Scheme of Studies BS ZOOLOGY

Session 2022 Onward

Department of Zoology

University of Chitral

BS ZOOLOGY (4-Year) PROGRAM

Nomenclature: BS ZOOLOGY

Eligibility Criteria: FSc (Pre Medical) with at least 45% marks

Duration: The minimum duration for completion of BS degree is four years and the maximum is six years.

Degree Completion Requirements:

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

a) Must have studied and passed the prescribed courses, totaling 136 credit hours.

b) Must have earned CGPA (Cumulative Grade Point Average) of at least 2.0 on a scale of 4.0.

Course Outline BS Zoology (4 Year Degree Program)

1st Semester			
Course Code	**Course Title**	**Credits Hours**	**Course Category**
ZOO- 311	English-I (Functional English)	3(3+0)	Compulsory-I
ZOO -313	Mathematics	3(3+0)	Compulsory-III
ZOO -314	Botany-I (Diversity of Plants)	3(2+1)	General- I
ZOO -315	Chemistry-I (Organic Chemistry)	3(2+1)	General – II
ZOO-316	Animal Diversity-I (Invertebrates)	4(3+1)	Foundation-I
Any One from the following			
ZOO-312	Islamic Studies	2(2+0)	Compulsory-II
ZOO -317	Ethics	2 (2+0)	Compulsory-II
Total Credits		18(15+3)	

2nd Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO- 321	English-II (Communication Skills)	3(3+0)	Compulsory-IV
ZOO-322	Pakistan Studies	2(2+0)	Compulsory-V
ZOO-323	Botany-II (Plant Systematics, Anatomy Development and Embryology)	3(2+1)	General- III
ZOO -324	Chemistry-II (Inorganic Chemistry)	3(2+1)	General - IV
ZOO-325	Cell Biology	3(2+1)	Foundation-II
ZOO-326	Animal Diversity-II (Chordates)	4(3+1)	Foundation-III
Total Credits		18 (14+4)	

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Semester-3rd			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO- 431	English-III: Technical writing and presentation skills	3(3+0)	Compulsory-VI
ZOO -432	Introduction to Computer	3(1+2)	Compulsory-VII
ZOO -433	Botany-III (Plant Physiology & Ecology)	3(2+1)	General - V
ZOO -434	Chemistry-III (Environmental Chemistry)	3(3+0)	General- VI
ZOO-435	Animal Form and Function-I	4(3+1)	Foundation-IV
Any one of the following			
ZOO -436	Social Sciences	2(2+0)	General - VII
ZOO- 437	Introduction to Philosophy	2 (2+0)	General- VII
Total Credits		18 (14+4)	

4th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO - 441	English-IV (Advanced Academic Reading and Writing)	3(3+0)	Compulsory-VIII
ZOO- 442	Animal Behavior	3(3+0)	Major-I
ZOO- 443	Biological Techniques	3(1+2)	Major-II
ZOO- 444	Biochemistry-I	3(2+1)	Foundation-V
ZOO- 445	Animal Form & Function-II	4(3+1)	Foundation-VI
Any one of the following			
ZOO - 446	Psychology	2(2+0)	General-VIII
ZOO - 447	Fundamentals of Geography	2 (2+0)	General-VIII
Total Credits		18 (14+4)	

5th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO- 551	Molecular Biology	3(2+1)	Foundation-VII
ZOO-552	Biochemistry-II	3(2+1)	Foundation-VIII
ZOO-553	Physiology	4(3+1)	Major-III
ZOO-554	Ecology	3(2+1)	Major-IV
ZOO-555	Evolution	2(2+0)	Foundation-IX
ZOO-556	Principles of Systematics	3(2+1)	Foundation-X
Total Credits		18 (13+5)	

6th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO-561	Research Methodology	2(2+0)	Major-V
ZOO 562	Biostatistics	3(2+1)	Compulsory-IX
ZOO-563	Developmental Biology	4(3+1)	Major-VI
ZOO-564	Genetics	4(3+1)	Major-VII
ZOO-565	Zoogeography and Palaeontology	3(2+1)	Major-VIII
Total Credits		16 (12+4)	

7th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO-671	Bioinformatics	3(1+2)	Major-IX
ZOO-672	Ichthyology	3(2+1)	Major-X
ZOO-673	Wildlife	3(2+1)	Major-XI
ZOO-674	Parasitology-I	3(2+1)	Elective-I
ZOO-675	Entomology-I	3(2+1)	Elective-II
Total Credits		15 (10+5)	

8th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO-681	Applied Fisheries	3(2+1)	Elective-III
ZOO-682	Parasitology-II	3(2+1)	Elective-IV
ZOO-683	Entomology-II	3(2+1)	Elective-V
Any two subjects from the following or Thesis			
ZOO-684	Economic Zoology	3(2+1)	Optional
ZOO-685	Immunology	3(2+1)	Optional
ZOO-686	Mammalogy	3(2+1)	Optional
ZOO-687	Ornithology	3(2+1)	Optional
ZOO-688	Microbiology	3(2+1)	Optional
OR			
ZOO-689	Thesis	6(0+6)	Optional
Total Credits		15 (10+5) or 15 (9+6)	

Total Credits: 18+18+18+18+18+16+15+15=136

Compulsory Courses (09) = 25 credit hours
General Courses (08) = 22 credit hours
Foundation Courses (10) = 33 credit hours
Major Courses (13) = 41 credit hours
Elective Courses (05) = 15 credit hours

Detail of the Courses of study BS 4 year

Semester-I

Semester 1st			
Course Code	**Course Title**	**Credits Hours**	**Course Category**
ZOO- 311	English-I (Functional English)	3(3+0)	Compulsory-I
ZOO -313	Mathematics	3(3+0)	Compulsory-III
ZOO -314	Botany-I (Diversity of Plants)	3(2+1)	General- I
ZOO -315	Chemistry-I (Organic Chemistry)	3(2+1)	General – II
ZOO-316	Animal Diversity-I (Invertebrates)	4(3+1)	Foundation-I
Any One from the following			
ZOO-312	Islamic Studies	2(2+0)	Compulsory-II
ZOO -317	Ethics	2(2+0)	Compulsory-II
Total Credits		18(15+3)	

Functional English

Compulsory-I ZOO – 311 English-I (Functional English) 3(3+0)

Course Contents

Basics of Grammar: Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verb, Punctuation and spelling Comprehension: Answers to questions on a given text

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)

