

**REVISED CURRICULUM  
OF  
BS ZOOLOGY**

# 1. Bachelor of Science (BS) Zoology

## STRUCTURE

Sr. No.	Categories	No. of Courses	Credit Hours
1.	Compulsory Requirement (No Choice)	09	25
2.	General Courses to be chosen from other departments	07	21
3.	Discipline Specific Foundation Courses	10	32
4.	Major Courses including Research Project / Internship	14	45
5.	Electives within the Major	04	13
	<b>Total</b>	<b>44</b>	<b>136</b>

- Total number of Credit hours 136 (HEC kept it flexible from 133-136)
- Duration 4 years
- Semester duration 15-18 weeks
- Semesters 8
- Course Load per Semester 15-18 Cr hrs
- Number of courses per semester 5-6

**YEAR-I****SEMESTER-I**

Course Code	Course Category	Course Title	Credits
ENG-101	COMPULSORY-I	English-I: Functional English	3(3+0)
PST-101	COMPULSORY-II	Pakistan Studies	2(2+0)
MATH-101	COMPULSORY-III	Mathematics-I	3(3+0)
BOT-112	GENERAL-I	Botany-I (Plant Diversity)	3(3+0)
CHEM-107	GENERAL-II	Chemistry-I (Inorganic)	3(3+0)
ZOO-101	FOUNDATION-I	Invertebrate Biology-I	3(2+1)
		Total Credits	<b>17</b>

**SEMESTER-II**

Course Code	Course Category	Course Title	Credits
ENG-102	COMPULSORY-IV	English-II: Communication Skills	3(3+0)
ISL-101	COMPULSORY-V	Islamic Studies / Ethics	2(2+0)
ZOO-102	FOUNDATION-II	Invertebrate Biology II	3(2+1)
BOT-116	GENERAL-III	Botany-II (Embryology, Anatomy and Morphology)	3(3+0)
CHEM-108	GENERAL-IV	Chemistry-II (Organic)	3(3+0)
CS-101	COMPULSORY-VI	Introduction to Computer	3(3+0)
		Total Credits	<b>17</b>

**YEAR-II****SEMESTER-III**

Course Code	Course Category	Course Title	Credits
ENG-103	COMPULSORY-VII	English-III: Technical writing and presentation skills	3(3+0)
ZOO-103	FOUNDATION-III	Animal Form and Function I	4(3+1)
BOT-116	GENERAL-V	Botany-III (Plant Physiology)	3(3+0)
CHEM-103	GENERAL-VI	Chemistry-III (Analytical Chemistry)	3(3+0)
ZOO-104	FOUNDATION-IV	Chordate Biology-I	3(2+1)
GEOG-321	COMPULSORY-VIII	Geography	2(2+0)
		Total Credits	<b>18</b>

**SEMESTER-IV**

Course Code	Course Category	Course Title	Credits
ZOO-108	MAJOR-I	Economic Zoology	3 (2+1)
ZOO-109	GENERAL-VII	Biochemistry-I	3(3+0)
ZOO-110	MAJOR-II	Biological Technique	3(1+2)
ZOO-105	FOUNDATION-V	Chordate Biology-II	3(2+1)
ZOO-107	FOUNDATION-VII	Evolution	2(2+0)
ZOO-106	FOUNDATION-VI	Animal Form & Function-II	4(3+1)
		Total Credits	<b>18</b>

**YEAR-III****SEMESTER-V**

Course Code	Course Category	Course Title	Credits
ZOO-304	MAJOR-III	Animal Behaviour	3(3+0)
ZOO-301	FOUNDATION-VIII	Biochemistry-II	3(2+1)
ZOO-302	FOUNDATION-IX	Cell Biology	3(2+1)
ZOO-305	MAJOR-IV	Wildlife	3(2+1)
ZOO-303	FOUNDATION-X	Principles of Systematics	4(3+1)
		Total Credits	<b>16</b>

**SEMESTER-VI**

Course Code	Course Category	Course Title	Credits
ZOO-309	MAJOR-VIII	Research Methodology	2(2+0)
ZOO-307	MAJOR-VI	Developmental Biology	4(3+1)
ZOO-308	MAJOR-VII	Ecology	4(3+1)
ZOO-306	MAJOR-V	Molecular Biology	3 (2+1)
ZOO-310	MAJOR-IX	Physiology	4(3+1)
		Total Credits	<b>17</b>

**YEAR-IV****SEMESTER-VII**

Course Code	Course Category	Course Title	Credits
ZOO-/ ZOO-499	MAJOR-X	Special Paper 1/ Thesis	3(2+1)/ 0+3
ZOO-312	MAJOR-XI	Genetics	4(3+1)
ZOO-	ELECTIVE-I	Special Paper 2	3(2+1)
ZOO-313	ELECTIVE-II	Biotechnology	4(3+1)
ZOO-314	COMPULSORY-IX	Biostatistics	4(3+1)
		Total Credits	<b>18</b>

