Assistant Director
Academics
University of Chitral

Scheme of Studies BS Zoology
2017-2021

Department of Zoology
University of Chitral

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 at least 135 credit hours.

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

Year-I Semester-I			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory-I	ZOO-311	English-I (Functional English)	3(3+0)
Compulsory-II	ZOO-312	Pakistan Studies	2(2+0)
Compulsory-III	ZOO-313	Mathematics	3(3+0)
General- I	ZOO-314	Botany – I (Diversity of Plants)	3(2+1)
General - II	ZOO-315	Chemistry-I (Organic Chemistry)	3(2+1)
Foundation-I	ZOO-316	Principles of Animal Life-I	4(3+1)
		Total Credits	18

Semester-II			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory-IV	ZOO-321	English-II (Communication Skills)	3(3+0)
Compulsory-V	ZOO-322	Islamic Studies	2(2+0)
Compulsory-VI	ZOO-323	Biostatistics	3(3+0)
General- III	ZOO-324	Botany-II (Plant Systematics, Anatomy and Development / Embryology)	3(2+1)
General - IV	ZOO-325	Chemistry-II (Inorganic Chemistry)	3(2+1)
Foundation-II	ZOO-326	Principles of Animal Life-II	4(3+1)
		Total Credits	18

Year-II Semester-III			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory-VII	ZOO-431	English-III: Technical writing and presentation skills	3(3+0)
Compulsory-VIII	ZOO-432	Introduction to Computer	3(1+2)
General- V	ZOO-433	Botany-III (Cell Biology, Genetics and Evolution)	3(2+1)
General - VI	ZOO-434	Chemistry-III (Environmental Chemistry)	3(3+0)
Foundation-III	ZOO-435	Invertebrates	4(3+1)
		Total Credits	16

Semester-IV			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory-IX	ZOO-441	English-IV (Advanced Academic Reading and Writing)	3(3+0)
General - VII	ZOO-442	Botany IV (Plant Physiology and Ecology)	3(2+1)
Foundation-IV	ZOO-443	Chordates	4(3+1)
Foundation-V	ZOO-444	Animal Form and Function I	4(3+1)
Foundation-VI	ZOO-445	Animal Form and Function II	4(3+1)
		Total Credits	18

Year III Semester-V			
Course Category	**Course Code**	**Course Title**	**Credits**
General - VIII	ZOO-551	Sociology	2(2+0)
Foundation-VII	ZOO-552	Biochemistry	4(3+1)
Major-I	ZOO-553	Cell & Molecular Biology	4(3+1)
Major-II	ZOO-554	Physiology	4(3+1)
Major-III	ZOO-555	Animal Behavior	3(2+1)
		Total Credits	17

Semester-VI			
Course Category	**Course Code**	**Course Title**	**Credits**
Foundation-VIII	ZOO-561	Biological Techniques	3(1+2)
Foundation-IX	ZOO-562	Evolution & Principles of Systematics	3(2+1)
Major-IV	ZOO-563	Developmental Biology	4(3+1)
Major-V	ZOO-564	Genetics	4(3+1)
Major-VI	ZOO-565	Synopsis & Research Methodology	2(2+0)
		Total Credits	16

Year -IV Semester-VII			
Course Category	**Course Code**	**Course Title**	**Credits**
Major-VII	ZOO-671	Environmental Biology	4(3+1)
Major-VIII	ZOO-672	Zoogeography & Paleontology	3(2+1)
Major-IX	ZOO-673	Parasitology I	4(3+1)
Major-X	ZOO-674	Wildlife	2(2+0)
Elective-I	ZOO-675	Entomology	3(2+1)
		Total Credits	16

Semester-VIII			
Course Category	**Course Code**	**Course Title**	**Credits**
Major-XI	ZOO-681	Bioinformatics	3(2+1)
Major-XII	THES-682/ZOO-686	Thesis/ Research Project/ Special Paper	4(0+4) 4(3+1)
Elective-II	ZOO-683	Applied Fisheries	3(2+1)
Elective-III	ZOO-684	Applied Entomology	3(2+1)
Elective-IV	ZOO-685	Parasitology II	3(2+1)
		Total Credits	16

Any one subject from the following or Thesis			
ZOO-686	Economic Zoology	4 (3+1)	Optional
ZOO-687	Ornithology	4 (3+1)	Optional

18+18+16+18+17+16+16+16=135

Year-I Semester-I			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory-I	ZOO-111	English-I (Functional English)	3(3+0)
Compulsory-II	ZOO-112	Pakistan Studies	2(2+0)
Compulsory-III	ZOO-113	Mathematics	3(3+0)
General- I	ZOO-114	Botany – I (Diversity of Plants)	3(2+1)
General - II	ZOO-115	Chemistry-I (Organic Chemistry)	3(2+1)
Foundation-I	ZOO-116	Principles of Animal Life-I	4(3+1)
		Total Credits	18

ZOO-111	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

Books Recommended

1. Thomson, A.J., Martinet, A.V. 1997. Practical English Grammar and Exercises 3rd Ed. Oxford University Press
2. Boutin, M-C., Brinand, S., Grellet, F. 1993. Writing. Intermediate and Supplementary Skills. Oxford Fourth Impression
3. Tomlinson, B., Ellis, R. 1992. Reading. Upper Intermediate. Oxford Supplementary Skills. Third Impression.

ZOO-112	Pakistan Studies	2(2+0)

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; People and Land: Indus Civilization, Muslim advent, Location and geo-physical features.

Government and Politics in Pakistan: Political and constitutional phases: 1947-58; 1958-71; 1971-77; 1977-88; 1988-99; 1999 onward.

Contemporary Pakistan: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

Books Recommended

1. Zaidi A.S. 2000. Issue in Pakistan's Economy. Karachi: Oxford University Press.
2. Rafique A. M. 1998. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
3. Safdar, M. 1994. Pakistan Political Roots & Development. Lahore.
4. Burke, S.M., Ziring L. 1993. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.
5. Noor ul Haq. 1993. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research.
6. Waseem, M. 1987. Pakistan Under Martial Law, Lahore: Vanguard.
7. Javed, B. S. 1980. State and Society in Pakistan. The Macmillan Press Ltd.
8. Lawrence, Z. 1980. Enigma of Political Development. Kent England: WmDawson & sons Ltd.
9. Ansar, Z. 1980. History & Culture of Sindh. Karachi: Royal Book Company.
10. Aziz, K.K. 1976. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research.
11. Wayne, W. 1972. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research,.
12. Khalid Bin Sayeed. 1967. The Political System of Pakistan. Boston: Houghton Mifflin.
13. Safdar, M. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-eIslamia, Club Road.
14. Tahir, A. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad

ZOO-113	Mathematics	3(3+0)

Course Contents

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equation, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.

Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.

Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Books Recommended

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

ZOO-114	Botany – I (Diversity of Plants)	3(2+1)

Course Contents

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

1. Viruses (RNA and DNA types) with special reference to TMV
2. Bacteria and Cyanobacteria (Nostoc, Anabaena, Oscillatoria) with specific reference to biofertilizers, pathogenicity and industrial importance;
3. Algae (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)
4. Fungi (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications.
5. Lichens (Physcia)
6. Bryophytes
   i. Riccia ii. Anthoceros iii. Funaria
7. Pteridophytes.
   i. Fossils and fossilization ii. Psilopsida (Psilotum)
   iii. Lycopsida (Selaginella)
   iv. Sphenopsida (Equisetum) v. Pteropsida (Marsilea) vi. Seed Habit h)
8. Gymnosperms
   i.Cycas ii.Pinus
   iii. Ephedra

Lab Outline:

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.

Recommended Books:

1.2. Lee,Prescott, R.E. 1999. Phyco L.M., Harley,lo gy. CJ.P. andambri Klein,dge University Pr A.D. 2004. Microbiology,ess, UK 3rd ed. WM. C. Brown Publishers.

3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. 4th ed. John Wiley and Sons Publishers.
4. Agrios, G.N. 2004. Plant pathology. 8th ed. Academic press London.
5. Vashishta, B.R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.
6. Andrew, H. N. 1961. Studies in Paleobotany. John Willey and Sons.
7. Ingrouille , M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
8. Mauseth**,** J.D**.** 2003**.** Botany**:** An Introduction to Plant Biology 3rd ed., Jones and Bartlett Pub. UK
9. Marti.J.Ingrouille & Plant: Diversity and Evolution. 2006 CUP
10. Taylor, T.N. & Taylor, E.D. 2000. Biology and Evolution of Fossil Plants. Prentice Hall. N.Y.

Journals / Periodicals: Pakistan Journal of Botany, American Journal of Botany, Canadian Journal of Botany, Annals of Botany

ZOO-115	Chemistry-I (Organic Chemistry)	3(2+1)

Course Contents:

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. **Recommended Books:** 1. Brown, W. and Poon, T., Introduction to Organic Chemistry, 3rd ed., John- Wiley & Sons, Inc., (2005). 16

2. John, E. M. Organic Chemistry, 8 th ed., Brooks/Cole Publishing Co, USA, (2012). 3. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).

4. Younus, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).

5. Sykes, P., A Guide Book to Mechanism in Organic Chemistry, 6th ed., Pearson Education Limited, England, (1986).

6. Solomons, T. W. G. and Fryhle, C. B., Organic Chemistry, 10th ed., John- Wiley & Sons, Inc., (2011).

7. Furniss, B. S., Hannaford, A. J., Smith, P. W. G., Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th ed., Longman, UK, (1989).