Listening: To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills: Urdu to English

Paragraph writing: Topics to be chosen at the discretion of the teacher

Presentation skills: Introduction to presentations and deliberations

Note: Extensive reading is required for vocabulary building

Islamic Studies

Compulsory-II	ZOO -312	Islamic Studies	2(2+0)

Course Contents

Objectives:

This course is aimed at:

1 To provide Basic information about Islamic Studies

2 To enhance understanding of the students regarding Islamic Civilization

3 To improve Students skill to perform prayers and other worships

4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies

1) Basic Concepts of Quran

2) History of Quran

3) Uloom-ul-Quran

Study of Selected Text of Holly Quran

1) Verses of Surah Al-Baqara Related to Faith(Verse No-284-286)

2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi

(Verse No-1-18)

3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)

4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)

Seerat of Holy Prophet (S.A.W) I

1) Life of Muhammad Bin Abdullah (Before Prophet Hood)

2) Life of Holy Prophet (S.A.W) in Makkah

3) Important Events of Life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

1) Life of Holy Prophet (S.A.W) in Madina

2) Important Events of Life of Holy Prophet in Madina

Introduction to Sunnah

1) Basic Concepts of Hadith

2) History of Hadith

3) Kinds of Hadith

4) Sunnah & Hadith

5) Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence

1) Basic Concepts of Islamic Law & Jurisprudence

2) History & Importance of Islamic Law & Jurisprudence

3) Sources of Islamic Law & Jurisprudence

Islamic Culture & Civilization

1) Basic Concepts of Islamic Culture & Civilization

2) Characteristics of Islamic Culture & Civilization

Islam & Science

1) Basic Concepts of Islam & Science

2) Contributions of Muslims in the Development of Science

3) Quran & Science

Islamic Economic System

1) Basic Concepts of Islamic Economic System

2) Islamic Concept of Riba

Political System of Islam

1) Basic Concepts of Islamic Political System

2) Islamic Concept of Sovereignty

3) Basic Institutions of Govt. in Islam

منتخب احادیث مبارکہ

حدیث نمبر:1

عن عبداللہ ابن عمربن الخطاب رضی اللہ عنہما قال سمعت رسول اللہ ﷺیقول:بنی الاسلام علیٰ خمس شہادۃ ان لا الٰہ الا اللہ وان محمدا عبدہٗ ورسولہ واقام الصلوٰۃ وایتاء الزکوٰۃ وحج البیت وصوم رمضان

حدیث نمبر2

عن انس بن مالک رضی اللہ عنہ قال قال رسول اللہ ﷺ:"من خرج فی طلب العلم فھو فی سبیل اللہ حتّیٰ یرجع"۔

حدیث نمبر:3

عن ابی امامۃ رضی اللہ عنہ قال قیل یارسول اللہ!الررجلان یلتقیان ایھما یبدا بالسلام فقال اولاھما باللہ"۔

حدیث نمبر4

عن ابی ھریرۃ رضی اللہ عنہ ان رسول اللہ ﷺ قال:" من حسن اسلام المرء ترکہ مالایعنیہ"۔

حدیث نمبر5

عن عبد اللہ ابن مسعود رضی اللہ عنہ قال قال:" رسول اللہ ﷺ لا یحل دم امرء مسلم الا باحدی الثّلث الثیب الزانی والنفس بالنفس والتارک لدینہ المفارق للجماعۃ"۔

حدیث نمبر6

عن ابی ھریرۃ رضی اللہ عنہ قال قال رسول اللہ ﷺ:"من اُفتی بغیر علم کا اثمہ علیٰ من افتاۃ ومن اشار علیٰ اخیہ بامر یعلم ان الرشد فی غیرہ فقد خانہ"۔

حدیث نمبر7

عن انس رضی اللہ قال قال رسول اللہ ﷺ :"والذی نفسی بیدہ لا یؤمن احدکم حتّیٰ یحب لاخیہ ما یحب لنفسہ"۔

حدیث نمبر8

عن ابی ھریرۃ رضی اللہ عنہ ان رسول اللہ ﷺ قال:" من کان یؤمن باللہ والیوم الآخر فلیقل خیرا او لیصمت ومن کان یؤمن باللہ والیوم الآخر فلیکرم جارہ ومن کا ن یؤمن باللہ والیوم الآخر فلیکرم ضیفہ"۔

حدیث نمبر9

عن ابی عمرو سفیان بن عبد اللہ رضی اللہ عنہ قال:" قلت یا رسول اللہ ﷺ قل لی فی الاسلام قولا لااسئل عنہ احدا غیرک قال:" قل آمنت باللہ ثم استقم"۔

حدیث نمبر10

عن ابی عبداللہ جابر بن عبد اللہ رضی اللہ عنہما ان رجلا سئل رسول اللہ ﷺ فقال:" ارأیت اذا صلیت المکتوبات وصمت رمضان واحللت الحلال وحرمت الحرام ولم ازد علیٰ ذٰلک شیئا ادخل الجنۃ قال:" نعم"۔

حدیث نمبر11

عن ابی سعید الخدری رضی اللہ عنہ ان رسول اللہ صلی اللہ علیہ وآلہ وسلم قال:" لا ضرر ولا ضرار فی الاسلام"۔

حدیث نمبر12

عن ابن عباس رضی اللہ عنہ قال قال رسول اللہ ﷺ:"فقیہ واحد اشد علی الشیطان من الف عابد"۔

حدیث نمبر13

عن ابی سعید الخدری رضی اللہ عنہ قال سمعت رسول اللہ ﷺ یقول:" من رأیٰ منکم منکراً فلیغیرہ بیدہ فان لم یستطع فبلسانہ فان لم یستطع فبقلبہ و ذٰالک اضعف الایمان"۔

حدیث نمبر14

عن عبداللہ بن عمرو بن العاص رضی اللہ عنہما قال قال رسول ﷺ:" لا یؤمن احدکم حتیٰ یکون ھواہ تبعاً لما جئت بہ"۔

حدیث نمبر15

عن ابی ھریرۃ رضی اللہ عنہ ان رجلا قال للنبی ﷺ:" اوصینی قال لا تغضب فردد مراراً"۔

حدیث نمبر16

عن ابی ھریرۃ رضی اللہ عنہ قال قال رسول اللہ ﷺ:" ایاکم و الحسد فان الحسد یأکل الحسنات کما تأکل النار الحطب"۔

