacylglycerol; utilization of triacylglycerol; activation of fatty acids and their transportation to mitochondria; beta-oxidation; bioenergetics of beta-oxidation; oxidation of

unsaturated and odd chain fatty acids; omega oxidation pathway; biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; fatty acid synthetase (FAS) multienzyme complex

11. Ketone bodies their biosynthesis, utilization and role in the tissues;
12. Cholesterol metabolism: steroid hormones.
13. Nitrogen metabolism: metabolic fate of amino acids; catabolism of amino acids; deamination and transamination; nitrogen excretion and urea cycle; regulation of urea cycle.

Practical

1. Preparation of standard curve for glucose by *ortho*-Toluidine method.
2. Tests for detection of carbohydrates in alkaline and acidic medium.
3. Tests for detection of Disaccharides.
4. Detection of Non-Reducing sugars in the presence of reducing sugars.
5. Demonstration of Acid Hydrolysis of Polysaccharide.
6. Separation and identification of various types of sugars, fatty acid and amino acid Thin Layer Chromatography (TLC).
7. Determination of pKa values of an amino acid by preparation of titration curves.
8. Biochemical tests for detection of different amino acids.
9. Separation of various protein fractions by precipitation method.
10. Demonstration of differential solubility of lipids in various solvents.
11. Quantitative analysis of phospholipids by estimation of inorganic phosphorous.
12. Quantitative analysis of Amylase activity from blood serum or liver.
13. Study on the effect of temperature on the enzymatic rate of reaction

Recommended Texts:

1. Bhagavan N. V. (2022). *Medical Biochemistry - E-Book*. Netherlands: Elsevier Health Sciences.
2. Nelson, D., L, Cox, M. (2021). *Lehninger Principles of Biochemistry*. WH Freeman: New York.
3. McKee J. R & McKee, T (2020). *Biochemistry: The Molecular Basis of Life*. United Kingdom: Oxford University Press.

Suggested Readings:

1. Alison, S., William, H. E & Daphne, C (2017). *Elliott Biochemistry and Molecular Biology*, (6thed). Oxford University Press.
2. Litwack, G. (2017). *Human Biochemistry*. Netherlands: Elsevier Science.
3. Papachristodoulou, D. K. (2014). *Biochemistry and Molecular Biology* (5thed.). Oxford University.

Course Code	ZOOL-6115	Course Title	Principles of Genetics	Credit Hours	3(2-1)
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Course Brief:

This course aims to provide understanding of basic concepts of genetics, providing a conceptual framework for future reference. It provides understanding about the continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes. The course develops the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment; understanding of probability concepts and using these concepts to solve problems.

Course Learning Objectives:

The main goals of this subject are to accurately diagram and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes, to identify and describe the process and purposes of the cell cycle, meiosis, and mitosis and to describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.

Course Contents:

1. Introduction: Forward and reverse genetics. The basic principles of inheritance (Mendelism): monohybrid and dihybrid crosses (definition - characteristics criss-cross inheritance),
2. Multiple alleles: blood groups and coat color in rabbits, genetics of Rh factor and erythroblastosisfoetalis.
3. Chromosomal basis of inheritance: chromosomal theory of inheritance, interaction of genes, epistasis, lethality and pleiotropism.
4. Chromosomal aberrations: changes in chromosomal number, euploidy, aneuploidy (Klinefelters syndrome, and turners syndrome, down syndrome and Edwards syndrome), structural changes, insertion, deletion (Cri du chat syndrome), duplication, inversion and translocation
5. Pedigree Analysis: Normal human chromosome complement; karyotyping, sex-determination and sex-linkage, sex determination in animals and humans, sex linked (hemophilia, muscular dystrophy, color blindness), sex influenced and sex limited traits,
6. Prenatal diagnosis: amniocentesis and choriovillus sampling - ultrasound scanning and fetoscopy. genetic counselling, Eugenics and Euthenics
7. Chromosome mapping: linkage, recombination (crossing over), chromosome mapping in eukaryotes.
8. Molecular genetics: gene concept (classical and modern), genetics of viruses and bacteria, transposons, mutation and DNA repair molecular genetic analysis,
9. Regulation of gene expression in prokaryotes: gene regulation in eukaryotes, genetic basis of diseases, like cancer,
10. Genetic control of animal development, the genetic control of the vertebrate immune system
11. Recombinant technology: the techniques of molecular genetics (elements of genetic engineering), PCR
12. Human genetics: single and multifactorial disorders, autosomal anomalies, pseudoautosomal genes, single gene disorders: gene mutation and disorders;

13. Autosomal single gene disorders (sickle cell anemia, brachydactyly; inborn errors of metabolism such as phenylketonuria, alkaptonuria), complex inheritance patterns, polygenic traits- cleft lip
14. and cleft palate, population genetics,
15. Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis

Practical

- 1 Identification of male and female fruit fly and isolation
- 2 Study of polytene chromosomes from the salivary glands of *Drosophila melanogaster*
- 3 Human karyotyping from photographs prepared slides: paper cut out method
- 4 Study of mitosis in plants by using onion root tip cells
- 5 Study of meiosis in the testes of male grasshopper
- 6 Study of blood group polymorphisms in local population
- 7 Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
- 8 Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc.), risk estimation and genetic counseling
- 9 Study of quantitative traits in humans: finger prints as model of polygenic traits
- 10 Probability problems. Tossing of coins. X^2 test

Recommended Texts:

1. Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., & Killian, D. (2021). *Concepts of genetics* (12th ed.). New Jersey: Pearson.
2. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2018). *Lewin's Gene-XII* (12th ed.). Massachusetts: Jones & Bartlett Learning.
3. Benjamin A. Pierce (2020). *Genetics: A conceptual Approach* (7th ed.). Macmillan International Higher education.

Suggested Readings:

1. Snustad, D. P., Simmons, M. J., & Gardner, E. J. (2003). *Principles of genetics* (8th ed.). New York: John Wiley and Sons Ltd.
2. Tamarin, R. H. (2001). *Principles of genetics* (7th ed.). New York: McGraw-Hill.
3. Van Hoeck, Kathy (2023). *Genetics: Laboratory and Classroom activities*. (2001 edition). Flinn Scientific.

Course Code	ZOOL-6116	Course Title	Biostatistics	Credit Hours	3(3-0)
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Course Brief:

The course aims to provide knowledge about the importance and use of statistics in life sciences and familiarize students with the methods of data analysis pertaining to their research work and to assess the significance of their experimental designs. Specific topics include tools for describing central tendency and variability in data; methods for performing inference on population means and proportions. After finishing this course, students will be able to recognize the importance of data collection and its role in determining scope of inference, can demonstrate a solid understanding of interval estimation and hypothesis testing.

Course Learning Objectives:

Apply appropriate statistical methods for analyzing one or two variables and can interpret statistical results correctly, effectively, and in context. More specifically, by the end of the course they will be able to identify cases and variables in a dataset, and classify variables as categorical or quantitative and to recognize when it is, and is not, appropriate to use sample data to infer information about a population.

Course Contents:

1. Introduction: Definition, branches of statistics, scope and importance of statistics
2. Data: Population and sample, variable, categorical and non-categorical data, Scales of measurements, Errors of measurements
3. Presentation of data: descriptive statistics , tabulation of data , parts of table and construction of table, diagrams and graphs, pictogram, histogram, line chart, histogram, applications and uses of histogram, construction of histogram, comparison of data using histogram, bar chart, multiple bar chart, pie chart, gantt chart, timeline, infograph, pedigree chart
4. Frequency distribution: empirical FD, relative FD, cumulative FD, class frequency, class limits, class boundaries, class mark, class interval, midpoints
5. Measures of central tendency : types of averages, arithmetic mean for grouped and ungrouped data, harmonic mean for grouped and ungrouped data, geometric mean for grouped and ungrouped data, median, quartiles,deciles, percentiles and mode, advantages and disadvantages of arithmetic mean, harmonic mean, geometric mean, median and mode.
6. Measures of dispersion: range, grouped and ungrouped data, coefficient of range, mean deviation of grouped and ungrouped data. coefficient of mean deviation, standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data
7. Probability: definition and properties, experiment and random experiment, event, outcome, trial and multiplication rule, sample space and sample point, mutually exclusive event, combinations and permutations, probability distribution, binomial experiment
8. Tests of significance: hypothesis testing, steps of hypothesis testing, Z-test, t-test; its types, Chi- square, ANOVA, its uses and LSD, Correlation, Regression,

Recommended Texts:

1. Field, A. (2017). *Discovering statistics with IBM SPSS statistics*(5thed.). New York: SAGE Publications Ltd.
2. Belle, G. V., Fisher, L. D., Heagerty, P. J., & Lumley, T. (2004). *Biostatistics – A methodology for the health sciences* (2nded.).John Wiley & Sons, Inc.

Suggested Readings:

1. Campbell, M. J., & Swinscow, T. D. V. (2021). *Statistics at square one*(12thed.). Wiley-Blackwell.
2. Quinn, G. P., & Keough, M. J. (2002). *Experimental design and data analysis for biologists*.

Semester VI

Course Code	ZOOL-6117	Course Title	Zoogeography & Paleontology	Credit Hours	3(2-1)
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Course Brief:

The objectives of the course are to provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time; to impart knowledge and concepts of evolution mainly on the basis of fossil record and give understanding that fossil records also provide information about the distribution of animals in the past eras. After completion of this course students will be able to reconstruct the biological traits of extinct organisms, can interpret the modes of life of fossil organisms.

Course Learning Objectives:

The students will learn about Paleogeography focusing on theories of continental drift and plate tectonics, zoogeographical regions mainly faunas and affinities of Palaeartic, Nearctic, Oriental, Ethiopian, Australian and Neotropical regions, Zoogeography of Pakistan and Geochronometry. The practical section will empower them with the knowledge of fauna of various zoogeographical regions and invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.

Course Contents:

1. Paleogeography: theories of continental drift and plate tectonics and pangea
2. Animal distribution: cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution, endemic distribution, barriers and dispersal
3. Zoogeographical regions: zoogeographic division and boundaries, geographic ranges, physical features, climates, faunas and affinities of Palaeartic, Nearctic, Oriental, Ethiopian, Australian, and Neotropical regions,
4. Zoogeography of Pakistan: The planet earth, history, age, shells of earth, atmosphere, hydrosphere, biosphere and lithosphere.
5. Rocks: igneous rocks, sedimentary rocks, metamorphic rocks.
6. Fossil and fossilization: fossil types and uses of fossils, nature of fossils, fossilization, invertebrates and vertebrate's fossils, biostratigraphy, fossils of Pakistan, Paleontological important areas of Pakistan.
7. Fossilization: geological time scale, Pre-Cambrian life, Post Cambrian life, Paleozoic life, Mesozoic life, Cenozoic life.
8. Paleontological techniques: excavation techniques, excavation tools and techniques, transportation and processing of fossils, presentation of fossils, pre requisites for paleontological excavation.
9. Geochronometry: Uranium/Lead dating, radiocarbon dating, methods, index fossils, evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

Practical

1. Map work for identification of various zoogeographical regions of the World.
2. Field trip to Natural Museum of History to study mould, cast, pseudomorph, coprolite, petrified fossils of plants and animals, invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms, vertebrate fossils e.g. horse/elephant/camel/bovids and Igneous, Sedimentary and Metamorphic rocks.