8. Pavia, D. L., Kriz, G. S., Lampman, G. M. and Engel, R. G., A Microscale Approach to Organic Laboratory Techniques, 5th ed., Brooks/ Cole Cengage Learning, (2013).

9. Mayo, D. W., Pike, R. M. and Forbes, D. C., Microscale Organic to Laboratory with Multistep and Multisacle Syntheses, 5 th ed., John-Wiley & Sons, Inc., (2011).

10. Gilbert, J. C. and Martin, S. F., Experimental Organic Chemistry: A Miniscale and Microscale Approach, 5th ed., Brooks/ Cole Cengage Learning, (2010).

ZOO-116	Principles of Animal Life-I	4(3+1)

Course Contents

The course aims to impart knowledge and understanding of:

- The concept and status of Zoology in life sciences and the common processes of life through its biochemical and molecular processes.
- The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
- Biochemical mechanisms eventually generating energy for animal work.
- Animals and their relationship with their environment.

Course Contents

Scope of Zoology: Introduction; significance and applications of zoology; animal diversity; the scientific method; environment and world resources. The Chemical Basis of Animal Life: Brief introduction to biomolecules; carbohydrates, lipids, proteins, and nucleic acids. Cellular Organization: Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, vacuoles;the nucleus: nuclear envelope, chromosomes and nucleolus.

Animal tissues: Types: epithelial, connective, muscle and nervous tissue; organs and organ systems.

Enzymes: Structure, types; function and factors affecting their activity; cofactors and coenzymes.

Energy Harvesting: Aerobic and anaerobic respiration: glycolysis, citric acid cycle and electron transport chain; fermentation, the major source of ATP.

Reproduction and Development: Types; asexual and sexual, gametogenesis, fertilization, metamorphosis, zygote and early development.
Ecological Concepts: Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles, and limiting factors, populations and communities, human population growth, pollutionresource depletion and biodiversity.

Practicals

1. Tests for different carbohydrates, proteins and lipids.

Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.

2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac). Note: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.
3. Plasmolysis and deplasmolysis in blood. Preparation of blood smears.
4. Protein digestion by pepsin.
5. Ecological notes on animals of a few model habitats.
6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).

Books Recommended

1. Pechenik, J.A. 2012. Biology of Invertebrates, 4th Edition (International), Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Miller, S.A., Harley, J.B. 2002. Zoology, 5th Edition (International), Singapore: McGraw Hill.
4. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International). Singapore: McGraw Hill.
5. Campbell, N.A. 2002. Biology. 6th Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Kent, G.C., Miller, S. 2000. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

****

Semester-II			
Course Category	**Course Code**	**Course Title**	**Credits**
Compulsory-IV	ZOO-121	English-II (Communication Skills)	3(3+0)
Compulsory-V	ZOO-122	Islamic Studies	2(2+0)
Compulsory-VI	ZOO-123	Biostatistics	3(3+0)
General- III	ZOO-124	Botany-II (Plant Systematics, Anatomy and Development / Embryology)	3(2+1)
General - IV	ZOO-125	Chemistry-II (Inorganic Chemistry)	3(2+1)
Foundation-II	ZOO-126	Principles of Animal Life-II	4(3+1)
		Total Credits	18

ZOO-121	English-II (Communication Skills)	3(3+0)

Course contents:

Communication

Definition, nature and importance of communication, Types of communication (verbal, non-verbal communication etc), effective communication, barriers of communication. **Technical Writing**

Report writing, c.v., letters, applications

Oral Communication

Bad listening habits, effective listening oral presentations, steps/procedures, instructional presentations, persuasive presentations, interviews and group discussions.

Books Recommended

1. Murray Cunningham, 'Communication' Macmillan
2. Allan A. Glathon, 1975 Pattern of Communication NP
3. Suson M. Ervin Tripp. 1973: Stonford University press
4. Scott 1974: Experience and Communication Forqan and Company
5. Simon and Schuster Communication Essentials University of Phoenix.
6. Managerial Communication A finger on the Pulse (3rd ed), Prentice Hall.
7. Murphy et. Al., Effective Business Communication
8. Hargie.O. Handbook of Communication Skills.2006. Routledge
9. Barker.A. Improve Your Communication Skills.2008. Kogan Page

ZOO-122	Islamic Studies	2(2+0)

Course Contents

Introduction to Quranic Studies: Basic Concepts of Quran: History of Quran; Uloomul -Quran

Study of Selected Text of Holy Quran: Verses of Surah Al-Baqra Related to Faith (Verse No-284-286), Verses of Surah Al-Hujrat Related to Adab AlNabi (Verse No-1-18),

Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77), Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Selected Text of Holy Quran: Verses of Surah Al-Ihzab Related to Adab alNabi (Verse No.6,21,40,56,57,58.), Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment, Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W) I: Life of Muhammad Bin Abdullah (Before Prophet Hood); Life of Holy Prophet (S.A.W) in Makkah; Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II: Life of Holy Prophet (S.A.W) in Madina: Important Events of Life Holy Prophet in Madina; Important Lessons Derived from the life of Holy Prophet in Madina

Introduction to Sunnah: Basic Concepts of Hadith; History of Hadith; Kinds of Hadith; Uloom –ul-Hadith; Sunnah & Hadith; Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence: Basic Concepts of Islamic Law & Jurisprudence; History & Importance of Islamic Law & Jurisprudence; Sources of Islamic Law & Jurisprudence; Nature of Differences in Islamic Law; Islam and Sectarianism

Islamic Culture & Civilization: Basic Concepts of Islamic Culture & Civilization; Historical Development of Islamic Culture & Civilization; Characteristics of Islamic Culture & Civilization; Islamic Culture & Civilization and Contemporary Issues

Islam & Science: Basic Concepts of Islam & Science; Contributions of Muslims in the Development of Science; Quran & Science

Islamic Economic System: Basic Concepts of Islamic Economic System; Means of Distribution of wealth in Islamic Economics; Islamic Concept of Riba; Islamic Ways of Trade & Commerce

Political System of Islam; Basic Concepts of Islamic Political System; Islamic Concept of Sovereignty; Basic Institutions of Govt. in Islam

Islamic History: Period of Khlaft-E-Rashida; Period of Ummayyads; Period of Abbasids **Social System of Islam;** Basic Concepts of Social System of Islam; Elements of Family; Ethical Values of Islam.

Books Recommended

1. Hameedullah M, "Emergence of Islam", IRI, Islamabad
2. Hameedullah M, "Muslim Conduct of State"
3. Hameedullah M. 'Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,"
5. Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
6. Hasan A.1993. Principles of Islamic Jurisprudence. Islamic Research Institute, International Islamic University, Islamabad.
7. Waliullah, M. 1982. Muslim Jurisprudence and the Quranic Law of Crimes. Islamic Book Service.
8. Bhatia, H.S.1989. Studies in Islamic Law, Religion and Society. Deep & Deep Publications New Delhi
9. Zia-ul-Haq M.2001. Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad

ZOO-123	Biostatistics	3(3+0)

Course Contents

Introduction and scope: use of statistics in biology. Population and sample: Stages of research,

Types of data: methods of data collection. Data arrangement and presentation, formation of tables and charts.

Measures of central tendency: computation of mean, median and mode from grouped and ungrouped data.

Measures of dispersion: computation of variance, standard deviation, standard error and their coefficients.

Probability rules: Binomial, poissons and normal distributions. Hypothesis testing, Student 't' test, Chi square test,

Handling of multiple samples: Analysis of variance and LSD.
Correlation and regression: Experimental designing, planning of an experiment, replication and randomization.

Books Recommended

1. Zar, J. H. 2013. Biostatistical analysis 4th Ed. Dorling Kindersley Publ.
2. Forthofer, R. N., Lee E. S., Hernandez, M. 2011. Biostatistics: A Guideto Design, Analysis and Discovery2nd Ed. Elsevier Inc.
3. Rao,K. V. 2009. Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers Publishers.
4. Quinn, G., P., Keough M. J.2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.
5. Norman G. R., Streiner, D. L. 2000. Biostatistics: The Bare Essentials. B.C. Decke Inc.
6. Campbell, R. C. 1989. Statistics for Biologists. Cambridge University Press.

ZOO-124	Botany-II (Plant Systematics, Anatomy and Development / Embryology)	3(2+1)

Course Outline:

a) Plant systematics

1. Introduction to Plant Systematics: aims, objectives and importance.
2. Classification: brief history of various systems of classification with emphasis on Takhtajan.
3. Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN). Vienna code.
4. Morphology: a detailed account of various morphological characters root, stem, leaf, inflorescence, flower, placentation and fruit types.
5. Diagnostic characters, economic importance and distribution pattern of the following families:

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

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like:

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

3. Meristem: types, stem and root apices
4. Vascular cambium
5. Structure and development of root, stem and leaf. Primary and secondary growth of dicot stem, periderm
6. Characteristics of wood: diffuse porous and ring porous, sap and heart wood, soft and hard wood, annual rings.

c) Development/Embryology

1. Early development of plant body:

2. Capsella bursa-pastoris
3. Structure and development of Anther Microsporogenesis, Microgametophyte
4. Structure of Ovule Megasporogenesis Megagametophyte
5. Endosperm formation
6. Parthenocarpy 7. Polyembryony **Lab Outline:**

Plant Systematics

1. Identification of families given in syllabus with the help of keys.
2. Technical description of common flowering plants belonging to families mentioned in theory.
3. Field trips shall be undertaken to study and collect local plants.
4. Students shall submit 40 fully identified herbarium specimens.