حدیث نمبر17

"عن ابی ھریرۃ رضی اللہ عنہ قال قال رسول اللہ ﷺ:" آیۃ المنافق ثلاث اذا حدث کذب واذا وعد اخلف واذا ائتمن خان

حدیث نمبر18

عن معاویۃ رضی اللہ عنہ قال قال رسول اللہﷺ:" من یرد اللہ بہ خیرا یفقہ فی الدین"۔

حدیث نمبر19

عن ابی ھریرۃ رضی اللہ عنہ قال قال رسول اللہﷺ:" من قال سبحان اللہ وبحمدہ مائۃ مرۃ حطت عنہ خطایاہ وان کانت مثل زبد البحر"۔

حدیث نمبر 20

انما الاعمال بالنیات انما لامرء ما نویٰ

Reference Books:

1) Hameed ullah Muhammad, “Emergence of Islam” , IRI,

Islamabad

2) Hameed ullah Muhammad, “Muslim Conduct of State”

3) Hameed ullah Muhammad, ‘Introduction to Islam

1) Mulana Muhammad Yousaf Islahi,”

5) Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.

6) Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research

Institute, International Islamic University, Islamabad (1993)

7) Mir Waliullah, “Muslim Jurisprudence and the Quranic Law of Crimes”

Islamic Book Service (1982)

8) H. S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep

Publications New Delhi (1989)

9) Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama

Iqbal Open University, I

Compulsory-III	ZOO -313	Mathematics	3(3+0)

Mathematics

Course Contents

1. Real and complex numbers: Introduction to real numbers, operations on real numbers, properties of real numbers, introduction to complex number, conjugate of complex number, operation (addition, subtraction, multiplication and division) on complex number.

2. Sets and Functions: Sets and its representation, types of sets, operations on sets (union, intersection and complement), commutative law, associative law, distributive law, De-Morgan’s laws, order pairs, Cartesian product of two sets, binary relation, function and types of function.

3. Matrices and determinants: Introduction to matrices, types of matrix, operation on square matrices (addition, subtraction and multiplication), inverse and determinants of matrix of order 2 by 2, Cramer rule to solve linear equation in two variable.

4. Quadratic equations: solution of quadratic equation in one variable by using quadratic formula, Qualitative analysis of roots of a quadratic equation, equations reducible to quadratic equation, cube root of unity, relationship between roots and coefficients of quadratic equations.

5. Sequences and series: Arithmetic sequences, geometric sequences and harmonic sequences.

7. Trigonometry: Introduction to trigonometry, trigonometric ratios, Pythagoras theorem, trigonometric identities.

Book Recommended:

1. Swokowski, E.W.1986. Fundamentals of Algebra and Trigonometry. 6th Ed., PWS-Kent Company.
2. Kaufmann, J.E., 1987.College Algebra andTrigonometry. PWS-Kent Company, Boston.
3. Dolciani, M.P., Wooton, W., Beckenback, E.F., Sharron, S.1978. Algebra 2 and Trigonometry, Houghton & Mifflin.

Diversity of Plants

General- I ZOO -314 Botany – I (Diversity of Plants)	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.

Organic Chemistry

General – II	ZOO -315	Chemistry-I	(Organic Chemistry)	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.

Practicals:

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.

Foundation-I	ZOO-316	Animal Diversity-I (Invertebrates)	4(3+1)

Animal Diversity-I (Invertebrates)

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.
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 adaptions 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 Echinodermta.

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.

Ethics

- 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.

Semester-II

Semester-2nd			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO- 321	English-II (Communication Skills)	3(3+0)	Compulsory-IV
ZOO-322	Pakistan Studies	2(2+0)	Compulsory-V
ZOO-323	Botany-II (Plant Systematics, Anatomy Development and Embryology)	3(2+1)	General- III
ZOO -324	Chemistry-II (Inorganic Chemistry)	3(2+1)	General - IV
ZOO-325	Cell Biology	3(2+1)	Foundation-II
ZOO-326	Animal Diversity-II (Chordates)	4(3+1)	Foundation-III
Total Credits		18 (14+4)	

English-II (Communication Skills)

Compulsory-IV	ZOO - **321**	**English-II (Communication Skills)**	**3(3+0)**

Paragraph writing: Practice in writing a good, unified, and coherent paragraph

Essay writing: Introduction

CV and job application: Translation skills; Urdu to English

Study skills: Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills: Letter/memo writing, minutes of meetings, use of library and internet
Presentation skills: Personality development (emphasis on content, style and pronunciation)

Note: *documentaries to be shown for discussion and review*

Books Recommended:

Boutin, Marie-Chrisitine, Brinandm, S.,Grellet, F. 1993. Writing: Intermediate. Oxford Supplementary Skills. Fourth Impression.

Nolasco, R. 1992. Writing: Upper-Intermediate. Oxford Skills. Fourth Impression. (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

Tomlinson, B., Ellis, R. 1991. Reading. Advanced Oxford Supplementary Skills. Third Impression.

Thomson, A.J., Martinet, A.V. 1986. Practical English Grammar Exercises 2. 3rd Ed. Oxford University Press.

Langan, J. Reading and Study Skills by Riachard York.

Pakistan Studies

Compulsory-V	ZOO -322	Pakistan Studies	2(2+0)

Objectives

The course aims to:

Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.

Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Contents

Historical Perspective:

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah

Factors leading to Muslim separatism; Social, Cultural, Religious and Economic Issues

People and Land; Indus Civilization and the Muslim advent

Location and geo-physical features.

Government and Politics in Pakistan:

Political and constitutional phases:

Initial constitutional problems

First constituent assembly of Pakistan

Objective Resolution

BPC 1st report, criticism

BPC 2nd Report, criticism

Bogra Formula and constitutional crisis

Establishment of 2nd Constituent Assembly and 1956 constitution

Features of 1956 constitution

Causes of failure of 1956 constitution and imposition of Martial Law of 1958

1962 constitution: salient features

1965 War and consequences

The causes of abrogation of 1962 constitution

1970 Elections and political crisis

The debacle of Bengal, causes and consequences

1973 constitution

Contemporary Pakistan:

Economic institutions and issues

Society and social structure

Books Recommended

- Zaidi A.S. 2000. Issue in Pakistan's Economy. Karachi: Oxford University Press.
- Rafique A. M. 1998. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
- Safdar, M. 1994. Pakistan Political Roots & Development. Lahore.
- Burke, S.M., Ziring L. 1993. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.
- Noor ul Haq. 1993. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research.
- Waseem, M. 1987. Pakistan Under Martial Law, Lahore: Vanguard.
- Javed, B. S. 1980. State and Society in Pakistan.
- Ali, K. (1977). A new history of Indo-Pakistan, since 1526. Aziz Publishers.
- Khan, H. (2005). Constitutional and political history of Pakistan. Oxford University Press, USA.