**SEMESTER-VIII**

Course Code	Course Category	Course Title	Credits
ZOO-321	MAJOR-XII	Bioinformatics	3(1+2)
ZOO-/ ZOO-499	MAJOR-XIII	Special Paper 1 (Group B) / Thesis	3(2+1)/ 0+3
ZOO-	ELECTIVE-III	Special Paper 2 (Group B	3(2+1)
ZOO-322	ELECTIVE-IV	Microbiology	3(2+1)
ZOO-323	MAJOR-XIV	Zoogeography & Paleontology	3(3+0)
		Total Credits	<b>15</b>

$$17+17+18+18+16+17+18+15= 136$$

COMPULSORY	09
GENERAL	07
FOUNDATION	10
MAJOR	14
ELECTIVE	04

## DETAIL OF COURSES

### Year-1

#### SEMESTER-I

Course Code	Course Category	Course Title	Credits
ENG-101	COMPULSORY-I	English-I: Functional English	3(3+0)
PST-101	COMPULSORY-II	Pakistan Studies	2(2+0)
MATH-101	COMPULSORY-III	Mathematics-I	3(3+0)
BOT-112	GENERAL-I	Botany-I (Plant Diversity)	3(3+0)
CHEM-107	GENERAL-II	Chemistry-I (Inorganic)	3(3+0)
ZOO-101	FOUNDATION-I	Invertebrate Biology-I	3(2+1)
		Total Credits	17

### ENG-101

### ENGLISH-I: FUNCTIONAL ENGLISH

3(3+0)

#### Course Objectives:

The course aims to:

- Enhance language skills through grammar, phrases and sentence making.
- Develop skills for English writing and translation.
- Enhance listening and speaking skills for wider use.

#### 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 3<sup>rd</sup> 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.

**Course Objectives:**

The course aims to:

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

**Course Contents:**

**Historical Perspective:** Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-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: Wm Dawson & 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-e-Islamia, Club Road.
14. Tahir, A. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.

**Course Objectives:**

The course aims to:

- Prepare the students with the essential tools of algebra
- Develop skills to apply the concepts and the techniques

**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. 6<sup>th</sup> 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.

**BOT-112**

**BOTANY-I (PLANT DIVERSITY)**

**3(3+0)**

### Course Objectives

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

### Course Content

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

**a) Viruses:** (RNA and DNA types) with special reference to TMV.

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

**c) Algae:** (*Chlamydomonas*, *Spirogyra*, *Chara*, *Vaucheria*, *Pinnularia*, *Ectocarpus*, *Polysiphonia*).

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

**e) Lichens:** (*Physcia*)

**f) Bryophytes :**

i. *Riccia*

ii. *Anthoceros*

iii. *Funaria*

**g) Pteridophytes:**

i. Fossils and fossilization

ii. Psilopsida (*Psilotum*)

iii. Lycopsida (*Selaginella*)

iv. Sphenopsida (*Equisetum*)

v. Pteropsida (*Marsilea*)

**h) Gymnosperms :**

i. *Cycas*

ii. *Pinus*

iii. *Ephedra*

### Recommended Books:

1. Lee, R.E. 1999. Phycology. Cambridge University Press, UK
2. Prescott, L.M., Harley, J.P. and Klein, A.D. 2004. Microbiology, 3<sup>rd</sup> ed. W.M. C. Brown Publishers.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. 4<sup>th</sup> ed. John Wiley and Sons Publishers.
4. Agrios, G.N. 2004. Plant pathology. 8<sup>th</sup> 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.

**CHEM-107                      CHEMISTRY-I (INORGANIC CHEMISTRY)                      3(3+0)**

**Course Objectives**

The program is aimed that the student should learn:

1. The Development of periodic law and properties of elements in a systematic way.
2. The principal of chemical bonding
3. Chemistry of acid and bases
4. Chemistry of p-block Elements

**Course Content**

**1. The Periodic Law and Periodicity**

Development of Periodic Table; Classification of elements based on *s*, *p*, *d* and *f* orbitals, group trends and periodic properties in *s*, *p*, *d* and *f* block elements, i.e., atomic radii, ionic radii, ionization potential, electron affinities, electro negativity and redox potential.

**2. Principles of Chemical Bonding**

Types of chemical bonding; ionic bonding; the localized bond approach: VB theory, hybridization and resonance; the delocalized approach to bonding: molecular orbital theory as applied to diatomic and polyatomic molecules, three center bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding.

**3. Acids and Bases**

Concepts of acids and bases including SHAB concept, 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.

**4. Chemistry of p-block Elements**

Chemistry and structure of *p*-block elements; main emphasis on the chemistry and structure of noble gases and their compounds, chemistry and structure of interhalogens, pseudohalogens and polyhalides. Prediction of shapes of molecules using VSEPR model and hybridization.

**Recommended Books**

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001
2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
3. Clyde Day, M. & Selbin, J., "Theoretical Inorganic Chemistry", 2<sup>nd</sup> Ed., Van Nustrand Reinhold, 1969.
4. Lee, J.D., "Concise Inorganic Chemistry", Chapman and Hall, 5<sup>th</sup> Edition, 1996.
5. Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2<sup>nd</sup> Edition, 1994.
6. Bassette, J. Denney, G. H. and Mendham, J., "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4<sup>th</sup> Edition, 1981.
7. Vogel, A. I., "A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis" Longman Green & Co. 1995.

**ZOO-101                      INVERTEBRATE BIOLOGY-I                      3(2+1)**

**Course Objectives:**

1. To provide the knowledge of evolutionary/phylogenetic relationship (from simple to the complex organisms).



2. To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.
3. To provide understanding of body organization, Feeding and Digestive system; Other Organ System.
4. To provide the description of mode of Reproduction and Development
5. To provide the information of their economic and ecological importance

## Course Contents

### Introduction

- a. Classification of Organisms:
- b. Evolutionary Relationships and Tree Diagrams: Patterns of organization.

