



**Scheme of Studies Bachelor of Science in Zoology
Fall 2023**

Additional Director Academics
University of Chitral

**Department of Zoology
University of Chitral**



General Requirements of the Programme

Nomenclature: Bachelor of Science in Zoology

Eligibility Criteria: Intermediate or equivalent with at least 45% marks in Biological/ Pre-Medical Science.

Duration: The minimum duration for completion of a BS degree is four years. The HEC allows a maximum period of seven years to complete BS degree requirements.

Pathway for the Associate Degree Holders in Zoology:

- The candidates with an Associate Degree in Zoology (AD Zoology) are eligible for admission in the 5th Semester of BS Zoology Programs. Such students shall complete the deficiency courses of General Education (if any) during the 5th to 8th Semester.
- The candidates who acquired AD in Zoology prior to the admission criteria (as stated above) are also eligible for admission in the 5th Semester of BS Zoology Programs. Such students shall also complete the deficiency courses of General Education (if any) during the 5th to 8th Semester.
- The minimum eligibility for admission in the fifth semester, in this case, is a 2.0 CGPA out of 4 in the prior qualification, i.e., conventional two-year BSc degree programs.
- Admission in the 5th Semester is subject to the availability of seats.

Pathway for Conventional Two-Year BSc Degree Holders

- Students having completed a conventional two-year BSc are allowed to be admitted in the fifth semester of the BS program, in which case students shall be required to complete deficiency courses through a bridging semester before the commencement of the fifth semester as determined by the department.
- Relevant courses from BSc (Chemistry, Botany Zoology, Geography)
- The minimum eligibility for admission in the fifth semester, in this case, is a 5% cumulative score in the prior qualification, i.e., conventional two-year BSc degree programs.
- Admission in the 5th Semester is subject to the availability of seats.

Exit with Associate Degree

The students, after successful completion of the 04 semesters in BS Zoology Programs, may exit with an Associate Degree in Zoology subject to completion of all requirements for the award of associate degree, i.e., Credit Hours, CGPA, and compulsory courses.

Degree Completion Requirements

To become eligible for the award of a BS degree, a student must satisfy the following requirements:

- a) Must have studied and passed the prescribed courses, totaling at least 120-130 credit hours.
- b) Must have earned a CGPA (Cumulative Grade Point Average) of at least 2.0 on a scale of 4.0. The students, after successful completion of 04 semesters in the BS Zoology Program, may exit with an **Associate Degree in Zoology** subject to completion of all requirements for

the award of an associate degree, i.e., Credit Hours, CGPA, and compulsory/major courses.



PROGRAM-WISE SCHEME OF STUDIES					
Domain	Credit Hours	General Education Courses	Major Courses	Interdisciplinary Courses	Internship/Field Experience/Capstone Project
Total CrHr	138	30	87	15	06

SEMESTER-WISE SCHEME OF STUDIES					
Semester	General education Course CrHr	Major CrHr	Interdisciplinary Courses CrHr	Internship/Capstone Project CrHr	Total CrHr
1 st	11	4	3		18
2 nd	5	7	6		18
3 rd	7	4	6		17
4 th	7	11			18
5 th		18			18
6 th		16			16
7 th		15		3	18
8 th		12		3	15
Total	30	87	15	6	138



SEMESTER-WISE BREAKDOWN

1 st Semester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-111	GE	Functional English	3(3+0)
ZOO-113	GE	Exploring Quantitative Skills	3(3+0)
ZOO-114	AC	Diversity of Plants	3(2+1)
ZOO-115	GE	Organic Chemistry	3(2+1)
ZOO-116	Major	Animal Diversity-I (Invertebrates)	4(3+1)
Any one of the following			
ZOO-112	GE	Islamic Studies	2(2+0)
ZOO-117	GE	Ethics	2(2+0)
Total Credit Hours			18(15+3)

2 nd Semester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-121	GE	Introduction to Expository Writing	3(3+0)
ZOO-122	GE	Ideology and Constitution of Pakistan	2(2+0)
ZOO-123	AC	Plant Systematics, Anatomy, Development and Embryology	3(2+1)
ZOO-124	AC	Inorganic Chemistry	3(2+1)
ZOO-125	Major	Animal Diversity-II (Chordates)	4(3+1)
ZOO-126	Major	Biostatistics	3(2+1)
Total Credit Hours			18(14+4)

3 rd Semester (17 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-231	GE	Entrepreneurship	2(2+0)
ZOO-232	GE	Information and Communication Technologies	3(2+1)
ZOO-233	AC	Plant Physiology & Ecology	3(2+1)
ZOO-234	AC	Environmental Chemistry	3(3+0)
ZOO-236	Major	Animal Form & Function-I	4(3+1)
Any one from the Following			
ZOO-235	GE	Principles of Sociology	2(2+0)
ZOO-237	GE	Social Anthropology	2(2+0)
Total Credit Hours			17(14+3)



4thSemester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO –241	GE	Civic & Community Engagement	2(2+0)
ZOO- 242	GE	Tools for Quantitative Reasoning	3(2+1)
ZOO- 243	Major	Cell and Molecular Biology	4(3+1)
ZOO- 244	Major	Biochemistry-I	3(2+1)
ZOO- 245	Major	Animal Form & Function-II	4(3+1)
Any one from the following			
ZOO- 246	GE	Introduction to Philosophy	2(2+0)
ZOO- 247	GE	Introduction to History	2(2+0)
Total Credit Hours			18(13+4)

5thSemester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO- 351	Major	Biological Techniques	3(1+2)
ZOO-352	Major	Biochemistry-II	3(2+1)
ZOO-353	Major	Physiology	4(3+1)
ZOO-354	Major	Ecology	3(2+1)
ZOO-355	Major	Evolution	2(2+0)
ZOO-356	Major	Principles of Systematics	3(2+1)
Total Credit Hours			18(14+4)

6thSemester (16 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-361	Major	Research Methodology	2(2+0)
ZOO 362	Major	Animal Behavior	3(3+0)
ZOO-363	Major	Developmental Biology	4(3+1)
ZOO-364	Major	Genetics	4(3+1)
ZOO-365	Major	Zoogeography and Paleontology	3(2+1)
Total Credit Hour			16(13+3)



7th Semester (18) Credit Hours			
Course Code	Domain	Course Name	Credit Hours
ZOO-472	Major	Ichthyology	3(2+1)
ZOO-473	Major	Wildlife	3(2+1)
ZOO-474	Major	Parasitology-I	3(2+1)
ZOO-475	Major	Entomology-I	3(2+1)
ZOO-476	FE/INT	Field experience/internship	3
Total Credit Hours			18(13+5)

Any one Major course from the following

ZOO-471	Major	Bioinformatics	3(2+1)
ZOO-477	Major	Biotechnology	3(2+1)

8th Semester (18) Credit Hours			
Course Code	Domain	Course Name	Credit Hours
ZOO-481	Major	Applied Fisheries	3(2+1)
ZOO-482	Major	Parasitology-II	3(2+1)
ZOO-483	Major	Entomology-II	3(2+1)
ZOO-484	CP	Capstone Project	3(2+1)
Any One Major course from the following			
ZOO-485	Major	Economic Zoology	3(2+1)
ZOO-486	Major	Immunology	3(2+1)
ZOO-487	Major	Mammalogy	3(2+1)
ZOO-488	Major	Ornithology	3(2+1)
ZOO-489	Major	Microbiology	3(2+1)
Total Credit Hours			15(10+5)



SEMESTER-1

1 st Semester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-111	GE	Functional English	3(3+0)
ZOO-113	GE	Exploring Quantitative Skills	3(3+0)
ZOO-114	AC	Diversity of Plants	3(2+1)
ZOO-115	GE	Organic Chemistry	3(2+1)
ZOO-116	Major	Animal Diversity-I (Invertebrates)	4(3+1)
Any one of the following			
ZOO-112	GE	Islamic Studies	2(2+0)
ZOO-117	GE	Ethics	2(2+0)
Total Credit Hours			18(15+3)

ZOO-111 Functional English

Contact Hours: 3-0

COURSE DESCRIPTION

The purpose of this course is to develop the English language proficiency of students and to help them become confident in reading, writing, speaking, and listening to the English language. Instead of teaching grammar in isolation and only at sentence level, this course is based on developing the language abilities of students through an integrated approach that provides opportunities to develop their listening, speaking, reading, and writing skills. With a focus on social interaction, the course draws specific attention to the accurate use of structures, improvement of pronunciation, and development of active vocabulary in descriptive, narrative, and instructional texts.

COURSE OUTCOMES

After completing this course, students will:

- have improved their listening and reading skills in English
- be able to communicate in written and oral English with peers and teachers
- rely less on their first languages and increase their use of English in formal and informal situations
- have a deeper understanding of correct English structures in descriptive, narrative, and instructional texts.

COURSE CONTENTS

Basics of Grammar

- Parts of Speech and their Usage
- Sentence and Its Structure



- Phrase, usage of phrases
- Clause, usage of clauses

Introductions

This first unit will provide students with an opportunity to interact with one another in oral and written forms. It will serve to introduce them and help them develop conversations through suggesting simple words and phrases to describe people, preferences, and other conversation topics in a logical sequence.

Making Introductions

- Making effective self and peer introductions
- Taking useful introductory notes

Expressing Requests and Enquiries

- Forming appropriate requests and enquiries
- Responding to enquiries
- Requests versus commands

Social Interaction

This unit is aimed at developing students' social interaction in English and expanding their interpersonal skills. Through class activities, they actively converse in formal and informal contexts to congratulate, express gratitude, make invitations, and respond to speakers in oral and written contexts.

Greetings

- Greeting friends and family on different occasions and for different reasons
- Responding to a positive event
- Using formal greeting expressions appropriately

Gratitude

- Using formal and informal expressions of gratitude appropriately
- Reading a story that uses expressions of gratitude
- Writing a formal letter to say thanks to a teacher, parent, or friend

Invitations

- Demonstrating the use of formal and informal expressions of invitation
- Developing verbal and written skills for invitations
- Responding to invitation requests by accepting or declining

Regrets

- Expressing regrets orally and in writing appropriately
- Saying sorry and accepting apologies

Giving and Following Directions

In this unit, students learn how to follow directions from a map as well as how to give directions to search for a location or specific information. They learn how to follow and provide clear instructions.

Following and Giving Directions

- Following directions from a map



- Giving directions to a location in oral and written forms
- Reaching a destination

Giving Clear Instructions

- Carrying out instructions
- Structuring instructions
- Writing clear instructions

Sharing experiences

In this unit, students will engage with different meanings in a variety of written and visual texts through shared, guided, and independent readings of narratives in various genres. Instructors will encourage them to respond to the narrative and imaginative texts by composing stories and sharing them in written and oral form.

Sharing narratives

- Reading short stories
- Reading excerpts, comic strips, interviews, and other common texts

Sharing unique experiences

- Summarizing and narrating true stories
- Solving word puzzles to develop language awareness
- Reading short stories and completing exercises to test comprehension
- Converting an event into a short story
- Using pictures as stimuli for narrative creation
- Using songs as examples of personal experience

Imaginative texts

- Developing imaginative texts by communicating engrossing stories and descriptions of scenes

Discussion

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Composition and Comprehension

Writing Mechanics

- Sentences, sentence fragments, and run-on sentences
- Subject-predicate and pronoun-reference agreement
- Punctuation and structure

Paragraph Writing (practice)

Essay Writing (practice)

Précis writing (practice)

TEXTBOOKS AND REFERENCES

- T. K. Carver and S. Fortinos-Riggs, Conversation Book II – English in Everyday Life (New York: Pearson Education Limited, 2006).



- J. Eastwood, Oxford Practice Grammar (Karachi: Oxford University Press, 2005).
- J. Swan, Practical English Usage, 3rd ed. (New York: Oxford University Press, 2005).
- J. Thomson and A. V. Martinet, A Practical English Grammar (Intermediate) (New York: Oxford University Press, 1986)
- Allama Iqbal Open University, Compulsory English 1 (Code 1423) (Islamabad: AIOU Press).
- BBC. (2013) Learning English. <http://www.bbc.co.uk/worldservice/learningenglish/>
- British Council. Learn English. <http://learnenglish.britishcouncil.org/en/>
- British Council and BBC. Learn English. <http://www.teachingenglish.org.uk/>
- Grammar English. <http://freesoftwarepc.biz/educational-software/download->

ZOO-112 Islamic Studies

Credit Hours 2(2-0)

Note: May be taught in Urdu.

Course Contents (English & Urdu)

English	Urdu
1. Introduction to Quranic Studies <ul style="list-style-type: none">• Basic Concepts of Quran• History of Quran• Uloom-ul -Quran	1. قرآنی علوم کا تعارف <ul style="list-style-type: none">• قرآن مجید کے بنیادی اصطلاحات• تاریخ تدوین و جمع قرآن• علوم القرآن
2. Study of Selected Text of Holy Quran <ul style="list-style-type: none">• Verses of Surah al-Furqan Related to Social Ethics (Verse No.6377)• Verses of Surah Al-Hashr (18,19, 20) Related to thinking, Day of Judgment	2. منتخب آیات کریمہ کا مطالعہ <ul style="list-style-type: none">• معاشرتی آداب سے متعلق سورہ الفرقان کی آیات نمبر 63-77• آخرت اور اسکی فکر سے متعلق سورہ الحشر کی آیات 18-20



<ul style="list-style-type: none">• Verses of Surah Al-Saff Related to Tafakur, Tadabbur (Verse No-1,14)	<ul style="list-style-type: none">• کائنات میں غور و فکر سے متعلق سورہ الصف کی آیات 1-14
<p>3. Seerat of Holy Prophet (PBUH)</p> <ul style="list-style-type: none">• Life of Holy Prophet (PBUH) in Makkah (After Prophethood) and its Important Events• Life of Holy Prophet (PBUH) in Madinah and its Important Events	<p>3. سیرت طیبہ ﷺ کا مطالعہ</p> <ul style="list-style-type: none">• مکہ مکرمہ میں بعد از نبوت حضور ﷺ کی زندگی اور اہم واقعات• مدینہ منورہ میں حضور ﷺ کی زندگی اور اہم واقعات
<p>4. Introduction to Sunnah</p> <ul style="list-style-type: none">• Basic Concepts of Hadith• History of Hadith• Kinds of Hadith• Legal Position of Sunnah	<p>4. تعارف حدیث و سنت</p> <ul style="list-style-type: none">• سنت و حدیث کا تعارف و اہمیت• تاریخ حدیث• حدیث کی اقسام• سنت کا شرعی مقام
<p>5. Selected Study from Text of Hadith</p> <ul style="list-style-type: none">• عن انس بن مالک رضی اللہ عنہ قال قال رسول اللہ ﷺ: "من خرج في طلب العلم فهو في سبيل الله حتى يرجع".• عن ابي امامة رضی اللہ عنہ قال قال قبیل یارسول اللہ! الررجلان يلتقيان ايهما يبدا بالسلام فقال اولاهما بالله".• عن ابي سعيد الخدري رضی اللہ عنہ قال سمعت رسول اللہ ﷺ يقول: "من رأى منكم منكراً فليغيره بيده فان لم يستطع فبلسانه فان لم يستطع فبقليه و ذالك اضعف الايمان"• عن ابي هريرة رضی اللہ عنہ قال قال رسول اللہ ﷺ: "آية المنافق ثلاث اذا حدث كذب واذا وعد اخلف واذا اتتمن خان"• عن ابي هريرة رضی اللہ عنہ قال قال رسول اللہ ﷺ: "اياكم والحسد فان الحسد يأكل الحسنات كما تأكل النار الحطب".• عن ابي هريرة رضی اللہ عنہ ان رسول اللہ ﷺ قال: "من كان يؤمن بالله واليوم الآخر فليقل خيراً او ليصمت ومن كان يؤمن بالله واليوم الآخر فليكرم ضيفه".• عن عبدالله ابن عمر بن الخطاب رضی اللہ عنہما قال سمعت رسول اللہ ﷺ يقول: بنى الاسلام على خمس شهادة ان لا اله الا الله وان محمدا عبده ورسوله واقام الصلوة وابتاء الزكوة وحج البيت وصوم رمضان• عن ابي هريرة رضی اللہ عنہ ان رسول اللہ ﷺ قال: "من حسن اسلام المرء تركه ما لايعنيه".	<ul style="list-style-type: none">• عن انس بن مالک رضی اللہ عنہ قال قال رسول اللہ ﷺ: "من خرج في طلب العلم فهو في سبيل الله حتى يرجع".• عن ابي امامة رضی اللہ عنہ قال قال قبیل یارسول اللہ! الررجلان يلتقيان ايهما يبدا بالسلام فقال اولاهما بالله".• عن ابي سعيد الخدري رضی اللہ عنہ قال سمعت رسول اللہ ﷺ يقول: "من رأى منكم منكراً فليغيره بيده فان لم يستطع فبلسانه فان لم يستطع فبقليه و ذالك اضعف الايمان"• عن ابي هريرة رضی اللہ عنہ قال قال رسول اللہ ﷺ: "آية المنافق ثلاث اذا حدث كذب واذا وعد اخلف واذا اتتمن خان"• عن ابي هريرة رضی اللہ عنہ قال قال رسول اللہ ﷺ: "اياكم والحسد فان الحسد يأكل الحسنات كما تأكل النار الحطب".• عن ابي هريرة رضی اللہ عنہ ان رسول اللہ ﷺ قال: "من كان يؤمن بالله واليوم الآخر فليقل خيراً او ليصمت ومن كان يؤمن بالله واليوم الآخر فليكرم ضيفه".• عن عبدالله ابن عمر بن الخطاب رضی اللہ عنہما قال سمعت رسول اللہ ﷺ يقول: بنى الاسلام على خمس شهادة ان لا اله الا الله وان محمدا عبده ورسوله واقام الصلوة وابتاء الزكوة وحج البيت وصوم رمضان• عن ابي هريرة رضی اللہ عنہ ان رسول اللہ ﷺ قال: "من حسن اسلام المرء تركه ما لايعنيه".
<p>6. Introduction to Islamic law and jurisprudence</p> <ul style="list-style-type: none">• History and Importance of Islamic Law and Jurisprudence• Sources of Islamic law and jurisprudence• Nature of differences in Islamic law• Islam and sectarianism	<p>6. اسلامی قانون اور فقہ کا تعارف</p> <ul style="list-style-type: none">• اسلامی قانون اور فقہ کی تاریخ اور اہمیت• اسلامی قانون اور فقہ کے ذرائع• اسلامی قانون میں اختلافات کی نوعیت• اسلام اور فرقہ واریت
<p>7. Political System of Islam</p> <ul style="list-style-type: none">• Basic Concepts of Islamic Political System• Islamic Concept of Sovereignty• Basic Institutions of government in Islam	<p>7. اسلام کا سیاسی نظام</p> <ul style="list-style-type: none">• اسلامی سیاسی نظام کے بنیادی تصورات• اسلامی تصور حاکمیت• اسلام میں حکومت کے بنیادی ادارے
<p>8. Social System of Islam</p> <ul style="list-style-type: none">• Basic concepts of social system of Islam• Elements of Family• Ethical Values of Islam	<p>8. اسلام کا معاشرتی نظام</p> <ul style="list-style-type: none">• اسلام کے معاشرتی نظام کے بنیادی تصورات• خاندان کے عناصر• اسلام کی اخلاقی اقدار