Botany-II (Plant Systematics, Anatomy Development / Embryology)

a) Plant systematics

General- III	ZOO -323	Botany-II (Plant Systematics, Anatomy Development / Embryology)	3(2+1)

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 primary body of plant.

Study of xylem 3-dimensional plane of wood.

T. S of angiosperm stem and leaf.

Anatomy of germinating seeds

Study of pollens

Chemistry-II (Inorganic Chemistry)

Course Contents:

General – IV	ZOO -324	Chemistry-II (Inorganic Chemistry)	3(2+1)

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.

Practicals:

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.

Cell Biology

Course Outline:

Foundation-II	ZOO-325	Cell Biology	3(2+1)

1. Introduction cell structure and function
a. Cell theory
b. Comparison of plant and animal cells
c. Comparison of prokaryotic and eukaryotic cells
2. Cell membranes
a. Structural models
b. Chemical composition and function
3. Cell Organelles (structure and function)
a. Endoplasmic reticulum
b. Golgi Bodies
c. Mitochondria
d. Lysosomes
e. Peroxysomes
f. Ribosome
4. Nucleus
a. Structure and function
b. Nuclear membrane
c. Chromatin
5. Cytoskeleton
a. Structure and types
b. Function of cytoskeleton
6. Cellular transport
a. Diffusion and osmosis
b. Facilitated and active transport
c. Endocytosis and exocytosis
7. Cellular reproduction
a. Cell cycle
b. Mitosis
c. Meiosis

Practical:

Microscopy

Staining techniques (Gram staining)

Identification of cell organelles (prepared slides)

Preparation of temporary whole mount.

Preparation of permanent whole mount.

Squash preparation of onion root tip for mitotic stages.

Study of mitotic and meiotic stages (prepared slides)

Books Recommended:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York

2.Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony BretscherHiddePloegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.

3.Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.

4.Karp, J. 2005. Celln and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC

5.De Robertis, E. D. P. 2017. Cell and Molecular Biology,8th edition, Lea &Febiger, New York

Animal Diversity-II (Chordates)

Course Outline:

Foundation-III	ZOO-326	Animal Diversity-II (Chordates)	4(3+1)

1. Protochordates

a. Classification of protochordates.

b. Structure, anatomy and organ systems of Acorn worms, Urochodates and Cephalochodates c. Reproduction; life histories and metamorphosis of protochodates.

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 Crocodilia

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 viviparity.

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 to PMNH for the study of 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

Semester-III

Semester-3rd			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO- 431	English-III: Technical writing and presentation skills	3(3+0)	Compulsory-VI
ZOO -432	Introduction to Computer	3(1+2)	Compulsory-VII
ZOO -433	Botany-III (Plant Physiology & Ecology)	3(2+1)	General - V
ZOO -434	Chemistry-III (Environmental Chemistry)	3(3+0)	General- VI
ZOO-435	Animal Form and Function-I	4(3+1)	Foundation-IV
Any one of the following			
ZOO -436	Social Sciences	2(2+0)	General - VII
ZOO- 437	Introduction to Philosophy	2 (2+0)	General- VII
Total Credits		18 (14+4)	

English-III: Technical writing and presentation skills

Compulsory-VI	ZOO - 431	English-III: Technical writing and presentation skills	3(3+0)

Course Contents:

Presentation skills: Essay writing: Descriptive, narrative, discursive, argumentative,

Academic writing: how to write a proposal for research paper/term paper, How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency),

Technical Report writing:

Progress report writing:

Note: *Extensive reading is required for vocabulary building*

Technical Writing and Presentation Skills

Essay Writing and Academic Writing

Books Recommended:

1. Langan, J. 2004. College Writing Skills McGraw-Hill Higher Education.

Kirszner. L.G., Mandell, S. R. Patterns of College Writing. 4thEd. by St. Martin's Press.

White, R. 1992. Writing, Advanced Oxford Supplementary Skills. Third Impression (particularly suitable for discursive, descriptive, argumentative and report writing).

Neulib, J., Cain, K. S., Ruffus, S., Scharton, M. (Editors). Reading. The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. (A reader that will give students exposure to the best of twentieth century literature).

Introduction to Computer

Compulsory-VII	ZOO -432	Introduction to Computer	3(1+2)

Basic of Computers

- Introduction and history of computers
- Generations of Computer
- Types of computers (analog, digital, hybrid)
- Classification of Computer
- Mainframe Computer, Minicomputer, Super Computer & Micro Computer
- Block diagram of Computer System.

Parts of Computer System

- Hardware
- Essential Computer Hardware (Processor, Memory, Input Devices, Output Devices & Storage devices)
- Software
- Data
- User

- **Processing Unit**
  - Data Processing Techniques
    - Manual Data Processing
    - Electronic Data Processing
  - Central Processing Unit (CPU)
    - ALU and Control Unit
    - Buses and Ports
- **Computer Memory/ Storage**
  - Memory and types
    - Primary/Internal memory (RAM & ROM)
    - Cache Memory and Registers
    - Units of Computer Memory (Bit, Byte, KB, MB, GB , TB)
  - Secondary Storage
    - Magnetic Devices
    - Optical Devices.
    - Solid State Devices
- **Input Devices**
  - Keyboard, Mouse, Scanner, Digital Camera
- **Output device**
  - Monitor (CRT, LED, LCD), Printer, Speaker
- **Software**

- System software
  - Operating system
- Application software
  - General purpose and Special Purpose Software

- **Networking Basic Concepts**
  - Computer Network (LAN & WAN) and its advantages
  - Server Based Network and Peer to Peer Network
- **Data Communication and Data Communication System (DCS)**
  - Components of DCS (Sender, Receiver, medium, Message & Protocol)
- **The Internet & Internet Services**
  - The World Wide Web
  - Electronic mail
  - File Transfer
  - Chat
  - Online Services
  - Instant Messaging
- Web Browsers, URL, Web Searching/ Browsing, Search Engine
- Social Networking Ethics, Cyber Crime and Types
- **Productivity Software/ Introduction to:**
  1. Microsoft Word (Beginner's Level)
  2. Microsoft Excel (Beginner's Level)
  3. Microsoft PowerPoint((Beginner's Level)

Text Books/Reference Books

1. Introduction to Computers by Peter Norton, 6th International Edition, McGraw-Hill
2. Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition, McGraw-Hill
3. Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Sawyer
4. Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.