### Animal-Like Protists: The Protozoa

- a. Evolutionary perspective; Life within a single plasma Membrane.
- b. Symbiotic life-style.
- c. Protozoon Taxonomy; (up to Phyla, subphyla and super Classes, wherever applicable).
- d. Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure.
- e. Nutrition; Genetic Control and Reproduction; Symbiotic ciliates.
- f. Further Phylogenetic Consideration.

### Multicellular And Tissue Levels of Organization

- a. Evolutionary Perspective.
- b. Origins of Multicellularity; Animal Origins.

### Phylum Porifera

- a. Characteristics and classification. Cell Types, Body Wall, and Skeletons.
- b. Water Current and Body Forms.
- c. Maintenance Functions, Reproduction.

### Phylum Cnidaria (Coelenterate)

- a. Characteristics and classification. The body Wall and Nematocysts: Alteration of Generations.
- b. Maintenance Functions; Reproduction and
- c. Classification up to Class.

### Phylum Ctenophore

- a. Characteristics, body organization

### The Triploblastic and With Acoelomate Body Plan Phylum Platyhelminthes

- a. Evolutionary Perspective; Classification up to class.
- b. The Free-Living Flatworms and the Tapeworms, adaptive modification for parasitic life style.

**Phylum Numerate:** Characteristics, body organization

**Phylum Gastrotrich:** Characteristics, body organization

### Pseudocoelomate Body Plan

#### Phylum Aschelminths

- a. Evolutionary perspective; General Characteristics; Classification up to order with External Features.
- b. Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum **Rotifera**, Phylum **Nematoda** and Phylum **Kinorhyncha**.
- c. Some Important Nematode Parasites of Humans.

## Practical:

**Note:** Classification of each member of each phylum up to order with adaptations in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of

computer must be used.

1. Study of Euglena, Amoeba, Endameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of prepared slides of sponges, spicules of sponges, and their various body forms. Study of representatives of classes of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.

**Recommended Principal Reference Book:**

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

**BOOKS FOR PRACTICAL**

1. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), Singapore: McGraw Hill.
2. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore: McGraw Hill.

**SEMESTER-II**

Course Code	Course Category	Course Title	Credits
ENG-102	COMPULSORY-IV	English-II: Communication Skills	3(3+0)
ISL-101	COMPULSORY-V	Islamic Studies / Ethics	2(2+0)
ZOO-102	FOUNDATION-II	Invertebrate Biology II	3(2+1)
BOT-116	GENERAL-III	Botany-II (Embryology, Anatomy and Morphology)	3(3+0)
CHEM-108	GENERAL-IV	Chemistry-II (Organic)	3(3+0)
CS-101	COMPULSORY-VI	Introduction to Computer	3(3+0)
		Total Credits	17

ENG-102

ENGLISH-II: COMMUNICATION SKILLS

3(3+0)

**Course Objectives:**

The course aims to:

- Enable the students to meet their real-life communication needs.

**Course Contents:**

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

**Essay writing:** Introduction

**CV and job application:** Translation skills; Urdu to English

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

**Academic skills:** Letter/memo writing, minutes of meetings, use of library and internet

**Presentation skills:** Personality development (emphasis on content, style and pronunciation)

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

**Books Recommended:**

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

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

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

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

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

ISL-101

ISLAMIC STUDIES

3(3+0)

**Course Objectives:**

This course aims to:

- Provide Basic information about Islamic Studies
- Enhance understanding of the students regarding Islamic Civilization
- Improve Students skill to perform prayers and other worships
- Enhance the skill of the students for understanding of issues related to faith and religious life.

**Course Contents:**

**Introduction to Quranic Studies:** Basic Concepts of Quran: History of Quran; Uloom-ul -Quran

**Study of Selected Text of Holly Quran:** Verses of Surah Al-Baqra Related to Faith (Verse No-284-286), Verses of Surah Al-Hujrat Related to Adab Al-Nabi

(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 Holly Quran:** Verses of Surah Al-Ihzab Related to Adab al-Nabi (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; Quranic & 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. Hameed ullah M, "Emergence of Islam", IRI, Islamabad
2. Hameed ullah M, "Muslim Conduct of State".
3. Hameed ullah 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 Jrisprudence 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.

**BOT-116**

**BOTANY-II**

**3(3+0)**

#### **Embryology and taxonomy of angiosperms**

##### **Objectives**

The course aims to

Understand identification and nomenclature of higher plants and structures and functions of tissues and organs at embryonic level.

##### **Course Content**

###### **Embryology:**

Early development of plant body:

1. Capsella bursa-pastoris
2. Structure and development of anther, Microsporogenesis and Microgametophyte
3. Structure of Ovule, Megasporogenesis Megagametophyte
4. Endosperm formation, types of endosperm.
5. Parthenocarpy
6. Polyembryony

## **Anatomy and Morphology**

### **Anatomy:**

1. **Cell wall:** structure and chemical composition
2. **Concept, structure and function of various tissues like:**
  - i. Parenchyma
  - ii. Collenchyma
  - iii. Sclerenchyma
  - iv. Epidermis (including stomata and trichomes)
  - v. Xylem
  - vi. Phloem
3. **Meristem:** types, stem and root apices.
4. Vascular cambium
5. Structure of root, stem and leaf. Primary and secondary growth of dicot stem
6. **Characteristics of wood:** diffuse porous and ring –porous, sap and heart wood, soft and hard wood, annual rings.