Recommended Readings

- Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
- Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001)
- H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989)
- Hameed ullah Muhammad, ‘Introduction to Islam Maulana Muhammad Yousaf Islahi,’
- Hameed ullah Muhammad, “Emergence of Islam” , IRI, Islamabad
- Hameed ullah Muhammad, “Muslim Conduct of State”
- Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” Leaf Publication Islamabad, Pakistan.
- Mir Waliullah, “Muslim Jurisprudence and the Quranic Law of Crimes” Islamic Book Service (1982)

ZOO-117 Ethics

Credit Hours 2(2+0)

Course Outlines

- Defining Ethics; and its relation to Philosophy
- Morality as Compared with other Normative Subjects
- Characteristics of Moral Principle
- The Purposes of Morality
- Cultural Relativism
- Cultural Relativism as a theory of Morality
- Judging a Cultural Practice to be Undesirable
- Ethical Subjectivism
- The First Stage: Emotivism
- Emotivism, Reason and Moral Facts
- The Presumed Connection between Morality and Religion
- The Natural Law Theory
- The Utilitarian Approach: a Revolution in Ethics:
- Mill’s Utilitarianism: a modified version
- Implications of Utilitarianism
- Is Happiness the Only Thing That Matters? Are Consequences All That Matters?
- Defense of Utilitarianism
- Kant and the Categorical Imperative
- Absolute Rules and the Duty Not to Lie
- Kant and the Respect for Person



- Retribution and Utility in the Theory of Punishment
- The Ethics of Virtue and the Ethics of Right Action
- Some Advantages of Virtue Ethics
- Business Ethics
- The Nature of Business Ethics
- The Ethics of Advertising and Green Issues in Business
- Environmental Ethics
- Arguments for and against the Use and Exploitation of the Natural Environment
- Bioethics---Ethical Issues in Medicine
- Confidentiality, Guilt and Innocence in Treating Patients, Euthanasia, Ethics and Behavior Control, Genetics

Recommended Books

1. Rachels, J., & Rachels, S. (2012). The Elements of Moral Philosophy 7e. McGraw Hill. ISBN: 0-07-247690-7
2. Loue, S. (2007). Textbook of research ethics: Theory and practice. Springer Science & Business Media.
3. Hendin, J. (1999). The Right Thing to Do. Feminist Press at CUNY.
4. Pojman, L. P., & Fieser, J. (2016). Cengage advantage ethics: Discovering right and wrong. Cengage Learning.
5. Vaughn, L. (2015). Doing ethics: Moral reasoning and contemporary issues. WW Norton & Company

ZOO – 113 Exploring Quantitative Skills

Cr. Hr. 03(3+0)

COURSE DESCRIPTION



This course aims to develop the basic mathematical skills which ultimately enhance problem solving skills using inductive and deductive reasoning and sets. The basic concepts will be developed with applications from the real world such as algebraic models with equations, rates, ratios, and percentages will be discussed. Students will also explore linear models, including rectangular-coordinates, functions, empowering them to analyze real-world problems with logical precision. By the end of course, students will have practiced problem-solving, logical reasoning, and mathematical modeling abilities to tackle diverse challenges confidently as follows:

- Students will be introduced to the above concepts, and they will be prepared to apply these concepts to analyze and interpret information in different walks of life.
- Students will get familiarized with the importance of quantitative reasoning skills in the modern age.
- This course will improve their ability to deal with scenarios involving numbers related issues in a logical manner.
- It will provide students an opportunity to appreciate the intellectual beauty of quantitative reasoning skills.
- It will prepare students to apply the quantitative reasoning skills in solving quantitative problems which they will experience in their practical lives.

COURSE CONTENTS

Exploring Importance of Quantitative Reasoning Skills

What is quantitative reasoning, Overview of contributions of mathematicians especially Muslim scholars.

Problem Solving Techniques

Understanding relationship between parts and whole, Practical life scenarios involving units and rate, Unit analysis as a problem-solving tool, Inductive and deductive reasoning, Problem solving strategies.

Numbers & the Universe

Understanding our World through numbers, Dealing with very big and small numbers & their applications, Understanding uncertainty and its applications, Introduction to number systems and different types of standard numbers and their role in practical life scenarios, square roots, cube roots, highest common factors, lowest common multiples, visualizing fractions, decimals, systems of measurements, an overview of contributions of mathematicians, unit analysis as a problem-solving tool.

Financial Issues

Money management (profit, loss, discount, taxation, and other scenarios involving percentage), money management in practical life scenarios like investments and federal budget, simple and compound interest, Saving plans and economy, percentage, profit,



loss, discount, taxation, and other scenarios involving percentage, simple and compound interest with applications.

Exploring Expressions

Practical scenarios involving expressions, equating two expressions in one variable & using it to solve practical problems, linear equations, quadratic equations and their applications in social and economic problems.

Exploring Beauty in Architecture & Landscape

Introduce geometrical objects through architecture and landscape, dealing with social and economic issues involving geometrical objects, fundamentals of geometry, applications of Pythagorean theorem, introduction to unit circles, trigonometric functions and inverse trigonometric functions, problem solving with geometry.

Venn Diagrams

Venn diagrams and their applications

TEACHER MANUAL

[Quantitative Reasoning Courses\Quantitative Reasoning Teacher Manual - Sept 2021 - HEC.pdf](#)

RECOMMENDED RESOURCES

1. R. N. Aufmann, I. S. Lockwood, R. D. Natio and D. K. Clegg, Mathematical Thinking and Quantitative Reasoning (2008), Houghton Mifflin Company (New York).
2. Bennett, I. & Briggs, W. (2015). Using and understanding mathematics (6th Edition). Pearson Education, Limited.
3. Blitzer, R. (2014). Precalculus. (5th Edition). Pearson Education, Limited.
4. Using and understanding mathematics, 6th edition by Jeffrey Bennet and William Briggs, published by Pearson USA.
5. Mathematical thinking and reasoning 2008 by Aufmann, Lockwood, Nation & Clegg published by Houghton Mifflin Company USA.
6. Precalculus by Robert Blitzer 5th edition published by Pearson USA.
7. Precalculus Graphical, Numerical, Algebraic 8th edition by Franklin D. Demana, Bert K. Waits, Gregory D. Foley & Daniel Kennedy published by Addison Wesley USA.
8. Precalculus Mathematics for Calculus, 6th edition by James Stewart, Lothar Redlin and Saleem Watson published by Brooks/Cole Cengage Learning USA.
9. GRE Math Review https://www.ets.org/s/gre/pdf/gre_math_review.pdf
OpenAlgebra.com
10. A free math study guide with notes and YouTube video tutorials.

ZOO-114 Diversity of Plants

Credit Hours 3(2+1)



Course Contents

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

Viruses (RNA and DNA types) with special reference to TMV

Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with specific reference to biofertilizers, pathogenicity and industrial importance

Algae (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)

Fungi (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications.

Lichens (Physcia)

Bryophytes

Riccia

Anthoceros

Funaria

Pteridophytes.

Fossils and fossilization, Psilopsida (Psilotum), Lycopsida (Selaginella), Sphenopsida (Equisetum), Pteropsida (Marsilea) Seed Habit

Gymnosperms:

Cycas, Pinus, Ephedra

Practicals:

Culturing, maintenance, preservation and staining of microorganisms. Study of morphology and reproductive structures of the types mentioned in theory.

Identification of various types mentioned from prepared slides and fresh collections.

ZOO-115 Organic Chemistry

Credit Hours 3(2+1)

Basic Concepts of Organic Chemistry:

Bonding and hybridization, localized and delocalized bonding, structure aromaticity, inductive effect, dipole moment, resonance and its rules, hyperconjugation, classification and nomenclature of organic compounds including IUPAC system, types of organic reactions (an overview).



Chemistry of Hydrocarbons: Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and electrophilic substitution reactions.

Chemistry of Functional Groups: Hydroxyl, ether and amino groups, preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications, carbonyl compounds, preparations and reaction mechanism of aldehydes and ketones and their applications, carboxylic acids and their derivatives, acidity of carboxylic acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydrides.

Practical:

Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization, and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride,

succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

ZOO-116 Animal Diversity-I (Invertebrates)

Credit Hours 4(3+1)

Course Contents:

Note: The minimum details of the titles in the content must be of the principal book Zoology by Miller and Harley. This must be kept in view in teaching and assessments.

1. INTRODUCTION

a. Classification of Organisms:

ANIMAL-LIKE PROTISTS: THE PROTOZOA

a. General Characteristics.

b. Classification up to class

c. Symbiotic Lifestyles

d. Locomotion in protozoa

e. Nutrition and Reproduction.

f. Economic importance of protozoa

e. General Characteristics of Paramecium

MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION Phylum Porifera

a. Characteristics and classification. Cell Types, Body Wall, and Skeletons;



- b. types of canal system;
- c. Reproduction.

**Phylum Cnidaria
(Coelenterate)**

- a. General Characteristics.
- b. Classification up to Class.
- c. The body Wall and Nematocysts
- d. Reproduction: Alteration of generations.
- e. Corals and coral reefs

Phylum Ctenophore;

- a. General Characteristics, body organization

**THE TRIPLOBLASTIC ORGANIZATION PHYLUM
PLATYHELMINTHES(ACOELOMATE)**

- a. General Characteristics.
- b. Classification up to class
- c. The Free-Living Flatworms and the Tapeworms, parasitic adaptations in platyhelminths

Phylum Nemertea.

- a. General Characteristics

Phylum Gastrotrichea;

- a. General Characteristics

PHYLUM ASCHELMINTHS (PSEUDOCOELOMATE)

- a. General Characteristics
- b. Classification up to class
- c. Type: *Ascaris lumbricoides*
- d. Characteristics of Phylum Rotifera and Phylum Kinorhyncha.
- e. Economic importance of Nematodes

COELOMATIC ORGANIZATION PHYLUM ANNELIDA

- a. General Characteristics
- b. Metamerism and Tagmatization,
- c. Classification up to Class.
- d. Locomotion, Feeding and the Digestive system, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Reproduction; Regeneration, Development, in Polychaeta, Oligochaeta and Hirudinea.

PHYLUM MOLLUSCA

- a. General Characteristics



- b. Classification up to class.
- c. Shell, Feeding, Digestion, Gas Exchange, Locomotion, d. Reproduction and Development of Gastropods, bivalves, and cephalopods
- d. Economic importance

PHYLUM ARTHROPODA

- a. General Characteristics
- b. Classification up to class.
- c. The Exoskeleton; Metamerism and Tagmatization
- d. Nutrition and digestive system
- e. Reproduction: Development, Metamorphosis; in class insecta, crustaceans and Arachnida
- f. Economic importance of crustaceans and insects.

PHYLUM ECHINODERMS

- a. General Characteristics
- b. Classification up to class.
- c. Maintenance Functions, Reproduction; Regeneration, Larval forms and phylogeny of class Asteroidea

Practical:

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

Study of Euglena, Amoeba, Entameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.

Study of prepared slides of sponges, spicules of sponges, and their various body forms. Study of representatives of classes of Phylum Porifera

Study of principal representatives of classes of Phylum Coelenterate.

Study of principal representatives of classes of Phylum Platyhelminthes.

Study of representatives of phylum Rotifer, Phylum Nematode.

Study of principal representatives of classes of Phylum Mollusca.

Study of principal representatives of classes of Phylum Annelida.

Study of principal representatives of classes of groups of Phylum Arthropoda

Study of representatives of classes of phylum Echinodermata.

Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.

Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.

How to make grade-wise series for preparation of temporary and permanent slides.

Recommended Principal Reference Book:



- Miller, A.S. and Harley, J.B. ; 1999 , 2002., 2007, 2009, 2012 & 2016 Zoology, 4th, 5th, 6th,7th, 8th, 9th & 10th Edition (International), Singapore : McGraw Hill. Additional Readings:
- Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
- Hickman, C.P., Roberts, L.C/, AND Larson, A., 2007. INTEGRATED PRINCIPLES OF ZOOLOGY, 12th & 13th Edition (International). Singapore: McGraw-Hill.
- Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition, (International), Singapore: McGraw-Hill.
- Kent, G. C. and Miller, S., 2001. COMPARATIVE ANATOMY OF VERTEBRATES New York: McGraw-Hill.
- Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin ummings Publishing Company, Inc.

BOOKS FOR PRACTICAL

Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition International), Singapore: McGraw-Hill.

Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore: McGraw-Hill.

SEMESTER II

2 nd Semester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-121	GE	Introduction to Expository Writing	3(3+0)
ZOO-122	GE	Ideology and Constitution of Pakistan	2(2+0)
ZOO-123	AC	Plant Systematics, Anatomy, Development and Embryology	3(2+1)
ZOO-124	AC	Inorganic Chemistry	3(2+1)
ZOO-125	Major	Animal Diversity-II (Chordates)	4(3+1)
ZOO-126	Major	Biostatistics	3(2+1)
Total Credit Hours			18(14+4)

ZOO-121: Introduction to Expository Writing

Cr. Hr. 3 (3+0)

COURSE DESCRIPTION

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 PBL (Project-based Learning) approach. Unit themes target the development of 21st century skills and focus on self-reflection and active community engagement. Course activities include lectures, group, pair and individual activities, as well as a series of required assignments, including reading and writing across various genres.



Finally, the course prepares students for taking the next course in the sequence, 'Expository Writing II: Cross-cultural Communication and Translation Skills'.

COURSE OBJECTIVES

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

1. Analyze basic communication skills and use them effectively in oral and written English
2. Develop skills as reflective and self-directed learners
3. Critically evaluate and review various types of texts and summarize them
4. Develop analytical and problem-solving skills to address various community-specific challenges
5. Intellectually engage with different stages of the writing process, such as: brainstorming, mind mapping, free writing, drafting and revision, etc.

LEARNING OUTCOMES

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

1. Write, edit and proofread a short essay in English language
2. Present ideas to the whole class in team presentations using English that is comprehensible and engaging.
3. Critically analyze a text written in English using SQW3R strategies
4. Conduct small-scale research about their communities
5. Draft a letter to editor.

COURSE CONTENTS

Unit 1: Expository Writing

- Introduction
- Types
- Usage

Unit 2: Self Reflection

- Introduction to the basics of the writing process
- Introduction to the steps of essay writing
- Students practice prewriting activities like brainstorming, listing, clustering and freewriting
- Students practice outlining of the essay

Unit 3: Personalized Learning

- Students reflect on their learning process
- Group discussion about learning styles based on the reading material provided to students
- Introduction to personalized learning
- Students practice goal setting
- And create a learning plan
- Introduction to the structure and significance of oral presentations
- Class discussion about content selection and slide preparation for oral presentations
- Peer review through a gallery walk



Unit 4: Critical Reading Skills

- Introduce authentic reading (DAWN newspaper and non-specialist academic books/texts)
- Conduct classroom reading activities (using strategies skimming, scanning, SQW3R, previewing, annotating, detailed reading and note-taking) using standard tests (TOEFL and IELTS) Assign books/articles/reports for their individual home assignments.
- Share model review reports and annotated bibliographies

Unit 5: Community Engagement

- Showing short documentaries to students on global environmental issues
- Student-led brainstorming on local versus global issues
- Teacher-led introduction to the unit assignment (using assignment sheet)
- Readings (or other input sources - video, social media) from local news on possible community issues, letters to editor and op-eds
- Identify research problems
- Begin drafting research questions based on the problems identified
- Facilitating students on developing research questions in groups
- Draft interview or survey questions for community research (in English or L1)
- In-class role-plays of interviews with community members
- Engaging students in critical reading and reflection on the issues found in different communities
- In-class work on understanding interview information, how to present interview or survey information
- Refining the research questions, designing a detailed research plan in groups, dividing the tasks and deciding the timeline for the completion of the project
- Exposure to interview questions and interviewing techniques to develop an in-depth understanding of the issues
- Continued group work on report outline
- In-class lecture and group work on analyzing information
- Discussion based on translating the data from the source language to the target language (English)
- Sharing the experience of field work in class orally
- Teacher feedback on outline of report (globally to entire class and individually to groups as needed)
- Revisions to oral report in groups Engaging students in individual structured reflective writing based on their experience of working on the project
- Sharing their reflective writing to learn about each other's points of view
- Think-pair-share the findings (group similar issues)
- Individual writing of reflection on the community engagement project and their role in the group
- Brainstorm using creativity for dissemination - cartoons, advertisements for university magazine or beyond, creating posts for FB



- Summarizing/ converting the report to a letter to the editor to highlight the problems explored and their possible solutions (homework - connecting activity for week 11 - Unit 5)

Unit 6: Letter to the Editor

- Teacher-directed instruction on genres (types) of writing focusing on letter-writing
- Model-practice-reflect: Introduce types of letters comparing the use of formal and informal vocabulary and phrases in each type
- Introduce the format and purpose of the letter-to-editor explaining with the help of an actual letter from a local newspaper
- Group reading of sample letters-to-editor selecting ones that deal with issues familiar to the students
- Invite a guest lecturer (local newspaper editor or faculty from journalism) to talk about what issues are currently raised in letters-to-editors and what are editors' criteria to accept letters for publication
- Work in groups to continue reviewing letter samples, analyzing the structure of letters
- Each group identifies an issue they want to write about and give a brief oral presentation to the class
- Submit the first draft of letters (to the teacher and peer-review group)
- In-class peer review of drafts using a checklist focusing on content and structure DUE:
- First draft of letter (to teacher and peer review group)
- Groups revise first draft of letter
- Differentiate among revision, proofreading and evaluation (as substages of finalizing documents)
- Discuss critically the draft-letter and implement the 'revision' phase of writing Reading of (DAWN) newspaper and sharing important letters (to editors) on local issues
- Groups revise second draft of letter Explicit instruction (paragraph structure, syntax, diction, grammar, and mechanics)
- Classroom discussion/debrief of activity Discuss critically and finalize the draft-letter as the last phase of writing

Teacher Manual & Suggested Reading

[Expository Writing Course Outline - Sept 2021 - HEC.pdf](#)

[Detailed Courses - Expository Writing - Sept 2021 - HEC.pdf](#)

[Expository Writing Teachers Manual - Sept 2021 - HEC.pdf](#)

ZOO-122: Ideology and Constitution of Pakistan

Cr. Hr. 02 (2+0)

Course Introduction

Pakistan studies is an important course at this university in which students' study about their motherland. The following are the specific objectives of the course.