Recommended Texts:

1. Benton, M. J., & Harper, D. A. (2020). *Introduction to paleobiology and the fossil record*. John Wiley & Sons.
2. Beddard, F. E. (2015). *A textbook of zoogeography*. Cambridge: Cambridge University Press.
3. Foote, M & Millar, A. I. (2007). *Principles of paleontology*. (3rd ed). USA: W. H. Freeman & Co.
4. Tiwari, S. K. (2006). *Fundamentals of world zoogeography*. Delhi: Sarup & Sons.

Suggested Readings:

1. Cox, C. B., Moore, P. D., & Ladle, R. J. (2021). *Biogeography: an ecological and evolutionary approach*. John Wiley & Sons.
2. Michael, J. B. David, A and Haper, T. (2009). *Paleobiology and the fossil record*. (3rd ed). UK: Wiley Black.
3. Michael, J. B., & Haper, D. A. T. (2009). *Paleobiology and the fossil record*. New York: Wiley & Blackwell.
4. Foote, M., & Millar, A. I. (2006). *Principles of paleontology*. New York: W. H. Freeman & Co.

Course Code	ZOOL-6118	Course Title	Research Methodologies & Bioethics	Credit Hours	3(3-0)
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Course Brief:

The course aims to develop research skills, provide understanding how to design scientific research, to collect data and its interpretation; emphasize the importance of ethics in scientific research and enable students to write a research proposal. It also introduces the data collection methods, data processing techniques, analysis options, writing review of literature, to deal with research problem and hypothesis development.

Course Learning Objectives:

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 introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis by developing an understanding of the ethical dimensions of conducting applied research, identifying various sources of information for literature review and data collection and appreciating the components of scholarly writing and evaluate its quality.

Course Contents:

1. Introduction: objectives of research, motivations
2. Research process: research methods vs. research methodology, scientific method,
3. Types of research, general steps involved in research, problems of research in Pakistan
4. Topic selection
4. Problem identification for research, criteria and evaluation
5. Literature review: importance and sources, referencing and citation and bibliography, plagiarism
6. Research design: parts, important concepts in research design
7. Aims and objectives: Research objectives, qualities of research objectives
8. Material and methods: bioethics, sampling, data collection and data analysis, sampling requirement, scales of measurement, error of measurement and its sources
9. Data analysis: processing, statistics in research, hypothesis testing, t-tests and ANOVA
10. Scientific writing: difference between thesis/report/synopsis/research proposal, parts of synopsis/project proposal, parts of thesis/report.
11. Budgeting: Cost estimates for a research project, funding sources e.g. USAID, HEC, DOST, HED, PMRC, WWF, PSF etc.

Recommended Texts:

1. Leedy, P.D., & Ormord, J.E. (2018). *Practical research: planning and design* (12thed.). New York: Pearson.
2. Creswell, J.W., & Creswell, J.D. (2022). *Research design quantitative qualitative and mixed methods approach* (6thed.). California: SAGE Publications

Suggested Readings:

1. Khan, J. A. (2008). *Research methodology*. New Delhi: APH Publishing.

2. Walliman, N. (2005). *Your research project, a step-by-step guide for the first-time researcher* (2nd ed.). California: SAGE Publications.
3. Hess-Biber, S.N., & Leavy, P. (2003). *Approaches to qualitative research, a reader on theory and practice*. (1st ed.) New York: Oxford University Press.
4. Laurel, B. (2003). *Design research, methods and perspectives*. Cambridge: The MIT Press.

Course Code	ZOOL-6119	Course Title	Molecular Biology	Credit Hours	3(2-1)
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Course Brief:

The course aims to impart knowledge about the animal cell and its complex organization and architecture. It enables students to understand various ultra-structural, molecular and functional aspects of the cells. Students will be able to describe and discuss the properties and biological significance of the major classes of molecules found in living organisms and the relationship between molecular structure and biological function, can relate how cell movement and cell-cell communication occur and discuss mechanisms of signal transduction and the lab work will provide platform to become familiar with various cell types through techniques of slide preparation.

Course Learning Objectives:

Understanding of microscopy to study cell structure and cellular compartmentalization will be provided to learners. Main emphasis of course is to develop familiarity with structure and function of cells at the molecular level, including the flow of information from genes to proteins, and regulation of cellular processes, signaling and proliferation in eukaryotic cells.

Course Contents:

1. Introduction to prokaryotic and eukaryotic cells: plasma membrane, its chemical composition structure and functions of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.
2. Cytoskeleton: microfilaments, microtubules, intermediate filaments.
3. Cytoplasmic Organelles: Membrane system, structural and functional commonalities.
4. Ultrastructure, chemical composition and functions of endoplasmic reticulum and their role in protein synthesis and drug metabolism, golgi apparatus its role in synthesis of glycoprotein,
5. Mitochondrial respiration and its significance as semi- autonomous organelle;
6. Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, glyoxysome with reference to glyoxylic acid cycle.
7. Nucleus: chromatin, heterochromatin, euchromatin, chromosome structure, coiling and nucleosome during different phases of cell cycle.
8. Replication: mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in eukaryotes with emphasis on DNA polymerases, concept of replicons etc.,
9. Transcription: variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved, RNA splicing, split genes, concept of ribozymes and Post transcriptional processing, RNA transduction, Genetic code, point mutations.
10. Translation: specific role of ribosomes, various factors, and posttranslational processing, control of gene expression in Prokaryotes.

Practical

1. Preparation of whole mount.
2. Preparation of human blood smear and identification of Leucocytes.
3. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).

4. Squash preparation of onion root tip for mitotic stages
5. Mounting of polytene chromosome (*Drosophila/Chironomous.*) Demonstration.
6. Cultural and staining of bacteria.

Recommended Texts:

1. Cooper, G. M., & Adams, K. (2022). *The cell: A molecular approach* (9th ed.). Massachusetts: Sinauer Associates.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M., & Amon, A. (2021). *Molecular cell biology* (9th ed.). New York: W. H. Freeman.
3. Karp, G., Iwasa, J., & Marshall, W. (2020). *Karp's cell and molecular biology: concepts and experiments* (9th ed.). New Jersey: John Wiley and Sons.

Suggested Readings:

1. De-Robertis, E. D. (2014). *Cell and molecular biology* (8th ed.). New York: Lea & Febiger.
2. Alberts, B., Hopkin, H., Johnson, A., Morgan, D., Walter, P., & Heald, R. (2023). *Essential cell Biology* (6th ed.). New York: W. W. Norton & Company.
3. Hofmann, A., & Clokie, S. (2018). *Wilson and Walker's principles and techniques of Biochemistry and molecular biology* (8th ed.). Cambridge: Cambridge University Press.

Semester VII

Course Code	ZOOL-6121	Course Title	Wildlife Conservation & Management	Credit Hours	3(2-1)
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Course Brief:

The aim of this course is to provide students with a comprehensive understanding of the principles, significance, and practices of wildlife conservation and management, with a special focus on the wildlife of Pakistan. It seeks to familiarize students with the ecological roles of wildlife, the factors affecting their survival, and the importance of preserving biodiversity for maintaining ecological balance and supporting human well-being. The course emphasizes the study of protected areas, endangered species, conservation strategies, and the impact of human activities on wildlife populations and their habitats. Additionally, it aims to develop practical skills in species identification, habitat assessment, wildlife census methods, and conservation awareness, enabling students to contribute effectively to conservation programs, research initiatives, and community-based wildlife protection efforts in Pakistan and beyond.

Contents:

1. Introduction to wildlife of Pakistan, biodiversity and its categories, wildlife in the context of its services.
2. Wildlife census and tracking methods: Direct and indirect methods.
3. Current status of wildlife (mammals, birds, reptiles, and amphibians) of Pakistan, vegetative zones and their associated wildlife in Pakistan.
4. Threats to wildlife of Pakistan; Natural and anthropogenic.
5. Threatened species (mammals, birds, reptiles, and amphibians) of Pakistan: vulnerable, endangered, critically endangered.
6. Introduction to conservation and management of wildlife, modes and significance of conservation and management, major challenges faced during conservation in Pakistan.
7. Conservation strategies
8. Protected areas in Pakistan: National parks, game reserves, wildlife sanctuaries, Ramsar sites, and biosphere reserves.
9. Role of national and international organizations in wildlife conservation.

Practical

1. Identification of Common Mammals, Birds and reptiles of Pakistan.
2. Animal distribution maps.
3. Visit to a National Park / Wildlife Sanctuary / Zoo / Museum.
4. Use of IUCN Red List and Conservation Status Assessment with IUCN database or printed data.
5. Preparation of Conservation Campaign Plans/ Awareness Posters.

Recommended Texts:

1. Cardinale, B., Primack, R., Murdoch, J. (2019). Conservation biology. Sinauer Associates: Oxford University Press
2. Primack, R.B. (2014). Essentials of Conservation Biology. Sinauer Associates.
3. Robinson, J.G. & Redford, K.H. (1991). Neotropical Wildlife Use and Conservation. University of Chicago Press.

Suggested Readings:

1. Khan, M. S. (2011). Amphibian and Reptiles of Pakistan. Krieger Publishing Company.
2. Grimmett, R., Roberts, T. J., Inskipp, T., & Byers, C. (2008). Birds of Pakistan. A&C Black.
3. Roberts, T. J. (1997). The mammals of Pakistan. Oxford: Oxford University Press.
4. WWF-Pakistan Reports & IUCN Publications.
5. Pakistan's National Biodiversity Strategy and Action Plan (NBSAP).
6. Research papers and case studies on wildlife conservation in Pakistan.

Course Code	ZOOL-6122	Course Title	Economic Zoology	Credit Hours	3(2-1)
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Course Brief:

The course will enable students to learn about the relationship of commerce with domestic animals, their products, by-products and associated farming practices. They will also learn about the importance of human and domestic animal diseases and their vital relation to the economy. This course also provides knowledge about internal and external parasites and their effects on domestic animals and their farming practices. It also familiarizes the students with the value of studying various general practices, principles and techniques in farming and rearing of animals in sericulture (silk worms), apiculture (honey bees), aquaculture (fisheries, pearl culture, prawns and oysters), poultry (domestic fowl and ostriches) and cattle husbandry

Course Learning Objectives:

Students will acquire basic knowledge of commerce and economics in relation to Zoology. Economic zoology imparts knowledge about application of zoological knowledge for the benefit of mankind which mainly includes culturing animals for mass production for human use and to control or eradicate animals that are injurious to man directly or indirectly.

Course Contents:

1. Basic concepts in Economic Zoology.
2. Parasitic protozoans and human disease.
3. Economic importance of protozoa.
4. Vectors of human and domestic animals.
5. Ecto- and endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and Arachnida).
6. Pests of pulse crops. Pests of oil seed crops, stored grain pests, pests of cotton, vegetables, fruits and tea.
7. Apiculture, and sericulture, lac insect culture and pearl culture
8. Aquaculture and fisheries (edible fresh water, pond and marine fish, prawns, pearl oysters). economic importance of fishes
9. Bird farming (poultry, quail, turkey, ostrich and pigeon).

Practical

1. To study the prepared slides of various types of ecto- and endo-parasites.
2. To observe and study museum specimens of vertebrate and invertebrate,
 3. Pests of important crops and stored grains in Pakistan.
 4. To visit Honey Bee farm. Write a report on their observations.
 5. Visit to Sericulture farm in a nearby locality and write report on their observations.
 6. Study visit to fish hatchery, nursery ponds, stocking ponds, commercial fish breeding farms.
 7. Report writing.

8. Identification of important species of Fish and their natural animal.
9. Visit to any bird farm and write a report on their observations.

Recommended Texts:

1. Ravindranathan, K. R. (2003). *Economic zoology* (1sted.). New Delhi, India: Dominant Publishers and Distributors.
2. Primack, R. B. (2000). *A Primer of conservation of biology* (2nded.). Massachusetts: Sinauer Associates.