### **Morphology:**

**A detailed account of various, Morphological characters of root, stem, leaf, inflorescence, flower, placentation and fruit types.**

### **Recommended Books:**

1. 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.
4. Panday, B.P. 2004. **A textbook of Botany (Angiosperms).** S. Chand and Co. New Delhi.
5. Raymond E, S. E. Eichhorn. 2005. **Esau's Plant Anatomy. Meristems cells and tissues of the plant body,** 3<sup>rd</sup> ed. John Wiley & Sons. Inc.
6. Fahn, A. 1990. **Plant Anatomy.** Pergamon Press, Oxford.
7. Esau, K. 1960. **Anatomy of Seed Plants.** John Wiley, New York.
8. 1 Mauseth, J.D. 1998. **An Introduction to Plant Biology: Multimedia Enhanced.** Jones and Bartlett Pub. UK
9. Moore, R.C., W.D. Clarke and Vodopich, D.S. 1998. **Botany.** McGraw Hill Company, U.S.A.
10. Raven, P.H., Evert, R.E. and Eichhorn, S.E. 1999. **Biology of Plants.** W.H. Freeman and Company Worth Publishers.
11. Panday, B.P. 2004. **A textbook of Botany (Angiosperms).** S. Chand and Co. New Delhi.
12. Maheshwari, P. 1971. **Embryology of Angiosperms,** McGraw Hill. New York.
13. Eames A.J. and L.H Mac Daniels. 2002. **An Introduction to Plant Anatomy.** Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.

**CHEM-108**

**CHEMISTRY-II (ORGANIC CHEMISTRY)**

**3(3+0)**

### **Objectives**

Understanding the basic knowledge about organic chemistry.

## **Course content**

### **Introduction to Organic Chemistry**

Organic chemistry-the chemistry of carbon compounds; the nature of organic chemistry-a historical perspective.

### **Chemical Bonding and Properties of Organic Molecules**

Localized and delocalized chemical bonding; concept of hybridization leading to bond angles, bond lengths, bond energies and shape of organic molecules; dipole moment; inductive and field effects; resonance; aromaticity; tautomerism; hyperconjugation; hydrogen bonding; acids and bases; factors affecting the strengths of acids and bases.

### **Classes and Nomenclature of Organic Compounds**

Classification of organic compounds; development of systematic nomenclature of organic compounds; IUPAC nomenclature of hydrocarbons and heteroatom functional groups.

### **Functional Group Chemistry**

A brief introduction to the chemistry of hydrocarbons, alkyl halides, alcohols, phenols, ethers, aldehydes, ketones, amines, and carboxylic acids and their derivatives.

## **Recommended Literature**

1. Clayden, J., Greeves, N., Warren, S. and Wothers, P., "Organic Chemistry", Oxford University Press, New York.
2. Loudon, G. M., "Organic Chemistry", Oxford University Press, New York
3. Sorrell, T. N., "Organic Chemistry", Viva Books Private Ltd., New Delhi.
4. Finar, I. L., "Organic Chemistry", Vol. 1, Pearson Education, Delhi.
5. Carey, F. A., "Organic Chemistry", McGraw-Hill, New York.
6. Ahluwalia, V. K. and Goyal, M., "A Text Book of Organic Chemistry", Narosa Publishing House, New Delhi
7. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
8. Bansal, R. K., "Organic Reaction Mechanisms", Tata McGraw-Hill Publishing Company Ltd., New Delhi.
9. Pine, S. H., "Organic Chemistry", National Book Foundation, Islamabad.
10. Bailey Jr., P. S. and Bailey, C. A., "Organic Chemistry-A Brief Survey of Concepts and Applications", Prentice-Hall, New Jersey.
11. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.
12. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry Part A: Structure and Mechanisms", Kluwer Academic /Plenum Publishers, New York.
13. Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
14. Hand, C. W. and Blewitt, H. L., "Acid-Base Chemistry", Macmillan Publishing Company, New York.
15. McMurry, J., "Organic Chemistry", Brooks/Cole Publishing Company, California.
16. Solomons, T. W. G. and Fryhle, C. B., "Organic Chemistry", John Wiley & Sons, New York.
17. Panico, R., Powell, W. H. and Richer, J. C., "A Guide to IUPAC Nomenclature of Organic Compounds", Jain-Interscience Press, Delhi.
18. Streitwieser Jr., A. and Heathcock, C.H., "Introduction to Organic Chemistry", Macmillan Publishing Company, New York.
19. Fox, M. A. and Whitesell, J. K., "Organic Chemistry", Jones and Bartlett Publishers, London.

**ZOO-102**

**INVERTEBRATE BIOLOGY-II**

**3(2+1)**

### **Course Objectives:**

1. To provide the knowledge of evolutionary/phylogenetic relationship (from simple to the complex organisms).
2. To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.