Anatomy and Embryology

1. Study of stomata and epidermis.
2. Tissues of primary body of plant.
3. Study of xylem 3-dimensional plane of wood.
4. T. S of angiosperm stem and leaf.
5. Anatomy of germinating seeds
6. Study of pollens

Recommended Books:

1 Mauseth, J. D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R. C., W. D. Clarke and Vodopich, D. S. 1998. Botany. McGraw Hill Company,
U.S.A.
3. Raven, P. H., Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants. W. H. Freeman and Company Worth Publishers.
5. Stuessy, T. F. 1990. Plant Taxonomy. Columbia University Press, USA.
6. Lawrence, G. H. M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
7. Panday, B. P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
8. Raymond E, S. E. Eichhorn. 2005. Esau's Plant Anatomy. Meristems cells and tissues of the plant body, 3rd Ed. John Wiley & Sons. Inc.
9. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
10. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
11. Maheshwari, P. 1971. Embryology of Angiosperms, McGraw-Hill. New York.
12. Eames A. J. and L. H Mac Daniels. 2002. An Introduction to Plant Anatomy. TataMac Graw-Hill Publishing Company, Limited, New Delhi.
13. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition, Regency Publications, New Delhi.
14. Naik, V. N. 2005 Taxonomy of Angiosperms. 20th Reprint. TataMac Graw-Hill Publishing Company, Limited New Delhi.
15. Rajput, M. T., S. S. Hassney and K. M. Khan. 1996. Plant Taxonomy. New Trends Computer Service, Hyderabad, Sindh, Pakistan.

Journals / Periodicals:

Pakistan Journal of Botany, Taxon, Phyton

ZOO-125	Chemistry-II (Inorganic Chemistry)	3(2+1)

Course Contents:

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

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

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

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.

Recommended Books:

1. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley & Sons, New York, (2007).
3. Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 3rd ed., Harper International SI Edition, (2006).
4. House, J. E., Inorganic Chemistry, Academic Press. USA, (2008).
5. Lee, J. D., Concise Inorganic Chemistry, 5th ed., Chapman and Hall, (1996).
6. Miessler, G. L., Tarr, D. A., Inorganic Chemistry, 3rd ed., Pearson Education, India, (2008).
7. Huheey, J. E., Kieter E. A., Keiter L. R., Inorganic Chemistry: Principles of Structure and Reactivity, 4 th ed., Benjamin-Cummings Pub Co., (1993).
8. Sharpe, A. G., Inorganic chemistry, 3 rd ed., Pearson Education India, (1981).
9. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).
10. Catherine E. House crdft, Alan G. Sharpe, Inorganic Chemistry, 3 rd ed., Prentice Hall, (2008).
11. Kathleen A. H., James E. H., Descriptive Inorganic Chemistry, 2 nd ed., Brooks Cole, (2010).
12. Wulfsberg G., Principles of Descriptive Inorganic Chemistry, 1 st ed., University Science Books, (1991).
13. Hill, R. H. JR and Fister, D. C., Laboratory Safety for Chemistry Students, JohnWiley & Sons, Inc., (2010).
14. Mendham, J., Denny, R. C., Barnes, J. D., Thomas, M. and Sivasankar, B., Vogel's Textbook of Quantitative Chemical Analysis, 6 th ed., Pearson Education, Ltd., (2000).
15. Svehla, G., Vogel's Qualitative Inorganic Analysis, 7 th ed., (7th imp.), Pearson Education, Ltd., (2009)

ZOO-126	Principles of Animal Life-II	4(3+1)

Course Contents

Cell Division: Cell cycles: Mitosis and meiosis; control of the cell cycle.

Inheritance Patterns: Mendelian genetics; inheritance patterns; gene, structure, chemical composition and types.

Chromosomes and Gene Linkage: Eukaryotic chromosomes; linkage and crossing over; chromosomal aberrations.

Cellular Control: DNA: the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA technologies and their applications.

Animal Behavior: Behaviour and its types, proximate and ultimate causes; anthropomorphism; development of behavior; learning; factors controlling animal behavior; communication; behavioral ecology; social behavior.

Evolution: A Historical Perspective: Theories of evolution: Natural selection Lamarckism and neo larmarckism, Darwinism and neo Darwinian.

Evolution and Gene Frequencies: Hardy-Weinberg principle; evolutionary mechanisms: population size, genetic drift, gene flow, de Vries mutation theory and rates of evolution, polymorphism; species and speciation; molecular evolution; mosaic evolution.

Practicals

1. Study of mitosis in onion root tip.
2. Study of meiosis in grasshopper testis (students should prepare the slide).
3. Problem based study of Mendelian ratio in animals.
4. Multiple alleles study in blood groups.
5. Survey study of a genetic factor in population and its frequency.
6. Study of karyotypes of Drosophila, mosquito.
7. Study of cytochemical detection of DNA in protozoa and avian blood cell.
8. Study to demonstrate nervous or endocrine basis of behavior (conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).

Books Recommended

1. Pechenik, J.A. 2012. Biology of Invertebrates, 4th Edition (International), Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Miller, S.A., Harley, J.B. 2002. Zoology, 5th Edition (International), Singapore: McGraw Hill.
4. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International). Singapore: McGraw Hill.
5. Campbell, N.A. 2002. Biology. 6th Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Kent, G.C., Miller, S. 2000. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

Year 2 Semester-III		
Course Code	**Course Title**	**Credits**
ZOO-231	English-III: Technical writing and presentation skills	3(3+0)
ZOO-232	Introduction to Computer	3(1+2)
ZOO-233	Botany-III (Cell Biology, Genetics and Evolution)	3(2+1)
ZOO-234	Chemistry-III (Environmental Chemistry)	3(3+0)

ZOO-235	Invertebrates	4(3+1)
	Total Credits	16

ZOO-231	English-III: Technical writing and presentation skills	3(3+0)

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** a) Essay Writing and Academic Writing **Books Recommended:**

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

ZOO-232	Introduction to Computer	3(1+2)

Brief history of computers and their applications: Major components of computer, computer and society, the social impact of computer age, computers in offices industry and education, office automation tools; word processing, graphic packages, data bases and spread sheets, current prints, research and future prospects, legal and moral aspects of computer science, using internet

Laboratory work pertaining to above course Books Recommended

1. Using information technology 2nd Ed, William Sawyer, Hutchinson
2. Introduction to computer by Peter Norton
3. Introduction to computer by P.K. Ceena
4. Dandamudi. S P. Fundamentals of Computer Organization and Design.2008. Springer

ZOO-233	Botany-III (Cell Biology, Genetics and Evolution)	3(2+1)

Course outline:

a) Cell biology

1. Structures and Functions of Biomolecules i. Carbohydrates ii. Lipids iii. Proteins iv. Nucleic Acids
2. Cell: Physico-chemical nature of plasma membrane and cytoplasm.
3. Ultrastructure of plant cell with a brief description and functions of the following organelles

i. Cell wall ii Endoplasmic reticulum
iii. Plastids vi.
Mitochondria v. Ribosomes vi.
Dictyosomes vii. Vacuole
viii. Microbodies (Glyoxysomes and Peroxisomes)

4. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis
5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
6. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

b) Genetics

1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.
2. Sex inked inheritance, sex linkage in Drosophila and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex linked characters, sex determination.
3. Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.
4. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. *lac* operon).
5. Transmission of genetic material in Bacteria: Conjugation and gene recombination in *E.coli*, transduction and transformation.
6. Principles of genetic engineering / biotechnology; Basic genetic engineering techniques.
7. Application of genetics in plant improvement: Induction of genetic variability (gene mutation, recombination), physical and chemical mutagens, selection, hybridization and plant breeding techniques. Development and release of new varieties.
8. Introduction to germplasm conservation

c) Evolution

The nature of evolutionary forces, adaptive radiations, differential reproductive potential, first plant cell, origin of organized structures, early aquatic and terrestrial ecosystem, first vascular plant.

Lab Outline: Cell

Biology

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

Genetics

1. Genetical problems related to transmission and distribution of genetic material.
2. Identification of DNA in plant material. Carmine staining.
3. Study of salivary gland chromosomes of Drosophila.

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V.R. (1986). Cytology and Genetics. Tata and McGraw Hill Publication Co. Ltd, New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding andEvolution, Vini Educational Books, New Delhi.
5. Strickberger, M.V. (1988), Genetics, MacMillan Press Ltd., London.
6. Carroll, S.B., Grenier, J.K. and Welnerbee, S.d. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Strickberger, M. W. 2000 Evolution. Jones & Bartlet Publishers Canada
9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press.

Journals / Periodicals: Theoretical & Applied Genetics, The Cell, Heredity.

ZOO-234	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.

Water Pollution:

Water pollution and waste water 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, bio-accumulation 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:

1. Baird, C. and Cann, M., *Environmental Chemistry*, 5th ed., W. H. Freeman & Company, (2012).
2. Dara, S. S. and Mihsra, D. D., *A Text Book of Environmental Chemistry and Pollution Control*, 9th ed., S. Chand & Co. Ltd., (2004).
3. **Singhi**, R. and Singh, V., *Green Chemistry forEnvironmental Remediation*, John-Willey & Sons, Inc., (2011).
4. Holloway, A. M. and Wayne, R. P., *Atmospheric Chemistry*, 1st ed., Royal Society of Chemistry, (2010).
5. Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. *Water Treatment Technologies for Removal of High Toxicity Pollutants*, Springerlink, UK, (2010).
6. Manahan, S. E., *Environmental Chemistry*, 9th ed., CRC press, Taylor & Francis group, USA, (2009).
7. Girard, J. E., *Principles of Environmental Chemistry*, 2nd ed.,Jones and Bartlett publishers, (2010).
8. 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).
9. Matalack, A., *Introduction to Green Chemistry*, 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
10. Wright, J., *Environmental Chemistry*, Routledge, (2003).
11. O'Neill, P., *Environmental Chemistry*, 3rd ed., Blackie Academic & Professional, (1998).