- To develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

Introduction to Ideology

Defining the Term Ideology, Role of Ideas, Contours of Ideology, Ideology, Truth and Power

Types of Ideologies, Left, Right and Center Debate, Old and New Ideologies, Views about Ideologies

Ideology of Pakistan

Aims and Objects of Pakistan's Formation

Ideology of Pakistan – its Importance

Basics of Pakistan's Ideology

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Iqbal's and M. A. Jinnah's Notions on Ideology of Pakistan

Constitution, Government and Politics

Definitions, Features, and Functions

Constitutional Development in Pakistan 1947-1973: Constitution of 1956, 1962

Salient Features of Constitution of Pakistan 1973

Fundamental Rights in Constitution of Pakistan 1973

Martial Law 1977-88,

Civilian Rule 1988-99

Martial Law 1999 Onward

Pakistan – Land and Peoples

Geography and its Importance

Natural resources and Their use

Agriculture and Industry

Population, Manpower, and Education



Contemporary Pakistan

Economic Institutions and Issues

Society and Social Structure

Foreign Policy of Pakistan and Challenges

Reference Materials:

- 1) The Emergence of Pakistan, Chaudary M., 1967
- 2) The making of Pakistan, Aziz. 1976
- 3) A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
- 4) Perspectives on Contemporary Pakistan Governance, Development and Environment Edited By Ghulam Ali, Ejaz Hussain, 2020
- 5) Any other standard and latest books covering the subject.

ZOO-123 Plant Systematics, Anatomy Development / Embryology

Credit Hours 3(2+1)

a) Plant Systematics

Introduction to Plant Systematics: aims, objectives and importance.

Classification: brief history of various systems of classification with emphasis on Takhtajan.

Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN). Vienna code.

Morphology: a detailed account of various morphological characters root, stem, leaf, inflorescence, flower, placentation and fruit types.

Diagnostic characters, economic importance and distribution pattern of the following families:

- i. Ranunculaceae
- ii. Brassicaceae (Cruciferae)
- iii. Fabaceae (Leguminosae)
- iv. Rosaceae
- v. Euphorbiaceae
- vi Cucurbitaceae
- vii. Lamiaceae (Labiatae)
- viii. Apiaceae (Umbelliferae)
- ix. Asteraceae (Compositae)
- x. Liliaceae (Sen. Lato)



b) Anatomy

Cell wall: structure and chemical composition

Concept, structure and function of various tissues like:

- i. Parenchyma
- ii. Collenchyma
- iii. Sclerenchyma
- iv. Phloem Epidermis (including stomata and trichomes)
- v. Xylem

Meristem: types, stem and root apices

Vascular cambium

Structure and development of root, stem and leaf. Primary and secondary growth of dicot stem, periderm

Characteristics of wood: diffuse porous and ring porous, sap and heart wood, soft and hard wood, annual rings.

c) Development/Embryology

Early development of plant body:

Capsella bursa-pastoris

Structure and development of Anther Microsporogenesis, Microgametophyte

Structure of Ovule Megasporogenesis Megagametophyte

Endosperm formation

Parthenocarpy

Polyembryony

Lab Outline:

Plant Systematics

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

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

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

Students shall submit 40 fully identified herbarium specimens.

Anatomy and Embryology

Study of stomata and epidermis.



Tissues of the primary body of the plant.

Study of xylem 3-dimensional plane of wood.

T. S of angiosperm stem and leaf.

Anatomy of germinating seeds

Study of pollens

ZOO -124 Inorganic Chemistry)

Credit Hours 3 (2+1)

Course Contents:

Chemical Bonding: Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion (VSEPR) model, molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding.

Acids and Bases: Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB), concept of relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions, theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

p-Block Elements: Physical and chemical properties of p-block elements with emphasis on some representative compounds, inter-halogens, pseudo-halogens and polyhalides.

Practical:

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD), disposal of chemical waste and first-aid practices, qualitative analysis of salt mixtures, quantitative analysis, acid- base titrations, preparation and standardization of acid and alkali solutions, redox titrations, preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample, gravimetric analysis, determination of barium in a given sample, determination of chloride in a given solution.

ZOO- 125 Animal Diversity-II (Chordates)

Credit Hours 4(3+1)

Course outline:

1. Protochordates

- Classification of protochordates
- Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates



c. Reproduction; life histories and metamorphosis of protochordates.

2. Fishes:

a. Vertebrate Success in Water.

b. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli

c. General adaptations for locomotion, feeding and nutrition, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development.

3. Amphibians:

a. The first terrestrial vertebrates.

b. Characteristics of amphibians

c. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura. d. Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion

e. Osmoregulation, reproduction, development and metamorphosis of caudate, anura and Gymnophiona.

4. Reptiles:

a. The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.

b. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodylia

c. 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.

5. Birds:

a. Classification, Feathers, flight and endothermy.

b. Phylogenetic relationships; ancient birds and the evolution of flight.

c. Diversity of modern birds.

d. 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.

6. Mammals:

a. Diversity and Classification, Characteristics of mammals: specialized teeth, endothermy, hair and vivi parity.

c. 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.



Practicals:

Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.

Visit PMNH for the study of the diversity of chordates.

Text and Reference Books:

- Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
- Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
- Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
- Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.

Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill

ZOO-126 Biostatistics

Credit Hours: 3(2-1)

COURSE OBJECTIVES:

This course helps students to understand the basic concepts of statistics, its nature, scope, and importance with special focus as a field of knowledge and its use relevance to biological or chemical, or social sciences. This course will equip and prepare students to evaluate and interpret basic descriptive and inferential statistics, and the design of research and data analysis in any field of scientific investigation.

COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will:

Gain a strong foundation in basic statistical and probabilistic concepts which extends to critical thinking, problem-solving, and data analysis skills. This course will equip students with essential skills and knowledge that can be applied across diverse academic and professional domains, enhancing student's problem-solving abilities, data analysis skills and analytical thinking.

Topics	Students Learning Outcomes



1. Introduction to Statistics and Statistical Thinking	1.1. Define statistics, the science of statistics and its importance, application of statistics in economics or management sciences. 1.2. Role of statistics in critical thinking and ethics 1.3. Fundamental elements of statistics 1.4. Basic terminologies in statistics 1.5. Branches of statistics (descriptive & inferential statistics). 1.6. Define data, types of data/variables, sources of data. 1.7. Measurement scales (nominal, ordinal, interval, ratio) 1.8. Exercises
2. Data Representation	2.1. Introduction to data representation 2.2. Basic principles of classification and tabulation 2.3. Construction of frequency distribution (discrete & continuous) 2.4. Diagrams, graphs, and their construction (Bar charts, Pie chart, Histogram, Frequency polygon & Frequency curve, Box and Whisker plot, Stem and Leaf plot) 2.5. Exercises
3. Numerical Descriptive Measures	3.1. Define measures of central tendency 3.2. Different types of averages (A.M, H.M, G.M etc.) 3.3. Other measures of central tendency (Median and Mode) 3.4. Relative merits and demerits of averages 3.5. Measures of skewness and kurtosis 3.6. Shape of distributions 3.7. Define measures of dispersion 3.8. Absolute & relative measure of dispersion 3.9. Different types of absolute dispersion (Range, Variance, Standard Deviation, Inter-quartile Range) 3.10. Relative dispersion (Coefficient of variation) 3.11. Exercises



4. Introduction to Sampling Theory	<p>4.1. Define sample, sampling, sample design, and sample frame.</p> <p>4.2. Sampling with and without replacement</p> <p>4.3. Types of error in sampling</p> <p>4.4. Random sampling (simple, stratified, cluster, systematic, & multistage sampling)</p> <p>4.5. Non-random sampling (convenience, purposive, quota, & snow-ball sampling)</p> <p>4.6. Exercises</p>
5. Introduction to Probability	<p>5.1. Define probability, probability definitions (classical/priori, relative/posteriori, axiomatic)</p> <p>5.2. Basic terminologies (sample space, sample points, events, mutually & not mutually exclusive events, exhaustive events)</p> <p>5.3. Define set theory, set operations and their application in probability.</p> <p>5.4. Rules of probability (additive, multiplicative and law of complement)</p> <p>5.5. Exercises</p>
6. Introduction to Hypothesis Testing	<p>6.1. Define hypothesis testing & estimation.</p> <p>6.2. Types of hypotheses (null & alternative/research hypothesis)</p> <p>6.3. Errors in decision making (Type I and Type II)</p> <p>6.4. Test statistic</p> <p>6.5. Critical value, rejection/acceptance region</p> <p>6.6. General pr</p>
7. Hypothesis Testing-Single Population	<p>7.1. Z distribution, one sample Z test</p> <p>7.2. Degree of freedom</p> <p>7.3. T distribution, one sample T test</p> <p>7.4. Chi-square distribution, Chi-square test of association</p> <p>7.5. Exercises</p>
8. Design of Experiments (For Botany students only)	<p>8.1. Define concept and design of experiments.</p> <p>8.2. Principles of experiment</p> <p>8.3. Planning of experiment</p> <p>8.4. Replication and Randomization</p>



	<p>8.5. Field plot technique 8.6. Layout and analysis of CRD</p>
<p>9. Hands-on Statistical Packages</p>	<p>9.1. Introduction to SPSS, defining variables, data punching/entry. 9.2. Hands-on SPSS (data analysis and visualization).</p>

RECOMMENDED BOOKS:

1. Zar, J. H., (2013). *Biostatistical Analysis*. Dorling Kindersley Publication.
2. Mann, P. S., (2010). *Introductory Statistics*. Wiley Publisher.
3. Quinn, G., Keough, P., (2011). *Experimental Design and Data Analysis for Biologists*. Cambridge University Press.
4. Pagano, M., Gauvreau, K., (2000). *Principles of Biostatistics*.
5. Walpole, R. E. (1982). *Introduction to Statistics*, 3rd Ed., Macmillan Publishing Co., Inc. New York.
6. Field A. (2013). *Discovering Statistics with IBM SPSS Statistics*. 4th Edition. SAGE Publication Ltd.
7. Sher Muhammad Chaudhry (2009). *Introduction to Statistical Theory, Part I & II*.

SEMESTER-III

3 rd Semester (17 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-231	GE	Entrepreneurship	2(2+0)
ZOO-232	GE	Information and Communication Technologies	3(2+1)
ZOO-233	AC	Plant Physiology & Ecology	3(2+1)
ZOO-234	AC	Environmental Chemistry	3(3+0)
ZOO-236	Major	Animal Form & Function-I	4(3+1)
Any one from the Following			
ZOO-235	GE	Principles of Sociology	2(2+0)
ZOO-237	GE	Social Anthropology	2(2+0)
Total Credit Hours			17(14+3)



ZOO-231 Entrepreneurship

Credit Hours: 2 (2-0)

Course Description

This course is designed for the students to understand that Starting & operating a new business which involves considerable risk & an effort to overcome the inertia against something new. In creating and growing a new venture, the entrepreneur assumes the responsibility and risks for its development & survival and enjoys the corresponding rewards. In the end the students will be able to develop business plans to start and initiate their own ventures.

Defining Entrepreneurship: Creation economic organization, dimensions of entrepreneurship.

The Macro Environment for Entrepreneurship: process of environmental analysis, sources of opportunities, industry and market structure.

The Competitive Environment: the perfect competition model, industry analysis, buyer power, supplier power, the threats of substitutes, entry barriers, rivalry between firms, competitor's analysis.

The International Environment: the macro environment of international entrepreneurship, international entrepreneurial strategies, international organization behavior.

Business Plan and Entrepreneurial Strategy: entry wedges, resource based strategies, strategy and industrial environment.

Marketing New Ventures: the marketing of entrepreneurship interface, marketing concepts and orientation, marketing strategy and sales forecasting.

Element of New Ventures: creating the organization

SME Definition: Importance of SME, SME in Pakistan.

Best Quality Management Practice in SME: customer relation management in SME.

Strategies of success of SME: The Business plan. Case study, Practical plan and Implementation

RECOMMENDED BOOKS

1. SMALL BUSINESS MANAGEMENT A CASE STUDY APPROACH, Devid Stokes, Latest Edition.
2. Mare J.Dollinger Entrepreneurship: Strategies and Resources. Austen Press.

ZOO – 232: Information and Communication Technologies

Cr. Hr. 03(2+1)



Course Description

Information technology literacy has become a fundamental requirement for any major. An understanding of the principles underlying digital devices, computer hardware, software, telecommunications, networking, and multimedia is an integral part of any IT curriculum. This course provides a sound foundation on the basic theoretical and practical principles behind these technologies and discusses up to date issues surrounding them including social aspects and how they impact everyday life.

Course Objectives

- Understand the fundamentals of information technology
- Learn core concepts of computing and modern systems
- Understand modern software programs and packages
- Learn about upcoming IT technologies

Week 01: Basic of Computers

- Introduction and history of computers
- Types of computers (analog, digital, hybrid)
- Block diagram of Computer System.

Week 02, 03: Parts of the Computer System

- Hardware (Essential Computer Hardware (Processor, Memory, Input Devices, Output Devices & Storage devices)
- Memory and types
- Primary/Internal memory (RAM & ROM)
- Units of Computer Memory (Bit, Byte, KB, MB, GB, TB)
- Secondary Storage
- Input Devices & Output device

Week 04, 05: Software

- System software
- Application software
- General purpose and Special purpose Software

Week 06: Data Communication and Data Communication System (DCS)

- Components of DCS (Sender, Receiver, medium, Message & Protocol)

Week 07: The Internet & Internet Services

- Electronic mail
- Chat, Online Services



- Web Browsers, URL, Web Searching/ Browsing, Search Engine

Week 08, 09: Operating Systems

- Introduction to Windows 10 & Installation
- Working with the Windows 10 Desktop

Week 10,11,12: Microsoft Word

- Creating and Modifying a Flyer
- Creating CV and Resume
- Creating a Research Paper

Week 13: Microsoft PowerPoint

- Creating and Editing Presentations with Pictures
- Enhancing Presentations with Shapes and SmartArt

Week 14, 15: Microsoft Excel

- Creating a Worksheet and a Chart
- Formulas, Functions, and Formatting

Week 16: Use of computer in daily life

- Computer as a teacher
- Online education (Example: Virtual University of Pakistan)

ZOO -233 Plant Physiology & Ecology

Credit Hours 3(2+1)

Course Outline

Physiology

Water relations: Water potential, Absorption of water Diffusion, Osmosis, osmotic potential, Stomata regulation

Mineral nutrition: Soil as a source of minerals. Essential mineral elements and their role plant metabolism. Deficiency symptoms of macronutrient

Photosynthesis: Introduction, Mechanism of photosynthesis; Differences between C3 and C4 plants, Factors affecting the process of photosynthesis

Growth: Definition; role of auxins, gibberellins, cytokinin, abscisic acid and ethylene in controlling growth. Introduction to plant tissue culture

Photoperiodism: Definition, Classification of plants based on photoperiod Dormancy: Definition and causes of seed and bud dormancy

Plant Movements: Classification of plant movements

Ecology



1. Introduction, aims, and applications of ecology.
2. Soil: Physical and Chemical properties of soil (soil formation, texture, pH, EC, organism, and organic matter, etc) and their relationships to plants.
3. Light and Temperature. Quality of light, diurnal and seasonal variations. Eco-physiological responses.
4. Water: Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on the distribution of plants.
5. Wind: Wind as an ecological factor and its importance.
6. Population Ecology: Introduction. A brief description of seed dispersal and seed bank.
7. Community Ecology: Ecological characteristics of plant community, Methods of sampling vegetation (Quadrat and line intercept), Major vegetation types of the local area.
8. Applied Ecology: Causes, effects and control of water logging and salinity with respect to Pakistan

Practical Physiology Section

Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization

Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations

Measurement of leaf water potential by the dye method

Determination of the temperature at which beetroot cells lose their permeability

Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a porometer/by cobalt chloride paper method

Chemical tests for the Starch, Cellulose, Lignin and Proteins

Extraction of amylase from germinating wheat seeds and study of its effect on starch breakdown

Measurement of carbon dioxide evolution during respiration of germinating seeds by the titration method

Measurement of light and temperature. Effect of light and temperature on seed germination

Practical Ecology Section

1. Determination of physical and chemical characteristics of soil.
2. Measurements of various population variables
3. Measurement of vegetation by Quadrat and line intercept methods.
4. Field trips to ecologically diverse habitats.