3. To provide understanding of body organization, Feeding and Digestive system; Other Organ System.
4. To provide the description of mode of Reproduction and Development
5. To provide the information of their economic and ecological importance

### **Course Contents**

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

### **COELOMATE BODY PLAN**

#### **PHYLUM MOLLUSCA**

- a. Evolutionary perspective; Relationship to other animals; Origin of the Coelom;
- b. Molluscan Characteristics, Classification up to class. The Characteristics of Shell and Associated Structures,
- c. Feeding, Digestion, Gas Exchange, Locomotion,
- d. Reproduction and Development, Other maintenance Functions and Diversity in Gastropods, Bivalves and Cephalopods:

#### **PHYLUM ANNELIDA**

- a. The Metameric Body Form; Evolutionary perspective; Relationship to other animals,
- b. Metamerism and Tagmatization, Classification up to Class. External Structure and Locomotion,
- c. Feeding and the Digestive system, Gas Exchange and Circulation,
- d. Nervous and Sensory Functions, Excretion,
- e. Regeneration, Reproduction and Development, in Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration.

#### **PHYLUM ARTHROPODA:**

- a. Evolutionary Perspective: Classification and Relationship to other Animals;
- b. Metamerism and Tagmatization;
- c. The Exoskeleton; Metamorphosis;
- d. Classification up to Class; Further Phylogenetic Consideration.

#### **The Hexapods and Myriapods:**

- a. Evolutionary Perspective: Classification up to class. External Structure and Locomotion,
- b. Nutrition and the Digestive system, Gas Exchange, Circulation and Temperature Regulation,
- c. Nervous and Sensory Functions, Excretion, Chemical Regulation,
- d. Reproduction and Development in Hexapoda,
- e. Insects Behavior, Insect and Human;

#### **PHYLUM ECHINODERMS**

- a. Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class.
- b. Maintenance Functions, Regeneration,
- c. Reproduction, and Development in Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa;

### **SOME LESSER-KNOWN INVERTEBRATES;**

The Lophophorates, Entoprocts, Cycliophores, and Cheatognaths.

#### **Practical:**

**Note:** Classification of each members of each phylum upto order with adaptations in relation to habitat

of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.

1. Study of principal representatives of classes of Phylum Mollusca.
2. Study of principal representatives of classes of Phylum Annelida.
3. Study of principal representatives of classes of groups of Phylum Arthropoda
4. Study of representatives of classes of phylum Echinoderm.
5. Preparation of permanent mount of Parapodia of Nereis and Daphnia. Drawing and labeling.
6. Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.
7. How to make grade-wise series for preparation of temporary and permanent slides.

#### **Recommended Principal Reference Book:**

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

#### **BOOKS FOR PRACTICAL**

1. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), Singapore : McGraw Hill.
2. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore : McGraw Hill.

**CS-101**

**INTRODUCTION TO COMPUTER**

**3(3+0)**

#### **Course Objectives:**

- Develop a vocabulary of key terms related to the computer and to software programs.
- Identify the components of a personal computer system.
- Demonstrate mouse and keyboard functions.
- Demonstrate window and menu commands and how they are used.
- Demonstrate how to organize files and documents on a USB/hard drive.
- Compose, format and edit a word document.
- Send email messages and navigate and search through the internet.

**Course Contents:**Data and Information, Information Processing Cycle, Components of a Computer, Advantages and Disadvantages of Using Computers, Categories of Computers, Computer Applications in Society. Keyboard and Pointing Devices, Types of Input, Input for Smart Phones, Game Controllers, Digital Cameras, Voice Input, Video Input, Scanners and Reading Devices, Biometric Input,



Terminals, Display Devices, LCD Monitors and LCD Screens, Plasma Monitors, CRT Monitors, Printers, Nonimpact Printers, Impact Printers, Speakers, Headphones, Data Projectors. Interactive Whiteboards, Storage, Hard disks, Flash Memory Storage, Solid State Drives, Memory Cards, USB Flash Drives, Cloud Storage, Optical Discs, Blue-Ray Discs, Magnetic Tapes, Magnetic Stripe Cards and Smart Cards, Microfilm and Microfiche, Enterprise Storage. Motherboard, Processor, Control Unit, Arithmetic Logic Unit, Machine Cycle. Data Representation, Memory Sizes, Types of Memory, RAM, Cache, ROM, Flash Memory. System Software, Operating Systems, Utility Programs. Application Software, Business Software, Graphics and Multimedia Software, Software for Home, Personal, and Educational Use, Web Applications. Application Software for Communications. Internet, World Wide Web, Networks, Intranets. Enterprise Computing, Computer Security Risks, Viruses. Introduction to MS Word, MS Excel, MS PowerPoint.

### Recommended Books

1. Shelly, G. B., & Vermaat, M. E. (2012). *Discovering computers fundamentals: your interactive guide to the digital world (Latest ed.)*. Cengage Learning.
2. Sawyer, S. C., & Williams, B. (2000). *Introduction to Using Information Technology (Latest ed.)*. McGraw-Hill Higher Education.
3. Brookshear, G. G., & Brookshear, J. G. (2002). *Computer science: an overview (Latest ed.)*. Addison-Wesley Longman Publishing Co., Inc.
4. O'Leary, T. (2010). *Computing Essentials (Introductory ed.)*. Career Education.
5. Sinha, P.K. (2007). *Computer Fundamentals (6<sup>th</sup> ed.)*. BPB publication.