ZOO-235	Invertebrates	4(3+1)

Course Contents

1. INTRODUCTION

a. Patterns of Organization

ANIMAL-LIKE PROTISTS: THE PROTOZOA

a. General Characteristics.

b. Classification up to class

c. Symbiotic Lifestyles

d. Locomotion in protozoa

e. Nutrition and Reproduction.

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;

General Characteristics

Phylum Gastrotrichea;

General Characteristics

PHYLUM ASCHELMINTHS (PSEUDOCOELOMATE)

a. General Characteristics

b. Classification up to class

b. Type: Ascaris lumbricoides

c. Characteristics of Phylum Rotifera and Phylum Kinorhyncha.

c. 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,
Reproduction and Development of Gastropods,bivalves and cephalopods

PHYLUM ARTHROPODA

a. General Characteristics

b. Classification up to class.

c. Metamerism and Tagmatization;
d. The Exoskeleton.

e. Nutrition and digestive system Reproduction: Development, Metamorphosis in class insecta,Crustaceans and Arachnida

f. Economic importance of crustaceans

PHYLUM ECHINODERMS

a. General Characteristics

b. Classification up to class.

c. Maintenance Functions ,Reproduction; Regeneration, Larval forms , phylogeny and general Characteristics of class Asteroidae

Practicals

Museum study of representative Phyla, Permanent slide preparations

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, 2. Paramecium as representative of animal like protists. (Prepared slides).
3. Study of sponges and their various body forms.
4. Study of principal representative classes of Phylum Cnidaria.
5. Study of principal representative classes of Phylum Platyhelminthes.
6. Study of representative of Phylum Rotifera, Phylum Nematoda.
7. Study of principal representative classes of Phylum Mollusca.
8. Study of principal representative classes of Phylum Annelida.
9. Study of principal representative classes of groups of Phylum Arthropoda.
10. Brief notes on medical/economic importance of the following:

Plasmodium, Entamoeba histolitica, Leishmania, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.

Books Recommended

1. Hickman, C.P., Roberts, L.S., Larson, A. 2011. Integrated Principles of Zoology, 15th Ed. (International). Singapore: McGraw Hill.
2. Miller, S.A., Harley, J.B. 2011. Zoology, 8th Ed. (International), Singapore: McGraw Hill.
3. Pechenik, J.A. 2010. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw Hill.
4. Campbell,N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
5. Miller, S.A., 2002. General Zoology Laboratory Manual. 5th Ed. (International). Singapore: McGraw Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

Semester-IV

Course Code	Course Title	Credits
ZOO-241	English-IV (Advanced Academic Reading and Writing)	3(3+0)
ZOO-242	Botany IV (Plant Physiology and Ecology)	3(2+1)
ZOO-243	Chordates	4(3+1)
ZOO-244	Animal Form and Function, I	4(3+1)
ZOO-245	Animal Form and Function II	4(3+1)
	Total Credits	18

ZOO-241	English-IV (Advanced Academic Reading and Writing)	3(3+0)

1. The art of listening

2. What is good listening?

3. Types of listening

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

4. 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

5. 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

6. 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 their
- Give no response
- Invalidate response, be negative
- Interrupt
- Criticize
- Diagnose what we said
- Give advice/solution quickly
- Change the subject
- Reassure without acknowledgment

7. Communication

- Communication skills
- Types of communications
- Importance and benefit of effective communication
- Components of communication
- Nonverbal communication
- Barriers to 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

8. Barrier to communication

- Noise
- Inappropriate medium
- Assumption/misconception
- Emotion
- Language difference
- Poor listening skill
- Distraction

9. Public speaking

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

10. 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

11. The speech communication process

- Speaker
- Message
- Channel
- Listener
- Feedback
- Interference
- Situation

12. 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

13. Situational audience analysis

- Unique traits of speaking situation
- Size
- Physical setting

14. Disposition toward the topic

- Interest , knowledge , attitude

15. Disposition towards the speaker

16. Disposition towards the occasion

17. Organization of speech

18. Connectives

- Transition
- Internal previews
  Internal summaries
  Signposts

19. Supporting material

- Example
- Statistics
- Testimony

20. 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

21. Many more things to remember for effective speech

- Use language accurately
- Use language clearly

- Use language Vividly
    - Imagery
    - Concrete words
    - Simile
    - Metaphor
    - Rhythm
    - Parallelism
    - Repetition
    - Alliteration
    - Antithesis

22. Speech delivery

- Types of delivery
- Read from manuscript
- Reciting from memory
- Impromptu
- Extemporaneously

23. Vocalization of speech

- Volume- loudness or softness
- Pitch- speed rate at which you speak
- Pauses
- Variety
- Pronunciation
- Articulation
- Dialect

24. Interviewing

- The nature and type of interview
- Interview structure
- How to be interviewed for a job
- How to be interviewed for an information-gathering interview
- The responsibilities of an interviewer

25. Types of interviews

- Information gathering interview
- Appraisal interview
- Problem solving interview
- Persuasion interview

26. Structure of interview

- Opening
- Body
- Conclusion

How to be interviewed for a job?

- Be aware of your skills and abilities
- Prepare your resume oA written concise, organized description of your qualifications

oComponents

- Personal information
- Career objectives
- Education and Objectives
- education
- experience
- Honor and special accomplishments
- Optional information
- Identify the need of your employer
- Listen respond and ask appropriate questions
- Follow up after the interview
- Ask appropriate questions

25. The right use of Diction

A	An	Accept	Except	Advice
Advise	Effect	Affect	Alright	Most
Amount	Between	Among	Amount	Number
As, As If, As Though	Like	Be sure and	Try and	Could of

Should of	Might of	Would of	Different than	Different from
Due to	Because of	Enthused/enthuse	Fewer	less
Hopefully	Irregardless	Lead	Led	Lend
Loan	Life	Lay	Principal	principle
Rise	Raise	Sit	Sat	Supposed to
Used to	Then	Than	Senior to	Junior to

26. Short stories reading and then presenting them in their own words in class

1. The gift of Magi (O, Henry)
2. The diamond necklace
3. over coat
4. His first flight
5. Rustam and suhrab

27. Common grammatical error

28. Successful strategies for group meeting

- Definition of group meetings
- Formation of a group meeting
- Background information on group meeting
- Purpose and kind of meeting
- Solving problem in meeting or groups
- Leadership responsibilities in meeting
- Participant responsibilities in meeting

29. Resume (Vita, Qualification Brief)

- Opening section
- Education
- Work experience
- Achievements
- Awards
- Service activities
- Personal data
- References
- Sample resume

30. Letters. Emails and memos

31. 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.

ZOO-242	Botany IV (Plant Physiology and Ecology)	3(2+1)

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

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

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

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

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

Plant Movements: Classification of plant movements

Books Recommended

1. Hopkins, W.B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York
2. Ihsan Illahi (1995). Plant Physiology, Biochemical Processes in Plants, UGC Press
3. Salisbury F.B. and Ross C.B. 1992. Plant physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA
4. Lambers. H, Chapin.F.S, Pons.T.L. Plant Physiological Ecology.2008.

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

Practicals

Measurement of environmental factors on land, water and air. Ecosystems: pond, agricultural or grassland, forest. Community analysis through different sampling techniques (quadrat, Transect). Population dynamics of grasshoppers. 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. Development of an ecological management plan of some selected area

Books Recommended

1. Odum, E. P. 1994. FUNDAMENTALS OF ECOLOGY. 3rd Edition W.B. Saunders. Philadelphia
2. Molles, M.C. 2005 Ecology: CONCEPTS AND APPLICATIONS. 6th Edition, McGraw Hill, New York, USA
3. 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
4. Slings by, D. And Cook, C., 1986. Practical Ecology. Mcmillan Education Ltd. UK 5. Chapman, J.L. And Reiss, M.J.1997. Ecology: Principles and Applications. Cambridge Univ. Press, Uk
6. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row
7. Newman, I. 1993. Applied ecology. Black well scientific publications oxford. UK
8. Coxes, C.B and Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6thEdition. Life Sciences King's College, London, UK
9. Molles .M. C.Ecology: Concepts and Applications, 4thEdition.2006. McGraw-Hill
10. Lambers. H, Chapin. F. S, Pons. T.L. Plant Physiological Ecology.2008. Springer 11. Valk. A. V. Herbaceous Plant Ecology: Recent Advances in Plant Ecology.2009. Springer

ZOO-243	Chordates	4(3+1)

Course Contents

a. **Protochrodates**: 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

5. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gasexchange and temperature regulation, nervous and sensory functions, excretion and osmoregulation,reproduction and development.

6. 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.

e. Migration and navigation.

7. Mammals:

a. Diversity and Classification of mammals

b. 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

Museum study of:

1. Protochordates
2. Pisces
3. Amphibia
4. Reptilia
5. Aves
6. Mammalia
7. Field trips to study animal diversity in an ecosystem.

Note: Preserved specimen and/or colored projection slide and/or CD ROM projection of computer must be used.