5. Measurements of wind velocity.

6. Measurement of light and temperature.

Books Recommended

- Hopkins, W.B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York
- Ihsan Illahi (1995). Plant Physiology, Biochemical Processes in Plants, UGC Press
- Salisbury F.B. and Ross C.B. 1992. Plant physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA
- Lambers. H, Chapin.F.S, Pons.T.L. Plant Physiological Ecology.2008.
- Odum, E. P. 1994. FUNDAMENTALS OF ECOLOGY. 3rd Edition W.B. Saunders. Philadelphia
- Molles, M.C. 2005 Ecology: CONCEPTS AND APPLICATIONS. 6th Edition, McGraw Hill, New York, USA
- Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E. and Turner, M.G., 1998. ECOLOGY. Oxford Univ. Press, UK
- Slings by, D. And Cook, C., 1986. Practical Ecology. Mcmillan Education Ltd. UK
- Chapman, J.L. And Reiss, M.J.1997. Ecology: Principles and Applications. Cambridge Univ. Press, UkSmith, R.L. 1980.
- Ecology and Field Biology, Harper and Row Newman, I. 1993. Applied ecology. Black well scientific publications oxford. UK
- Coxes, C.B and Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6th Edition. Life Sciences King's College, London, UK
- Molles .M. C. Ecology: Concepts and Applications, 4th Edition.2006. McGraw-Hill
- Lambers. H, Chapin. F. S, Pons. T.L. Plant Physiological Ecology.2008. Springer
- Valk. A. V. Herbaceous Plant Ecology: Recent Advances in Plant Ecology.2009. Springer

ZOO -234 Environmental Chemistry

Credit Hours 3 (3+0)

Course Contents:

Atmospheric Pollution:

The atmosphere, composition, temperature and pressure profile, role of free radicals in the atmosphere, temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone–the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Radiation ecology:

Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws).



Water Pollution:

Water pollution and wastewater treatment, municipal, industrial and agricultural sources of pollution, heavy metals contamination of water, eutrophication, detergents and phosphates in water, water quality criteria, water purification: primary, secondary and advanced treatment, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Land pollution:

Soil and mineral resources, general principles of metal extraction, heavy metals contamination of soil, toxicity of heavy metals, bioaccumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Chemistry:

Atom economy, integrated pest management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water-based paints.

Recommended Books:

- Baird, C. and Cann, M., *Environmental Chemistry*, 5th ed., W. H. Freeman & Company, (2012).
- Dara, S. S. and Mihsra, D. D., *A Text Book of Environmental Chemistry and Pollution Control*, 9th ed., S. Chand & Co. Ltd., (2004).
- **Singhi**, R. and Singh, V., *Green Chemistry for Environmental Remediation*, John-Wiley & Sons, Inc., (2011).
- Holloway, A. M. and Wayne, R. P., *Atmospheric Chemistry*, 1st ed., Royal Society of Chemistry, (2010).
- Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. *Water Treatment Technologies for Removal of High Toxicity Pollutants*, Springerlink, UK, (2010).
- Manahan, S. E., *Environmental Chemistry*, 9th ed., CRC press, Taylor & Francis group, USA, (2009).
- Girard, J. E., *Principles of Environmental Chemistry*, 2nd ed., Jones and Bartlett publishers, (2010).
- Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. and Hulsal, C., *Principles of Environmental Chemistry*, 1st ed., Royal Society of Chemistry, (2007).
- Matalack, A., *Introduction to Green Chemistry*, 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
- Wright, J., *Environmental Chemistry*, Routledge, (2003).
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ZOO-236 Animal Form and Function-I

Credit Hours 4(3+1)

Course Outline:

1. Communication I:



Nerves: Neurons: structure and function. Ionic distribution across the membrane. Resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Ion channels. Action potentials in neurons; Electrical and chemical synaptic transmission

2. Communication II:

a. **Senses: Sensory reception:** baroreceptors, chemoreceptors, georeceptors, hygrometers, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates

b. **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

3. Communication III:

a. **The Endocrine System and Chemical Messengers:** Chemical messengers: hormones chemistry; and their feedback systems; Mechanisms of hormone actions, hormone receptors, signal transduction and hormonal coordination.

b. **Hormones** with principal function each of porifera, cnidarians, platyhelminthes, nemertean, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

4. Circulation and Immunity:

a. Internal transport and circulatory systems in invertebrates

b. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells

5. 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

Practicals:

1. Study and notes of skeleton of Labeo (Labeorohita), Frog (Hoplobatrachustigerinus), Varanus (Varanus bengalensis), fowl (Gallus gallusdomesticus) and rabbit (Oryctolagus cuniculus).

2. Earthworm or leech; cockroach, freshwater mussel, Channa or Catlacatla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.

3. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

Books Recommended:

- Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.



- Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
- Miller, S.A. and Harley, J.B. 2002. Zoology, 5th Ed (International), Singapore: McGraw-Hill.
- Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing
- Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.
- Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill.

ZOO-235 Principles of Sociology

Credit Hours 2(2-0)

Course Objectives:

The course is designed to introduce the students with sociological concepts and the discipline. The focus of the course shall be on significant concepts like social systems and structures, socio-economic changes and social processes. The course will provide due foundation for further studies in the field of sociology.

Course Outline:

1. Introduction

- Historical back ground of Sociology
- Definition, Scope, and Subject Matter
- Sociology as a Science
- Relationship of Sociology with other Social Sciences

2. Community, Society, Associations and Organizations

- Community Introduction, Definition, Elements and Types
- Society, Definition, Types
- Difference between Society and community

2.1. Associations, Meaning and definition

- Non-Voluntary
- Voluntary

2.2 Organization

- Informal
- Formal

3. Social Interaction

- Levels of Social Interaction
- Process of Social Interaction
- Cooperation



- Competition
- Conflict
- Accommodation
- Acculturation and diffusion
- Assimilation
- Amalgamation

4. Social Groups

- Definition & Functions
- Classification of social groups
 - In-groups and out- groups
 - Primary and Secondary group
 - Reference groups
 - Informal and Formal groups
 - Pressure groups
 - Importance of Group Life

5. Culture

- Definition, aspects and characteristics of Culture
- Material and non-material culture
- Ideal and real culture

4.1. Elements of culture

- Beliefs
- Values
- Norms and social sanctions

6. Socialization & Personality

- Role and status
- Socialization, definitions, and types of socialization
- Agencies of socialization

Suggested Readings:

1. Giddens, A. (2002). *Introduction to Sociology*. UK: Polity Press.
2. Henslin, J. M. (2004). *Sociology: A Down to Earth Approach*. Toronto: Allen and Bacon.
3. Kerbo, H. R. (1989). *Sociology: Social Structure and Social Conflict*. New York: Macmillan Publishing Company.
4. Tischler, H. L. (2002). *Introduction to Sociology* (7th ed.) New York: The Harcourt Press.
5. Horton Paul B. and Hunt, Chester (1990), *Sociology* Singapore: McGraw Hill company
6. Macions, J.J. (2015). *Sociology* (16th Ed.)
7. *Sociology – 1,2* by Allama Iqbal open university, Islamabad
8. Taga, Abdul Hameed (2000) *An Introduction to Sociology*, Lahore



ZOO-236 Social Anthropology

Credit Hours 2(2-0)

Objective:

The course aims to introduce the pertinent concepts and theories about evolution of humans and culture. The course will dilate branches of anthropology including physical anthropology, archaeology, socio-cultural anthropology, and linguistic anthropology.

Course Outline

1. Introduction
 - a. Definition, Concept and Branches: physical, social, archaeology, liguisitics
 - b. Relationship of anthropology with other social sciences,
 - c. Relation between sociology and anthropology
 - d. Anthropological research techniques
 - e. Growth of anthropological theories
2. Evolution
 - a. Evolution of Evolution
 - b. Mendel's Law of Segregation
 - c. Mitosis & Meiosis
3. How we discover Past
 - a. Kinds of evidence
 - b. Analyze & dating the evidence
 - c. Site creation
4. The Living Primates
 - a. Common features of primates
 - b. Classification of primates
 - c. Hominoids
5. Primates Evolution: From Early Primates to Hominoids
 - a. Eon, Eras & Epochs
 - b. Cenozoic Era In detail
6. The first Hominoids
 - a. Australopithecus Anamensis
 - b. Australopithecus afarensis & africanus
 - c. Australopithecus Robustus
 - d. Homo *heidelbergensis/neanderthalensis*.
 - e. Homos habilis
 - f. Homo erectus
 - g. Homo Sapiens
7. The Stone Age
 - a. Paleolithic
 - b. Mesolithic
 - c. Neolithic
8. Culture
 - a. The nature of culture



- b. Definition, Properties and Taxonomy
 - c. the evolution and growth of culture
 - d. universal aspects of culture
 - e. Material and Non-Material aspects
 - f. Cultural Diversity and Integration
 - g. Globalization and culture
9. Origin of Cities & States
 10. Origin of Food Production & Settled Life
 11. Language and Communication
 - a. Origin of language
 - b. Structure of language
 - c. Socio-linguistics
 - d. Nonverbal communication
 12. Marriage
 - a. Kinship
 - b. Types of Marriage
 - c. Concept of Incest Taboo
 - d. Kinship systems,
 - e. Rule of decent
 - f. Types of decent system
 13. Political System
 - a. Kind of political systems
 - b. Political system and economic system
 14. Religion
 - a. Origin, functions of religion
 - b. Religion and cultural ecology
 - c. Religion and social control
 - d. Kinds of religion
 - e. Witchcraft and Sorcery

Recommended Books:-

1. Ahmad, Akbar S. 1990. Pakistani Society, Karachi, Royal Books Co.
2. Bernard, H. Russel. 1994. Research Methods in Anthropology, Qualitative and Quantitative Approaches. London: Sage Publications
3. Bodley, John H. 1994. Cultural Anthropology, California: Mayfield Publishing Co.
4. Brogger, Jan. 1993. Social Anthropology and the Lonely Crowd. New Delhi: Reliance Publishing
5. Ember, Carol R. & Ember Melvin. 1990. Anthropology, 6th ed. Englewood Cliffs: Prentice Hall, Ince. Harper and Row
6. Harris Marvin. 1987. Cultural Anthropology. New York: Harper and Row
7. Harris Marvin. 1985. Culture, People, nature; An Introduction to General Anthropology London: Harper and Row
8. Hertzler J. O. 1981. The Social Structure of Islam. Cambridge: Cambridge University Press
9. Kennedy, Charles H. 1992. Pakistan London: Westview Press, Oxford
10. David Pocock, (1998) "Understanding Social Anthropology". The athlone press London;



11. Eliotd Chapple & Carletons S. coon (2004) Principles of Anthropology cosmo publications, India;
12. Fellmann/Getis/ Fellmann (1985) Human Geography (Land scope of human activates). wm brown publishers;



SEMESTER IV

4 th Semester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO – 241	GE	Civic & Community Engagement	2(2+0)
ZOO- 242	GE	Tools for Quantitative Reasoning	3(2+1)
ZOO- 243	Major	Cell and Molecular Biology	4(3+1)
ZOO- 244	Major	Biochemistry-I	3(2+1)
ZOO- 245	Major	Animal Form & Function-II	4(3+1)
Any one From the following			
ZOO- 246	GE	Introduction to Philosophy	2(2+0)
ZOO- 247	GE	Introduction to History	2(2+0)
Total Credit Hours			18(13+5)

ZOO-241 Civics and Community Engagement

Credit Hours: 2(2-0)

Description

Teach students the importance and role of active citizenship in promoting a productive, harmonious and development society/ world. Educate students about the importance of concepts, skills and philosophy of community linkages in developing a sustainable society. Inculcate the importance of community involvement for ensuring an improved, tolerant and generative society/ world. Provide an opportunity to the students to develop their relationship with the community.

Contents

1. Introduction to citizenship education and Community Engagement
2. Identity, Culture, and Social Harmony
3. Multi-cultural society and inter-cultural dialogue
4. Active Citizen: Locally Active, Globally Connected
5. Human rights, constitutionalism and citizens' responsibilities
6. Social issues in Pakistan
7. Social Action Project
8. Assignment (Formative/Summative)

Recommended Books

1. John J. Macionis, Linda Marie Gerber, Sociology (New York: Pearson Education, 2010)
2. Community Development, Social Action and Social Planning by Alan Twelvetrees 12 May 2017
3. The Constitution of the Islamic Republic of Pakistan (Pakistan: The National Assembly of Pakistan, 2012), also available online at the official website of National Assembly of



Suggested Books

1. Anne Karin Larsen, Participation in Community Work: International Perspectives (Vishanthie Sewpaul, Grete Oline Hole, 2013)
2. British Council, Active Citizen's Social Action Projects Guide (Scotland: British Council, 2017)

ZOO-242 Tools for Quantitative Reasoning

Cr. Hr. 03(2+1)

COURSE DESCRIPTION

The primary objective of this course is to explore probability and statistics. The curriculum includes in-depth study of exponential and logarithmic functions, as well as problem-solving related to these mathematical concepts. Solving system of linear equations and matrix algebra is the part of this course which ultimately develops the necessary background for data analysis. Overall, the course aims to equip students with a comprehensive understanding of mathematical concepts relevant to probability and statistics enabling them to apply these skills in real-world problems. The following are the main objectives:

- Students will be introduced to the above listed concepts, and they will be prepared to apply these concepts to practical life scenarios.
- This course will enhance their ability to deal with scenarios involving quantitative reasoning skills in a logical manner which they can face in their practical lives.
- It will prepare students to deal with different forms of data occurring in professional, social and natural sciences.
- Students will be introduced to scenarios involving functions and probability in different disciplines.
- This course will prepare the students to apply the quantitative reasoning skills in other disciplines.
- This course will provide solid foundation for students to use the quantitative reasoning skills in solving practical life problems.

COURSE CONTENTS

Exploring Graphical Information

Investigating relationships between variables, Exploring tools to find relationship between variables, Resources, and population growth: dealing with economic, environmental, and social issues.

Building blocks of a plane

Graphical and analytical approaches to solve a problem, Applications of graphical & analytical approaches to solve social & economic problems.



Exploring inequalities

Understanding inequalities around us, dealing with practical problems involving inequalities in different disciplines

Comparing quantities

Golden ratio in sculptures, Comparison of statements and their use in social and economic problems, Applications of ratio and proportion, Sequence, Arithmetic sequence, geometric sequence, counting principles and their applications.

Thinking Logically

Survival in the modern World, Propositions and truth values, Categorical proposition, and its applications

Understanding Data

Introduction to data, tabular and graphical presentation of data, descriptive analysis of data, standard deviation, measure of the locations, Scatter plots, Pearson's correlation coefficient, measure of dispersions, sampling distributions, levels of measurements, experimental design and basic rules of probability.

TEACHER MANUAL

[Quantitative Reasoning Courses\Quantitative Reasoning Teacher Manual - Sept 2021 - HEC.pdf](#)

RECOMMENDED RESOURCES

1. Using and understanding mathematics, 6th edition by Jeffrey Bennet and William Briggs, published by Pearson USA.
2. Mathematical thinking and reasoning 2008 by Aufmann, Lockwood, Nation & Clegg published by Houghton Mifflin Company USA.
3. Pre-calculus by Robert Blitzer 5th edition published by Pearson USA.
4. Pre-calculus Graphical, Numerical, Algebraic 8th edition by Franklin D. Demana, Bert K. Waits, Gregory D. Foley & Daniel Kennedy published by Addison Wesley USA.
5. Pre-calculus Mathematics for Calculus, 6th edition by James Stewart, Lothar Redlin and Saleem Watson published by Brooks/Cole Cengage Learning USA.
6. OpenAlgebra.com A free math study guide with notes and YouTube video tutorials.
7. R. N. Aufmann, J. S. Lockwood, R. D. Natio and D. K. Clegg, *Mathematical Thinking and Quantitative Reasoning* (2008), Houghton Mifflin Company (New York).
8. Blitzer, R. (2014). *Precalculus*. (5th Edition). Pearson Education, Limited.



9. R. Walpole, R. Myers, S. Myers and K. Ye, *Probability and Statistics/or Engineers & Scientists* (9th Edition), Pearson.
10. Bennett, J. & Briggs, W. (2015). *Using and understanding mathematics* (6th Edition). Pearson Education, Limited.
11. J. Yeo, T. K. Send, L. C. Yee I. Chow, N.C. Meng, J. Liew, O. C. Hong, *New Syllabus Mathematics* (7th edition 2019), Oxford University Press.

ZOO-243 Cell and Molecular Biology

Credit Hours: 4(3-1)

Introduction to prokaryotic and eukaryotic cells: Plasma membrane, its chemical composition structure and functions of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.

Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments. Cytoplasmic

Organelles: Membrane system, structural and functional commonalities. 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, Mitochondrial respiration and its significance as semi-autonomous organelle; 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.

Nucleus: chromatin, heterochromatin, euchromatin, chromosome structure, coiling and nucleosome during different phases of cell cycle.

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.,

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 posttranscriptional processing, RNA transduction, Genetic code, point mutations.

Translation: Specific role of Ribosomes, various factors, and posttranslational processing, control of gene expression in Prokaryotes.

Practicals

1. Identification of cell organelles
2. Preparation of temporary whole mount.
3. Preparation of permanent whole mount (demonstration)
4. Preparation of human blood smear and identification of Leucocytes.



5. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).
6. Squash preparation of onion root tip for mitotic stages.
7. Mounting of polytene chromosome (Drosophila/Chironomous.) Demonstration.
8. Detection and quantitative determination of chromosomal DNA and RNA.
9. Cultural and staining of bacteria and yeast.
10. Separation of different sized DNA fragments on agarose gel.
11. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).

Books Recommended

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2013. Molecular Biology of the Cell. Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H., Baltimore, D. 2013. Molecular Cell Biology, Scientific American Inc. N.Y.
3. Friefelder, D. 2010. Molecular Biology.
4. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach,. Sinauer Associates, INC.
5. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
6. De Robertis, E. D. P., De Robertis Jr. E. N. F. 1987. Cell and Molecular Biology, Lea &Febiger, New York

ZOO-244 Biochemistry-I

Credit Hours 3(2+1)

Course Contents

1. Introduction to Macromolecules

- a. Structure, types and role of various building blocks their respective macromolecules.

Carbohydrates: Introduction; Classification Stereoisomerism in carbohydrate, Structure, types and role of monosaccharides, oligosaccharides and polysaccharides; Glycosaminoglycans and glycoconjugates. Carbohydrates as an information carrier molecule.