Botany-III (Plant Physiology & Ecology)

Physiology

General – V	ZOO -433	Botany-III (Plant Physiology & Ecology)	3(2+1)

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.

8. 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 RowNewman, 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

Chemistry-III (Environmental Chemistry)

General- VI	ZOO -434	Chemistry-III (Environmental Chemistry)	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-Willey & 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).

Animal Form and Function-I

Course Outline:

Foundation-IV	ZOO-435	Animal Form and Function-I	4(3+1)

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, hygroreceptors, 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, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

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.

Social Sciences

General – VII	ZOO -436	Social Sciences	2(2+0)

Introduction

Definition, Scope, and Subject Matter

Sociology as a Science

Historical background of Sociology

Basic Concepts

Group, Community, Society

Associations: Non-Voluntary, Voluntary

Organization: Informal, Formal

Social Interaction,

Levels of Social Interaction, Process of Social Interaction

Cooperation, Competition, Conflict, Accommodation, Acculturation and diffusion, Assimilation, Amalgamation

Social Groups

Definition and Functions, Types of social groups, In and out groups, Primary and Secondary group, Reference groups, Informal and Formal groups, Pressure groups

Socialization and Personality

Personality, Factors in Personality Formation, Socialization, Agencies of Socialization, Role and Status

Recommended Books:

- Anderson, Margaret and Howard F. Taylor. 2001. *Sociology the Essentials*. Australia: Wadsworth.
- Brown, Ken 2004. *Sociology*. UK: Polity Press
- Gidden, Anthony 2002. *Introduction to Sociology*. UK: Polity Press.
- Macionis, John J. 2006. 10th Edition *Sociology* New Jersey: Prentice-Hall
- Tischler, Henry L. 2002. *Introduction to Sociology* 7th ed. New York: The Harcourt Press.
- Frank N Magill. 2003. *International Encyclopedia of Sociology*. U.S.A: Fitzroy Dearborn Publishers
- Macionis, John J. 2005. *Sociology* 10th ed. South Asia: Pearson Education
- Kerbo, Harold R. 1989. *Sociology: Social Structure and Social Conflict.* New York: Macmillan Publishing Company.
- Koening Samuel. 1957. *Sociology: An Introduction to the Science of Society*. New York: Barnes and Nobel.
- Lee, Alfred Mclung and Lee, Elizabeth Briant 1961. *Marriage and The family.* New York: Barnes and Noble, Inc.
- Leslie, Gerald et al. 1973. *Order and Change: Introductory Sociology* Toronto: Oxford University Press.
- Lenski, Gevbard and Lenski, Jeam. 1982. *Human Societies*. 4th edition New York: McGraw-Hill Book Company.

Introduction to Philosophy

General – VII	ZOO -437	Introduction to Philosophy	2(2+0)

INTRODUCTION

a. Definition of philosophy
b. Literal and General Subject Matter
c. Nature and Scope of Philosophy
d. Branches of Philosophy:
   Metaphysics; (Substance, Self and Identity)
   Ontology, Cosmology, philosophical psychology.

EPISTEMOLOGY

a. Knowledge (Definition, Scope, Nature and Conditions of Knowledge)
b. Empiricism,
c. Rationalism,
d. Skepticism,
e. Institution Theories of Truth

LOGIC

a. Basic Logical Concepts
b. Inductive and Deductive reasoning
c. Logical Fallacy:
   - Inductive fallacy
   - False Dilemma
   - Ad hominem
   - Straw man

ETHICS

a. Introduction (Nature and Scope)
b. Normative and applied Ethics
   - The challenge of Bioethics
   - Environmental ethics
   - Business ethics and emerging technologies

ASTHETICS

a. Definition, and nature
b. Objectivity vs Subjectivity
c. School of thoughts in Philosophy: Greek philosophical thoughts

MATERIALISM

a. Introduction and Types
   - Mechanistic materialism
   - Dialectical materialism
   - Naturalistic humanism
b. Realism
c. Pragmatism
d. Existentialism
e. Phenomenalism
f. Analytic Tradition

Book Recommended

a. Smith N. 2022. Introduction to Philosophy. OpenStax Rice University.
b. Cahn, Steven M. Classics of Western Philosophy. 6th ed. (Indianapolis: Hackett, 2002) Cottingham,
c. John. Ed. Western Philosophy. 1st ed. (Oxford, UK: Blackwell Publishers, 1996).
d. Gould, James A. (ed.), Classic Philosophical Question, 10th ed. (New York: MacMillan Pub. Co.,

Semester-IV

Semester-4th			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO - 441	English-IV (Advanced Academic Reading and Writing)	3(3+0)	Compulsory-VIII
ZOO- 442	Animal Behavior	3(3+0)	Major-I
ZOO- 443	Biological Techniques	3(1+2)	Major-II
ZOO- 444	Biochemistry-I	3(2+1)	Foundation-V
ZOO- 445	Animal Form & Function-II	4(3+1)	Foundation-VI
Any one of the following			
ZOO - 446	Psychology	2(2+0)	General-VIII
ZOO - 447	Fundamentals of Geography	2 (2+0)	General-VIII
Total Credits		18 (14+4)	

English-IV (Advanced Academic Reading and Writing)

Compulsory-VIII	ZOO - 441	English-IV (Advanced Academic Reading and Writing)	3(3+0)

- **The art of listening**
- **What is good listening?**

- **Types of listening**

  Appreciative, Listening for pleasure or enjoyment, Empathetic, Comprehensive, Critical

- **Tips for good listening**

  Face the speaker, Maintain eye contact, Minimize the external distractions, Respond appropriately, Focus on what the speaker is saying, Minimize the internal distractions, Keep an open mind, Avoid letting the speaker know how you handled a similar situation, Even if the speaker is launching a complaint against you, wait until they finish to defend yourself, Engage yourself, Body language, Silence, Touching, Some audio listening

- **Ways to become effective listener**

Setting the stage. Appropriate Physical Environment, Removal of distraction, Be open and accessible, Maintain relaxed, open posture that shows concentration, Ensure mutual understanding reflect feelings, Offer acknowledgement (say uh, huh), Paraphrase main ideas, Interrupt to clarify, Confirm next step