Books Recommended

1. Hickman, C.P., Roberts, L.S., Larson, A. 2011. Integrated Principles of Zoology, 15th Ed. (International). Singapore: McGraw Hill.
2. 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.
3. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. International), Singapore: McGraw Hill.
4. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. Latest edition New York: McGraw Hill.
5. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

ZOO-244	Animal Form and Function I	4(3+1)

Course Contents

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 of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of *Labeo*, *Rana tigrina*, *Varanus*, fowl and rabbit.

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

3. Earthworm or leech; cockroach, freshwater mussel, Channa or *Catla catla* or *Labeo* or any other local fish, frog, pigeon and rat or mouse and rabbits are representative animals for study in dissections.
4. Study of models or preserved brains of representative animals and notes on adaptations.
5. Study of nervous system of earthworm and a fish.
6. Study of endocrine system in an insect and a rabbit
7. Study of different types of blood cells in blood smear of rabbit.
8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

Books recommended

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

ZOO-245	Animal Form and Function II	4(3+1)

Course Contents

1. Protection, Support, and Movement:

a. Protection: the integumentary system of invertebrates and vertebrates.

b. Movement and support: the skeletal system of invertebrates and vertebrates.

c. Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates

2. Nutrition and Digestion:

a. Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion

b. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.

c. The mammalian digestive system: gastrointestinal motility and its control

d. Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gall bladder in digestion.

3. Temperature and Body Fluid Regulation:

e. Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations;

Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds and Mammals

f. Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate

g. Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions. Reproduction and Development

4.Reproduction:

h. Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction;
i. Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes;

Practicals

1. Study of excretory system in an invertebrate and a vertebrate representative (Model).
2. Study of nutritive canal in an invertebrate and a vertebrate representative (Dissection).
3. Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
4. Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
5. Study of hormonal influence of a reproductive function (Model).
6. Study of preserved advanced stages of avian and mammalian development for amniotic membranes and placenta (Model).
7. Study of stages in the development of an Echinoderm.
8. Study of early stages in the development of a frog, chick and a mammal.

Note: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

Books Recommended

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

Year III Semester-V		
Course Code	**Course Title**	**Credits**
ZOO-551	Sociology	2(2+0)
ZOO-552	Biochemistry	4(3+1)
ZOO-553	Cell & Molecular Biology	4(3+1)
ZOO-554	Physiology	4(3+1)
ZOO-555	Animal Behavior	3(2+1)
	Total Credits	17

ZOO-551	Sociology	2(2+0)

1. Introduction
    a. Definition, Scope, and Subject Matter
    b. Sociology as a Science
    c. Historical back ground of Sociology
2. Basic Concepts
    a. Group, Community, Society
    b. Associations
        i. Non-Voluntary
        ii. Voluntary
    c. Organization
        i. Informal
        ii. Formal
    d. Social Interaction
        i. Levels of Social Interaction
        ii. Process of Social Interaction
            a) Cooperation
            b) Competition
            c) Conflict
            d) Accommodation
            e) Acculturation and diffusion
            f) Assimilation
            g) Amalgamation
3. Social Groups
    a. Definition and Functions
    b. Types of social groups
        i. In and out groups
        ii. Primary and Secondary group
        iii. Reference groups iv.Informal and Formal groups
        v. Pressure groups

4. Socialization and Personality
    a. Personality, Factors in Personality Formation
    b. Socialization, Agencies of Socialization
    c. Role and Status

Recommended Books:

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

ZOO-352	Biochemistry	4(3+1)

Course Contents

Amino acids, peptides and proteins: standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, cytochrome c; Proteins: level of structural organization, example of structural and functional proteins.

Enzymes: Introduction; important characteristics of enzymes; immobilized enzymes; how enzymes work; example of enzymatic reaction; enzyme kinetics, enzyme rate of reaction and substrate concentration, how pH and temperature effect on enzyme activity.

Carbohydrates: Classification, types, important characteristics and structure of carbohydrates; cyclic structure of monosaccharides; cyanohydrin formation; disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides.

Lipids: fatty acids, their types and major characteristics; storage lipids, acylglycerols; waxes; structural lipids in membranes; major functions of lipids; lipoproteins, their types and major functions.

Vitamins and cofactors: occurrence, structure and biochemical function of vitamins B complex group.

Metabolism: detailed description of glycolysis and catabolism of other hexoses; regulation and bioenergetics of glycolysis. Anabolic role of glycolysis; fate of pyruvate under aerobic and anaerobic conditions, lactate, acetyl CoA and ethanol formation; alcoholic fermentation; gluconeogenesis, its regulation and significance in the tissues; feeder pathways in glycolysis;

utilization of other carbohydrates in glycolysis phosphorolysis and starch; regulation of glycogen metabolism. Citric acid (TCA) cycle: conversion of pyruvate to acetyl CoA, pyruvate dehydrogenase, a multi-enzyme complex; detailed description of citric acid cycle; bioenergetics and conservation of energy produced in the

cycle. Anabolic or biosynthetic role of citric acid cycle intermediates; replenishing or anaplerotic reactions and their role; regulation of citric acid cycle; Electron transport and its components, oxidative phosphorylation, chemiosmotic theory, ATP synthesis, uncouple electron transport and heat generation.

Practicals

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

Books Recommended

1. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan worth Publishers, New York.
2. Berg, J. M., Tymoczko,J. L.,Lubert Stryer. 2010. Biochemistry. 7TH Ed.
3. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D.,Darnell, J. 2012. Molecular Cell Biology.
4. McKee, T., McKee, J.R. 2003.Biochemistry: The Molecular Basis of Life. 3rd Edition, McGraw Hill.
5. Wilson, K., Walker, J. 1994.Practical Biochemistry: Principles and Techniques, 4th Ed., Cambridge University Press

ZOO-353	Cell & Molecular Biology	4(3+1)

Course Contents

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

Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments. Cytoplasmic **Organelles**:Membrane system, structural and functional commonalities. Ultrastructure, chemical composition and functions of Endoplasmic Reticulum and their role in protein synthesis and drug metabolism, Golgi apparatus its role in synthesis of glycoprotein, Mitochondrial respiration and its significance as semi-autonomous organelle; Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, Glycoxysome with reference to glyoxylic acid cycle. **Nucleus**: chromatin, heterochromatin, euchromatin, chromosome structure, coiling and nucleosome during different phases of cell cycle.

Replication: mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with emphasis on DNA polymerases, concept of replicons etc., **Transcription**: variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved, RNA splicing, split genes, concept of ribozymes and posttranscriptional processing, RNA transduction, Genetic code, point mutations.

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

Practicals

1. Identification of cell organelles
2. Preparation of temporary whole mount.
3. Preparation of permanent whole mount (demonstration)
4. Preparation of human blood smear and identification of Leucocytes.
5. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).
6. Squash preparation of onion root tip for mitotic stages.
7. Mounting of polytene chromosome (Drosophila/Chironomous.) Demonstration.
8. Detection and quantitative determination of chromosomal DNA and RNA.
9. Cultural and staining of bacteria and yeast.
10. Separation of different sized DNA fragments on agarose gel.
11. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).

Books Recommended

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

ZOO-354	Physiology	4(3+1)

Course Contents

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

Neuromuscular interaction at cell and molecular level muscle

Cardiovascular Physiology:

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

Neurogenic heart and their expression.

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.

Respiratory Physiology:

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

of respiration and stimulus factors in various animals.

Respiration adaptations in hypoxia and hypercapnia etc.

Air breathing and respiratory adaptations diver animals

Excretory Physiology:

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

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

Physiology of Nutrition:

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

Regulation of digestive secretions.

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

Potential and Movements in gastrointestinal tract and control of motility

Practicals

1. Determination of haemoglobin content, haematocrit and cell counting.
2. Preparation of blood smears.
3. Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of stimulus strength, effect of stimulus frequency (tetany), effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human.
4. Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology.

5. Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
6. Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure glycemia altered by exercise.
7. Effect of insulin on glycemia, study of stages in estrous cycle.

Books Recommended

1. Guyton, A.C., Hall, J.E. 2013. Textbook of Medical Physiology, 10th Ed. W.B. Saunders Company, Philadelphia.Sherwood 2013
2. Tharp, G.,Woodman, D. 2010. Experiments in Physiology, 10th Ed. Bejamin Cummings.
3. Fox, S. 2010. Laboratory manual of human physiology. McGraw-Hill Sciences.
4. Randall, D., Burggren, W., French, K., Fernald, R. 2002. Eckert

Animal Physiology: Mechanisms and Adaptations, 5th Ed. W.H. Freeman and Company, New York

5. Bullock, J., Boyle, J., Wang, M.B. Physiology, 4th Ed. 2001. Lippincott, Williams and Wilkins, Philadelphia.
6. Berne, R.M., Levy, M.N. 2000. Principles of Physiology, 3rd Ed. St. Lious, Mosby.
7. Withers, P.C. 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
8. Schmidt-Nelsen, K. 1997. Animal Physiology, Adaptation and Environment, 5th Edition. Cambridge University Press, Cambridge

ZOO-355	Animal Behavior	3(2+1)

Course Contents

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

Practicals

1. Locomotory behavior of small animals, earthworm, garden snails etc.
2. Ear pinna reflex responses in domestic cats
3. Preparation of skinner box or maze for study of mouse or rat behavior
4. Mother-pup bond in mice and rats
5. Infant killing behavior
6. Pecking behavior of chickens
7. Hiding behavior of chicks
8. Observation of birds' nests and study of parental behavior
9. Altruistic behavior in monkeys

Books Recommended

1. Dugatkin, L. A. 2012. Principles of Animal Behavior. W.W. Nortan and Co. New York.
2. Scott, G. 2005.Essential Animal Behavior. Blackwell Pub. New York.
3. Goodenough, J., McGuire, B., Wallace, R.A. 2001. Perspective on Animal Behavior. John Wiley & Sons, New York

Semester-VI		
Course Code	**Course Title**	**Credits**
ZOO-361	Biological Techniques	3(1+2)
ZOO-362	Evolution & Principles of Systematics	3(2+1)
ZOO-363	Developmental Biology	4(3+1)
ZOO-364	Genetics	4(3+1)
ZOO-365	Synopsis & Research Methodology	2(2+0)
	Total Credits	16

ZOO-361	Biological Techniques	3(1+2)

Course Contents

Microscopy: Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, Bright field (Compound Microscope), Scanning microscopy, Eyepiece micrometers, Camera Lucida Phase Contrast Dark field Interference microscope, Electron microscope.