2. Amino acids, peptides & proteins:

- a. Types of amino acids & their classification;
- b. Uncommon amino acids; Acid/base behavior of amino acids.
- c. Titration curves in amino acids and their importance:
- d. Peptides & proteins;
- e. Biologically active peptides & polypeptides;
- f. Amino acid sequence in proteins & their importance; Conjugated proteins;

2.1. Purification Techniques for Proteins



a. An outline of purification techniques for proteins; column chromatography, electrophoresis; Isoelectric focusing;

2.2. Organization of proteins:

- Structural levels of proteins; covalent structure of proteins;
- function of some structural & functional proteins; Hemoglobin, Cytochrome-
- Chymotrypsin, alpha Keratin and Collagen; Proproteins, their examples and role;

3. Enzymes

Enzymes, their importance, classification & nomenclature, Function & inhibition.

4. Lipids:

Introduction & classification of lipids; Fatty acids, their types; Storage lipids;

4.1. Classification and important characteristics;

Triacylglycerols; waxes Structural/membrane lipids; Glycerophospholipids with Ether and Ester linkages Galactolipids & Sulfolipids: Sphingolipids their types & importance: Sterols, their structure, types & functions. Examples of Functional diversity of Lipids as Signaling molecules, Cofactors, Electron carrier, antioxidants, pigments etc.

5. Nucleic acids

Nucleic acids and their types; Structure and role of various Bases in nucleic acids, Nucleoside & Nucleotides; Structure of DNA and RNA molecules; Organization and Chemistry of Double helical structure of DNA with their details.

Practical:

- Preparation of standard curve for glucose by ortho-Toluidine method.
- Estimation of glucose from blood serum or any other fluid using ortho Toluidine technique.
- Tests for detection of carbohydrates in alkaline medium.
- Tests for detection of carbohydrates in acidic medium.
- Tests for detection of Disaccharides.
- Tests to demonstrate relative instability of glycosidic linkage in carbohydrates.
- Detection of Non-Reducing sugars in the presence of reducing sugars.
- Demonstration of Acid Hydrolysis of Polysaccharide.
- Determination of pKa values of an amino acid by preparation of titration curves
- Preparation of standard curve of proteins by Biuret method.
- Estimation of blood serum proteins or any unknown concentration of protein using Biuret technique.

Recommended Books



- Lehninger principle of biochemistry by David L.Nelson and Michael M.Cox , 7th latest edition,ISBN-10:1-4641-2611-9,ISBN-13:978-14641-2611-6
- Biochemistry by Jeremy M. Berg, John L. Tymoczko; LubertStryer ,ISBN-10:1429229365,ISBN-13:97814229229364
- Berg, J. M.,Tymoczko,J. L., LubertStryer. 2010. Biochemistry. 7th Ed.
- Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D, Darnell, J. 2012. Molecular Cell Biology.
- David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.
- Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet. D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.
- Zubay, G.,1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
- Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York
- Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan Worth Publishers, New York.
- McKee, T., McKee, J.R. 2003.Biochemistry:
•The Molecular Basis of Life. 3rd Edition, McGraw-Hill
- Lodish, H., Berk, A., Zipursky, S. L., Paul.M., Baltimore D,Darnell, J. 2012. Molecular Cell Biology.
- McKee, T., McKee, J.R. 2003.Biochemistry:
• The Molecular Basis of Life. 3rd Edition, McGraw-Hill
- Molecular cell biology W.H Freeman by Lodish, Berk, Krieger, Scott, Bretscher,Ploegh and Matsudaira 8th edition/latest edition,ISBN:1464183392,ISBN-13:97814641183393

Textbook for Practical:

- Plummer, David T., 1990. An Introduction to Practical Biochemistry, 4th Ed. McGraw-Hill Book Company, London.
- Wilson, K and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4th Ed., Cambridge University Press.
- Sawhney, S.K and Singh, R., 2008. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, India



ZOO- 445 Animal Form & Function-II
Credit Hours 4 (3+1)

Course Outline:

1. Protection, Support, and Movement:

- a. Protection: the integumentary system of invertebrates and vertebrates.
- b. Movement and support: the skeletal system of invertebrates and vertebrates.
- c. Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates

2. Nutrition and Digestion:

- a. Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion
- b. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
- c. The mammalian digestive system: gastrointestinal motility and its control
- d. 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 gall bladder in digestion.

3. Temperature and Body Fluid Regulation:

- a. Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations.
- b. Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds and Mammals
- c. Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate
- d. Excretory Systems: How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions. Reproduction and Development

4. Reproduction:

- a. Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction.
- b. Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction.
- c. Sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes.

Practicals:

- Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
- Study of excretory system in an invertebrate and a vertebrate representative (Model).
- Study of dissection system in invertebrate and a vertebrate representative (Dissection).



- 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.*

Books Recommended

- Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.
- Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
- Miller, S.A., Harley, J.B. 2002. Zoology, 5th Ed. (International), Singapore: McGraw-Hill.
- Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin /Cummings Publishing Company, Inc.
- Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.
- Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill

ZOO -246 Introduction to Philosophy

Credit Hours 2(2+0)

Course Description

The course introduces undergraduate students to some of the main concerns in philosophy concentrating on the works of major thinkers such as Plato, Aristotle, Descartes, Hume, Kant, Hegel, Marx, Kierkegaard, Husserl, Sartre, Foucault, and Derrida, to name a few. The class discussions will center on broad philosophical concerns: the nature of philosophy, the nature and limits of human knowledge, the scope and limits of human freedom, the differences between right and wrong conduct, the nature of good life, and the meaning and the value of human existence. The students will thus be given introductory overview of different areas of philosophy beginning with Plato. The topics for discussion will include: Morality, Free Will, Metaphysics and Knowledge. The basic principles and methods of logical reasoning will be introduced and students will be given opportunity to participate actively in class discussions.

Course Objectives

- Understanding basic concepts of philosophy in the fields of metaphysics, axiology, and epistemology.
- Understanding of philosophical terms.

Course Contents

1. A review of the history of philosophy
2. A discussion on the major problems and methods of philosophy
3. Studying the work of at least ONE philosopher from each of the following groups:



Week	Topics
1	Introduction Definition of philosophy Literal and general Subject Matter, Nature, and Scope of philosophy
2-3`	Branches of philosophy Metaphysics Branches of Metaphysics (Ontology, Cosmology, and philosophical psychology)
4-5	Epistemology Knowledge (Definition, Nature, Scope and condition of knowledge, Empiricism. Rationalism, institution theories of Truth)
6-7	logic Basic Logical concepts Deductive Reasoning vs. inductive Reasoning
8-9	Ethics Definition, Nature, and Scope Branches of Ethics (Normative Ethics and Applied Ethics Normative theories of truth)
10	Aesthetics Definition and Nature objectivity vs. subjectivity
11	Greek philosophical thought Schools of thought in philosophy.
12-13	Materialism (Mechanistic Materialism Dialectical Materialism and Naturalistic Humanism) b-Idealism (subjective idealism objective idealism and personal idealism)
14	Realism (Naïve Realism Representative realism, critical Realism Dogmatic and agnostic realism)
15-16	Pragmatism



	Existentialism Phenomenalism Analytic Tradition
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Recommended Books

- Copi, Irving M. and Carl Cohen, introduction to logic, 2009, An imprint of Pearson Education.
- Durant, Will. The story of philosophy, 1985, services Book club, Rawalpindi, Pakistan. National Book foundation, Islamabad, Pakistan.
- Stewart, David and Blocker, H. Gene. Fundamentals of philosophy, 2006, Pearson Education inc. Dorling Kindersley Pvt . Ltd, India
- Stace, W.T.C critical History of Greek philosophy, 2008, 5th Reprint, National Book foundation, Islamabad, Pakistan.
- Titus, Harold H. Living issues in philosophy (An introductory Text Book), 1964, 4th Edition, American Book company, USA

ZOO-247 Introduction to History

Credit Hours 2(2+0)

Course Description

This is an Introductory level course consist of a review of major concepts relevant to the understanding of history as discipline and as a Process. It focuses on the introduction of major concepts, terminologies and issues, understanding of those are essential for the study of history. It will aim at the clarification of basic notions or ideas about what is history and what history is for. It evolves around the idea of the place of history as a source of knowledge and how can we approach historical knowledge with a sense of evolution

Course Objectives

The purpose of this course is:

- To make students aware of the nature of historical knowledge and research.
- To inculcate among the students a sense of historical evolution of human knowledge, development and progress
- To develop among the students an ability to understand the common themes of historical knowledge.
- To inculcate among the students of history a sense of critical thinking.
- The Course shall form the basis for the ensuing courses of History at different levels.

Course Outcomes

At the end of the course the students shall be able to:

- Have an understanding of the major concept of historical Knowledge.



- Have an ability to distinguish between ‘historical’ and ‘Instinctual’ aspects of human knowledge.
- Have an ability to understand the historical evolution.
- Have an ability to plan a role in the future development.

Course Contents

- What is History?
 - Literal, terminological and conceptual meaning of history
 - History as Fact
 - History as Process
 - History as Narrative
- Memory, Record and History
- Nature of History:
 - Being and Becoming;
 - Continuity and Change;
 - Evolution, Progress and Development
 - Macrocosm & Microcosm: Time, Space, Causation
 - Facts and opinion/ objectivity & Subjectivity
- Utility, Benefits & importance of History:
 - History as a corrective/cohesive force;
 - History as a repetitive force
 - Continuity of History from Past to Future
 - Lessons from Past Historical determinism, etc.
 - History as Mother of All Sciences/Knowledge
- Epistemological nature of History:
 - Relationship of History with other forms of knowledge:
 - Natural Sciences
 - Social Sciences
 - Literature and Arts
- Forms and Classification of History

Suggested Readings

1. Burke, Varieties of Cultural History, Cornell University Press, 1977
2. Carlo, Ginzburg. Clues. Myths, and the Historical Method, John Hopkins: University Press, 1992
3. Carr, E. H., What is History? Harmondsworth: Penguin, 1961
4. Cohn, Bernard. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988



5. Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.
6. Daniels, Studying History: How and Why, New Jersey, 1981.
7. Gertrude Himmelfarb. The New History and the Old, Cambridge: Harvard University Press, 1987
8. Govranski. History Meaning and Methods, USA, 1969
9. Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991
10. Qadir, Khurram, Tarikh Nigari Nazriyat-o-Irtiqā, Lahore: Palgrave, 1994.
11. Qureshi, Muhammad Aslam. A Study of Historiography. Lahore: Pakistan Book Centre, Latest Edition.
12. Steedman. Caroline, Dust: The Archive and Cultural History, Manchester University Press, 2002
13. Stern Fritz, Varieties of History: from Voltaire to the Present, Vintage, 2nd Edition 1975
14. Tahir Kamran, The Idea of History Through Ages, Lahore: Progressive Publisher, 1993
15. Lemon, M. C., Philosophy of History, London: Routledge, 2003
16. Marwick, Arthur, The New Nature of History, London, 1989, pp.31-35.
17. Roberts, Geoffrey, ed., History and Narrative Reader, London: Routledge, 2001.
18. Shafique, Muhammad, British Historiography of South Asia: Aspects of Early Imperial Patterns and Perceptions, Islamabad, NIHCR, Quaid-e-Azam University, 2016

SEMESTER V

5 th Semester (18 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO- 351	Major	Biological Techniques	3(1+2)
ZOO-352	Major	Biochemistry-II	3(2+1)
ZOO-353	Major	Physiology	4(3+1)
ZOO-354	Major	Ecology	3(2+1)
ZOO-355	Major	Evolution	2(2+0)
ZOO-356	Major	Principles of Systematics	3(2+1)
Total Credit Hours			18(14+4)



ZOO- 351 Biological Techniques

Credit Hours 3(1+2)

Course Contents:

1. Microscopy:

- a. Principles of light microscopy. Magnification, Resolution,
- b. Types of microscopy (Bright field, Dark field, Phase Contrast)
- c. Confocal Microscopy
- d. Electron microscope: Scanning electron microscope and Transmission electron microscope (SEM and TEM).

2. Standard unit system for weight, length, volume and Micrometry:

- a. Different Measurement systems (length; surface; weight, volume, temperature), Calculations and related conversions
- b. Concentrations- percent volume; ppt; ppm - molarity, normality, molality c. Preparation of stock solutions of various strengths d. Use of stage and ocular micrometers
- e. Calibration of ocular micrometer and measurement of size animal and plant cell and nuclei

Specimen preparation for optical microscopy:

- a. Introduction to Microtomy and its types
- b. Tissue Fixation, dehydration, clearing, embedding, Section cutting (transverse, longitudinal section)
- c. Tissue mounting (dry mount, wet mount)
- d. Staining: Hematoxylin and Eosin staining

Separation and purification techniques:

- a. Cell fractionation
- b. Centrifugation and its types
- c. Filtration and its types,
 - a. Chromatography: Principle, applications, types,
 - b. Paper chromatography and thin layer chromatography c. Column chromatography
 - d. High pressure liquid chromatography.
 - e. Electrophoresis: Principle, applications and types (Agarose and PAGE).
- a. Principle, applications, types



b. Visible/UV spectrophotometry

Basic principles of Sampling and Preservation:

- a. Sampling from soil, water, air, plants and animals b. Preservation of dry and wet specimens.
c. Preservation techniques. Lyophilization, preservation in ethanol, formalin etc.

DNA sequencing

- a. Polymerase chain reaction (PCR), principle and application
b. DNA sequencing (Sanger and Maxam Gilbert).

Preparation of slides (dry mount and wet mount)

Observation of wet mounts of human cheek cells employing bright and dark field microscopy

Measurement of cell size: bacterial and eukaryotic Cell

Recording of microscopic observations with the help of camera lucida

Liquid handling: proper use of pipettes and micropipettes

Hematoxylin and Eosin staining

Gram's staining,

Handling of centrifuge machines

Paper Chromatography

Thin layer chromatography of amino acids

Spectrophotometric estimation of glucose

Collection and Preservation of representative animals of various phyla

Books Recommended:

- Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
- Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part I. Cambridge University Press, UK.
- Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part II. Cambridge University Press, UK.
- Curot, M. 1997. Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
- Curot, M. 1997. Environmental Sampling and Analysis: For Technician. CRC Press LLC. USA
- Slingsby, D., Cock, C. 1986. Practical ecology. McMillan Education Ltd. London.
- Rob Reed/ David HOLMES, Jonathan Weyers/ Allan Jones Pearson, Practical skill in bio-molecular sciences.
- Gallagher, S.R. and Wiley E.A. 2008. Current protocols essential laboratory Techniques. John Wiley & Sons Inc, USA.

ZOO-352 Biochemistry-II

Credit Hours 3(2+1)

1. Bioenergetics



- a. Concept of Free Energy; Standard Free Energy change;
- b. Energy rich compounds and their role in metabolism.

2. Metabolism

- a. Detailed description of Glycolysis and Catabolism of other Hexoses;
- b. Regulation and Bioenergetics of Glycolysis. Anabolic role of Glycolysis;
- c. Fate of Pyruvate under Aerobic and Anaerobic conditions, Lactate and Alcoholic Fermentation;
- d. Gluconeogenesis, its Regulation and significance in the tissues; Feeder Pathways in Glycolysis; Utilization of other carbohydrates in Glycolysis;
- e. Phosphorolysis of Glycogen and Starch; Regulation of Glycogen metabolism; Utilization of dietary polysaccharides (Starch) and Disaccharides (Sucrose and Galactose). Biosynthesis of Glycogen, Starch and Sucrose;
- f. Pentose phosphate pathway of Glucose oxidation and its major role in the animal tissues.
- g. Citric acid (TCA) cycle: Conversion of Pyruvate to Acetyl CoA, Pyruvate dehydrogenase, a multi-enzyme complex;
- h. 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.

3. Lipid metabolism

- a. Digestion, mobilization and transport of Fats; Biosynthesis of Triacylglycerol;
- b. Utilization of Triacylglycerol; Oxidation of Fatty acids; Activation of Fatty acids and their transportation to mitochondria;
- c. Beta (β)-Oxidation; Bioenergetics of β -oxidation; Omega (ω)-Oxidation pathway; d. Biosynthesis of Saturated Fatty acid, Supply of raw material for palmitic acid synthesis; Fatty acid synthetase (FAS) multienzyme complex;
- e. Models of FAS system in Bacteria, Plants, vertebrate tissue and Yeast cell; Biosynthesis of unsaturated Fatty acids, Aerobic and Anaerobic pathways. Ketone bodies and their biosynthesis, utilization and role in the tissues;

4. Cholesterol metabolism

- a. Cholesterol biosynthesis and its Regulation; Steroid hormones, their types and main functions; Prostaglandins, their types, synthesis, inhibition and main functions.

5. Nitrogen metabolism

- a. Metabolic fate of amino acids; Catabolism of amino acids; Deamination and Transamination;
- b. Role of glutamate, glutamine and alanine in transport of ammonia in tissues; c. Nitrogen excretion and urea cycle; Regulation of urea cycle;



- d. Pathways of amino acid degradation showing entry points in Citric acid cycle; Decarboxylation of amino acids to biological amines.
- e. Biosynthesis of some amino acids; Incorporation of ammonia in glutamate and glutamine;
- f. Purine and Pyrimidine biosynthesis showing the sources of various atoms in both molecules.

Practical:

- Preparation of standard curve of proteins using Lowry's technique.
Estimation of tissue (liver) proteins using Lowry's technique.
Estimation of Free Amino Acids in Biological samples colorimetrically.
Separation and identification of various amino acids by paper chromatography.
Separation of proteins by Polycrylamide Gel Electrophoresis (PAGE).
Preparation of standard curve and estimation of DNA by colorimetric analysis using Diphenylamine method.
Preparation of standard curve and estimation of total RNA by colorimetric analysis using Orcinol method.
Quantitative analysis of Amylase activity from blood serum or liver.
Effect of temperature and pH on enzymatic rate of reaction.