Suggested Readings:

1. Mirza, Z. B. (1998). *Animal biodiversity of Pakistan* (1sted.). Rawalpindi: Printopack.
2. Akhtar, M., & Muzaffar, N. (2008). *Introduction to apiculture*. Lahore: Punjab University Press.
3. Blackiston, H. (2001). *Beekeeping for dummies*. Indiana: Wiley Publishing.

Course Code	ZOOL-6123	Course Title	Microbiology & Immunology	Credit Hours	3(2-1)
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Course Brief:

The course aims to give understanding of the basic concepts of microbiology and immunology and its importance in biological sciences, provide information about basic principles of microbiology and immunological mechanisms against different diseases and gives understanding of immunization, immunological tolerance etc. After completion of the lecture component of the course, successful students will be able to understand morphology and fine structure of bacteria, cultural characteristics and immunological response along with the understanding of how it is triggered and regulated. It will also help students to recognize how microorganisms solve the fundamental problems their environments present. The laboratory practice can help them to study of bacteria, fungi and protozoa, staining techniques and can apply scientific method to collect, interpret, and present scientific data in microbiology and immunology.

Contents:

Microbiology:

1. Microbiology introduction and history.
2. Microscopic examination of microorganisms.
3. Characterization, classification and cultivation methods of microorganisms.
4. Morphology of bacteria.

Immunology:

1. Immunology: introduction, types: natural and acquired immunity.
2. Antigens and their types, antigenicity, factors important for immunogenicity of an antigen, cell mediated and humoral
3. Immunoglobulins: synthesis of antibodies, types of antibodies
4. Antigen antibody interactions
5. Hypersensitivity: Immediate hypersensitivity, delayed type or cell mediated hypersensitivity.
6. Immunological tolerance and autoimmunity: autoimmune diseases and types, factors responsible for autoimmunity, immunity against infectious diseases, immuno deficiency diseases.
7. Immunization; immunization procedures, vaccines and their types.

Practical

1. Study of bacteria, fungi and protozoa.
2. Staining of microorganisms: simple staining, negative staining.
3. Demonstration of special structures by stains; capsular stain, spore stain, metachromatic granule stain, acid fast stain, flagella stain.
4. Estimations of total serum proteins, albumins and globulin concentrations in mammalian blood.
5. Diagnosis of immunoglobulin proteins by enzyme linked immunosorbent assay (ELISA).
6. Antigen-antibody reaction by agglutination and precipitation reaction.
7. Visit to pathological laboratory and report writing.

Recommended Texts:

1. Benson, H. J. (2002). *Microbial applications: laboratory manual in general microbiology* (8th ed.). London: McGraw-Hill.
2. Pelczar, Jr., Chan, E. C. S., & Krieg, M. R. (2010). *Microbiology: application based approach*. London: McGraw Hill.
3. Punt, J., Stranford, S., Jones, P., & Owen, J. A. (2018). *Kuby's immunology* (8th ed.). New York: W. H. Freeman Company.

Suggested Readings:

1. Madigan, M. T. (2009). *Brock biology of microorganisms* (12th ed.). London: Pearson/Benjamin Cummings.
2. Stainier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, R. R. (1986). *The microbial world*. London: Prentice Hall.
3. Abbas, A., Lichtman, A., & Pilla, S. (2017). *Cellular and molecular immunology* (9th ed.). Amsterdam: Elsevier.

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Semester VIII

Course Code	ZOOL-6124	Course Title	Computational Biology	Credit Hours	3(2-1)
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Course Brief

The course will provide an introduction to Computational Biology with a focus on fundamental problems and information on the tools used to compute solutions to the problems, and the theory of Biology upon which those tools are based. This involves algorithm, and storage/database development of genomics data. It also describes the different types of data found at the NCBI and EBI resources. This course has three main objectives i.e. to organize vast reams of molecular biology data in an efficient manner; to develop tools that aid in the analysis of such data; and to interpret the results accurately and meaningfully. The advent and rapid rise of Computational Biology has been due to the massive increases in computing power and laboratory technology in recent years. These advances have made it possible to process and analyze the digital information regarding DNA, genes and genomes. A student completing Computational Biology course shall be able to apply it for problem-solving skills, including the ability to develop new algorithms and analysis methods.

Contents:

1. Introduction: Introduction to computers, software, hardware, operating systems
2. Computational Biology: scope of Computational Biology, useful websites, aims of Computational Biology, disciplines related to Computational Biology, major tasks involved in Computational Biology analysis, Computational Biology tools
3. Biological databases: data and information, databases, data acquisition, NCBI, major DNA databases around the world, major protein databases in the world, primary protein sequence databases, secondary protein databases, tertiary protein databases, protein structure databases, specialized databases, genome and organism databases, miscellaneous databases
4. Genome mapping: genetic and linkage mapping, physical mapping
5. Gene family: introduction and types, protein family, globin family as an example, globin genes and chains, evolution of globin proteins in human, combination and types of globin proteins in human
6. Data retrieval: Searching sequence databases, FASTA format, retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data
7. Primer designing: primer and probe, qualities of primer, general rules for primer designing
8. Websites used for primer designing
9. Sequence alignment: importance and significance of alignment, methods for sequence alignment, Local and global alignment, pair-wise local alignment, uses of local alignment
10. BLAST: introduction and types, uses, algorithm, BLAST Score
11. Amino acid matrices: amino acids and their symbols, amino acid scoring matrices, PAM and BLOSUM, comparison of PAM and BLOSUM
12. Multiple sequence alignment: introduction, tools for MSA, uses and importance
13. Phylogenetic analysis: Introduction, interpretation, rooted and unrooted tree, phylogenetic methods, tree terminology, comparison of methods, software
14. Protein structure prediction: homology modelling, threading, *ab initio* modelling, motivation to acquire structure, protein 3D structure, software/databases

15. Molecular docking: introduction, steps, importance and uses
16. Microarrays: Gene expression, differential expression, DNA chips, principle of microarray, types, steps of a microarray experiment, qualitative interpretation of results, applications of microarray, advantages and disadvantages of microarray.

Practical

1. Introduction to NCBI
2. Retrieving Literature from NCBI
3. Classification of an organism using NCBI
4. Retrieving FASTA sequence for nucleotide and protein
5. Retrieving disease gene information
6. Searching gene families
7. Primer Designing
8. BLASTing a nucleotide / amino acid sequence
9. Multiple sequence alignment using different amino acids / nucleotide sequences
10. Phylogenetic analysis of different nucleotide / amino acid sequences
11. Microarrays data retrieval from the web

Recommended Texts:

1. Selzer, P. M., Marhofer, R. J., & Kock, O. (2018). *Applied bioinformatics: an introduction*. Berlin: Springer Publishing.
2. Lesk, A. (2019). *Introduction to bioinformatics* (5th ed.). Oxford: Oxford University Press.

Suggested Readings:

1. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). *Bioinformatics methods and applications: genomics, proteomics and drug discovery*. Dehli: PHI Publishing.
2. Primrose, S. B., & Twyman, R. M. (2004). *Genomics: applications in human biology*. New York: Willey-Blackwell.
3. Krane, D. E., & Raymer, M. L. (2002). *Fundamental concepts of bioinformatics*. New Jersey: Benjamin Cummings.



Course Code	ZOOL-6125	Course Title	Capstone Project	Credit Hours	3(0-3)
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ANNEXURE-I

ZOOL-6126

Aquaculture

3(2-1)

As there is an increased demand of natural and organic food globally, there are various scientific strategies being adapted at commercial level to fulfill the demand of natural food resources with growing population. This course will equip the students with advanced knowledge about aquaculture, its development and future role in human nutrition. This will enable the young students to understand principles of aquaculture and its relationship with biological systems which is important for better planning and management of aquatic resources in Pakistan. Different assisted reproductive technologies and rearing techniques will be discussed for maximum growth of required species on large scale. It will teach about different aquaculture species, their rearing facilities and management by using advanced techniques in practical section. Students will be able to understand the basic requirements to develop aquaculture on commercial scale and be familiar with the outcomes with relevance to their practical life.

Contents

1. The concept of aquaculture, principles of aquaculture management.
2. Aquaculture in raceways, cages and enclosures,
3. Use of waste waters in aquaculture.
4. Mari-culture: substrate system, sea water, ponds.
5. Aquaculture in fresh and brackish waters.
6. Aquaculture in practice: culture of algae, culture of seaweed, culture of mollusks, culture of crustaceans.
8. Culture of freshwater prawns and shrimps:
9. Artificial feeds for aquaculture: Feed constituents, Diet formulation and Processing.
10. Role of biotechnology in sustainable aquaculture development.

Practical

1. Determination of water quality for aquaculture
2. Determination of metals (Cd, Zn, Co, Mn, Fe) in water, plankton and fish
3. Fish feed formulation and processing

Recommended Texts

1. Metha, V. (2009). *Fisheries and aquaculture biotechnology* (2nd ed.). New Dehli: Campus Books International.
2. Sharma, O. P. (2009). *Handbook of fisheries and aquaculture*. New Dehli: Agrotech Publishing.

Suggested Readings

1. Stickney, R. R. (2009). *Aquaculture: an introductory text*. London: CABI Publishing.
2. Pandey, B. N., Deshpande, S., & Pandey, P. N. (2007). *Aquaculture*. New Dehli: APH Publishing Corporation.
3. Parker, R. O. (2004). *Aquaculture science* (4th ed.). London: Delmar Learning.

The objective of this course is to enable the student to understand philosophy and significance of wildlife conservation; understand the wildlife management rules and regulations in Pakistan and to understand how national and international agencies are involved in conservation and management of wildlife. Students will be able to apply knowledge to solve problems related to wildlife conservation and management. They will learn about the biodiversity of amphibians, reptiles, birds and mammals, along with the wildlife and its distribution in different major eco zones of Pakistan. The major aims of the subject include knowing what type of wildlife exist in Pakistan and its biodiversity, moreover, how wildlife is being secured in Pakistan. After this course students will become able to participate in wildlife census. The practical section will cover the mammal's population census techniques, ecological indices and procedures for studying species richness, Simpson Index, Shannon and Weiner Function.

Contents

1. Biodiversity: definition, types, levels,
2. Status of biodiversity; importance
3. Natural resources and biodiversity: ecological aspects, impacts, loss of biodiversity,
4. Protection and conservation of biodiversity.
5. Wildlife: introduction, important wild animals of Pakistan,
6. Wildlife importance, wildlife management.
7. Eco zones of Pakistan: wildlife and its distribution in different major eco zones of Pakistan.
8. Wildlife census techniques
9. Modern census techniques for mammals and birds, diversity indices.

Practical

1. Procedures for studying species richness, Simpson Index, Shannon and Weiner Function.
2. Population of some local subterranean animals.
3. Bird's population census techniques.
4. Mammal's population census techniques.
5. Study of wildlife habitats.

Recommended Texts

1. Kumar, U., & Asija, M. J. (2002). *Biodiversity: principles and conservation*. Ohio: Crescent News.
2. Starr, C., & Taggart, R. (2005). *Biology: the unit and diversity of life* (11th ed.). India: Cengage Learning.

Suggested Readings

1. Fryxell, J. M., Sinclair, A. R., & Caughley, G. (2014). *Wildlife ecology, conservation, and management* (3rd ed.). West Sussex: Wiley-Blackwell.
2. Bolen, E. G., & Robinson, W. (2002). *Wildlife ecology and management* (5th ed.). London: Pearson.