## Year-II SEMESTER-III

Course Code	Course Category	Course Title	Credits
ENG-103	COMPULSORY-VII	English-III: Technical writing and presentation skills	3(3+0)
ZOO-103	FOUNDATION-III	Animal Form and Function I	4(3+1)
BOT-116	GENERAL-V	Botany-III (Plant Physiology)	3(3+0)
CHEM-103	GENERAL-VI	Chemistry-III (Physical Chemistry)	3(2+1)
ZOO-104	FOUNDATION-IV	Chordate Biology-I	3(2+1)
GEOG-321	COMPULSORY-VIII	Geography	2(2+0)
		Total Credits	<b>18</b>

### ENG-102      TECHNICAL WRITING AND PRESENTATION SKILLS    3(3+0)

#### Objectives:

The course aims to:

- Enhance language skills
- Develop critical thinking

#### Course Contents:

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

**Academic writing:** How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

**Technical Report writing:****Progress report writing:**

*Note: Extensive reading is required for vocabulary building*

**Books Recommended:**

1. Langan, J. 2004. College Writing Skills McGraw-Hill Higher Education.
2. Kirsznner. L.G., Mandell, S. R. Patterns of College Writing. 4<sup>th</sup> Ed. By St. Martin's Press.
3. White, R. 1992. Writing.Advanced.Oxford Supplementary Skills.Third Impression (particularly suitable for discursive, descriptive, argumentative and report writing).
4. Neulib, J., Cain, K. S., Ruffus, S., Scharton, M. (Editors). Reading. The Mercury Reader.A Custom Publication.Compiled by norther Illinois University.(A reader that will give students exposure to the best of twentieth century literature).

**BOT-116****BOTANY-III (PLANT PHYSIOLOGY)****3(2+1)****Objective**

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

**Course Content:**

**1. Water relations:** (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomatal regulation.

**2. Mineral nutrition:** Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.

**3. Photosynthesis:** Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle).

Differences between C<sub>3</sub> and C<sub>4</sub> plants. Factors affecting this process, Products of photosynthesis.

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

**5. Photoperiodism:** Definition, historical background, Classification of plants based on photoperiodic response, Role of phytochromes, and hormones and metabolites in photoperiodism,

**6. Dormancy:** Definition and causes of seed and bud dormancy; methods of breaking seed dormancy. Physiological processes during seed germination.

**7. Plant Movements:** Classification. Tropic movements- phototropism, gravitropism and their mechanisms. Nastic movements.

**Books Recommended**

1. Ihsan, I. 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
2. Witham and Devlin. 1986 Exercises in Plant Physiology, AWS Publishers, Boston.
3. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4<sup>th</sup>. Ed. Sinauers Publ. Co. Inc. Calif.
4. Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5<sup>th</sup> Edition. Wadsworth Publishing Co. Belmont CA.
5. Hopkins, W. B. 1999. Introduction to Plant Physiology. 2<sup>nd</sup> Ed. John Wiley and Sons. New York
6. Schultz, J. C. 2005. Plant Ecology. Springer-Verlag, Berlin.

**CHEM-108****CHEMISTRY-III (PHYSICAL CHEMISTRY)****3(3+0)**

## Objectives

- This course will introduce you to the vocabulary and concepts used in basic Analytical Chemistry.
- You will learn the details of steps involved in the preparation and analysis of a sample, the chemical basis and various techniques of analysis.
- You will also learn and use statistical methods to determine the precision and accuracy of experimental results.
- Graded assignments, quizzes, class tests and a *final exam* will test your understanding of the material dealing with these goals.
- To develop skills needed to solve analytical problems in a quantitative manner, particularly with the aid of the spreadsheet tools.
- Teaching laboratory skills that will give students confidence in their ability to obtain high-quality analytical data.

## Course Description

- Introduction to Analytical Chemistry
- Measuring Apparatus
- Expression of Quantities and Concentrations
- Basic Approach to Equilibrium
- Errors in Chemical Analyses and Quality of Results
- Chemicals and reagents
- Use and handling of standards
- Sampling
- Errors
- Precision, Accuracy, Signal-to-noise ratio, Limits of detection and
- Statistical Evaluation of Data
- Quality Control and Quality Assurance

## Text and Reference books:

1. McQuarrie, D. A. and Simon, J. D., Physical Chemistry – A Molecular Approach, 1<sup>st</sup> ed., University Science Books, (1997).
2. Atkins, P. and Paula, J. D., Atkins's Physical Chemistry, 9<sup>th</sup> ed., Oxford University Press, (2010).
3. Shoemaker, D., Experiments in Physical Chemistry, 8<sup>th</sup> ed., McGraw Hill Publishing Company Limited, (2003).
4. Silbey, R., Alberty, R. and Bawendi, M., Physical Chemistry, 4<sup>th</sup> ed., (2005).
5. Glasstone, S., Textbook of Physical Chemistry, Macmillan London (1960).
6. James, A. M., Prichard, F. E., Practical Physical Chemistry, 3<sup>rd</sup> ed., Longman Group Limited, New York, (1974).
7. Chaudhary, S. U., Ilmi Textbook of Physical Chemistry, 2<sup>nd</sup> ed., Ilmi Kitab Khana, Lahore, (2013).
8. Atkins, P., Jones, L., Chemical Principles: The Quest for Insight, 5<sup>th</sup> ed., W. H. Freeman, New York, (2010).
9. Linder, B., Elementary Physical Chemistry, World Scientific Publishing Co. Pvt. Ltd., (2011).
10. Davis, W. M., Dykstra, C. E., Physical Chemistry: A Modern Introduction, 2<sup>nd</sup> ed., CRC Press, (2011).