Recommended Books

- Plummer, David T., 1990. An Introduction to Practical Biochemistry, 4th Edition McGraw-Hill Book Company, London.
- Wilson, K and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4th Edition, Cambridge University Press.
- Alexander, R.R. and Griffiths, J.M. 1993. Basic biochemical methods. Wiley Liss, New York.
- Sawhney, S. K. and Singh, R., 2006. Introductory Practical Biochemistry, 2nd Edition, Narosa Publishing House.
- Oser, B. L., (Latest Edition). Hawk's Physiological Chemistry, McGraw Hill Book Company.
- David L. Nelson and Michael M. Cox, 2005. Lehninger Principles of Biochemistry 4th Edition, Macmillan Worth Publishers, New York.

Additional Readings:

- Lubert Stryer, 1995. Biochemistry, 4th Edition, W.H. Freeman & Company, New York.
- Murray, R. K., Granner, D. K., Mayer, P.A. and Rodwells, V. W., 2000. Harper's Biochemistry, McGraw Hill Book Company, New York.
- Elliott, W. H. and Elliot, D. C., 2002. Biochemistry and Molecular Biology, Oxford Medical Publications, Oxford University Press.
- Voet, D., Voet, J. G. and Pratt, C.W., 1999. Biochemistry, John Wiley & Sons.
- Zubay, G. 1993. Biochemistry, Wm. C. Brown Publishers, Oxford.

ZOO -353 Physiology
Credit Hours 4 (3+1)
Concept of Physiology



Principles of Homeostasis and conformity

Principles of regulation and adaptation

Nerve and Muscle Physiology:

Neurotransmitters in communications

Receptors of neurotransmitters in diverse physiological responses

Excitatory and inhibitory postsynaptic potentials

Neuronal networks and their role in nervous integration

Neuromuscular interaction at cell and molecular level muscle

Types of muscle contractions and muscle fatigue.

Cardiovascular Physiology:

Electrical activity of heart; self-excitability and auto-rhythmicity of myogenic heart.

Neurogenic heart and their expression. Electrocardiography and Kymography.

Hemodynamics, Relationship between blood flow, pressure and resistance. Their role in performance of the function in a variety of vertebrates. Control of cardiac activity, cardiac output and peripheral circulation.

Respiratory Physiology:

Mechanism of respiratory gases exchange in aquatic and terrestrial respiratory structures.

Control of respiration and stimulus factors in various animals.

Respiration adaptations in hypoxia and hypercapnia etc.

Air breathing and respiratory adaptations diver animals.

Excretory Physiology:

Strategy of mammalian large glomerular filtration and reabsorption in nitrogenous excretion.

Patterns of nitrogenous excretion in various animals and their phylogenetic significance.

Physiology of Nutrition:

Adaptation of nutritive canal for digestion and absorption of nutrients in different animals specifically the vertebrates.

Regulation of digestive secretions.

Mechanisms of water, ions and nutrients absorptions and their significances in diverse groups.

Potential and Movements in gastrointestinal tract and control of motility.

Practicals:

Respiration and Circulation

Study of respiratory pigments in various animals and hemoglobins in various vertebrates.

Normal cardiac activity in amphibian model, the effect of temperature, the effect of drug, heart block, tetanization of heart.



Measurement and effects of various factors on blood pressure. Blood pressure alteration in exercise.

Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer),

Nerve and Muscle

Study of salient features of electromyography

Study of excitable and contractile properties of a nerve-muscle preparation.

Nervous System:

Study of brains in different animals in relation to complexity of functions.

Study of human brain model and different areas eliciting behaviours.

Videos study on 1 and 2 studies.

Hormones System:

Video studies on the effects of hormones in breeding season behaviours of various behaviours.

Study through clinics data on the insulin and glycemia in type 1 and type 2 diabetic subjects.

Text/Reference Books:

- **Principles of Animal Physiology Third Edition** Moyes, Christopher D. Schulte, Patricia M. Publisher: Pearson; 3rd edition, 2015.
- **Eckert Animal Physiology** Fifth Edition David Randall, Warren Burggren, Kathleen French W. H. Freeman; 2001.
- **Animal Physiology: From Genes to Organisms** 2nd Edition Lauralee Sherwood, Hillar Klandorf, Paul Yancey Brooks Cole; 2012.
- **Animal Physiology** 4th Edition Richard W. Hill, Gordon A. Wyse, Margaret Anderson Sinauer Associates, Oxford University Press, 2016.

ZOO-354 Ecology

Credit Hours 3(2+1)

Course Outline

1. Energy

a. Basic Concepts of and Types of Ecology, ecological organization

b. Laws of thermodynamics, primary and secondary productions

c. Trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.

2. Biogeochemical cycle:

a. Nitrogen, Phosphorus, Sulphur, Water, Carbon and nutrient.

3. Limiting factors

a. Basic Concepts, Temperature, Soil, Water and Humidity, Light and Fire.



4. Global ecosystems:

- a. Atmosphere, Hydrosphere, Lithosphere and Ecosphere.
- b. An overview of Ecosystem with special reference to Ecological Niche, basic concepts and types
- c. Major ecosystem of world, Forest, Grassland, Desert, Tundra and Agricultural ecosystems.
- d. 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. Exotic and Invasive Species

- a. Desertification, Deforestation, exotic and invasive species

Practicals

Population Sampling Techniques (Quadrat, Line Transact, Point count, Focal Scan and Capture and Recapture Method).

Study of different Ecosystems (Fresh Water, Terrestrial, Marine /Mountain/ Desert).

Ecological Notes.

Measurements of physical Factors of different Ecosystems.

Adaptive features of animals in relation to food and environment.

Food chain studies through analysis of gut contents.

Analysis of polluted and fresh water for biotic and abiotic variations.

Field visits for study of selected terrestrial habitat and writing notes

Experimental design and approaches in ecological research; writing a research project

Development of an ecological management plan of some selected area

Recommended Books

- Molles, M.C. 2005. Ecology: Concepts and Applications. 6th Ed., McGraw Hill, New York, USA.



- Cox, C.B., Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6th Ed., Life Sciences King's College, London, UK.
- 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 Univ. Press, UK.
- Chapman, J.L., Reiss, M.J. 1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.
- Odum, E. P. 1994. Fundamentals of Ecology. 3rd Ed. W.B. Saunders. Philadelphia.
- Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford. UK
- Slingsby, D., Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK.

ZOO-355 Evolution

Credit Hours 2(2+0)

Course Contents

Introduction:

- a. An overview of evolutionary Biology. Brief introduction to evolution, natural selection and phylogenetics.
- b. Early evolutionary thoughts: evolutionary biology before Darwin
- c. Theories of Biological evolution; theory of natural selection, modern synthetic theory.
- d. Evidence for Evolution: Embryological, Anatomical, Molecular & Biochemical, Physiological and Paleontological evidence.

Modern concept of Natural Selection:

- a. Components of Natural Selection; VISTA: Variation and Inheritance, Survival and Differential Reproductive success, Time and Adaptation
- b. Types of selections: Directional, stabilizing, and disruptive.
- c. Levels of selection: Genic, Individual, Group and Species selection,
- d. Examples of natural selection in the field and experiment

Microevolution and Macroevolution:

- a. Microevolution: factors initiating elementary evolutionary changes; mutations, immigration, crossbreeding, genetic drift; changing allele frequencies
- b. Macroevolution: Role of Isolation in evolution, Adaptive radiations, regression, immigration, and crossbreeding
- c. Convergence and Divergence; Batesian mimicry, Mullerian mimicry, Allometry

Major Transitions

- a. Overview of major transitions.
- b. Evolution of Eukaryotic cell.
- c. Evolution of Multicellularity.
- d. Evolution of Individuality.
- e. Solitary to group living.



f. Evolution of Man, Horse and Elephant

Extinctions and Evolutionary Trends

- The concept of extinction.
- Background extinction.
- Mass extinction.
- Factors correlated with extinction.
- Rates of evolution: punctuated equilibrium, Phyletic gradualism.

Evolution of Sexual Selection

- Darwin's concept,
- Fisher's view,
- Zahavi's handicap theory
- Recapitulation

Text and Reference Books:

- Bergstorm C.T and Duagtkin L.A. 2016. Evolution. ISBN 9780393937930. W. W. Norton & Company, Inc., 500 Fifth Avenue, New York, NY 10110-0017.
- Strickberger. M.W.2012. Evolution. Jones & Barrett Publishers. Gower Street, London, England.
- Ridley, M. 1993. Evolution. Blackwell Scientific Publications, New York, USA.
- Moody, P.A. 1989. Introduction to Evolution, Harper and Row, Publishers, New York
- Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and Practical Practice of Phylogenetic systematics. 2nd Ed. Wiley-Blackwell

ZOO-356 Principles of Systematics

Credit Hours 3(2+1)

Course Contents:

Importance and applications of systematics:

Taxonomy in Animal science, systematics as a profession and its future perspectives.

History of taxonomy:

systematics, basic terminology of systematics, theories of biological classifications.

Taxonomic characters:

Kinds and weightage, micro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Species concept.

Species concept:

Typological, Nominalist species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation,

Taxonomic procedures and collections:

Taxonomic problem and the pre-requisite of collection; Methods of collection and their preservation. Curation; cataloguing and storage, duration,

Systematics Publications:

Features of taxonomic publications; Catalogue, Monographs, Checklists, Atlas, Faunal Work, Keys; types and merit demerits, Illustrations, Some online taxonomic resources.



Rules of Zoological Nomenclature:

ICZN, interpretation, application of important rules, Principles of ICZN, law of priority and validity of names.

Practical:

Study of preserved invertebrate species and their classification up to class level.

Collection, preservation and identification of common species with the help of keys

Preparation of keys for the identification of specimens

Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.

Books Recommended:

- Wiley, E.O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2nd Ed. Wiley-Blackwell. Hill, New York
- Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw-Hill, New York
-
- Mayr, E. Animal Species and Evolution, 1985. Harvard University Press.
- Heywood, V.H. Taxonomy and Ecology. 1975. Academic Press, London

Semester-VI

6 th Semester (16 Credit Hours)			
Course Code	Domain	Course Name	Credit Hours
ZOO-361	Major	Research Methodology	2(2+0)
ZOO 362	Major	Animal Behavior	3(3+0)
ZOO-363	Major	Developmental Biology	4(3+1)
ZOO-364	Major	Genetics	4(3+1)
ZOO-365	Major	Zoogeography and Palaeontology	3(2+1)
Total Credit Hour			16(13+3)

ZOO-361 Research Methodology

Credit Hours 2(2+0)

Course Contents:

1. Introduction:

a. Objectives of Research, Motivations

2. Research Process:



- a. Research methods vs. research methodology, scientific method
- b. Types of research, general steps involved in research
- c. Problems of research in Pakistan

3. Topic Selection:

- a. Problem identification for research, criteria and evaluation

4. Literature review:

- a. Importance and sources
- b. Referencing and citation and Bibliography
- c. plagiarism

5. Research Design:

- a. Parts, important features, important concepts in research design

6. Aims and objectives:

- a. Research objectives, qualities of research objectives

7. Material and methods:

- a. Bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources

8. Data Analysis:

- a. Processing, statistics in research, hypothesis testing, t-tests and ANOVA

9. Scientific Writing:

- a. Difference between thesis/report/synopsis/research proposal.
- b. Parts of synopsis/project proposal, parts of thesis/report

Budgeting: Cost estimates for a research project, funding sources e.g. USAID, HEC, DoST, HED, PMRC, WWF, PSF etc.

Text and Reference Books:

- Paul Leedy, 2004, Practical Research: Planning and Design (8th Edition), Jeanne Ellis Ormrod
- Creswell, J. W. (2013). Research Design Quantitative Qualitative and Mixed Methods Approaches. Sage.
- Hess-Biber, S. N. and P. Leavy. (2004). Approaches to Qualitative Research, A Reader on Theory and Practice. New York, Oxford University Press.
- Khan, J.A. (2008). Research Methodology. New Delhi: APH Publishing.
- Kothari, C.R., & Gaurav, G. (2014). Research Methodology: Methods and Techniques. New Delhi: New Age International.



- Kumar, R. (2011). Research Methodology: A Step By Step Guide for Beginners. Cornwall: SAGE Publications, Inc.
- Laurel, B. (2003). Design Research, Methods and Perspectives. London England, The MIT Press.
- Walliman, N. (2005). Your Research Project, 2nd Edition, A step by step guide for the first-time researcher. New Delhi, Vistaar Publications

ZOO- 362 Animal Behavior

Credit Hours 3(3+0)

Course Outline

1. Introduction to Animal Behavior

- 1.1 Introduction, Ethology, Classical Ethology, Anthropomorphism
- 1.2 The four levels of analysis: Proximate and ultimate causes of behavior.
- 1.3 Foundations of Animal Behavior:
 - a) Natural Selection,
 - b) Individual Learning and
 - c) Cultural Transmission
- 1.4 Approaches to study of animal behavior: Conceptual, theoretical and empirical

2. Development of behavior:

- 2.1 Role of external and internal stimuli and animal responses
- 2.2 Neural and Physiological mechanisms (hormones) of behavior.
- 2.3 Role of genes, molecular genetics, development, and maturation

3. Types of Behavior:

- 3.1 Innate behavior, and innate releasing mechanisms with examples.
- 3.2 Learned behavior,
- 3.3 Types of learning and its mechanisms, quick learners' vs slow learners.
- 3.4 Complex behaviors and decision-making key to understand and develop multiple behavioral choices.

4. Circadian rhythms

- 4.1 Biological Rhythms and concept of bio-rhythmicity in animals.
- 4.2 Types of circadian rhythms
- 4.3 Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities.
- 4.4 Migration

5. Sociobiology and social behaviors

- 5.1 Social organization in animals and group living; benefits and costs of group living.
- 5.2 Social organization in insects and mammals.
- 5.3 Aggression, Dominance Hierarchies, Appeasement,
- 5.4 Cooperation,
- 5.5 Kinship, Altruism, Hamilton Rule, Territoriality,

6. Foraging and Anti-Predatory behavior:

- 6.1 Finding food, optimal foraging theory
- 6.2 Successful foragers and winners of predator-prey relationships.



- 6.3 Foraging and Predation trade-off
- 6.4 Predator avoidance behavior in different animals,

7. Reproductive Behaviors:

- 7.1 Sexual Selection; Cost and benefits of sexual reproduction,
- 7.2 Inter and Intra sexual selection, Sexual Conflicts
- 7.3 Mating Systems (a) Monogamous (b) Polygamous: Polyandrous and Polygynous
- 7.4 Parental Care; Types
- 7.5 Parental care in Fishes, Amphibians, Reptiles, Birds and Mammals.

8. Communication in animals:

- 8.1 Communication, Signals, Channel and Medium
- 8.2 Various types of communication; Auditory, chemical, visual, tactile, bioacoustics, electrical
- 8.3 Various types of chemical signals in animals' behavior and their importance in ecosystems.
- 8.4 Evolution of signals
- 8.5 Reliability of signals

TEXT AND REFERENCE BOOKS:

- Dngatkin, L. A. 2012. Principles of Animal Behavior. W.W. Norton and Co. New York.
- Nordell, S.E. and Valone, T.J. 2017. Animal Behavior. Concepts, Methods, and Applications. Second edition. ISBN 978-0-19-027674-4
- Alcock, J. 2010. Animal behavior, an evolutionary approach. 9th Edition. Sinauer Publishers.
- Barnard, C. J. (2004). Animal behaviour: mechanism, development, function and evolution. Pearson Education.
- Goodenough, J., McGuire, B., Wallace, R.A. 2001. Perspective on Animal Behavior. John Wiley & Sons, New York.

ZOO-363 Developmental Biology

Credit Hours 4(3+1)

Course Outlines

1. Introduction

- a. History and Basic Concepts of developmental biology
- b. 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



Primates Menstrual cycle

3. Oogenesis

Mechanism of oogenesis among various classes of vertebrates. b.

Vitellogenesis

Hormonal control of Vitellogenesis and oogenesis

4. Fertilization

a. External & Internal Fertilization

b. Species-specific recognition of sperm and egg

c. Fusion of male and female gametes

d. Polyspermy: slow and fast blocks to polyspermy

e. Activation of egg metabolism

5. IN VITRO Fertilization (IVF)

a. History, Steps and advantages of IVF

b. Disadvantages and risk factors

6. Cleavage & Blastulation

a. Patterns of embryonic cleavage and blastulation among different vertebrate classes b.
Mechanism of cleavage.

7. Gastrulation

a. Fate maps

b. Gastrulation in amphibians, birds and mammals

8. Early Vertebrate Development

a. Neurulation, ectoderm, mesoderm and endoderm formation

9. Placenta and extraembryonic membranes

10. Cellular Basis of Morphogenesis

a. Differential cell affinity, cell adhesion molecules

b. Organogenesis

c. Mechanism of teratogenesis

11. Aging and Regeneration in vertebrates

Practical:

Study of the structure of gametes in some representative cases, i.e. frog, fish and mammal.



Hen's egg internal and external structural details

Microscopic analysis of hen's egg yolk, albumin and shell membranes

Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.

Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.

Study of developmental stages of nematodes through microscopic analysis of animal dung

Semen analysis

Dactylography and its uses in developmental biology

Recommended Books

- Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.
- Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill.
- Scott F. Gilbert and Michael J.F. Barres. 2016. Developmental Biology. Sinauer Associates, Sunderland, MA.
- Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
- Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
- Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.

- Saunders, J. W. 1982. Developmental Biology, McMillan and company.
- Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

ZOO-364 Genetics

Credit Hours 4(3+1)

Course Contents:

Introduction

- a. Classical, molecular and population Genetics:
- b. Scope and importance of genetics,
- c. Forward and reverse genetics.
- d. The basic principles of Inheritance (Mendelism): Monohybrid and Dihybrid crosses (Definition - characteristics criss-cross inheritance).
- e. Multiple Alleles: blood groups and coat color in rabbits.
- b. Genetics of Rh factor and Erythroblastosis Foetalis.

Chromosomal Basis of Inheritance:

- a. Chromosomal theory of inheritance
- b. Interaction of genes,
- c. Epistasis,



- d. Lethality and
- e. Pleiotropism.