This course is designed to familiarize students with the basic concepts and significance of biotechnology. This course is designed to introduce learners with a solid understanding of science, technology and business management, along with the entrepreneurial skills required to exploit technological advances within a competitive environment. The goal of biotechnology is to produce pharmaceutical products by using living organisms such as bacterial cells, yeast, mammalian cells, etc., that are placed in culture to produce substances with pharmacological activity, such as monoclonal antibodies for the treatment of tumors. The main objectives of the subject are to teach, train and qualify skilled scientists in many disciplines of biotechnology and to provide an intensive and in-depth learning about technical and critical thinking skills necessary for success in the field of biotechnology. Upon completion of the course, the students will develop awareness and knowledge of different basic topics of biotechnology through lectures and practical classes.

Contents

1. Introduction: definitions, classes, types of modern biotechnology and historical perspective,
2. Genetics and biotechnology: genome, human genome, diversity of human genome, short tandem repeats, nomenclature,
3. Polymerase Chain Reaction, principle, requirements, procedures and applications, gel electrophoresis, definition, principle, steps/methods involved, DNA ladder, allelic ladder
4. Genetic engineering introduction, steps, vectors and its types, characteristics of vectors, plasmids and restriction enzymes, screening, blue white screen, negative and positive control, competent cells, insulin as an example, genetically modified organisms,
5. Cloning, its types of cloning, cell cloning, molecular cloning, organism cloning, applications and uses
6. Animal and insect biotechnology: introduction, reasons for producing GM animals.
7. Bioprocess technology: introduction, requirements of bioreactors, types of bioreactors, bacterial and mammalian cell culturing, production of industrially important chemicals
8. Biotechnology and medicine: applications, monoclonal antibodies, importance, steps for production of monoclonal antibodies
9. Public perception of biotechnology: current issues in bioethics (autopsy, GMOs, stem cells, euthanasia, organ transplant, human cloning, IVF, surrogacy and sperm donor)
10. Bioethics and Islam: introduction and principles of bioethics, concept of bioethics in different religions, principles of Islamic bioethics.

Practical

1. DNA Extraction from different sources
2. Quantification of DNA using gel electrophoresis and spectrophotometer
3. Amplification of DNA using PCR
4. PCR product measurement using gel electrophoresis
5. Gender typing of human and animal samples using PCR
6. Restriction fragment length polymorphism of samples
7. Species identification of different animal samples using PCR and RFLP

Recommended Texts

1. Clark, D. B., & Pazdernik, N. J. (2015). *Biotechnology* (2nd ed.). Amsterdam: Academic Cell
2. Schmid, R. D., Schmidt-Dannert, C., & Hammelehle, R. (2016). *Biotechnology: an illustrated primer*. New York: Willey-Blackwell.

Suggested Readings

1. Brown, T. A. (2016). *Gene cloning and DNA analysis: an introduction* (7th ed.). New York: Willey- Blackwell.
2. Butler, J. M. (2009). *Fundamentals of forensic DNA typing*. Amsterdam, Boston: Academic Press.
3. Furr, A. K. (2008). *CRC handbook of laboratory safety* (5th ed.). Florida: CRC Press.
4. Smith, J. E. (2009). *Biotechnology* (5th ed.). Cambridge: Cambridge University Press.

The course aims to provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development; impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction and provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. Students will learn how developmental biology is having a significant impact on our understanding of modern molecular techniques in developmental biology and Uses of transgenic animals in developmental biology. The students will be able to understand and compare basic principles of embryology through understanding the embryonic adaptations with help of morphology and anatomy of embryos of different vertebrates. The practical section will enable them to go through study of prepared slides for the development of amphioxus, mammals, frog and chick isolation, identification and culture of various developmental stages.

Contents

1. Historical review of embryology.
2. Uses of modern molecular techniques in developmental biology.
3. Origin of germ cells (gametogenesis).
4. Spermatogenesis & oogenesis, structure and organization of male and female gametes.
5. Fertilization: chemistry of fertilization, molecular biology of fertilization, surface changes in the egg and sperm surface.
6. Twinning, parthenogenesis, cleavage, blastulation, fate maps and their preparation,
7. Morphogenetic movements and gastrulation in mammals and frog.
8. Stem cells technology and its uses in developmental biology.
9. Embryonic adaptations and placentation, umbilical cord and parturition.
10. Aging

Practical

1. Study of model eggs of different invertebrates and vertebrates.
2. Dactylography, and its uses in embryology.
3. Isolation, identification and culture of various developmental stages of *Ascaris lumbricoides* eggs from human/ *Neosascaris vituolarum* eggs from cattle dung (kept for 3 weeks at 240°C in desiccator) by using Telman's centrifugation technique.
4. Study of prepared slides for the development of Amphioxus, mammals, frog and chick.
5. Semen analysis by using improved Neubauer Hemocytometer, Use of dactylography in developmental biology,
6. Peripheral blood smear (abnormal erythrocyte morphology e.g., target cells, microcyte, macrocytes, slit cell, acanthocytes & tear drop cells as screening procedures for thalassemia diagnosis.

Recommended Texts

1. Gilbert, S. F., & Barresi, M. J. F. (2020). *Developmental biology* (11th ed.). Oxford: Oxford University Press, Incorporated.
2. Patten, B. N. (2004). *Foundation of embryology*. New York, London: McGraw Hill Books Company, Inc.

Suggested Readings

1. Oppenheimer, S. (2004). *Introduction to embryonic development* (4th ed.). New Jersey: Pearson Education.
2. Saddler, T. W. (2011). *Langmans medical embryology* (Revised ed.). New York: Wolters Kluwer Health.

The course is aimed to impart knowledge about endocrine glands, their anatomy, the hormones released from them and the physiological role of these hormones in body. Endocrinology involves the evaluation and management of disorders of the body's glands, hormonal secretions, and resultant changes in body metabolic activity. The course is designed to provide an understanding to structures and function of endocrine glands. It also provides an understanding of the common endocrine disorders, metabolic regulations, and metabolic abnormalities, and their management. Furthermore, in all body cells, hormones influence the metabolism of nucleotides, proteins, lipids, carbohydrates, vitamins, water, and therefore, knowledge of endocrinology and metabolism is important. The students will study the endocrine system in terms of structure, function and its role in regulating metabolism, growth and reproduction in different animals, with reference to some disorders resulting from dysfunction. By the end of this course, the students should be able to examine and describe glands and can determine hormonal impact and syndromes.

Contents

1. The endocrine system; type of hormones; endocrine and nervous system relationship
2. Hypothalamus and pituitary: hypothalamic hormones: origin, chemistry and actions; anterior pituitary & hormones: hypothalamic pituitary regulation, general chemistry, physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: release, regulation and actions of vasopressin and oxytocin.
3. Thyroid gland: anatomy and histology of gland; formation and secretion of thyroid hormones; factors affecting thyroid function.
4. Calcitropic and mineral metabolism hormones: chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols.
5. Pancreatic hormones and regulatory peptides of the gut: anatomy and histology for sources of the hormones; chemistry, physiological roles and mechanism of action of insulin and glucagon
6. Adrenal medulla and catecholamines: chromaffin cell and organization; structure of adrenal medulla; biosynthesis, storage, release and metabolism; adrenergic receptors.
7. Adrenal cortex: steroid biochemistry; physiological actions of corticoid hormones; regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.
8. Testes: androgenic tissue: structure and chemistry; transport, metabolism and mechanism of action.
9. Ovaries: ovarian hormones: steroid biochemistry and biosynthesis; transport, metabolism and mechanism of action.
10. Overview of endocrine mechanisms in invertebrates.

Practical

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc.
2. Histological and ultra-structure features of endocrine glands;

3. Experiments to demonstrate physiological roles of hormones of different endocrine glands;
4. Experiments to demonstrate regulation of hormones releases.
5. Experiments to demonstrate functional diversity of hormones in different vertebrates.
6. Experiments on endocrine mechanism in vertebrates.

Recommended Texts

1. Greenspan, F. S., & Stewler, G. J. (2002). *Basic and clinical endocrinology* (5th ed.). London: Prentice Hall International Inc.
2. Wilson, J. D., Foster, D. W., Kronenberg, H. M., & Larsen, P. R. (2008). *William's textbook of endocrinology*. Philadelphia: W.D. Saunders Company.

Suggested Readings

1. DeGroot, L. J., & Jameson, J. L. (2001). *Endocrinology* (4th ed.). Philadelphia: W.B. Saunders.
2. Giffin, J. E., & Ojeda, S. R. (2000). *Textbook of endocrine physiology* (4th ed.). Oxford: Oxford University Press.

The main objective of the course is to develop knowledge about classification of insect orders and their economic importance. This subject provides students with a broadly-based education in the science and practice of entomology. After this course, students can classify the insects up to orders level. It also includes diagnostic characters of the insect orders, knowledge about insects of economic and medical importance and brief account of biological control, chemical control and integrated pest management. This subject also imparts knowledge about common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary of insects. Moreover, some brief account on household pests and their management and knowledge of pests of cotton, rice and sugarcane will also be the part of learning. The practical section will enable the students to collect, preserve and identify insects up to families and can have core knowledge of entomology.

Contents

1. Introduction to Economic Entomology: Definition and scope, Importance of insects in economy, Insect diversity and classification (brief overview)
2. Insects as Pests: Concepts of pest and pest status, types of pests: occasional, regular, and potential, causes of pest outbreaks
3. Crop Pests and Their Management: Major pests of cereal crops (e.g., rice, wheat, maize), pests of cash crops (e.g., cotton, sugarcane, tobacco), pests of fruits and vegetables, pest of stored grains, pest of forest trees
4. Insects of Medical and Veterinary Importance: insect vectors of human diseases: mosquitoes, sandflies, tsetse flies; myiasis-causing insects, pests of livestock: biting flies, lice, fleas
5. Beneficial Insects: pollinators: Honey bees, bumble bees, etc., biological control agents: Parasitoids and predators, insects as food and in silk, lac, and dye production
6. Pest Surveillance and Forecasting: monitoring pest populations, economic threshold levels (ETL) and economic injury levels (EIL)
7. Pest Control Methods: mechanical and physical control, cultural practices, biological control, chemical control (insecticides, resistance, environmental effects), botanical pesticides, integrated Pest Management (IPM)
8. Insecticide Classification and Toxicology: types of insecticides: organophosphates, carbamates, pyrethroids, etc., mode of action, formulations and application methods, environmental and human health risks
9. Emerging Trends in Economic Entomology: use of biotechnology (Bt crops), RNA interference (RNAi), Sterile insect technique (SIT), Use of pheromones and semiochemicals

Practical

1. Identification of Major Insect Orders
2. Collection and Preservation of Insects
3. Identification of Crop Pests and Damage Symptoms
4. Identification of Stored Grain Pests
5. Identification of Beneficial Insects (pollinators, parasitoids, predators)
6. Study of Insecticide Formulations and Application Equipment
7. Field Visit to Crop Fields/Orchards to Observe Pest Infestation
8. Preparation of IPM Models for Common Crops

9. Setting up Light Traps/Pheromone Traps
10. Preparation of Entomological Boxes and Insect Mounting

Recommended Texts

1. Pedigo, L. P., & Rice, M. E. (2015). *Entomology and pest management* (6th ed.). Long Grove: Waveland Press.
2. Richards, O. W., & Davies, R. J. (1977). *Imm's general textbook of entomology* (Vol-II, 10th ed.). London: Chapman & Hall.
3. Dhaliwal, G. S., & Arora, R. (2019). *Principles of Insect Pest Management*. Kalyani Publishers.
4. Foster, W. (2025). *Economic entomology*. Alexis Press.