Micrometery and Morphometry: Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter).

Standard system for weight, length, volume: Calculations and related conversions of each:- Metric system- length; surface; weight – Square measures- Cubic measures (volumetric)- Circular or angular measure Concentrations- percent volume; ppt; ppm - Chemical molarity, normality Temperature- Celsius, centigrade, Fahrenheit. Preparation of stock solutions of various strengths

Specimen preparation for optical microscopy: Microtomy: Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections.

Extraction techniques: Centrifugation, Ultracentrifugation, cell fractionation, filtration, Distillation, Use of Soxhalet and Rotary evaporator for extraction.

Separation Techniques: Chromatography: Principle, applications, types, thin layer, column, gas, ion exchange chromatography. Electrophoresis: Principle, applications, types.

Spectrophotometery: Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.

Basic principles of Sampling and Preservation: Sampling soil organisms, invertebrates, Aquatic animals, Mammals, Estimation of population size, Preservation of dry and wet specimens. Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field. Practicals

1. Observation of wet mounts of human cheek cells employing bright and dark field microscopy
2. Measurement of cell size: bacterial and eukaryotic
3. Recording of microscopic observations with the help of camera lucida
4. Liquid handling: proper use of pipettes and micropittes
5. Histological preparations: skeletal muscle, intestine liver and testes
6. Handling of centrifuge machines
7. Thin layer chromatography of amino acids
8. Spectrophotometric estimation of glucose
9. Spectrophotometric estimation of total proteins
10. Preservation of representative animals of various phyla
11. Electrophoretic separation of proteins
12. Electrophoretic separation of DNA

Books Recommended

1. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
2. Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part I. Cambridge University Press, UK.
3. Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part II. Cambridge University Press, UK.
4. Curos, M. 1997.Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
5. Curos, M. 1997.Environmental Sampling and Analysis: For Technician. CRC Press LLC. USA.
6. Slings by, D., Cock, C.1986. Practical Ecology. McMillan Education Ltd. London.

ZOO-362	Evolution & Principles of Systematics	3(2+1)

(Note: Evolution and Principles of Systematic Zoology 60% and 40% weightage, respectively. Three questions from Evolution and two questions from Systematic will be attempted by the students).

Course Contents

(i). Evolution

The nature and origin to life: Evidences of evolution (molecular, embryological & paleontological).

Theories of Evolution: Theories to explain the diversity of life–Modern synthetic theory, factors initiating elementary evolutionary changes (micro-evolution) by changing gene frequencies, mutation pressure, selection pressure, immigration and crossbreeding, genetic drift.

Role of isolation in evolution: Factors of large evolutionary changes (macro/mega evolution) - allometry, orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of selection, selection patterns, laboratory and field example regarding action of Natural Selection. Action of Natural Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry, Sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory, Recapitulation theory, Trend and rates in evolution.

(ii). Systematic Zoology

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, microtaxonomy, taxonomic categories: specific category, infraspecific category, higher categories; Species concept.

Typological species concept: Nominalistic species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation, Taxonomic procedures, taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

Systematics publications: International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

Practicals

1. Study of preserved invertebrate species and their classification upto class level.
2. Collection, preservation and identification of common species with the help of keys.
3. Preparation of keys for the identification of specimens.
4. Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.

Books Recommended Evolution

1. Strickberger. M.W. 2012. Evolution.Jones & Barrett Publishers.
2. Ridley, M. 1993. Evolution. Blackwell Scientific Publications.
3. Moody, P.A. 1989. Introduction to Evolution, Harper and RowPublishers, New York.
4. Dobzhansky, T., Ayala, F.J., Stebbins, G.L., Valentine, J.W. 1973. Evolution. W.H. Freeman and Company.
5. Mayr, E. 1965.Populations, Species and Evolution, Harvard University Press.
6. Dobzhansky, T. 1951. Genetics and the origin of species. Columbia University Press, New York.

Systematic Zoology

1. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2nd Ed. Wiley-Blackwell.
2. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York.

3. Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw Hill, New York
4. Mayr, E. Animal Species and Evolution, 1985. Harvard University Press.
5. Heywood, V.H. Taxonomy and Ecology. 1975. Academic Press, London.
6. Whili, M.J.D. Modes of Speciation, 1978. W.H. Freeman and Co., San Francisco

ZOO-363	Developmental Biology	4(3+1)

Course Contents

Introduction: Principal features of development, origin of sexual reproduction, developmental patterns; Spermatogenesis; Oogenesis.

Fertilization: Recognition of sperm and egg, fusion of gametes, activation of egg metabolism, rearrangement of egg cytoplasm.

Cleavage: Patterns of embryonic cleavage, mechanism of cleavage.

Gastrulation: Fate maps, gastrulation in sea urchin, amphibians, birds and mammals.

Early Vertebrate Development: Neurulation, ectoderm, mesoderm and endoderm.

Cellular Basis of Morphogenesis: Differential cell affinity, cell adhesion molecules.

Mechanism of Cellular Differentiation: RNA processing, translational regulation of developmental process, cell-fate by progressive determinants, autonomous cell specification by cytoplasmic determinants, establishment of body axes and mechanism of teratogenesis; Secondary Induction.

Organogenesis: A brief account; Origin and migration of germ cells in vertebrates. Factors controlling growth and oncogenesis. Post embryonic Development and metamorphosis Hormones as mediators of development; Regeneration in vertebrates.

Practicals

1. Study of the structure of gametes in some representative cases, i.e. frog, fish, fowl and a mammal.
2. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
3. Preparation and study of serial sections of frog or chick embryos.
4. Application of microsurgical techniques on chick embryos In vitro.
5. Preparation and staining of histological slides.

Books Recommended

1. Gilbert, S. F. 2012. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw Hill.
3. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
4. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
5. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
6. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co

ZOO-364	Genetics	4(3+1)

Course Contents

Classical Genetics: Scope and importance of genetics, gene concept; classical and modern),

Multiple Alleles: blood groups and coat color in rabbits.

Chromosomal Basis of Inheritance: interaction of genes, changes in chromosomal number, euploidy, aneuploidy, polyploidy; structural changes, insertion, deletion (Cri du chat syndrome), duplication and translocation

Pedigree Analysis: Normal human chromosome complement; Karyotyping.

Sex-determination and Sex-linkage: Sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes.

Molecular Genetics: Elements of genetic engineering; genetic basis of diseases, like cancer, genetic control of animal development. Human Genetics; Single and Multifactorial Disorders: Autosomal anomalies, Pseudoautosomal genes, (eg. Down syndrome, Edwards syndrome and), Single gene disorders Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria). Definition - characteristics crisscross inheritance. Polygenic traits-Cleft lip and cleft palate, Sex-linked Chromosomal anomalies: Klinefelters syndrome, and Turners syndrome.

Sex-influenced inheritance: Hemophilia, muscular dystrophy, color blindness. Prenatal Diagnosis: Amniocentesis and choriovillus sampling – Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics.

Population Genetics: Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Practicals

1. Mitosis (Onion root tips.) 2. Meiosis (Grass hopper testes)
3. Blood groups.
4. Salivary gland Chromosomes of Drosophila melanogaster
5. General morphology of Drosophila melanogaster
6. Human Pedigree analysis problems
7. Human Genetics problems
8. Probability problems. Tossing of coins. X2 test
9. Study of transformed bacteria on the basis of antibiotic resistance.

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. 2000. 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. 2014. Genetics. McMillan, New York. USA

ZOO-365	Synopsis & Research Methodology	2(2+0)

Course Contents

Significance: objectives of research, Types of research, Research approaches,

Research process: steps involved in research process, (Survey, Observation, case study, experimental, historical and comparative methods)

Data: Types of Data, Data collection, processing, analysis, Review of literature, Research problem, Hypothesis.

Bioethics: Ethical, legal, social and scientific issues in Biological Research.

Plagiarism:

Funding Sources: A brief idea about the funding agencies such as HEC, PSF, USAID etc.

Writing of Research Proposal: Thesis/Report and Research Paper: Footnotes and Bibliography.

Books Recommended

1. Robert, A. Day. 1989. How to write and publish a scientific research paper. 3rd Edition.
2. Holmann, H.H. 1962. Biological research method. Olvyer and Boyd Ltd

Year -IV Semester-VII		
Course Code	**Course Title**	**Credits**
ZOO-471	Environmental Biology	4(3+1)
ZOO-472	Zoogeography & Paleontology	3(2+1)
ZOO-473	Parasitology I	4(3+1)
ZOO-474	Wildlife	2(2+0)
ZOO-475	Entomology	3(2+1)
	Total Credits	16

ZOO-471	Environmental Biology	4(3+1)

Course Contents

Energy: laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.