Chromosomal Aberrations

- a. Changes in chromosomal number, Euploidy, aneuploidy (Klinefelters syndrome, and Turners syndrome, Down syndrome and Edwards syndrome).
- b. Structural changes; insertion, deletion (Cri du chat syndrome), duplication,
- c. Inversion and translocation

Pedigree Analysis:

- a. Normal human chromosome complement; Karyotyping.
- b. Sex-determination and Sex-linkage:
- c. Sex determination in animals and humans,
- d. Sex linked (Hemophilia, muscular dystrophy, color blindness), sex influenced and sex-limited traits,
- e. Prenatal Diagnosis: Amniocentesis and choriovillus sampling -Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics

Chromosome mapping

- a. Linkage,
- b. Recombination (crossing over)
- c. Chromosome mapping in eukaryotes.

Molecular Genetics

- a. Gene Concept (classical and modern),
- b. Genetics of Viruses and Bacteria, Transposons,
- c. Mutation and DNA repair
- d. Molecular Genetic Analysis,
- e. Regulation of Gene Expression in Prokaryotes,
- f. Gene Regulation in Eukaryotes

The genetic control of the Vertebrate Immune System

- a. The Techniques of Molecular Genetics (elements of genetic engineering),
- b. PCR
- c. Single and Multifactorial Disorders: Autosomal anomalies, Pseudoautosomal genes,
- d. Single gene disorders: Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria).
- e. Complex Inheritance Patterns, Polygenic traits- Cleft lip and cleft palate,
- f. Hardy-Wienberg equilibrium,
- g. Systematic and Dispersive pressures, Inbreeding and heterosis

Practical:



1. Drosophila culture techniques: preparation and maintenance of culture
2. Identification of male and female fruit fly and isolation of virgin females
3. Study of polytene chromosomes from the salivary glands of Drosophila melanogaster
4. Mutation induction in Drosophila
5. Human karyotyping from photographs prepared slides: paper cut out method
6. Preparation of human metaphase chromosomes from blood lymphocytes
7. Study of mitosis in plants by using onion root tip cells
8. Study of meiosis in the testes of male grasshopper
9. Extraction of genomic DNA from whole blood (lymphocytes)
10. Separation of heterogeneous population of bio-molecules through electrophoresis
11. Study of blood group polymorphisms in local population
12. Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
13. Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc), risk estimation and genetic counseling.
14. Study of quantitative traits in humans: finger prints as model of polygenic traits
15. Study of Barr bodies in human cell nucleus
16. Dermatoglyphics in normal and mentally retarded subjects
17. Probability problems. Tossing of coins. X²test
18. Study of transformed bacteria on the basis of antibiotic resistance
19. PCR

Books Recommended:

1. Snustad, D.P., Simmons, M.J. 2003. Principles of Genetics. 3rd Ed., John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. 2001. Principles of Genetics. 7th Ed., WCB publishers USA.
3. Lewin, B. 2013. GENE-VIII. Oxford University Press. UK.
4. Gardener, E.J., Simmons, M.J., Snustad, D.P. 1991. Principles of Genetics. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. 2015. Genetics. McMillan, New York. USA.(9780024181206)
6. PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
7. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.
8. William S. Klug, 2014. Concept of Genetics, ISBN-11: 978-0321948915
9. Lewin's Gene XI BY Jocelyn E. Krebs et al. 2013, isbn-13:978-1449659851,ISBN-
10. Gene- XI by Lewin's,2013,ISBN:978-1449659851

ZOO-365 Zoogeography and Paleontology

Credit Hour 3(2+1)

Course Contents

1. Paleo geography

a. Theories of continental drift and plate tectonics b. Pangea



2. Animal distribution

- a. cosmopolitan distribution
- b. discontinuous distribution
- c. isolation distribution
- d. bipolar distribution
- e. endemic distribution
- f. barriers and dispersal.

3. Zoogeographical regions:

- a. Zoogeographic Division and Boundaries
- b. Geographic Ranges, Physical Features
 - Climates,
 - Faunas And Affinities of Palaearctic, Nearctic Regions, Oriental, Ethiopian, Australian, And Neotropical Regions
 - **Paleontology:**
 - a. History, age, shells of earth
 - b. atmosphere, hydrosphere, biosphere and lithosphere.
 - c. Types; Igneous rocks, sedimentary rocks and metamorphic rocks.
 - d. Fossil types and uses of fossils, nature of fossils.
 - Fossilization
 - Invertebrates and Vertebrates Fossil
 - Biostratigraphy
 - Fossils of Pakistan
 - Paleontologically important areas of Pakistan.

8. Fossilization:

- Geological time scale.
- Pre-Cambrian life.
- Post Cambrian life,
- Paleozoic life
- Mesozoic life
- Cenozoic life.

09. Geochronometry:

- Uranium/Lead dating
- radiocarbon dating, methods, index fossils
- Paleoeecology, Paleomagnetism.

Practical:

1. Study of fauna of various zoogeographical regions.
2. Study of mould, cast, pseudomorph, coprolite, petrified fossils of plants and animals.



3. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
4. Study of vertebrate fossils e.g. horse/elephant/camel/bovids.
5. Study and identification of Igneous, Sedimentary and Metamorphic rocks
6. Map work for identification of various zoogeographical regions of the World.

Recommended Books

- Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
- Beddard, F. E. 2008. A text book of zoogeography. Bibliobazar, LLC.
- Brouwer, A. 1977. General Palaeontology, Oliver and Boyd, London.
- Darlington, P. J. Jr. 1963. Zoogeography, John Wiley and Sons
- Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.
- Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
- Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup & Sons. Delhi.

Semester-VII

7 th Semester (18) Credit Hours			
Course Code	Domain	Course Name	Credit Hours
ZOO-471/ ZOO-477	Major	Bioinformatics/ Biotechnology	3(2+1) 3(2+1)
ZOO-472	Major	Ichthyology	3(2+1)
ZOO-473	Major	Wildlife	3(2+1)
ZOO-474	Major	Parasitology-I	3(2+1)
ZOO-475	Major	Entomology-I	3(2+1)
ZOO-476		Field experience/internship	3
Total Credit Hours			18(13+5)

ZOO-471 Bioinformatics

Credit Hours 3 (1+2)

Course Contents:

1. Introduction:

- a. Introduction to Bioinformatics, Scope of bioinformatics, useful websites



b. Aims of bioinformatics, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools c. Human genome project

2. Biological databases

- a. Data and types of data, data acquisition
- b. Major DNA databases around the world, NCBI, BOLD, DDBJ
- c. Major protein databases in the world, protein sequence databases, protein structure databases
- d. Specialized databases, genome and organism databases e. Non sequence databases, pubmed, pubmed health, OMIM

3. Genome mapping

Genetic and linkage mapping, physical mapping

4. Gene family:

- a. Introduction, 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.

5. Data Retrieval:

- a. Searching sequence databases
- b. FASTA format
- c. retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data

6. Primer Designing:

- a. Primer and probe, qualities of primer, general rules for primer designing
- b. Websites used for primer designing

7. Sequence Alignment:

- a. Importance and significance of alignment, methods for sequence alignment
- b. Local and global alignment, pair-wise local alignment

8. BLAST: Introduction, types, uses, algorithm, BLAST Scores

9. Multiple Sequence Alignment:

- a. Introduction, tools for MSA, uses and importance

10. Phylogenetic analysis:

- a. Introduction, interpretation, rooted and unrooted tree,
- b. phylogenetic methods, tree terminology, comparison of methods, software



- Introduction to NCBI
- Retrieving Literature from NCBI
- Classification of an organism using NCBI
- Retrieving FASTA sequence for nucleotide and protein
- Retrieving disease gene information
- Searching gene families
- Primer Designing
- Blasting a nucleotide / amino acid sequence
- Multiple Sequence Alignment using different amino acids / nucleotide sequences
- Phylogenetic Analysis of different nucleotide / amino acid sequences
- Microarrays data retrieval from the web

Recommended Books

- Baxevanis, A.D., Ouellette, B.F.F. (2011) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley & sons, Inc.
- Rastogi, S.C., Mendiratta, N., Rastogi, P. (2011) Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. PHI publishing.
- Pevsner, J. (2015) Bioinformatics and Functional Genomics. 3rd Edition. Wiley-Blackwell
- Lesk, A. (2014) Introduction to Bioinformatics. 4th Edition. Oxford University Press
- Selzer, P., Marhofer, R. and Rohwer, A. (2008) Applied Bioinformatics: An Introduction. Springer publishing, Germany
- Primerose, S.B. (2004) Genomics: Applications in Human Biology. WileyBlackwell
- Westhead, D.R., Parish, J.H., Twyman, R.M. (2003) Instant Notes on Bioinformatics. Viva Books Private Limited.
- Krane, D.E. and Raymer, M.L. (2002) Fundamental Concepts of Bioinformatics. Benjamin Cummings.
- Gibas, C. and Jambeck, P. (2001) Developing Bioinformatics Computer Skills. O'Reilly publishers.

Websites

- <http://www.ncbi.nlm.nih.gov>
- <http://www.ebi.ac.uk>
- <http://www.rcsb.org>

<http://www.ensemble.org>

ZOO-477 Biotechnology

Credit Hours 3 (2+1)

Course Objectives:

To acquaint students of zoology with the basic concepts and significance of biotechnology.

Course outcomes: Upon successful completion of the course, the students should be able to

1. COMPREHEND about the introduction and history of biotechnology
2. UNDERSTANDING of core molecular genetics concepts including molecular biology, genetics, cell biology, physiology, and evolution 108



3. KNOW about basic of rDNA technology, concept and principle and application of genetic engineering, transgenic animals, cryopreservation, apoptosis, and animal cloning.

Course Content:

1. Introduction: a. Definitions, classes, types of modern biotechnology b. Historical perspective, timeline of important events in the field of biotechnology

2. Genetics and Biotechnology: a. Genome, human genome, types and size of human genome, diversity of human genome b. Short Tandem Repeats, nomenclature, uses of STRs, inheritance of STRs, allele, locus, genotype, phenotype c. Polymerase Chain Reaction, principle, requirements, procedures and applications, Gel electrophoresis, definition, principle, steps/methods involved, DNA ladder, allelic ladder

3. Biotechnology and Justice: a. Sources of DNA, Forensic DNA testing, b. Principles, techniques, types and applications

4. Genetic Engineering a. Introduction, Steps, Vectors and its types, characteristics of vectors b. Plasmids and its types, pBR322, pUC19, Ti-Plasmid c. Restriction Enzymes, Screening, Blue White Screen, Negative and Positive Control, Competent Cells, Insulin as an example, genetically modified organisms d. Cloning, its types of cloning, cell cloning, molecular cloning, organism cloning, applications and uses

5. Animal and Insect Biotechnology: a. Introduction, reasons for producing GM animals, b. Genetic manipulation, mammalian cloning, somatic cell nuclear transfer, procedure and uses, GM hormones and vaccines, GM insects

6. Bioprocess Technology: a. Introduction, requirements of bioreactors, types of bioreactors b. Bacterial and mammalian cell culturing, production of novel antibiotics, steps for production of antibiotics, production of industrially important chemicals

7. Biotechnology and Medicine: a. Applications, monoclonal antibodies, importance, steps for production of monoclonal antibodies

8. Stem Cell Biotechnology: a. Introduction, sources – embryonic stem cells, adult stem cells b. Types of stem cells based on potency, applications of stem cells. 109

9. Public Perception of Biotechnology: a. Current issues in bioethics (Autopsy, GMOs, Stem Cells, Euthanasia, Organ Transplant, Human Cloning, IVF, Surrogacy and sperm donor, etc)

10. Bioethics and Islamic Bioethics: a. Introduction and principles of bioethics, b. Concept of bioethics in different religions, principles of Islamic bioethics

Practicals:

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 Teaching methodology:

Text and Reference Books:

1. Clark, D.B., Pazdernik, N.J. (2015) Biotechnology. 2nd Edition. Academic Cell
2. Glick, B., Pasternak, J.J., Patten, C.L. (2009) Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition. ASM Press.
3. Freeman, S., Quillin, K., Allison, L. (2013) Biological Science. 5th Edition. Pearson. 110
4. Schmid, R.D., Schmidt-Dannert, C., Hammelehle, R. (2016) Biotechnology: An Illustrated Primer. Willey-Blackwell.
5. Dehlinger, C.A. (2014) Molecular Biotechnology. Jones & Bartlett Learning
6. Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction. 7th Edition. Willey-Blackwell.
7. Butler, J.M. (2009) Fundamentals of Forensic DNA Typing. Academic Press.
8. Setlow J. K. (2000). Genetic Engineering: Principles and Methods. Kluwer Academic Publishers
9. Krishna.V.S. (2007) Bioethics and Biosafety in Biotechnology. New Age International
10. Furr, A.K. (2008) CRC Handbook of Laboratory Safety. 5th Edition. Boca Raton, FL, CRC Press

ZOO-472 Ichthyology

Credit Hours 3(2+1)

Course Contents:

1. Classification and distribution of freshwater fishes
 - a. Systematic position of fish in animal kingdom
 - b. Distribution of various commercial and noncommercial fishes of Pakistan
2. Morphology of fishes
 - a. External features of fishes
3. Coordination of fishes
 - a. Fish muscular system, locomotion and energetics of swimming.
 - b. Physiology of respiration and air breathing among fishes.



- c. Cardiovascular system,
- d. Blood and its circulation and hydromineral balance: Osmoregulation, ionic regulation, stress responses, freezing resistance, and acid-base balance.
- e. Digestion and control of gastro-intestinal motility in fish. Physiology of gas bladder: Use of gas by the fish as a source of static lift.
- f. Gas in the gas bladder: Loss, retention, and secretion of gas.
- g. Process of aestivation in fish.
- h. Control of kidney function in fish. Sensory system and communication in fish: Acoustico-lateralis system, sound reception and production.

Practical:

1. Collection and identification of some freshwater and marine water fishes.
2. Dissection of fishes for studying anatomical features (Reproductive, Digestive, Respiratory and circulatory systems).

Books Recommended:

1. Lagler, K.F., J.E. Baradach and R.R. Miller. 2009. Ichthyology. John Wiley and Sons, Inc., New York, USA.
2. Moyle, P.B. and J.J. Cech. 2008. Fishes: An Introduction to Ichthyology. 6th Ed. Prentice Hall, New Jersey, USA.
1. David, H. 2003. The Physiology of Fishes 3rd Ed. CRC Press, UK.

ZOO-473 Wildlife

Credit Hours 3(2+1)

Course Outlines:

Wildlife of Pakistan

- a. Introduction
- b. Philosophy and significance of wildlife conservation
- c. Important Definitions
- d. Identification
- e. Distribution
- f. Status



g. Conservation and Management of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan

Biodiversity and sustainability of wildlife.

Wildlife rules and regulations in Pakistan

a. Provincial Rules

b. Federal Management of Wildlife (NCCW)

National and International agencies involved in conservation and management of wildlife

a. National Organizations

b. International Organizations

Protected Areas in Pakistan

Sanctuaries

Game Reserves

National Parks

Ramsar convention

a. Wetlands

b. Ramsar Criteria

c. Ramsar Sites

Threatened species of Pakistan.

a. Vulnerable

b. Endangered

c. Critically Endangered

Practicals:

Visit to protected areas of Pakistan (Captive, Semi-captive and Wild Areas)

Ecological Indices

Animal Distribution Maps

Text and Reference Books:

Ali, S.S. 2005 Wildlife of Pakistan.

Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.

Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.



Roberts, T. J., 1991, 1992. The Birds of Pakistan, Vol. I and II. Oxford University Press

Roberts, T. J., 1997. The Mammals of Pakistan, Oxford University Press

Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.

Wildlife of the Punjab, Punjab Wildlife Department.

Khan M. S. 2011, Amphibian and Reptiles of Pakistan

Mirza Z.B. 2011 Biodiversity of Pakistan

ZOO-474 Parasitology-I

Credit Hours 3(2+1)

Course Contents:

Protozoology

- Introduction, Systematic, geographical distribution, habitats, biology,
- pathogenesis, important symptoms, mode of transmission laboratory methods of diagnosis,
- Control of protozoa of medical and veterinary importance like **Amoebae**; Pathogenic, non-Pathogenic and opportunistic amoebae.

Flagellates;

- Intestinal ,Oral and Genital flagellates,
- Blood and tissue flagellates.
- Sporozoans ,Ciliates and Microsporidians.

Pathology

- The cell and cell injury and its relationship to disease.
- Acute and chronic inflammations
- Wound healing.

Books Recommended:

- Chandler, A.C. and Read, C.P., (1961). Introduction to Parasitology. Int.Ed. Wiley Poppan, New York.
- Chandrasoma , P. and Taylor, C.R.(1997). Concise Pathology. Prentice Hali International Inc. New Jersey USA.
- Dixon, M. E. Aid to Pathology. Churchill Livingstone, Edinburgh London and New York.
- Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
- Levine, N. D. Protozoan Parasites of domestic animals and of man. Durgers publishing Burgers publishing Co: Minnesota.
- Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.



- Noble, E.R and Noble, G.A. (1982). Parasitology: the biology of animal parasites. Lea and Febiger, Philadelphia.
- Olsen, O. W. (1974). Animal Parasites: their life cycle and ecology. University Park Press Baltimore
- Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
- Robbins, S. L. Basic Pathology. W. B. Saunders Co: London, Toronto.
- Roberts, L.S. and Jonovy, J.Jr., (2005). Foundation of Parasitology. W. Brown Publishers, Chicasgo, USA.
- Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.
- Schmidt, G. D. and Robbert, T. S. (2001). Foundation of Parasitology. The C.V. Mosby Company, Saint Louise
- Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.

ZOO-475 Entomology-I

Credit Hours 3(2+1)

Course Outline:

Morphology and Physiology

- a. An introduction of Entomology.
- b. Complete morphology of an insect.
- c. Anatomy and Physiology of various systems with special reference to digestive, nervous, circulatory, respiratory, excretory and reproductive system.
- d. Development and metamorphosis.
- e. Hibernation and diapause.