Suggested Readings

1. Metcalf, C. L., & Flint, W. P. (2018). *Destructive and useful insects: their habits and control*. New Dehli: Agri Horti Press.
2. Kachhwaha, N. (Ed.). (2023). *Essentials of economic entomology* (Vol. 5). AkiNik Publications.
3. Singh, G., Srivastava, K. P., & Dhaliwal, G. S. (2023). *A textbook of applied entomology* (Vol. 2, 4th ed.). Kalyani Publishers.
4. David, B. V., & Ramamurthy, V. V. (2017). *Elements of economic entomology* (8th ed.). Brillion Publishing.

This course is designed to provide review of the different environmental subjects including ecological, conservation, pollution, resources, population and socioeconomic issues of Pakistan. To impart knowledge about management and planning issues using case studies. The environmental study prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. In this subject students will learn about environmental and social impacts of growing population and affluence by addressing population problems, food production and its distribution, integrated pest management and several types of pollution with their impact on human life and their combating strategies. The learners will also have knowledge about major atmospheric changes due to acid deposition, global warming, greenhouse effect and ozone depletion. Energy sources and issues related to fossil fuel and nuclear power will also be discussed along with the alternate energy resources. In the end of this course students will be able to identify and analyze various environmental issues.

Contents

1. Environmental and social impacts of growing
2. Food production and its distribution
3. Pest and pest control: need and approach to pest control,
4. Water pollution: human impact on water resources,
5. Sewage pollution: sewage hazards and sewage managements.
6. Hazardous chemical pollution: nature of chemical risks, pollution sources and control.
7. Major atmospheric changes: acid deposition, global warming / cooling, greenhouse effect, ozone depletion.
8. Solid waste: landfills, incineration, management and solutions.
9. Energy resources: energy sources and uses; issues related to fossil fuel and nuclear power, alternate energy resources.
10. Environmental issues in Pakistan
11. Issues related to conservation of habitat and biodiversity:
12. Conservation strategies. Industrial pollution: sources and remediation.

Practical

1. Study of the various characteristics of the population with the help of the statistical data (Age profile, family size and educational status, etc.).
2. Study of the types of the pesticides and their characteristics.
3. Study of the relationship between relative humidity and temperature of Lahore for a particular time period.
4. Estimation of total particulate matter in air by using air sampler.
5. Determination of Sodium and Potassium in various water samples using flame photometer.
6. Determination of Chromium, Lead and Copper in industrial effluent.
7. To study the urban environment and urban environmental issues.
8. To study the eutrophic conditions in various ponds.
9. To study noise level at different places in city (main road crossings, railway station, hospital) using noise level meter.

10. To study the level of occurrence of various diseases among families of (i) Class students (ii) Low income groups, high income groups.

Recommended Texts

1. Botkin, D. B., & Keller, E. A. (2000). *Environmental science: earth as a living planet* (3rd ed.). New York: John Wiley and Sons Inc.
2. Wright, R. T., & Nebel, B. J. (2008). *Environmental science* (10th ed.). London: Pearson Prentice Hall

Suggested Readings

1. Bradbury, I. K. (1999). *The biosphere* (2nd ed.). New Jersey: Wiley.
2. Ahmad, R. Z. (2000). *Pakistan- a descriptive atlas: a comprehensive geo-politics course* (1st ed.). Lahore: Feroze sons Pvt. Ltd.
3. Khan, F. K. (1993). *A geography of Pakistan environment (environment, people and economy)* (1st ed.). New York: Oxford University Press.

This course is formulated to provide sufficient knowledge about all physiological phenomena in fishes. The objective of this course is to provide practical information to obtain better growth of fishes during extensive or semi-intensive culture, to impart knowledge about breeding of most culturable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons. The course presents an introduction to physiological adaptations in fish in relation to their environment. An important part of the course relates to functional physiological regulatory mechanisms. The course is adapted to a focus of fish physiology, breeding including other physiological processes in fishes as respiration, circulation, acid-base balance, osmoregulation and ionic regulation, swimming and buoyancy, sensory physiology, egg and larval physiology, digestion, energetic and growth, reproduction, fish health and diseases. In the end of the course the students will also have knowledge of fish migration (to nursery ground, to maturation grounds, freshwater to marine water, and marine water to freshwater) and fish behavior (learning and memory, light response for maturation, courtship behavior, aquarium fish behavior).

Contents

1. Fish nutrition: digestive system, stomach less fishes, stomach fishes, digestion and absorption, food,
2. Transportation: blood, blood cells, circulation, arterial system, venous system, capillaries,
3. Respiration: gills, lungs, skin, swim bladder, homeostasis
4. Excretion: kidneys, osmoregulation
5. Reproduction: gonads, testes and ovaries, artificial fertilization of sex cells.
6. Breeding: natural (seasonal), artificial, hormonal induced breeding, temperature & photoperiod, control induced breeding
7. Growth: extensive culture, semi intensive culture, Intensive culture
8. Fish health: water quality, hygiene of fish culture facilities, hygiene of equipment used in fish culture
9. Diseases and their control: viral, bacterial, fungal, parasitic, protozoan, helminths, arthropods
10. Fish migration: to nursery ground, to maturation grounds, freshwater to marine water, marine water to freshwater
11. Fish behavior: learning and memory, courtship behavior, aquarium fish behavior

Practical

1. Study of gut contents.
2. Study of feeding modification and adaptation in fish.
3. Study of respiratory adaptation in fish.
4. Study of blood cells and their counts in normal and diseased fish.
5. Study of water quality parameters (DO, NH₃, hardness, alkalinity, turbidity, transparency, temperature, salinity).
6. Study of various forms of swim bladder as hydrostatic organ.
7. Study fecundity of various fish species.
8. Study the effects of reproductive hormone (GnRH) on fish maturation.
9. Diagnosis of bacterial infection in infected fish.
10. Study of fish parasites.
11. Visit to various fish seed hatcheries during breeding seasons.

Recommended Texts

1. Kestin, S. C., & Warris, P. D. (2002). *Kestin farmed fish quality*. Oxford: Blackwell Science.
2. Saksena, D. N. (1999). *Ichthyology: recent research advances*. Dehli: Oscar Publications.

Suggested Readings

1. Stickney, R. R. (2016). *Aquaculture* (3rd ed.). Oxfordshire: CABI.
2. Maseke, C. (1987). *Fish aquaculture*. Oxford: Pergamon Press, Oxford.
3. Huet, M. (1973). *Textbook of fish culture: breeding and cultivation*. London: Blackwell Publishing Company.
4. Gorbman, A. (1983). *Comparative endocrinology* (1st ed.). New York: John Wiley & Sons.

This course provides knowledge about blood formation, morphology, physiology and biochemistry of blood cells, basic mechanisms and types. This course presents the functional morphology of blood cells (normal and abnormal), how important blood diseases manifest, and the approaches to diagnosis and treatment of blood and clotting diseases. It imparts knowledge about advanced techniques in studying serological and hematological techniques including blood coagulation. By the end of this course the student should be able to demonstrate an understanding of the components of human blood and characteristics, functions, abnormalities and disease states of each and can demonstrate proficiency in the skills necessary to perform blood cell counts, and evaluation of blood elements within stated limits of accuracy. After the laboratory practice they will be able to apply principles of safety, quality assurance and quality control in hematology, can compare and contrast hematology values under normal and abnormal conditions and can evaluate normal and abnormal cell morphology with associated diseases.

Contents

1. Blood formed elements and plasma.
2. Erythropoiesis and general aspects of anemia
3. Megaloblastic anemia and other megaloblastic anemia.
4. Blood collection techniques.
5. Anticoagulants. Hemolytic anemia.
6. Structure, types and genetic disorders of hemoglobin.
7. Leukopoiesis. Lymphocytes, monocytes, granulocytes and their disorders.
8. Platelets and thrombopoiesis.
9. Blood coagulation. Bleeding disorders.

Practical

1. Blood smear of different vertebrates to compare the RBCs morphology.
2. Total erythrocyte and leucocyte counts. Study of granulocytes and agranulocytes.
3. Differential leukocytes. Estimation of Hemoglobin. Study of erythrocytes sedimentation.
4. Comparison of blood counts of diseased (Anemia) and healthy individuals.
5. Morphological alterations in erythrocytes in various disease conditions like sickle cell anemia.

Recommended Texts

1. Hoffbrand, A. V., & Moss, P.A.H. (2002). *Essential hematology*. New York: Blackwell Publishing.
2. Bain, B. J., Bates, I., & Laffan, M. A. (2016). *Dacie & Lewis practical haematology* (12th ed.). London: Elsevier Health Sciences.

Suggested Readings

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (2017). *Molecular biology of the cell*. New York: Garland Publishing Inc.
2. Cooper, G. (2018). *The cell: A molecular approach* (8th ed.). Oxford: Oxford University Press.

This course is formulated to study the evolution and taxonomy of fish, to provide the knowledge regarding fish biology and to elaborate the anatomy and physiology of fish. The overarching goal of this course is to learn how the biological evolution process has shaped the existing taxonomic diversity and physiological variability of fishes. To achieve this goal, students will allow to survey fish diversity and examine the connections between anatomical traits and biological function as exemplified by living fish species. After this course students will be able to describe how the aquatic environment shapes all aspects of the biology of fish species, can explain how anatomy relates to function across major organ systems in fishes and can describe the basic function and organization of fish organ systems. The course focuses on physiological processes in fish including, respiration, circulation, acid-base balance, osmoregulation and ionic regulation, locomotion and energetics of swimming, swimming and buoyancy and digestion and control of gastro-intestinal motility in fish. Therefore, students will be provided an in-depth review of each topic in ichthyology.

Contents

1. Classification of Pisces. Morphological features of fish,
2. Fish muscular system and locomotion.
3. Physiology of respiration and air breathing among fishes.
4. Cardiovascular system, blood and its circulation
5. Digestion and control of gastro-intestinal motility in fish.
6. Physiology of gas bladder: use of gas by the fish as a source of static lift.
7. Gas in the gas bladder: loss, retention and secretion of gas.
8. Process of aestivation in fish. Sensory system and communication in fish: Sound reception

Practical

1. Study of classification of fishes and some selected fish species
2. Study of Fish anatomy, physiology and adaptations, fish dissections
3. Study of fish habitats, fish fauna of Pakistan
4. Study of fish reproduction, oocytes and aquaculture and food requirements
5. Study of environmental, ecological and economic importance of fishes
6. Study of ornamental fishes. Field visits to fish hatcheries

Recommended Texts

1. Lagler, K. F., Baradach, J. E., & Miller, R. R. (2009). *Ichthyology*. New York: John Wiley and Sons, Inc.
2. Moyle, P. B., & Cech, J. J. (2008). *Fishes: An introduction to ichthyology* (6th ed.). New Jersey: Prentice Hall.

Suggested Readings

1. David, H. (2003). *The physiology of fishes* (3rd ed.). Florida: CRC Press.
2. Smith, L. S. (2002). *Introduction to fish physiology* (2nd ed.). Washington DC: Argent Labs.

The course aims to give understanding of the basic concepts of immunology and its importance in biological sciences, provide information about immunological mechanisms against different diseases and gives understanding of immunization, immunological tolerance etc. After this course the students will be able to understand immunobiology, immunophysiology and immunopathology. The course has brief account on natural and acquired immunity, active and passive immunity, antigens and elicitation of immune responses. The students will be able to describe immunological response and how it is triggered and regulated. This subject also focuses on detection and application of antigen-antibody reactions, antigen antibody interactions and monoclonal antibodies. Cellular basis of immune response will also be discussed in detail along with the immunological tolerance and autoimmunity. The students will be able to describe immunological response and how it is triggered and regulated and they acquire for problem solving capacity about immune responsiveness.