**Course Objectives**

The objectives of the course are:-

1. To enable them to understand the Taxonomic characteristics of protochordates and chordates.
2. To impart knowledge about the phylogenetic relationships of protochordates and various classes of chordates.
3. To develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

**Course outline:****1. Protochordates**

- a. Classification of protochordates.
- b. Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates
- c. Reproduction; life histories and metamorphosis of protochordates.
- d. Phylogenetic relationships.

**2. Fishes:**

- a. Vertebrate Success in Water.
- b. Phylogenetic relationships of Pisces.
- c. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli
- d. Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).

**3. Amphibians:**

- a. The first terrestrial vertebrates. Characteristics of amphibians
- b. Phylogenetic relationships.
- 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 and
- e. Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.

**Practicals:**

- a. Classification and study of lab specimens of hemichordates, fishes, amphibians.
- b. Visit to PMNH for the study of diversity of chordates.

**Text and Reference books:**

1. Campbell, N.A. Biology. 9<sup>th</sup> Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
2. Miller, S.A. and Harley, J.B. 2010. Zoology, 8<sup>th</sup> Edition (International) Singapore: McGraw Hill.
3. Miller, S.A. 2002. General Zoology Laboratory Manual. 5<sup>th</sup> Ed.(International), Singapore: McGraw Hill.

4. **Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14<sup>th</sup> Edition (International), 2009. Singapore: McGraw Hill.**
5. **Pechenik, J.A. Biology of Invertebrates, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.**

**ZOO-103**

**ANIMAL FORM AND FUNCTION-I**

**4 (3+1)**

**Course Objectives**

5. To teach about animals' diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times.
6. To impart understanding of diverse strategic structural adaptations in each of the functions of integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory and respiratory systems for effective survival in their specific conditions.
7. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
8. To embrace the phenomena in basic structure of each system that determines its particular function.

**Course Outline:**

**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

**Communication I:**

- a. Nerves: Neurons: structure and function.

**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

**Communication III:**

- a. The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action
- b. Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemertean, nematodes, mollusks, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

**Circulation and Immunity:**

- a. Internal transport and circulatory systems in invertebrates
- b. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells
- c. 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 (*Labeo rohita*), Frog (*Hoplobatrachus tigerinus*), Varanus (*Varanus bengalensis*), fowl (*Gallus gallus domesticus*) and rabbit (*Oryctolagus cuniculus*).  
Note: Exercises of notes on the adaptations of skeletons to their function must be done.
3. Earthworm or leech; cockroach, freshwater mussel, Channa or *Catla catla* or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.
5. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

### Books recommended

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

**GEOG-321**

**GEOGRAPHY (PHYSICAL GEOGRAPHY)**

**2(2+0)**

### Course outline

#### Lithosphere

1. Internal structure of earth.
2. Rocks—origin, formation and types: Igneous Rocks, Sedimentary and Metamorphic Rocks.
3. Plate tectonics, mountain building, geomorphic processes.
4. Endogenic and exogenic Processes and their resultant landforms
5. Earthquakes and volcanic activity folding and faulting.
6. Weathering, mass wasting, cycle of erosion, erosion and deposition.
7. Landforms produced by surface water, ground water, wind and glaciers.

#### Atmosphere

1. Composition and structure of atmosphere
2. Atmospheric temperature and pressure, global circulation,
3. Air masses and fronts
4. Cyclones and other disturbances
5. Atmospheric moisture and precipitation.

#### Hydrosphere

1. Ocean deposits, composition, temperature, and salinity of ocean Water,
2. Movements of the ocean water; waves, currents and tides.
3. Formation and types of soils

### Books Recommended

1. Christopherson, R.W. (2000), Geo-systems, Prentice-Hall, Inc, USA.
2. De Blij, H. J and Muller, P.O. (1996), Physical Geography of the global Environment, USA, John Wiley and Sons Inc.
3. Diwan A.P. & D.K. Arora (1995), Origin of the Ocean, Anmol Publisher, Delhi.
4. Mcliveen, J.F.R. (1992), Fundamentals of Weather and climate, Prentice Hall New Jersey
5. Miller, G.T. (1996), Living in the Environment, Principles, connections and solutions, Wadsworth
6. Monkhouse, F.J. (1996), Principles of Physical Geography, Hodder & Stoughton, London
7. Strahlar, A.N., Strahlar, A.H. (2004), Physical Environment, John Wiley, New York
8. Stringer, E.T. (2004), Modern Physical Geography New York: John Wiley.