Classification of insect orders:

- a. General account of apterygota
- b. Subclass:Apterygota
- c. Order Collembola
- d. Order Diplura
- e. Order Zygentoma
- f. Order Protura
- g. Order:Archaeognatha

Subclass:Exopterygota

- a. Order Dermaptera
- b. Order Dictyoptera
- c. Order Embiidina
- d. Order Neuroptera
- e. Order Strepsiptera
- f. Order Mantophasmatodea



- g. Order Mecoptera
- h. Order Orthoptera
- i. Order Phasmatodeaj.
- j. Order Phthiraptera
- k. Order Plecoptera
- l. Order Psocoptera
- m. Order Siphonaptera
- n. Order Zoraptera
- o. Order Megaloptera
- p. Order Raphidioptera
- q. Order Ephemeroptera
- r. Order Odonata

Endopterygota

- a. Order Megaloptera
- b. Order Hymenoptera
- c. Order Coleoptera
- d. Order Lepidoptera
- e. Order Trichoptera
- f. Order Siphonaptera
- g. Order Diptera
- h. Order Neuroptera
- i. Order Mecoptera
- j. Order Raphidioptera
- k. Order Strepsiptera

Practical:

- a. Field visits for collection of different developmental stages of insects belonging to different orders.
- b. Identification and classification of collected specimens.
- c. Field visits and report writing of insect fauna of different crops.
- d. Field visits for survey of different control strategies being practiced for control of insect pests.
- e. Museum visits

Text and Reference Books:

- Atwal, A.S., 2015. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
- Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
- Chapman, R. F., 2013. The Insects-Structure and Function. 5th Edition. Cambridge University Press, New York.
- Gullan, P. J. and Cranstan, P. S., 2014. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
- Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A



Semester-VIII

8 th Semester (18) Credit Hours			
Course Code	Domain	Course Name	Credit Hours
ZOO-481	Major	Applied Fisheries	3(2+1)
ZOO-482	Major	Parasitology-II	3(0+3)
ZOO-483	Major	Entomology-II	3(2+1)
ZOO-484	CP	Capstone Project	3(2+1)
Any one Major course from the following			
ZOO-485	Major	Economic Zoology	3(2+1)
ZOO-486	Major	Immunology	3(2+1)
ZOO-487	Major	Mammalogy	3(2+1)
ZOO-488	Major	Ornithology	3(2+1)
ZOO-489	Major	Microbiology	3(2+1)
Total Credit Hours			18(13+5)

ZOO-481 Applied Fisheries

Credit Hours 3 (2+1)

Course Contents:

History and significance of aquaculture; Study of management techniques and habitat improvement; Designing, construction, fertilization, manuring, stocking and harvesting of a fish pond; Study of native and exotic fishes of Pakistan; Shellfish and fin fish; Fishing gears and crafts/nets used in Pakistan; Fish ways; construction and importance. Bye products of fish industry; Methods of processing fish such as drying, salting smoking, curing, freezing etc; Study of fish parasites, common diseases and enemies of fishes. Pollution and its effect on fish population; Methods of population estimation by direct count, catch effort, mark re-capture method, tagging of fish; Artificial propagation induced spawning techniques; Marketing strategies; transport of fish and seed; Major problems of fishermen in Pakistan;

Practical

- Collection and identification of common zooplanktons
- Study of gut contents of fish
- Statistical analysis of fish growth, length-weight relationship
- Study of farm fishes of KPK
- Visit to a fish farm/hatchery to study installations/methods of breeding
- Prepared slides of fish parasites



- Analysis of physical properties (temperature, light, colour, turbidity, conductivity etc.) and chemical properties (pH, oxygen, carbon dioxide, salinity, dissolved solids/salts) of water;
- General methods of age growth studies; reading of age from scales, opercula, otolith and back calculation from bones;
- Study of larvae, fry and fingerlings of a common fish, regulation of fishing, enactment of fishery legislation.

Books Recommended:

- Ali S.S.1999 Freshwater Fishery Biology, Naseem Book Depo, Hyderabad, Pakistan.
- Rath, R.H.1993 Freshwater Aquaculture, Scientific Publishers, Delhi,India.
- Stickney, R. R., & Gatlin III, D. M. (2022). Aquaculture: An introductory text. Cabi.
- Lucas, J. S., Southgate, P. C., & Tucker, C. S. (Eds.). (2019). Aquaculture: Farming aquatic animals and plants. John Wiley & Sons.
- Rounsefell, G.A.and Everhart, W.H. 1953 Fisheries Science, John Wiley and Sons, New York
- Mirza, M.R.and Bhatti, M.N.1993 Pakistan ki Machlian aur Mahi ParwariFerozsons, Lah

ZOO-482 Parasitology-II

Credit Hours 3(2+1)

Course contents:

Basic principles and concepts in Parasitology, Taxonomy, etiology, biology, epidemiology, pathology and pathogenesis, diagnosis, life cycle, control and treatment of:

Digenetic Trematodes:

- a. *Schistosoma mansoni*
- b. *S.japonicum*
- c. *S.haematobium*
- d. *Fasciola hepatica*
- e. *Fasciolopsis buski*
- f. *Paragonimus westermani*
- g. *Colonorchis sinensis*
- h. *Heterophyes heterophyes*

Monogenetic trematodes:

- a. *Dactylogyrus vastator*

Cestodes:

- a. *Diphyllobothrium latum*,
- b. *Taenia saginata* *T.solium*
- c. *Echinococcus granulosus*
- d. *Hymenolepis nana*
- e. *Dipylidium caninum*

Nematodes:

- a. *Trichuris trichiura*
- b. *Trichenella spiralis*



- c. *Strongyloides stercoralis*
- d. *Ancylostoma duodenale*
- e. *Ascaris lumbricoides*
- f. *Toxocara canis*
- g. *Enterobius vermicularis*
- h. *Wuchereria bancrofti*
- i. *Onchocerca volvulus*
- j. *Loa loa* and
- k. *Dracunculus medinensis*

Practical

- a. Stage and ocular micrometry for measurement of helminths.
- b. Preparation of temporary and permanent mounts of parasites from the following animals: a. Fish b. Frog/toad c. Fowl/Pigeon d. Rat/Mouse.
- c. Study of helminths from prepared slides.
- d. Study of eggs / larvae from feces and prepared slides.
- e. Diagnosis of medically important parasites in fecal specimen by using: Tillman's centrifugation technique, by Lugol's iodine staining technique

Books Recommended:

- Robberts, L. Sand Janovy John Jr. (2005). Foundation of Parasitology. 7th edition. The C.V. Mosby Company, Saint Louis
- Dixon, M. E. Aid to Pathology. Churchill Livingstone, Edinburgh London and New York
- Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
- Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
- Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.
- Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
- Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.

ZOO- 483 Entomology-II

Credit Hours 3(2+1)

Course Contents:

Introduction to Applied Entomology

Principles of

- apiculture,
- sericulture and
- lac culture.



General characteristics, life cycles and habits of insects of medical importance

Mosquito
Sand fly

General characteristics, life cycles and habits of insects of veterinary importance

Horse fly
Blow fly

Insect pests of Agriculture

Rice
Sugarcane

Insect pests of Household

Cockroach
Silver fish
Insect pests of Store grains
Red flour beetle
Rice Weevil

Pest Management

- Cultural, legislative Control
- Physical and Mechanical Control
- Biological Control
- Chemical Control
- Other approaches; Genetic, integrated control
- Relative merits of various types of insect control.
- Pest's management practices in Pakistan- oriental review.

Practical:

Applied Entomology

Collection, identification and preservation of different pests and other insects of medical and veterinary importance. Study of sericulture and apiculture. Operation of various types of sprayers. Dusters, fumigation emulsions. Preparation of insecticide emulsions in different concentration. The record of laboratory and fieldwork will be maintained and presented at the time of examination.

Books Recommended:

- Atwal, A. S. (1984) Agricultural pests of India and Southeast Asia. Kalyani Publishers Delhi
- Imms, A.D. (1957) A General Textbook of Entomology. 9th ed. Revised by O. W.
- Metcalf, G. L. & Flint, W.P. (1962) Destructive and useful insects. Mc Graw Hill New York.
- Ross, H. H., Herms, W. E. & Janes, M. T. (1982) A text book of Entomology. John Wiley and sons, New York
- Herms, W. E. & Janes, M. T. Medical Entomology. The Macmillan Co. New York
- Carter, W. Insects in relation to plant diseases.



- g. Green, M. B. Hartley, G.S. & West, T.P. Chemicals for crop protection and pest control, Pergamon Press, New York
- h. De Bach, P. Biological control of insect pests and weeds. Chapman and Hall, London.
- i. Matheson, R. (1950). Medical Entomology. Comstock Publishing Associates, N.Y.

ZOO- 485 Economic Zoology

Credit Hours 3(2+1)

Objectives:

Course Outline:

Basic concepts in Economic Zoology.

Parasitic protozoans and human disease. Economic importance of protozoa.

Vectors of human and domestic animals. Ecto- and Endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and Arachnida).

Apiculture, and Sericulture, Lac insect culture and Pearl culture Aquaculture and Fisheries (Edible Fresh water, Pond and Marine fish, Prawns, Pearl oysters).

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
1. pests of important crops and stored grains in Pakistan.
2. To visit Honey Bee farm. Write a report on their observations.
3. Visit to Sericulture farm in a nearby locality and write a report on their observations.
4. Study visit to fish Hatchery, Nursery ponds, Stocking ponds, Commercial fish breeding farms and report writing.
5. Identification of important species of Fish and their natural animal.
6. Visit to any bird farm and write a report on their observations.

Text and Reference books:

1. Economic Zoology. Ravindranathan, K. R. 2003. 1st ed. Dominant Publishers and Distributers. New Delhi. India
2. Principles of Wildlife Management. Bailey, J. A. 1986. John Wiley and Sons Inc.USA.
3. Wildlife ecology and management. Robinson, W. L. and Bolen, E. G. 1984. McMillan Publishing Company. Cambridge, UK.
4. A Primer of Conservation of Biology. Primack R. B. 2000. 2nd ed. Sinauer Associates Inc. USA.
5. Animal biodiversity of Pakistan. Mirza, Z. B. 1998. 1st ed: Printopack, Rawalpindi. Pakistan.
6. Ahmad, R. and Muzaffar, N., 1987. Rearing of Silkworm. Misc. Pub. Pak. Agric. Res. Council, pp. 53.
7. Akhtar, M. and Muzaffar, N., 2008. Introduction to Apiculture, Department of Zoology, Punjab University Press, 36 pp.



8. Anon, 1986. The Hive and the Honeybee. Dadant& Sons. Illinois, USA, pp. 740.

ZOO-486 Immunology

Credit Hours 3(2+1)

Course Outline:

1. Introduction

- a. Introduction to immunity.
- b. Immune response
- c. Infectious agents

2. Innate Immunity and Inflammation

- a. Sentinel cells and circulating leukocytes
- b. Inflammatory events and signaling
- c. The formation of pus

3. Microbial Recognition and Responses in Innate Immunity

- a. Pattern recognition receptors
- b. Innate immune signaling
- c. The complement system

4. Antibodies

- a. B lymphocytes
- b. Antibody structure and function

5. Lymphocyte Development and Diversity

- a. Lymphocyte development
- b. Clonal selection and expansion
- c. Differences between B and T lymphocytes
- d. The generation of lymphocyte receptor diversity

6. T Cell Activation by Antigens

- a. The role of dendritic cells
- b. The lymphatic system and delivery of antigen to lymph nodes
- c. Adaptive immune activation in secondary lymphoid tissues
- d. Antigen presentation



7. T Cell-Dependent B Cell Responses

- a. T Cell activation of B cells
- b. Isotype switching and affinity maturation

8. Helper T Cells

- a. Helper T cell functions
- b. The role of helper T cells in disease

Practical:

1. Antibody Purification and Conjugation
2. Immuno fluorescence
3. Gel Technique
4. ELISA
5. SDS PAGE/Western blots.

Text and Reference Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell (5th ed. 2008, Garland)
2. Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby: Immunology (2003, Freeman).
3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt: Roitt's Essential Immunology (12th ed. 2012, Blackwell)
4. Abul Abbas , Andrew H. Lichtman, Shiv Pillai. Cellular and Molecular Immunology , 9th edition, 2017. Elsevier Pub Co.
5. Gerd R. Burmester, Antonio Pezzutto Color Atlas of Immunology, 2006. Thieme Stuttgart, New York.

ZOO-487 Mammalogy

Credit Hours 3(2+1)

Course Outlines:

- a. **Introduction and History of mammalogy**; basic characteristics of mammals; diversified habitats for mammals in Pakistan and various continents.
- b. **Mammalian phylogeny**; dentition and dental formulae, cranial characteristics, evolution of mammals. Concepts of viviparity and ovo-viviparity.
- c. **Biogeography**; mammalian radiations, biogeography of mammals of Pakistan, occurrence, habits and varied habitats, importance to ecosystems and negative values.



- d. **Food and feeding strategies;** preferred food sources of mammals, foraging habits, diurnal and nocturnal feeding regimes of mammals; ecological constraints and mammalian adaptations. Concepts of stenophagy and euryphagy.
- e. **Population dynamics of mammals;** rates of natality, mortality, immigration and emigration
- f. **Population modeling concepts in mammals;** mammalian crowding and scuffles with respect to various environments.
- g. **Communication and social organization;** chemical signaling in mammals, types and causes of occurrence, communication skills and emergence of mammalian call notes.
- h. **Mammalian Adaptations;** concept of torpor formation, aestivation, hibernation, acoustic lateralis systems in mammals. Concept of molecular basis of mammalian adaptations.
- i. **Behavior of mammals;** home range, territoriality, predation pressure, evolutionary arms races and competition for resources.

Practical:

1. General survey of mammalian species (Visits to zoological museums and zoos and field study)
2. Study of techniques for the collection of mammals, their identification, and systematic relationships
3. Comparative study of the mammalian skeleton
4. Dissection of a rabbit or rat to expose its different systems

Text and Reference Books:

1. Vaghan, T. A., J. M. Ryan and N. J. Czaplewski. 2010. Mammalogy. 5th Ed. The John Hopkins University Press, New York, USA.
1. Feldhamer, G. A., L. C. Drickamer, S. H. Vessey, J. F. Merritt and C. Krajewski. 2007. Mammalogy: Adaptation, Diversity, Ecology. 3rd Ed. The John Hopkins University Press, New York, USA.
2. Genoways, H.H., 2000. Current Mammalogy. Plennium Press, New York

ZOO-488 Ornithology

Credit Hours 3(2+1)

Course Outlines

- a. **Introduction to ornithology;** basic ecology and themes of study.
- b. **Classification** and taxonomy of birds up to orders and species
- c. **Evolution of birds;** evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis.
- d. **Behavioral studies of birds:** song and sound dialects in birds; types of songs; preferred season and time for bird pleasure calls; distress calls. Courtship behavior in birds, bird foraging,



nesting and roosting activities. Learned and imprinting mechanisms in birds; brood parasitism and importance.

e. **Predator-Prey relationships**, mobbing impacts; foraging and territoriality scuffles; predator avoidance.

f. **Physiology of birds**: types of food; mastication; digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds.

g. **Bird conservation strategies**; sanctuaries and importance of urban zoos in bird life.

Practical:

1. Identification characteristics and taxonomy of birds to orders and families.
2. Dissection of sparrow, pigeon or common myna.
3. Study of gut contents of birds to assess their feeding habits.
4. Bird watching and preparation of ethograms

Text and Reference Books:

1. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
2. Lovette, I. J., & Fitzpatrick, J. W. (Eds.). (2016). Handbook of bird biology. John Wiley & Sons.
3. A.J.Urfi (2009). Birds of India: A Literary Companion, OUP.
4. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.
5. Kaiser, G. W. (2008). The Inner Bird: Anatomy and Evolution. Amazon Co.
6. Handbook of Bird Biology (2014). Cornell Lab. Ornithology. Princeton University Press. New Jersey, USA.

ZOO-489 Microbiology

Credit Hours 3(2+1)

Course Outline:

1. The beginnings of Microbiology

- a. Discovery of the microbial world
- b. Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods
- c. The scope of microbiology
- d. Microbial evolution, systematics and taxonomy.
- e. Characterization and identification of microorganisms
- f. Nomenclature and Bergey's manual

2. Morphology and fine structure of bacteria



- a. Size, shape and arrangement of bacterial cells
- b. Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks
- c. Structure and chemical composition of cell wall
- d. Cytoplasmic membrane
- e. Protoplasts, spheroplasts, the cytoplasm, nuclear material

3. Cultivation of bacteria

- a. Nutritional requirements and nutritional types of bacteria
- b. Physical conditions required for growth
- c. Bacteriological media
- d. Choice of media and conditions of incubation

4. Reproduction and growth of bacteria

- a. Modes of cell division
- b. New cell formation, Normal growth cycle of bacteria, synchronous growth, Continuous culture
- c. Quantitative measurement of bacterial growth, Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method
- d. Determination of nitrogen content and dry weight of cells
- e. The selection of a procedure to measure growth and importance of measurement of growth

5. Pure cultures and cultural characteristics

- a. Natural microbial populations, Selective methods, Chemical methods, Physical methods, Biological methods, Selection in nature
- b. Pure cultures, Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections
- c. Cultural characteristics; Colony characteristics, Characteristics of broth cultures

6. Prokaryotic diversity

- a. Purple and green bacteria, cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria
- b. Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and Chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria,



Endospore forming Grampositive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria

c. Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes

d. Archaea, Extremely Halophilic archaea, Methane producing archaea, Methanogens, Hyperthermophilic archaea, Thermoplasma

Practical:

1. Preparation of culture media
2. Pure culturing and cultivation of microbes
3. Simple, Gram, endospore, capsular, flagellar and acid fast staining of different genera of bacteria/Vital staining and microscopic observations of protozoa
4. Isolation of bacteriophages

Text and Reference Books:

1. Microbiology: An Introduction, 12th ed. (2018) by Gerard J. Tortora, Berdell R. Funke, Christine L. Case.
2. Prescott's Microbiology, 10th ed. (2017) by Joanne Willey, Linda Sherwood and Christopher J. Woolverton.
3. Laboratory Experiments in Microbiology, 11th ed. (2015) by Ted R. Johnson and Christine L. Case.