Contents

1. Immunology: introduction.
2. Immunity: types: natural and acquired immunity.
3. Antigens and their types, antigenicity, factors important for immunogenicity of an antigen, cell mediated and humoral: nature of antigens
4. Immunoglobulins: synthesis of antibodies, types of antibodies
5. Detection and application of antigen-antibody reactions
6. Antigen antibody interactions
7. Monoclonal antibodies: importance, synthesis. Major histocompatibility complex: types and importance.
8. Cellular basis of immune response: origin of lymphocytes, primary and secondary lymphoid organs, specific response of individual lymphocytes to antigenic stimulation,
9. Hypersensitivity: Immediate hypersensitivity, delayed type or cell mediated hypersensitivity.
10. Immunological tolerance and autoimmunity: autoimmune diseases and types, factors responsible for autoimmunity. Transplantation immunology, immunity against infectious diseases, immuno deficiency diseases.
11. Immunization; immunization procedures, vaccines and their types.

Practical

1. Study of different types of leucocytes in: blood, bone marrow, spleen and thymus in mammals.
2. Estimations of total serum proteins, albumins and globulin concentrations in mammalian blood.
3. Differentiation of globulin proteins in blood serum of mouse by electrophoresis.
4. Diagnosis of immunoglobulin proteins by enzyme linked immunosorbent assay (ELISA).
5. Isolation of lymphocytes and resetting technique.
6. Antigen-antibody reaction by agglutination and precipitation reaction.
7. Antigen antibody reaction by using adjuvant.
8. Diagnosis of typhoid fever by Widal test.
9. Visit to pathological laboratory and report writing.

Recommended Texts

1. Punt, J., Stranford, S., Jones, P., & Owen, J. A. (2018). *Kuby's immunology* (8th ed.). New York: W. H. Freeman Company.
2. Delves, P. J., Martin, J. S., Burton, D. R., & Roitt, I. M. (2017). *Roitt's essential immunology* (13th ed.). New York: Wiley Blackwell.

Suggested Readings

1. Abbas, A., Lichtman, A., & Pilla, S. (2017). *Cellular and molecular immunology* (9th ed.). Amsterdam: Elsevier.
2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (1994). *Cellular and molecular immunology*. London: Elsevier Health Sciences

The course aims to impart knowledge about approaches to control pest in an integrated manner. It will develop the understanding of multiple strategies to control various pests of human interest. This course will provide introduction, historical background and geographical distribution of various insect species along factors that makes them pest. Available biological pest control, their identification and distribution will be introduced through these learning's. Students will be given knowledge about biological features and varieties of biological mediators to control insect pests. Theoretical foundation of pest control will be highlighted. Moreover, it includes opportunities and challenges for insect pest control in developing countries, concept of economic threshold level and concept of classical biological control. Understanding about recent strategies which are in practice nationally or internationally to manage pests will be given to students. Several techniques which are commercially used for rearing of biological pest control agents including culturing of bacteria and virus will be familiarized.

Contents

1. Introduction: foundation, approaches and objectives.
2. Opportunities and challenges for insect pest control.
3. Concept of economic threshold level, economic injury level.
4. Ranking of natural enemies, major threats to the natural enemies.
5. Concept of classical biological control.
6. Effects of different agronomic practices on the population of predators.
7. Relationship of biological control to the sustainable agriculture.
8. Augmentation and inoculation of natural enemies.
9. Limitation of biological control and modern trends to overcome this problem.

Practical

1. Collection and identification of important pests and their enemies,
2. Techniques to culture and maintain selected natural enemies of insect pests in the laboratory and in the fields.

Recommended Texts

1. Bradford, A. H., & Howard V. C. (2008). *Theoretical approaches to biological control*. New York: Cambridge University Press.
2. DeBach, P. (1991). *Biological control by natural enemies* (2nd ed.). Cambridge: Cambridge University Press.

Suggested Readings

1. Dent, D. (2005). *Insect pest management* (2nd ed.). London: CABI.
2. Pedigo, L. P., & Rice, M. E. (2015). *Entomology and pest management* (6th ed.). Amsterdam: Waveland Press.
3. Van Driesche, R. G., & Bellows, T. S. Jr. (2012). *Biological control*. London: Springer Science & Business Media.

Microbiology is the study of microorganisms which include: bacteria, viruses, viroids, yeast, molds, protozoans, algae, fungi and other very small organisms. Microbiology is important because it helps us to understand and treat diseases. This course covers basic principles of microbiology and provides an introduction to the characterization and classification of microorganisms and cultivation of bacteria. Students are expected to gain a fundamental understanding of microbes including viruses, Bacteria, Archaea and eukaryotic microorganisms. After completion of the lecture component of the course, successful students will be able to understand morphology and fine structure of bacteria, cultural characteristics and microbial metabolism processes. It will also help students to recognize how microorganisms solve the fundamental problems their environments present. The laboratory practice can help them to study of bacteria, fungi and protozoa, staining techniques and can apply scientific method to collect, interpret, and present scientific data in microbiology and related fields.

Contents

1. Microbiology introduction and history.
2. Microscopic examination of microorganisms.
3. Characterization and classification of microorganisms.
4. Morphology of bacteria.
5. Morphology of Protozoa
6. Methods of bacteria cultivation
7. Culturing techniques
8. Observation of culture and metabolism

Practical

1. Study of bacteria, fungi and protozoa.
2. Staining of microorganisms: simple staining, negative staining.
3. Demonstration of special structures by stains; capsular stain, spore stain, metachromatic granule stain, acid fast stain, flagella stain.

Recommended Texts

1. Benson, H. J. (2002). *Microbial applications: laboratory manual in general microbiology* (8th ed.). London: McGraw-Hill.
2. Pelczar, Jr., Chan, E. C. S., & Krieg, M. R. (2010). *Microbiology: application based approach*. London: McGraw Hill.

Suggested Readings

1. Madigan, M. T. (2009). *Brock biology of microorganisms* (12th ed.). London: Pearson/Benjamin Cummings.
2. Stainier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, R. R. (1986). *The microbial world*. London: Prentice Hall.

The course aims to develop knowledge about phylogeny of bacteria, their mode of nutrition and their diversity. The course will impart knowledge about phylogenetic relationship of the bacteria with other prokaryotes. Microbiology is important because it helps us to understand and treat diseases. This course covers basic evolutionary lineage of bacteria (proteobacteria). Students are provided fundamental understanding of phototrophic, chemo lithotrophic and methanotrophic proteobacteria, aerobic and facultative aerobic chemo organotrophic proteobacteria and morphologically unusual proteobacteria. After completion of the lecture component of the course, successful students will be able to understand the structural similarities and differences among delta and epsilon proteobacteria, firmicutes, mollicutes and actinobacteria. It will also help students to appreciate the diversity of cyanobacteria and prochlorophytes and can recognize how microorganisms solve the fundamental problems their environments.

Contents

1. Diversity of Archea,
2. The phylogeny of bacteria and proteobacteria,
3. Aerobic and facultative aerobic proteobacteria,
4. Bacterial physiology
5. Delta and epsilon proteobacteria,
6. Firmicutes, mollicutes and actinobacteria,
7. Cyanobacteria and prochlorophytes,
8. Chlamydia, the planctomycetes,
9. Verrucomicrobia, Flavobacteria and Acidobacteria,
10. Cytophaga group, Green Sulfur bacteria, Spirochetes, Dienococci, the green non sulfur bacteria.

Practical

1. Culturing of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates.
2. Isolation and stock culturing of bacteria.
3. Quantitative plating method. The turbidimetric estimation of microbial growth.
4. Study of bacterial viruses. Biochemical characterization of bacteria.

Recommended Texts

1. Madigan, M. T. (2009). *Bröck biology of microorganisms* (12th ed.). London: Pearson/Benjamin Cummings.
2. Benson, H. J. (2002). *Microbial applications: laboratory manual in general microbiology* (8th ed.). Montreal: McGraw-Hill.

Suggested Readings

1. Pelczar, Jr., Chan, E. C. S., & Krieg, M. R. (2010). *Microbiology: application based approach*. London: McGraw Hill.
2. Stainier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, R. R. (1986). *The microbial world*. London: Prentice Hall.

The course is designed to develop understanding of molecular mechanisms of hormone action, their molecular assessment and use of molecular techniques to treat endocrine disorders. The course of Molecular and Clinical Endocrinology aims to provide excellence in clinical care for all aspects of health and disease related to endocrine management like thyroid, adrenal, parathyroid, diabetes, pituitary, bone, and obesity and lipid disorders. It also provides an understanding of the general mechanisms in molecular endocrinology, radioimmunoassay, immune radiometric, immune chemiluminometric and radio receptor assays and their statistical procedures. Furthermore, in all body cells, hormones influence the metabolism of nucleotides, proteins, lipids, carbohydrates, vitamins, water, and therefore, knowledge of endocrinology and metabolism is important. The students will study the endocrine system in terms functional pathology in endocrine glands, disorders of growth and puberty, endocrine hypertension and Poly endocrine syndromes. By the end of this course, the students should be able to examine and describe glands and can determine their hormonal impacts.

Contents

1. General mechanisms in molecular endocrinology: subcellular structure of cells secreting protein hormones; Process of hormone secretion;
2. Mechanisms of action of hormones: hormone systems and intracellular communication;
3. Hormones acting at cell surface: properties of hormone receptor interaction,
4. Biochemistry and molecular interaction of steroid receptor, gene expression,
5. Functional pathology in endocrine glands: neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, corticotrophin regulation;
6. Pituitary disorders: prolactinomas, acromegaly, Cushing's syndrome. Diabetes insipidus,
7. Thyroid diseases of excess and deficient hormones
8. Adrenal gland: disorders of cortex; disorders of adrenal medulla
9. Disorders of ovarian function and hormonal therapy;
10. Abnormalities of testicular functions and hormonal therapy.
11. Fuel homeostasis: glucose homeostasis and hypoglycemia; diabetes mellitus; disorders of lipoprotein metabolism; eating disorders: obesity, anorexia nervosa and bulimia nervosa.
12. Development and growth: disorders of growth and puberty.
13. Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer;
14. Measurements of hormones: radioimmunoassay, immune radiometric, immune chemiluminometric and radio receptor assays and their statistical procedures

Practical

1. Studies on recognition and response of receptors.
2. Studies of disorders of pituitary by observing anatomical and histological features.
3. Studies of thyroid status in deficient and excess hormone functions.
4. Studies of type 1 and type 2 diabetes mellitus: Epidemiology of the types in population, studies of management of the type 2.

5. Model studies of disorders of ovarian and testicular disorders.
6. Model studies of obesity and anorexia.
7. Studies of hormonal status in puberty and aging.

Recommended Texts

1. Greenspan, F. S., & Stewler, G. J. (2002). *Basic and clinical endocrinology* (5th ed.). London: Prentice Hall International Inc.
2. Larsen, P. R., Kronenberg, H. M., Melmed, S., & Plonsky, K. S. (2003). *William's textbook of endocrinology* (10th ed.). Philadelphia: W.B. Saunders Company.

Suggested Readings

1. DeGroot, L. J., & Jameson, J. L. (2001). *Endocrinology* (4th ed.). Philadelphia: W.B. Saunders.
2. Griffin, J. E., & Ojeda, S. R. (2000). *Textbook of endocrine physiology* (4th ed.). Oxford: Oxford University Press.
3. Neal, J. M. (2000). *Basic endocrinology: an interactive approach*. London: Blackwell Science Inc.