- **Barrier to Listening include**

  Worry, fear, anger, grief and depression, Individual bias and prejudice, Semantics and language differences, Noise and verbal "clutter", Preoccupation, boredom and shrinking attention spans, Act distracted (look at your watch!), Tell your own story without acknowledging, Give no response, Invalidate response, be negative, Interrupt, Criticize, Diagnose what we said, Give advice/solution quickly, Change the subject, Reassure without acknowledgment

- **Communication**

  Communication skills, Types of communications, Importance and benefit of effective communication, Components of communication, Nonverbal communication, Difference between hearing and listening, Essential of communication (Dos), Essential of communication (Don'ts), Ways to improve the communication, Common ways to communicate with

- **Public speaking**

  Talk, conversation, speech and rhetoric, Speaking opportunities at work place, home daily life

- **PS and conversation**

  Organization of thought, Tailoring the message to the right audience, Interesting start, Consideration of audience feedback, PS is structural, PS requires normal language, PS requires delivery method

- **The speech communication process**

  Speaker, Message, Channel, Listener, Feedback, Interference, Situation

- **Analysis of audience**

PS is audience centered, Kind of audience, Psychology of audience, Care of egocentrism of people, Demographic analysis of audience, Observable traits, Age, gender, racial, ethical background, religion group

- **Situational audience analysis**

  Unique traits of speaking situation, Size, Physical setting

- **Disposition toward the topic**

  Interest, knowledge , attitude

- **Disposition towards the speaker**
- **Disposition towards the occasion**
- **Organization of speech**
- **Connectives**

  Transition, Internal previews, Internal summaries, Signposts

- **Supporting material**

  Example, Statistics, Testimony

- **Beginning and ending of speech**

  Get attention and interest, Reveal the topic, Establish credibility and Goodwill, Preview the body of the speech, Signal the end of the speech, Reinforce the central idea

- **Letters. Emails and memos**

- Watching some movies or listening material from ILETS or TOFEL courses based on thematic or important course related issues and then writing as assignment or doing some quiz on them.

Animal Behaviour

Major-I	ZOO- 442	Animal Behavior	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. Nortan and Co.New York.
- Nordell, S.E. and Valone, T.J. 2017. Animal Behavior. Concepts, Methods, and Applications. Second edition. iSBn978-0-19-027674-4
- 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.

Biological Techniques

Major-II	ZOO- 443	Biological Techniques	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 Micrometery:

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.

- Curos, M. 1997.Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
- Curos, M. 1997. Environmental Sampling and Analysis: ForTechnician. 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.

Biochemistry-I

Foundation-V	ZOO- 444	Biochemistry-I	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:

a. Structural levels of proteins; Covalent structure of proteins;

b. function of some structural & functional proteins; Hemoglobin, Cytochrome-

c: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;

Triacyclglycerols; waxes Structural/membrane lipids; Glycerophospholipids with Ether and Ester linkages Galactolipids &Sulfolipds: 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

Animal Form & Function-II

Foundation-VI	ZOO- 445	Animal Form & Function-II	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

1. **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.

2. 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

3. 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 slidesand/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. NewYork: McGraw-Hill.

- Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill

Psychology

General-VIII	ZOO - 446	Psychology	2(2+0)

Understanding Psychology

Psychology: Scientific perspective, Historical perspective, Schools of psychology, Methods of psychology, Ethical issues, Fields of psychology and their application

Biological Basis of Behaviour

Neuron and its function, Central nervous system, Peripheral nervous system, Endocrine system

Sensation and Perception

Senses: Vision, audition, smell, taste and kinesthetic, Introduction to perception

Learning

Definition of learning, Types of learning: Classical and operant conditioning, Punishment and its effects, Latent and observational learning

Memory

Definition and types of memory, Processes and techniques of improving memory Forgetting: Nature and causes

Cognition and Language

Concept of cognition, Problem solving, Judgment and decision making, Language development

Language and cognition, Language and culture

Intelligence and Creativity

Concept of intelligence, Theories of intelligence, Assessment of intelligence, Mental retardation

Concept of creativity and its stages

Motivation and Emotion

Introduction to motivation, Factors affecting motivation, Introduction to emotions, Types of emotions

Personality

Defining personality, Personality assessment

Recommended Books

- Atkinson R. C., & Smith, E. E. (2000). *Introduction to psychology* (13th ed.). NY: Harcourt Brace College Publishers.
- Coon, D., &Mutterer, J. (2008).*Introduction to psychology: Gateways to mind andbehavior*(12th ed.). USA: Wadsworth Cengage Learning.
- Fernald, L. D., & Fernald, P.S (2005).*Introduction* to psychology. USA; WMC Brown Publishers.
- Fredrickson, B., Nolen-Hoeksema, S., Loftus, G., &Wagenaar, W. (2009). *Atkinson& Hilgard's introduction to psychology* (15th ed.). USA: Wadsworth.
- Glassman, W.E. (2000). *Approaches* to psychology.Open University Press. Hayes, N. (2000). *Foundation of psychology* (3rd ed.). UK: Thomson Learning.
- Kalat, J. W. (2010). *Introduction to psychology*.USA: Cengage Learning, Inc. Lahey,
- B. B. (2004). *Psychology*: *An introduction* (8th ed.). UK: McGraw-Hill Companies
- Inc. Leahey,T. H. (1992). *A history of psychology: Main currents in psychologicalthought.* New Jersey: Prentice-Hall International,
- Inc.Myers, D. G. (2011).*Psychology* (10th ed.). USA: Wadsworth Publishers.
- Ormord, J. E. (1995). *Educational psychology: Developing learners*. USA: Prentice Hall, Inc.

Fundamentals of Geography

General-VIII ZOO - 447 Fundamentals of Geography 2(2+0)

Course objectives:

To expose students with the founding principles of Geography and geographical knowledge.

Course outline:

Introduction

Definition, scope and branches of Geography

Roots of the discipline and basis of geographic concepts Themes and tradition of geography.