Biogeochemical cycle: nitrogen, phosphorus, sulpher, water, carbon, nutrient.

Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire. **Global ecosystems**: (atmosphere, hydrosphere, lithosphere, ecosphere). An overview of ecosystem with special reference to ecological niche: basic concepts and types. Major ecosystem of world: Marine, Estuarine, Freshwater, Wetlands, Tundra, Forest, Grassland, Desert and Agricultural ecosystems.

Population ecology: basic population characters, growth and growth curves, population dynamics and regulations.

Community ecology: basic concepts, community analysis, ecotones, inter-population interactions.

Applied Ecology: resources and their ecological management (mineral, agricultural desalination and weather modification, forest and range management, landscape and land use);

Pollution: (definition, types, cost, origin and management); water (sources, domestic and industrial pollution, heavy metals); air (sulpher dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE & CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution.

Radiation ecology: global environmental changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, desertification, deforestation, exotic and invasive species, radioactivity leakage, environmental laws).

Practicals

1. Measurement of environmental factors on land, water and air.
2. Study of different ecosystems: pond, agricultural or grassland, forest.
3. Community analysis through different sampling techniques (quadrat, Transect),
4. Population studies mark and recapture method, statistical analysis of field data.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.

8. Field visits for study of selected terrestrial habitat and writing notes.
9. Experimental design and approaches in ecological research; writing a research project
10. Development of an ecological management plan of some selected area.

Books Recommended

1. Molles, M.C. 2005. Ecology: Concepts and Applications. 6th Ed., McGraw Hill, New York, USA.
2. Cox, C.B., Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6thEd., Life Sciences King's College, London, UK.
3. 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.
4. Chapman, J.L., Reiss, M.J.1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.
5. Odum, E. P. 1994. Fundamentals of Ecology. 3rd Ed. W.B. Saunders. Philadelphia.
6. Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford. UK.
7. Slingsby, D., Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK

ZOO-472	Zoogeography & Paleontology	3(2+1)

Course Contents

(i) Zoogeography: Branches of zoogeography: descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography.

Animal distribution: cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution, barriers and dispersal. Zoogeographical regions: zoogeographic division and boundaries, geographic ranges, physical features, climates, faunas and affinities of Palaearctic, Nearctic regions, Oriental, Ethiopian, Australian, and Neotropical Regions, insular fauna Palaeogeography: Theories of continental drift and plate tectonics; Pangea.

Zoogeography of Pakistan:

(ii). Paleontology

The Planet Earth: History, age, shells of earth; atmosphere, hydrosphere, biosphere and lithosphere.

Rocks: types; lgneous rocks, sedimentary rocks and metamorphic rocks.

Fossil types and uses of fossils, nature of fossils.

Fossilization: Geological time scale. Pre-Cambrian life. Post Cambrian life, Palaeozoic life, Mesozoic life, Cenozoic life.

Geochronometry: Uranium/Lead dating, radiocarbon dating methods

Practicals

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 Metamorphicrocks 6. Map work for identification of various zoogeographical regions of the World.

Books Recommended Zoogeography

1. Beddard, F. E. 2008. A text book of zoogeography. Bibliobazar, LLC.
2. Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup & Sons. Delhi.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Darlington, P. J. Jr. 1963. Zoogeography, John Wiley and Sons.

Paleontology

1. Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
2. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H.Freeman & Co. USA.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Brouwer, A. 1977. General Palaeontology, Oliver and Boyed, London

ZOO-473	Parasitology I (Protozoology, Pathology and Immunology)	4(3+1)

Course Contents:

Protozoology

Systematic, geographical distribution, habitats, biology, pathogenesis, important symptoms, mode of transmission laboratory methods of diagnosis, and control of protozoa of medical and veterinary importance.

Pathology and Immunity

The cell and cell injury and its relationship to disease. Acute and chronic inflammations, wound healing, disorders of growth, benign and malignant tumors in case of infections immunity, and hypersensitivity in case of parasitic diseases.

Practical

A study of parasitic Protozoa of medical veterinary importance with special reference to differential morphological features. Preparation of permanent mounts of parasitic Protozoa. Examination of human feces and from domesticated animals by using standard laboratory techniques. Techniques and study of blood parasite study of different types of pathological tissues from prepared slides.

Books Recommended:

1. Barriga, O.O., (1981). The Immunology of Parasitic infection. University of Park Press, Baltimore.
2. Chandler, A.C. and Read, C.P., (1961). Introduction to Parasitology. Int.Ed. Wiley Poppan, New York.
3. Chandrasoma , P. and Taylor, C.R.(1997). Concise Pathology. Prentice Hali International Inc. New Jercy USA.
4. Dixon, M. E. Aid to Pathology. Churchill Livingstone, Edinburgh London and New York.
5. Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
6. Levine, N. D. Protozoan Parasites of domestic animals and of man. Durgers publishing Burgers publishing Co: Minnesota.
7. Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.
8. Noble, E.R and Noble, G.A. (1982). Parasitology: the biology of animal parasites. Lea and Febiger, Philadelphia.
9. Olsen, O. W. (1974). Animal Parasites: their life cycle and ecology. University Park Press Baltimore
10. Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
11. Robbins, S. L. Basic Pathology. W. B. Saunders Co: London, Toronto.
12. Roberts,L.S. and Jonovy ,J.Jr., (2005). Foundation of Parasitology. W. Brown Publishers, Chicasgo, USA.
13. Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.

14. Schmidt, G. D. and Robbert, T. S. (2001). Foundation of Parasitology. The C.V. Mosby Company, Saint Louise
15. Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
16. Thomson, A.D. and Cotton, R.E. (1980). Lecture Notes on Pathology. Blackwell Publication, Oxford London.
17. Wakelin, D., (1984). Immunity to Parasite. Edward Amold, London.
18. Walter, J.B. and Israel, MS (1979). General Pathology. Charchill Living Stone Edinburgh, London and New York.

ZOO-474	Wildlife	2(2+0)

Course Contents

Wildlife: Animal occurrence, protection, needs of animals, maintenance, and the habitat. Techniques: Ground and aerial tracking, GPS, radiotelemetry, maps etc.

Wildlife Conservation: Philosophy and significance, Biodiversity and sustainability of wildlife.

Wildlife Agencies: National and International agencies involved in conservation and management of wildlife. International conventions, agreements.

Wildlife of Pakistan: identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan.

Wildlife rules and regulations in Pakistan: Sanctuaries, Game Reserves and National Parks in Pakistan. Endangered species of Pakistan.

(Note: The teacher is suggested to provide blank maps of Pakistan in the theory class to the students to indicate the distribution of the animals. Similar blanks maps should be attached with the question paper, if distribution of animals is asked from the student in the theory paper).

Books Recommended

1. Ali, S.S. 1999. Paleontology, Zoogeography& Wildlife Management. Nasim Book Depot. Hyderabad, India.
2. Roberts, T. J. 1998. The Birds of Pakistan, (Vol. II), Oxford University Press.
3. Roberts, T. J. 1992. The Birds of Pakistan, (Vol.I). Oxford University Press.
4. Magon, C.F. 1988. Biology of Freshwater Ponds. Longman and Scientific Publication.
5. Bailey, J.A. 1986. Principles of Wildlife Management. John Wiley and Sons.
6. Robinson, W.L., Bolen, E.G. 1984. Wildlife Ecology and Management. McMillan, Cambridge.
7. Roberts, T.J. 1977. Mammals of Pakistan. Ernest Benon Ltd, London.
8. Ali S., Ripley S. D. 1973. A Handbook of Birds of India & Pakistan, Oxford University Press, London.
9. Elirza Z.B, the Birds of Pakistan

ZOO-475	Entomology	3(2+1)

Morphology and Physiology:

An introduction of Entomology with a brief description of different classes of Arthropods. Complete morphology of an insect. Anatomy and Physiology of various systems with special reference to digestive, nervous, circulatory, respiratory, excretory and reproductive system. Development and metamorphosis. Hibernation and diapause.

Taxonomy and Ecology

Classification of insects up to orders. Insect ecology with special reference to factors effecting the population, population estimations. Insect societies.

Practicals

1. Dissection of various insects, to expose their internal anatomy.
2. Preparation of mouth parts, antennae, wings, legs and genitalia of different insects.
3. To study the whole mounts of Collembola, silverfish, thrips, aphids, lice and fleas.
4. Preparation of killing bottles, preservation, pinning and setting of insects.
5. Study of metamorphosis and different types of insects' larvae and pupae, life history of an insect.
6. Classification and identification of insects.

Books Recommended:

1. Imms, A.D. (1957) A General Textbook of Entomology. 9th ed. Revised by O. W.
2. Richards and R. G. Davies, (1957) Reprinted with minor corrections, 1960. Methuen and Co. London.886 pp.
3. Richards, O. W. and Davies, R. G. (1977) Imms' General Textbook of Entomology. Vol. 1. 10th ed. Chapman and Hall. Reprinted in India in 1993. 418 pp.
4. Borror, D. J. and Delong, D. M. (1971) An Introduction to the Study of Insects. 2nd ed. Hold, Rinehart and Winston, N. York. 812 pp.
5. Ross, H. H. (1965) A textbook of Entomology. John Wiley and sons, New York.
6. Snodgrass, R. E. (1935) Principles of Insect Morphology. McGraw Hill New York.
7. Wigglesworth, V. B. (1972) The Principles of Insect Physiology. 7th ed. (Lowpriced). English Language Book Society and Chapman and Hall, London. Reprinted 1979.
8. Patton, R. L. (1963) Introduction to Insect Physiology. Saunders, London.