The course will provide knowledge about bird diversity, avian anatomy, physiology and adaptations, bird behavior and socioeconomic and ecological importance. This course is an advanced undergraduate survey of ornithology. This means that students will learn about both science and birds at the same time. This course combines traditional zoology with an emphasis upon avian biology and diversity, and is delivered along with aspects of conservation management and practices. Students will learn about birds: how to identify them, what are the major characteristics and distinguishing features of the major groups of birds, and how birds function in a diversity of environments. However, this course will also cover a modern scientific approach to birds, which has as its goal not just understanding birds, but using birds as a means to uncover general biological principles that may apply to all living things. Students will acquire by the end of the course a new appreciation and knowledge of birds, additional understanding of biological concepts, and an improved ability to be an active scientist.

Contents

1. Introduction to ornithology, class Aves, taxonomy of birds up to orders, families and major species;
2. Biology of fossil bird's archaeopteryx, archaeornithes, neornithes;
3. Morphology and surface anatomy of bird, and development structure of feathers, plumage;
4. Structure of bones;
5. Basic embryology of birds;
6. Internal anatomy of birds;
7. Systems physiology;
8. Blood circulatory, cardiovascular physiology, heart, blood cells
9. Respiratory system, air sacs, ventilation of lungs, metabolic rates, oxygen consumption;
10. Urinary system, kidney physiology and production of solid or semisolid excreta, brain physiology and anatomy, special senses, olfaction, vision, taste;
11. Digestive system, anatomy,
12. Morphological and physiological adaptations of birds to flying,
13. Reproductive organs anatomy and physiology
14. Types of behavior in birds
15. Endangered species of birds; bird conservation and sanctuaries.
16. Anatomy and physiology of game and predatory species.
17. Birds of Pakistan: aquatic, forest and game birds and birds of prey.
18. Birds as pests.

Practical

1. Identification characteristics and taxonomy of birds to orders and families
2. Dissection of sparrow, pigeon, myna, other available birds
3. Anatomy of bones, skull, girdles, spine, vertebrae, feathers, plumage
4. Study of gut contents of birds to understand feeding habits
5. Incubation of chicken eggs to learn avian embryogenesis
6. Bird stuffing and preservation of eggs
7. Identification of bird species through feathers and egg shells
8. Beak and claw structures
9. Study of bird songs, recording bird songs, fundamental experimentation to understand

- bird songs in sensitive and sensorimotor phases
10. Bird watching and preparation of ethograms
 11. Study of Predator-prey relationship among birds
 12. Study of Brood parasitism
 13. Study of flying mechanics through models

Recommended Texts

1. Howell, S. N. G. (2010). *Peterson reference guide to molt in north American birds*. Amzaon: Peterson Reference Guides.
2. Urfi, A. J. (2009). *Birds of India: a literary companion*. New York: Oxford University Press.

Suggested Readings

1. Rank, B. (2004). *Ornithology: ecology and evolution of Darwin's finches*. New Jersey: Princeton. W. H. Freeman.
2. Sibley, D. A., & Alfred, A. (2002). *Sibley's birding basics*. New York: New York Press.
3. Ali, S. S., & Ripley, D. (2001). *Handbook of the birds of India and Pakistan: together with those of Bangladesh, Nepal, Bhutan and Sri Lanka*. Reprint. New Delhi: Oxford University Press.

This course gives details of physiological systems maintaining the homeostasis of animals. Interrelations of the systems and regulatory features of the each system's function will be focused. The major goal of the course is to provide a course of study in mammalian, principally human, systems physiology, building on knowledge of basic physiological principles. Its contents mainly cover cardiovascular system, respiratory system, renal system, gastrointestinal system and osmoregulation. It also focuses on environmental challenges of temperature regulation like temperature and animal energetics, temperature relation of ectotherms, heterotherms and endotherms. Laboratory practice will enable the students to study of heart in prepared frogs, to study blood pressure in various physiological states, study of electrocardiograms and to determine the oxygen consumption in fish and mouse and effects of various factors affecting it. Physiological systems and adaptations also focus on how the metabolic, neuromuscular, cardiovascular, and respiratory systems respond to the demands of varying adaptations and it modifies these systems.

Contents

1. Cardiovascular System: blood and homeostasis
2. Arterial system; microcirculation and lymphatics; control of cardiac output; special circulations: cutaneous, skeletal, coronary, cerebral and fetal.
3. Respiratory System: overview of respiratory system; mechanical aspects of breathing; transport of oxygen and carbon dioxide; respiratory responses in extreme conditions.
4. Renal System: elements of renal function; tubular function in nephron and osmolarity;
5. Gastrointestinal System: gastrointestinal secretions and their control: salivary, gastric, pancreatic and liver; digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water; motility of gastrointestinal tract:
6. Osmoregulation: Problems of osmoregulation; obligatory exchange of ions and water; osmoregulators and osmoconformers; osmoregulation in aqueous and terrestrial environments.
7. Environmental challenges: temperature relation of ectotherms, heterotherms and endotherms; dormancy: special metabolic state;
8. Body rhythms.

Practical

1. Experiments on the study of heart in prepared frogs.
2. Study of blood pressure in various physiological states.
3. Study of electrocardiograms.
4. Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of factors.
5. Demonstration of respiratory volume and pulmonary function tests.
6. Experiments on digestion on nutrients by enzymes and effects of factors; Study of exocrine secretion in stomach or pancreas and effects of factors. Experiments on kidney regulation of osmolality.
7. Urine analysis.
8. Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Recommended Texts

1. Randall, D., Burggren, W., French, K., & Fernald, R. (2002). *Eckert animal physiology: mechanisms and adaptations* (5th ed.). New York: W.H. Freeman & Company.
2. Tharp, G., & Woodman, D. (2002). *Experiments in physiology* (8th ed.). London: Prentice Hall.

Suggested Readings

1. Berne, R. M., & Levy, M. N. (2000). *Principles of physiology* (3rd ed.). St. Louis: Mosby.
2. Guyton, A. C., & Hall, J. E. (2015). *Textbook of medical physiology* (12th ed.). Philadelphia: W.B. Saunders Company.

The course aims to provide knowledge about reproductive system and its role in the behavior of the animals. It will enable the students to develop the understanding about the role of sex hormone in sexual behavior and their interaction during development. The major objective of this course is to provide students with a sound coverage of human reproductive physiology within the framework of human body. This is achieved by first covering fundamentals of the structure and function of the male and female reproductive tracts, gametogenesis, fertilization, early embryogenesis, fetal development and preparation for birth, contraceptive methods and maternal adaptations to pregnancy. It particularly emphasizes on the hormonal control of reproduction. This in turn provides an important foundation to consider sexual differentiation and development, contraception, infertility and current reproductive technologies. Finally, human reproductive behavior and its implications to our future are considered in the light of our evolutionary history, culture and society.

Contents

1. Introduction, sex determination and differentiation:
2. Hormonal and neural factors and their interaction in ovarian, testicular and reproductive targets functions;
3. The interactions in development in estrous and menstrual cycle
4. Reproductive behaviors: Physiological basis of male and female sexual behavior and maternal behavior;
5. Endocrine basis of communication in reproduction
6. Pheromone in mammalian reproduction;
7. Rhythms in reproduction and pregnancy;
8. Hormonal mechanism in fertilization, zygote transport and implantation.
9. Placental steroid and polypeptide hormones; maternal metabolism gestation, hormonal mechanism in parturition.
10. Lactation: Hormonal mechanism in lactation,
11. Hormonal and metabolic aspects in menopause
12. Fertility control mechanisms in male and female

Practical

1. Study of male and female reproductive tract; physiological histology of segments of male and female reproductive tracts;
2. Recognition of spermatogonial cells, ovarian follicles and corpus luteum in gonads; study of hormonal mechanisms in super ovulation and implantation;
3. Tests for pregnancy recognition;
4. Experiments on role of gonads in maintenance of accessory sex gland in males and target structures in females;
5. Study of fertility control procedures in populations.

Recommended Texts

1. Evert, B. J., & Johnson, M. H. (2000). *Essential reproduction*. Oxford: Blackwell Science Inc.
2. Larsen, P. R., Kronenberg, H. M., Melmed, S., & Plonsky, K. S. (2003). *William's textbook of endocrinology* (10th ed.). Philadelphia: W.B. Saunders Company.

Suggested Readings

1. Knobil, E., & Neill, J. D. (2006). *The physiology of reproduction* (Vol. 2). Houston: Gulf Professional Publishing.

This course will provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance knowledge about their pathology, host parasite relationship and control measures. Overall aim of the course is to provide students with knowledge concerning biological, epidemiological and ecological aspects of parasites causing diseases to humans, enable them to understand the pathogenesis, clinical presentations and complications of parasitic diseases, to establish knowledge regarding pathogenesis, clinical presentations and complications of parasitic diseases and to provide students with adequate knowledge about endemic parasites and national parasitic problems as well as re-emerging parasitic infection. By the end of the courses, students will be able to describe the world distribution of important parasitic infections and the epidemiologic principles and the effect of social and demographic patterns on parasitic disease and vulnerability and can describe molecular, biochemical and cellular mechanisms that occur in the body of humans infected with parasites.

Contents

1. Introduction to parasitology.
2. Relationship to other sciences.
3. Some basic definitions: basic principles and concepts.
4. Immunology and pathology.
5. Susceptibility and resistance, innate defense mechanisms.
6. Acquired immune response in vertebrates
7. Immunodiagnosis and pathogenesis of parasitic infections.
8. Host-parasite relationship.
9. Parasitic protozoa, form, function and classification: Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae.
10. The Amoebas: Order Amoebida, order Schizopyrenida.
11. Phylum Apicomplexa, Gregarines, Coccidia and related organisms.
12. Phylum ciliophora, ciliated protistan parasites,
13. Classification of Phylum Mesozoa.
14. Systematics, morphology and biology of Arthropods (causing or responsible for transmission of disease).
15. Chemical and non-chemical control of Arthropods of medical and veterinary importance.
16. Pathology of Helminths: host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance.

Practical

1. Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance.
2. Section cutting of the infected tissues and the study of their pathology.
3. Methods of collection, preservation and transportation of parasitic material.
4. Qualitative and quantitative fecal examination for helminth ova.
5. Collection, preservation and preparation of slides of local helminthes and their identification.
6. Identification of insects of medical and veterinary importance.

Recommended Texts

1. Roberts, L. S., & Janovy, J. Jr. (2005). *Foundations of parasitology* (7th ed.).

Chicago, London, Tokyo, Toronto: W.M. Brown Publishers.

2. Urquhart, G. M., Hucan, J. L., Dunn, A. M., & Jennings, F. W. (2000). *Veterinary parasitology*. London: Longman Scientific and Technical publications.

Suggested Readings

1. Watson, J. M. (2014). *Introduction to animal parasitology*. London: Elsevier
2. Cheesbrough, M. (2006). *Laboratory practice in tropical countries* (2nd ed.). Cambridge: University Press Cambridge.

The course objectives are to provide knowledge about the nature and mode of action of different categories of toxicants and to provide knowledge about the procedural protocols used in toxicological studies. The major contents of the course includes measuring toxicity and assessing risk, chemistry of toxicants; toxicity testing methods; routes of exposure, responses to varying doses of substances and LD50 experiments. Toxicokinetics aims to empower the students with the understanding of absorption and bioavailability and contrasting kinetics of lipophilic substances, routes of absorption (the oral, respiratory and dermal) and elimination. In addition, students will learn about biotransformation (phase I reaction and phase II reaction), cellular sites of action, effect of toxicants on enzymes and mechanism of cell death (apoptosis, necrosis, stress, repair) and recovery. The aim of this subject is to train high-quality scientists in applied toxicology with a heightened respect for the environment. Students will develop a broad range of skills, knowledge and experience required for successful careers.