Tools of geography

The Universe

Galaxies and solar system

The Earth as a planet

Celestial positions, its shape and size

Rotation, revolution, and related phenomena

Sphere of the Earth:

Lithosphere, Atmosphere, Hydrosphere, Biosphere

Man Environmental Interaction

Population,

Major economic activities,

Settlements

Recommended Books:

- Arbogast, A. F. (2007) Discovering Physical Geography, Jhon Wiley and Sons, London.
- Christopherson, R. W. (2009) Geo systems: An Introduction to Physical Geography, Person Prentice Hall, New Jersey.
- De Blij, H. J and Muller, P. O. (1996) Physical Geography of the Global Environment, USA, Jhon Wiley and sons Inc., New Jersey.
- Guinness, J. P. & Nagle, G. (2011) Geography, Hodder Education, London.
- King, C. (1980) Physical Geography, Basil Blackwell, Oxford.
- Miller, G. T. (2008) Living in the Environment, Principles, connections and Solutions, Wadsworth, USA.

Semester-V

Semester-5th			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO- 551	Molecular Biology	3(2+1)	Foundation-VII
ZOO-552	Biochemistry-II	3(2+1)	Foundation-VIII
ZOO-553	Physiology	4(3+1)	Major-III
ZOO-554	Ecology	3(2+1)	Major-IV
ZOO-555	Evolution	2(2+0)	Foundation-IX
ZOO-556	Principles of Systematics	3(2+1)	Foundation-X
Total Credits		18 (13+5)	

Molecular Biology

Foundation-VII	ZOO- 551	Molecular Biology	3(2+1)

Course Outline:

1. Introduction

a. Introduction to nucleic acids
b. Chromosome structure, Chromatin,
c. DNA forms, structures and packaging
d. RNA types and structures

2. Replication

a. DNA replication in prokaryotes
b. DNA replication in eukaryotes
c. Enzymology of replication
d. DNA damage and repair

3. Transcription

a. Types of RNA polymerases in prokaryotes and eukaryotes
b. Synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved
c. RNA processing
d. Split genes, concept of ribozymes
c. Genetic Code

4. Translation

a. Role of Ribosomes
b. Mechanism of translation in prokaryotes and eukaryotes
c. Various factors, and posttranslational processing

5. Mutation

a. Types of Mutations
b. Base-Analogue Mutagens
c. Chemical Mutagens

6. Gene expression and control

a. Control of gene expression in Prokaryotes.
b. Inducible and repressible operons.
c. Control of gene expression in eukaryotes.

Practical.

1. Preparation of different stock solutions used in molecular biology (solution used in PCR, electrophoresis, DNA isolation, RNA isolation and Protein isolation.
2. Isolation of DNA from human blood.
3. Quantification of DNA and RNA through spectrophotometer.
4. DNA amplification through polymerase chain reaction.
5. Separation of different sized DNA fragments on agarose gel

Text and Reference books:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York

2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H.Freeman Publishers, Scientific American Inc.
3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates,INC.
4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
5. De Robertis, E.D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, NewYork

Biochemistry-II

Foundation-VIII	ZOO-552	Biochemistry-II	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 cycleintermediates; 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 (ß)-Oxidation; Bioenergetics of ß-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

Orctinol 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 BookCompany.

David L. Nelson and Michael M. Cox, 2005. Lehninger Principles of Biochemistry 4th Edition, Macmillan Worth Publishers, New York.

Additional Readings:

LubertStryer, 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 Bok 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.

Physiology

Major-III	ZOO-553	Physiology	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 variety of vertebrates.

Control of cardiac activity, cardiac output and peripheral circulation.

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.

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

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

Normal cardiac activity in amphibian model, effect of temperature, 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 type1 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, HillarKlandorf, Paul Yancey Brooks Cole; 2012.
- **Animal Physiology** 4th Edition Richard W. Hill, Gordon A. Wyse, Margaret Anderson Sinauer Associates, Oxford University Press, 2016.

Ecology

Major-IV	ZOO-554	Ecology	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, Sulpher, 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 (Quadrate, 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. AppliedEcology. Black Well Scientific Publications Oxford. UK

Slingsby, D., Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK.

Evolution

Foundation-IX	ZOO-555	Evolution	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

a. The concept of extinction.
b. Background extinction.
c. Mass extinction.
d. Factors correlated with extinction.
e. Rates of evolution: punctuated equilibrium, Phyletic gradualism.

Evolution of Sexual Selection

a. Darwin's concept,
b. Fisher's view,
c. Zahavi's handicap theory
d. 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, NewYork
- Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and Practical Practice of Phylogenetic systematics. 2nd Ed. Wiley-Blackwell

Principles of Systematic

Foundation-X	ZOO-556	Principles of Systematics	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.

Practicals:

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 Yor

Mayr, E. Animal Species and Evolution, 1985.Harvard University Press.

Heywood, V.H. Taxonomy and Ecology. 1975. Academic Press, London

Semester-VI

Semester-6th			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO-561	Research Methodology	2(2+0)	Major-V
ZOO 562	Biostatistics	3(2+1)	Compulsory-IX
ZOO-563	Developmental Biology	4(3+1)	Major-VI
ZOO-564	Genetics	4(3+1)	Major-VII
ZOO-565	Zoogeography and Palaeontology	3(2+1)	Major-VIII
Total Credits		16 (12+4)	

Research Methodology

Major-V ZOO-561	Research Methodology	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 Quantitatvive 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

Biostatistics

Compulsory-IX	ZOO -562	Biostatistics	3(2+1)

Course Contents:

1. Introduction:

a. Definition, branches of statistics,

b. Scope and importance of statistics

2. Data:

a. Population and sample, variable, categorical and non-categorical data, b.
Scales of measurements, errors of measurements

3. Presentation of data:
a. Descriptive statistics b.
Tabulation of data

c. Parts of table and construction of table.

d. Diagrams and graphs, pictogram, historigram, line chart, histogram, applications and uses of histogram

e. Construction of histogram, comparison of data using histogram,

f. Bar chart, multiple bar chart, pie chart, gantt chart, timeline, infograph, pedigree chart

4.Frequency distribution:

a. Empirical FD, relative FD, Cumulative FD, class frequency, class limits, class boundaries, class mark, class interval, midpoints.

5. Measures of Central Tendency:

a. Types of averages, arithmetic mean for grouped and ungrouped data, harmonic mean for grouped and ungrouped data, geometric mean for grouped and ungrouped data, median, quartiles, deciles, percentiles and mode.

b. Advantages and disadvantages of arithmetic mean, harmonic mean, geometric mean, median and mode.

6. Measures of Dispersion:

a. Range, grouped and ungrouped data, coefficient of range

b. Mean deviation of grouped and ungrouped data. Coefficient of mean deviation.

c. Standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data.