Semester-VIII		
Course Code	**Course Title**	**Credits**
ZOO-481	Bioinformatics	3(2+1)
THES-482 /ZOO-486	Thesis/ Research Project/ Special Paper	4(0+4)
ZOO-483	Applied Fisheries	3(2+1)
ZOO-484	Applied Entomology	3(2+1)
ZOO-485	Parasitology II	3(2+1)
	Total Credits	16

Any one subject from the following or Thesis			
ZOO-486	Economic Zoology	4 (3+1)	Optional
ZOO-487	Ornithology	4 (3+1)	Optional

ZOO-481	Bioinformatics	3(2+1)

Course Contents

Introduction to BI: What is BI; history of BI; Uses of BI (Protein, Gene); comparison of BI with experimental tools.

Basic principles of computing in bioinformatics: Basic acquisition and database: DDBJ, NCBI and EMBL

Short introduction to DNA, RNA and protein: amino acids, sequence; analyzing Protein sequence using BI tools; sequence-structure function.

Retrieving protein sequences from database (FASTA): Alignment of protein\ nucleotide sequences (BLAST, CLUSTALW); Computing physicochemical parameters of proteins (eg. PROTPARAM); Predicting elements of secondary structure of proteins (eg. PSSP); Retrieval, understanding and predicting 3D structure of protein from sequence; PTMs (eg NETPHOS etc.)

Enzyme classification: retrieval databases

Short introduction to DNA/RNA: structure, genetic code; analyzing the DNA/RNA sequence by the use of BI tools Retrieving the DNA sequence from database; Computing the sequence Identifying restriction sites; Predicting elements of DNA/RNA secondary structure; Computing the optimal alignment between two or more DNA sequences

PRIMER designing for PCR (PRIMER3+, PRIMER-BLAST, OLIGO-CALC etc.)

Short introduction to proteomics and genomics, and the role of bioinformatics in the pharmaceutical industry.

Practicals

1. Retrieval of FASTA sequence
2. Determination of proteins physical and chemical parameters
3. Finding similar sequences for protein and DNA
4. Multiple alignment
5. Predicting proteins secondary structure
6. Predicting RNA secondary structure

7. Predicting protein PTM
8. Finding protein families
9. Determination of gene location on chromosome 10.SNPs

11.Primer design

Books Recommended

1. Baxevanis, A.D., Ouellette, B.F.F, 2011. Bioinformatics: A Practical Guide to The Analysis of Genes and Proteins. John Wiley & sons, Inc.
2. Rastogi, S.C., Mendiratta, N.,Rastogi, P. 2011. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. PHI publishing.
3. Selzer, P., Marhofer, R. and Rohwer, A. 2008. Applied Bioinformatics: An Introduction. Springer publishing, Germany.
4. Baxevanic, A.D., Ouellette, B.F.F. 2004. Bioinformatics: A Practical Guide to The Analysis of Genes and Proteins, 3rdEd. O'Reilly publishers.
5. Moody, G. 2004. Digital Code of Life: How Bioinformatics is Revolutionizing Science, Medicine and Business. John Wiley and Sons.
6. Westhead, D.R., Parish, J.H., Twyman, R.M. 2003. Instant Notes on Bioinformatics. Viva Books Private Limited.
7. Orengo, C. A., Jones, D.T., Thornton, J.M. 2003. Bioinformatics: Genes, Proteins and Computers (Advanced Text). Roultledge.
8. Krane, D.E. and Raymer, M.L. 2002. FUNDAMENTAL CONCEPTS OF BIOINFORMATICS. Benjamin Cummings.
9. Gibas, C. and Jambeck, P. 2001. Developing Bioinformatics Computer SKILLS. m O'Reilly publishers.

Websites

1. http://www.ncbi.nlm.nih.gov
2. http://www.ebi.ac.uk
3. http://foldoc.doc.ic.ac.uk/foldoc/index.html
4. http://wit.integratedgenomics.com/GOLD/

ZOO-482	Thesis/Research Project/Internship	4(0+4)

All the students will have to do research; they should start their research in 7th semester. The research will be extended till 8th semester. In this semester (8thsemester), students must complete their research, write thesis and defend through presentations and viva voce. Research will be compulsory; no special paper will be allowed.

ZOO-483	Applied Fisheries	3(2+1)

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

Practical

1. Collection and identification of common zooplanktons

2. Study of gut contents of fish
3. Statistical analysis of fish growth, length-weight relationship
4. Study of farm fishes of KPK
5. Visit to a fish farm/hatchery to study installations/methods of breeding
6. Prepared slides of fish parasites
7. Analysis of physical properties (temperature, light, colour, turbidity, conductivity etc.) and chemical properties (pH, oxygen, carbon dioxide, salinity, dissolved solids/salts) of water;
8. General methods of age growth studies; reading of age from scales, opercula, otolith and back calculation from bones;
9. Study of larvae, fry and fingerlings of a common fish, regulation of fishing, enactment of fishery legislation.

Books Recommended:

1. Ali S.S.1999 Freshwater Fishery Biology, Naseem Book Depo, Hyderabad, Pakistan.
2. Rath, R.H.1993 Freshwater Aquaculture, Scientific Publishers, Delhi,India.
3. Rounsefell, G.A.and Everhart, W.H. 1953 Fisheries Science, John Wiely and Sons, New York
4. Mirza, M.R.and Bhatti, M.N.1993 Pakistan ki Machlian aur Mahi Parwari Ferozsons, Lahore

ZOO-484	Entomology II: (Applied Entomology and Pest Management)	3(2+1)

Course Contents:

Applied Entomology:

Principles of apiculture, sericulture and lac culture. Study and identification of pests of agriculture, stored grain and households. General characteristics, life cycles and habits of insects of medical and veterinary importance. Study of various insect-borne diseases.

Pest management

The principles of pest control/management viz., physical, mechanical, culture, legislative biological, genetic, chemical and integrated control. Relative merits of various types of insect control. Pest's management practices in Pakistan- oriental review.

Books Recommended:

1. Atwal, A. S. (1984) Agricultural pests of India and South East Asia. Kalyani Publishers Delhi
2. Imms, A.D. (1957) A General Textbook of Entomology. 9th ed. Revised by O. W.
3. Metcalf, G. L. & Flint, W.P. (1962) Destructive and useful insects. Mc Graw Hill New York.
4. Ross, H. H., Herms, W. E. & Janes, M. T. (1982) A text book of Entomology.John Wiley and sons, New York
5. Herms, W. E. & Janes, M. T. Medical Entomology. The Macmillan Co. New York 6.Carter, W.Insects in relation to plant diseases.
7. Green, M. B. Hartley, G.S. & West, T.P. Chemicals for crop protection and pest control, Pergamon Press, New York
8. De Bach, P. Biological control of insect pests and weeds. Chapman and Hall, London.
9. Matheson, R. (1950). Medical Entomology. Comstock Publishing Associates, N.Y.

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.

ZOO-485	Parasitology II (Helminthology)	3(2+1)

Course contents: Basic principles and concepts in Parasitology, Taxonomy, etiology, biology, epedemiology, pathology and pathogenesis, diagnosis, life cycle, control and treatment of **Digenetic Trematodes**:*Schistosoma mansoni, S.japonicum, S.haematobium, Fasciola hepatica, Fasciolopsis buski, Paragonimus westermani, Colonorchis sinensis, Heterophyes heterophyes,* **Monogenetic trematodes**:*Dactylogyrus vastator, Gyrodactylus,* **Cestodes:** *Diphyllobothriam latum, Taenia saginata, T.solium, Echinococcus granulosus, Hymenolepis nana, Dipylidium caninum,* **Nematodes:** *Trichuris trichiura, Trichenella spiralis, Strongyloides stercoralis, Ancylostoma duodenale, Necator americanus, Ascaris lumbricoides, Toxocara canis, Enterobius vermicularis, Wuchereria bancrofti, Brugia malayi, Onchocerca volvulus, Loa loa* and *Dracunculus medinensis.*

Practicals

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

Books Recommended:

1. Robberts, L. Sand Janovy John Jr. (2005). Foundation of Parasitology. 7th edition. The C.V. Mosby Company, Saint Louise
2. Dixon, M. E. Aid to Pathology. Churchill Livingstone, Edinburgh London and New York.
3. Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
4. Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
5. Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.

6. Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London

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).

Pest and Pest Management

Pests of pulse crops

Pests of oil seed crops

Stored grain pests

Pests of cotton

Pests of vegetables

Pests of fruits.

Pests of tea.

Economics of Culture

Apiculture

Sericulture

Lac insect culture

Pearl culture

Aquaculture and Fisheries (Edible Freshwater, 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 andreport 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. NewDelhi. 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 PublishingCompany. 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, PunjabUniversity Press, 36 pp.
8. Anon, 1986. The Hive and the Honeybee. Dadant & Sons. Illinois, USA, pp. 740.

Ornithology

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. Biology of Fossil birds: study of the representative birds viz Archaeopteryx,Archaeornithes and Neoornithes.Comparison with the present existing birds.

e. **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.

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

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

h. **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.

Member 1_____

Member 2_____

Member 3_____

Head of Department_____