Contents

1. Introduction, Chemistry of toxicants; routes of exposure, responses to varying doses of substances, time of exposure; the LD50 experiments,
2. Toxicokinetics: Introduction; pharmacokinetics and toxicokinetics,
3. Absorption: the oral, respiratory and dermal route of exposure, distribution, Elimination, toxicokinetic models: mathematical models of elimination, Absorption and bioavailability; contrasting kinetics of lipophilic substances.
4. Biotransformation: Introduction, Primary biotransformation (phase I reaction)
5. Secondary metabolism (phase II reaction).
6. Cellular sites of action, introduction, interaction of toxicants with proteins,
7. Effect of toxicants on enzymes, receptors and ion channels,
8. Effects of toxicants on lipids and nucleic acids,
9. Mechanism of cell death; apoptosis, necrosis, stress, repair and recovery.

Practical

1. Study of Biototoxicity assay for LC50.
2. Study the effects of different teratogenic chemicals on the development of human/rat embryo.
3. Study the effect of Ethanol on the development of chick embryo with different doses.
4. Study the effect of Xylene on the development of chick embryo.

Recommended Texts

1. Stine, K. E., & Brown, T. M. (2015). *Principles of toxicology*. London: CRC press, Taylor and Francis Group.
2. Marquardt, H., Schafer, S. G., McClellan, R. O., & Welsch, F. (2004). *Toxicology*. San Diego: Academic press.
3. Barile, F. A. (2013). *Principles of toxicology testing*. London: CRC Press, Taylor and Francis Group.

The aim of this course is to equip students with a scientific understanding of endangered species, the causes behind their decline, and the strategies used for their conservation and recovery. The course emphasizes the ecological, genetic, and socio-political aspects of species endangerment, with a particular focus on threatened species in Pakistan. Students will explore concepts such as population viability, in situ and ex situ conservation, species recovery planning, legal protections, and community-based initiatives. The course also aims to develop skills in identifying endangered species, evaluating threats, and designing practical conservation strategies to support long-term species survival and biodiversity conservation at national and global levels.

Contents

1. Introduction to Endangered Species: Definitions, categories (vulnerable, endangered, critically endangered), importance of species conservation.
2. Causes of Species Endangerment: Habitat loss, overexploitation, invasive species, pollution, climate change, and disease.
3. IUCN Red List and Conservation Status: Red List categories, criteria for listing, interpretation of species status.
4. Population Assessment and Monitoring Techniques: Population viability analysis, habitat suitability models, census and tracking methods.
5. Endangered Species of Pakistan: Mammals, birds, reptiles, and amphibians
6. Conservation of Endangered Species: In situ and ex-situ conservation
7. Conservation Genetics and Small Population Challenges: Inbreeding, genetic drift, loss of heterozygosity, and their role in species decline.
8. Legal and Institutional Framework: National and international conventions, wildlife protection laws, and the role of organizations (IUCN, WWF, CITES, CBD).
9. Species Recovery Planning and Case Studies: Steps in recovery planning, prioritization, success stories and failures — with emphasis on species in Pakistan.

Practical

1. Use of IUCN Red List to Identify Threatened Species of Pakistan.
2. Preparation of Species Fact Sheets for Selected Endangered Animals.
3. Field Survey Techniques for Assessing Threats and Population Size.
4. Visit to a Protected Area or Conservation Breeding Center.

Recommended Texts

1. Primack, R.B. (2014). *Essentials of Conservation Biology*. Sinauer Associates.
2. Groom, M.J., Meffe, G.K., & Carroll, C.R. (2006). *Principles of Conservation Biology*. Sinauer Associates.
3. Cardinale, B., Primack, R., & Murdoch, J. (2019). *Conservation Biology*. Oxford University Press.

Suggested Readings

1. Sheikh, K.M., & Molur, S. (2005). *Status and Red List of Pakistan's Mammals*. IUCN Pakistan.
2. Khan, M.S. (2011). *Amphibians and Reptiles of Pakistan*. Krieger Publishing Company.
3. Roberts, T.J. (1997). *The Mammals of Pakistan*. Oxford University Press.

The aim of this course is to provide students with a comprehensive understanding of the classification, significance, and management of protected areas, with a special focus on Pakistan's National Parks, Wildlife Sanctuaries, Game Reserves, Ramsar Sites, and Biosphere Reserves. The course seeks to familiarize students with the ecological, recreational, cultural, and economic roles of protected areas, the criteria for their establishment, and the legal frameworks governing their protection. It also addresses challenges in protected area management, human-wildlife conflict, and sustainable tourism. Additionally, this course aims to develop skills in mapping, documentation, and protected area evaluation, enabling students to actively participate in conservation planning and management efforts at local and national levels.

Contents

1. Introduction to protected areas: Definition, history, objectives and IUCN categories.
2. Significance of protected areas in Biodiversity conservation
3. National Park: Introduction, criteria, significance, status and important national parks in Pakistan.
4. Game reserves: Introduction, criteria, significance, status and important game reserves in Pakistan.
5. Wildlife sanctuaries: Introduction, criteria, significance, status and important wildlife sanctuaries in Pakistan.
6. Ramsar sites and Biosphere reserves: introduction to wetland, Ramsar convention, Ramsar sites in Pakistan, Biosphere reserves introduction and biosphere zones in Pakistan.
7. Protected Area Management and Zonation: challenges in their management and measures for their resolution.
8. Legal Framework and Policies: Wildlife Protection Acts, National and Provincial Laws, and international agreements.

Practical

1. Mapping and Distribution of National Parks, Sanctuaries, and Protected Areas of Pakistan.
2. Visit to a Nearby National Park / Sanctuary / Game Reserve.

Recommended Texts

1. Primack, R.B. (2014). *Essentials of Conservation Biology*. Sinauer Associates.
2. Cardinale, B., Primack, R., & Murdoch, J. (2019). *Conservation Biology*. Oxford University Press.
3. Eagles, P.F.J., McCool, S.F., & Haynes, C.D. (2002). *Sustainable Tourism in Protected Areas: Guidelines for Planning and Management*. IUCN.

Suggested Readings

1. WWF-Pakistan Reports on Protected Areas and Conservation Challenges.
2. Pakistan's National Biodiversity Strategy and Action Plan (NBSAP).
3. IUCN Pakistan Reports and Ramsar Convention Updates.
4. Recent research papers and case studies on protected area management in Pakistan.

The aim of this course is to provide students with fundamental knowledge and hands-on experience in the art and science of taxidermy, focusing on the preservation, preparation, and display of animal specimens for educational, research, and exhibition purposes. It seeks to introduce students to the techniques, tools, materials, and ethical considerations involved in taxidermy, emphasizing its significance in wildlife conservation education, museum curation, and species documentation. The course emphasizes both theoretical knowledge and practical skills, enabling students to preserve skins, skulls, and mounts of mammals, birds, reptiles, and fishes. Additionally, it aims to develop awareness about the legal, cultural, and ethical aspects of handling wildlife specimens in Pakistan.

Contents

9. Introduction to Taxidermy: Definition, history, scope, and significance of taxidermy in zoology, museums, and conservation education.
10. Types of Taxidermy: Study skins, mounts, skeletal preparation, antler mounting, trophy preparation, and wet specimens.
11. Tools, Materials, and Chemicals Used in Taxidermy: essential tools, preservatives, tanning agents, stuffing materials, and mounting hardware.
12. Skinning Techniques: Methods of skinning for mammals, birds, reptiles, and fishes — dorsal, ventral, and case skinning.
13. Preservation Techniques: Cleaning, salting, tanning, and preservation of skins and skulls.
14. Mounting Techniques: Preparation and mounting of mammal heads, bird forms, fish models, and skeletal mounts.
15. Stuffing and Moulding: Methods of stuffing, shaping, and moulding to retain natural posture and appearance.
16. Restoration, Repair, and Finishing: Repairing damages, painting, grooming, eye setting, and adding naturalistic touches.
17. Ethical and Legal Considerations: Wildlife protection laws, permits, handling endangered species, and ethical responsibilities in taxidermy.

Practical

3. Demonstration and Practice of Skinning Techniques for Small Mammals and Birds.
4. Cleaning, Preserving, and Tanning of Animal Skins.
5. Mounting and Stuffing of a Small Bird or Mammal Specimen.
6. Preparation of Bone Skeletons and Skull Cleaning Techniques.
7. Mounting of trophy/head.
8. Visit to a Natural History Museum or Wildlife Display Center for Study of Taxidermy Collections.

Recommended Texts

1. Patuzzi, A. (2019). *The Art of Taxidermy*. CSIRO Publishing.
2. Hornaday, W.T. (2004). *Taxidermy and Zoological Collecting*. Dover Publications.
3. Moyer, R. (2008). *Fundamentals of Taxidermy*. Breakthrough Publications.

Suggested Readings

5. WWF-Pakistan Guidelines on Ethical Wildlife Handling and Display.
6. Research articles and case studies on museum specimen preparation and wildlife displays in Pakistan.

The aim of this course is to provide students with a thorough understanding of the genetic principles and applications relevant to the conservation and management of wildlife populations. It seeks to introduce the role of genetic diversity in species survival, the consequences of genetic drift, inbreeding, and population bottlenecks, and the use of molecular tools in assessing and conserving genetic variation. The course emphasizes the application of genetic data in species conservation planning, captive breeding programs, and population recovery initiatives. Additionally, it aims to develop practical skills in DNA extraction, PCR, molecular marker analysis, and interpretation of genetic data for conservation decision-making in Pakistan and beyond.

Contents

1. Introduction to Conservation Genetics: Definition, history, scope, and significance in wildlife conservation.
2. Genetic Variation and its Importance: Types of genetic variation, sources of genetic diversity, and its role in species adaptability and long-term survival.
3. Population Genetics Basics: Gene pool, gene flow, genetic drift, mutation, selection, Hardy-Weinberg equilibrium.
4. Loss of Genetic Diversity: Genetic drift, inbreeding, bottleneck effects, founder effects, and their implications for small and isolated populations.
5. Genetic Management of Small Populations: Strategies to maintain genetic diversity in fragmented, endangered, and captive populations.
6. Molecular Markers in Conservation: Types of molecular markers (microsatellites, mtDNA, SNPs), their applications in population structure analysis, parentage testing, and genetic monitoring.
7. Genetic Identification of Species and Populations: DNA barcoding, species delimitation, and forensic applications in wildlife conservation.
8. Case Studies in Conservation Genetics: Genetic rescue case study

Practical

1. Use of Molecular Markers for Species and Population Identification.
2. Interpretation of Genetic Diversity Data and Calculation of Genetic Parameters.
3. Construction and Analysis of Population Genetic Structure (using simulated or provided data).
4. Visit to a Molecular Genetics Laboratory.

Recommended Texts

1. Frankham, R., Ballou, J.D., & Briscoe, D.A. (2010). Introduction to Conservation Genetics. Cambridge University Press.
2. Allendorf, F.W., Luikart, G., & Aitken, S.N. (2013). Conservation and the Genetics of Populations. Wiley-Blackwell.

Suggested Readings

1. Sheikh, K.M., & Molur, S. (2005). Status and Red List of Pakistan's Mammals. IUCN Pakistan.
2. WWF-Pakistan Reports and Genetic Conservation Strategies.
3. IUCN Species Survival Commission (SSC) Genetic Guidelines.
4. Recent research articles, genetic monitoring reports, and case studies from Pakistan and South Asia.