7. Probability:

a. Definition, properties, experiment and random experiment, event, outcome, trial, multiplication rule, sample space and sample point, mutually exclusive event, combinations and permutations, probability distribution, binomial experiment

8. Tests of Significance:

1. Hypothesis Testing
2. Steps of Hypothesis testing

3. Z-tests
4. t-tests
5. Chi-square test
6. ANOVA and its uses
7. LSD
8. Correlation
9. Regression

Practicals / Tutorials:

Data collection, arrangement and frequency table

Data presentation in table, graphs (simple bar chart, multiple bar chart, component bar chart)

Construction of timeline, pedigree chart, organogram, Gantt chart, infogram

4. Calculating arithmetic mean, harmonic mean and geometric mean, median and mode from ungrouped and grouped data
5. Calculating mean deviation, standard deviation and variance from ungrouped and grouped data
6. Probability distribution
7. z-test
8. T-test
9. ANOVA
10. Correlation
11. Regression

Recommended Books

Field A. (2013) Discovering Statistics with IBM SPSS Statistics. 4th Edition. SAGE Publication Ltd.

Belle V. B, Fisher, L.D., Heagerty, P.J., Lumley, T. (2004) Biostatistics– A methodology for the health sciences. 2nd Edition. Wiley-Interscience

Quinn, G. (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press

Campbell, M.J., Swinscow, T.D.V. (2009) Statistics at Square One. 11th Edition. BMJ Books.

Developmental Biology

Major-VI – Zoo-563-	Developmental Biology-	4 (3+1)

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.

Genetics

Major-VII	ZOO-564	Genetics	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. Willium 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. 10:1449659853
11. Gene- XI by Lewin's,2013,ISBN:978-1449659851

Zoogeography and Palaeontology

Major-VIII ZOO-565 Zoogeography and Palaeontology 3(2+1)

Course Outline:

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; lgneous 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
- Paleoecology, 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 Boyed, 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

7th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO-671	Bioinformatics	3(1+2)	Major-IX
ZOO-672	Ichthyology	3(2+1)	Major-X
ZOO-673	Wildlife	3(2+1)	Major-XI
ZOO-674	Parasitology-I	3(2+1)	Elective-I
ZOO-675	Entomology-I	3(2+1)	Elective-II
Total Credits		15 (10+5)	

Bioinformatics

Course Code	Course Title	Credit Hours	Course Category
ZOO-671	Bioinformatics	3 (1+2)	Major-IX

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. Willey-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. WilleyBlackwell

- 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

Ichthyology

Major-X	ZOO-672	Ichthyology	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.

3. David, H. 2003. The Physiology of Fishes 3rd Ed. CRC Press, UK.

Wildlife

Major-XI	ZOO-673	Wildlife	3(2+1)

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. I1 and II. Oxford UniversityPress

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

Parasitology-I

Elective-II	ZOO-674	Parasitology I	3(2+1)

Course Contents:

Protozoology

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

Flagellates;

a. Intestinal, Oral and Genital flagellates,
b. Blood and tissue flagellates.
c. Sporozoans, Ciliates and Microsporidians.

Pathology

a. The cell and cell injury and its relationship to disease.
b. Acute and chronic inflammations
c. woundhealing.

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 Jercy 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.

Entomology-I

Elective-III	ZOO-675	Entomology-I	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. Order Phthiraptera

j. Order Plecoptera

k. Order Psocoptera

l. Order Siphonaptera

m. Order Zoraptera

n. Order Megaloptera

o. Order Raphidioptera

p. Order Ephemeroptera

q. 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

8th Semester			
Course Code	**Course Title**	**Credits**	**Course Category**
ZOO-681	Applied Fisheries	3 (2+1)	Elective-III
ZOO-682	Parasitology-II	3 (2+1)	Elective-IV
ZOO-683	Entomology-II	3 (2+1)	Elective-V
Any two subjects from the following or Thesis			
ZOO-684	Economic Zoology	3 (2+1)	Optional
ZOO-685	Immunology	3 (2+1)	Optional
ZOO-686	Mammalogy	3 (2+1)	Optional
ZOO-687	Ornithology	3 (2+1)	Optional
ZOO-688	Microbiology	3 (2+1)	Optional
OR			
ZOO-689	Thesis	6(0+6)	Optional
Total Credits		15 (10+5) or 15 (6+9)	

Applied Fisheries

Elective-IV	ZOO-683	Applied Fisheries	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 andseed; 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 Wiely and Sons, New York
- Mirza, M.R.and Bhatti, M.N.1993 Pakistan ki Machlian aur Mahi ParwariFerozsons, Lah

Parasitology-II

➢ Elective-V	ZOO-684	Parasitology II	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. Heterophyesheterophyes,

Monogenetic trematodes:

a. Dactylogyrus vastator,

Cestodes:

a. Diphyllobothriam 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 Louise

Dixon, M. E. Aid to Pathology. Churchill Livingstone, Edinburgh London and New York

Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. CambridgeUniversity 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.

Entomology-II

Elective-IV	ZOO-685	Entomology-II	3(2+1)

Course Contents:

Introduction to Applied Entomology

a. Principles of
   - apiculture,
   - sericulture and
   - lac culture.

b. General characteristics, life cycles and habits of insects of medical importance
   a) Mosquito
   b) Sandfly

a. General characteristics, life cycles and habits of insects of veterinary importance
   a. Horse fly
   b. Blow fly

b. Insect pests of Agriculutre
   a. Rice
   b. Sugarcane

c. Insect pests of Household
d. Cockroach
e. Silver fish
f. Insect pests of Store grains

- Red flour beetle
- Rice Weevil

Pest Management

a. Cultural, legislative Control
b. Physical and Mechanical Control

c. Biological Control
d. Chemical Control
e. Other approaches; Genetic, integrated control
f. Relative merits of various types of insect control.
g. 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:

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

Optional Subjects

Economic Zoology

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 near by locality and write 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. Dominent 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.

Immunology

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: 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.

Ornithology

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.

Mammalogy

Cr: 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 laterlis 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. Vaghuan, 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

Microbiology

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, Zymomonous 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.

4. Brock Biology of Microorganisms, 14th ed. (2014) by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock.

5. Alcamo's Fundamentals of Microbiology, 9th ed.(2012) by Jeffrey C Pommerville.

6. Bergey's Manual of Systematic Bacteriology(2012). 7. Microbiology Principles and Explorations (2001) by Jacquelyn, G.G