### SEMESTER-IV

Course Code	Course Category	Course Title	Credits
ZOO-108	MAJOR-I	Economic Zoology	3
ZOO-109	GENERAL-VII	Biochemistry-I	3(3+0)
ZOO-110	MAJOR-II	Biological Technique	3(1+2)
ZOO-105	FOUNDATION-V	Chordate Biology-II	3(2+1)
ZOO-107	FOUNDATION-VII	Evolution	2(2+0)
ZOO-106	FOUNDATION-VI	Animal Form & Function-II	4(3+1)
		Total Credits	<b>18</b>

**ZOO-108**

**ECONOMIC ZOOLOGY**

**3(3+0)**

### Course Objectives

The objectives of the course are:-

1. To educate scholars about the relationship of commerce with domestic animals, their products, by-products and associated farming practices
2. To teach the importance of human and domestic animal diseases and their vital relation to the economy
3. To provide knowledge about internal and external parasites and their effects on domestic animals and their farming practices
4. To familiarize with the value of studying various general practices, principles and techniques in farming and rearing of animals in sericulture (silk worms), apiculture (honey bees), aquaculture (fisheries, pearl culture, prawns and oysters), poultry (domestic fowl and ostriches) and cattle husbandry
5. To study the economics and principles of stored grained pests, pesticides and integrated pest management

### Course outline:

1. Basic concepts in Economic Zoology.
2. Parasitic protozoans and human disease. Economic importance of protozoa.
3. Vectors of human and domestic animals.
4. Ecto- and Endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and

Arachnida).

5. Apiculture, and Sericulture, Lac insect culture and Pearl culture
6. Aquaculture and Fisheries (Edible Fresh water, Pond and Marine fish, Prawns,). Economic importance of fishes.
7. Bird farming (Poultry).

#### Visits

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

#### Text and Reference books:

1. *Economic Zoology*. Ravindranathan, K. R. 2003. 1<sup>st</sup> ed. Dominant Publishers and Distributors. New Delhi. India
2. *Principles of Wildlife Management*. Bailey, J. A. 1986. John Wiley and Sons Inc. USA.
3. *Wildlife ecology and management*. Robinson, W. L. and Bolen, E. G. 1984. McMillan Publishing Company. Cambridge, UK.
4. *A Primer of Conservation of Biology*. Primack R. B. 2000. 2<sup>nd</sup> ed. Sinauer Associates Inc. USA.
5. *Animal biodiversity of Pakistan*. Mirza, Z. B. 1998. 1<sup>st</sup> ed: Printopack, Rawalpindi. Pakistan.
6. Ahmad, R. and Muzaffar, N., 1987. Rearing of Silkworm. Misc. Pub. Pak. Agric. Res. Council, pp. 53.
7. Akhtar, M. and Muzaffar, N., 2008. Introduction to Apiculture, Department of Zoology, Punjab University Press, 36 pp.
8. Anon, 1986. The Hive and the Honeybee. Dadant & Sons. Illinois, USA, pp. 740.
9. Anon, 1999. FAO Bulletins on Sericulture Nos. 1 & 2. FAO Office, Rome, Italy.
10. Blackiston, H., 2001. Beekeeping for Dummies. Wiley Publishing, Inc. Indiana, USA, pp. 303.
11. Shukla, G.S. and Upadhyay, V.B., 1997. Economic Zoology, 3<sup>rd</sup> Ed. Rastogi Publications, Meerut, India, pp. 369.

**ZOO-105**

**CHORDATE BIOLOGY-II**

**3(2+1)**

#### Course Objectives

The objectives of the course are:-

1. To enable them to understand the Taxonomic characteristics of protochordates and chordates.
2. To impart knowledge about the phylogenetic relationships of protochordates and various classes of chordates.
3. To develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

#### Course Content



## 1. Reptiles:

- a. The First Amniotes and cladistic interpretation of the amniotic lineage.  
General characteristics of reptiles.
- b. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata and Crocodilia
- c. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development of helonia, squamata, Rhynchocephalia and crocodilian.
- d. further phylogenetic considerations.

## 2. 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.

## 3. Mammals:

- a. Classification, Specialized teeth, endothermy, hair and viviparity.
- b. Diversity of mammals.
- 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.

## 4. Adaptations:

Aquatic, Cursorial, fossorial, arboreal, aerial

## Practicals:

- a. Classification and study of lab specimens of reptiles, birds and mammals.
- b. Visit to PMNH for the study of diversity of chordates.
- c. Visit to various natural parks, sanctuaries and protected areas of Pakistan.

## Text and Reference books:

1. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
2. 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. **Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14<sup>th</sup> Edition (International), 2009. Singapore: McGraw Hill.**
5. **Pechenik, J.A. Biology of Invertebrates, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.**

ZOO-107

EVOLUTION

2(2+0)

## Course Objectives:

1. To provide detailed account based on origin of life

2. To develop some basic concepts and ideas for causing evolutionary changes.
3. To determine the significance of systematics in relation to their nomenclature.

**Course Content:**

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

**Text and Reference Books:**

1. Strickberger. M.W. 2012. Evolution. Jones & Barrett Publishers. Gower Street, London, England.
2. Ridley, M. 1993. Evolution. Blackwell Scientific Publications, New York, USA.
3. Moody, P.A. 1989. *Introduction to Evolution*, Harper and Row, Publishers, New York
4. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and Practical Practice of Phylogenetic systematics. 2nd Ed. Wiley-Blackwell.
5. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York.

**ZOO-109**

**BIOCHEMISTRY-I**

**3(3+0)**

**COURSE OBJECTIVES:**

1. To provide knowledge about macro molecule of eukaryotic cells and organelles, including membrane structure and dynamics.
2. To provide in-depth knowledge about the polymerized organic compounds of life.
3. To provide knowledge of the principles of bioenergetics and enzyme catalysis.
4. To provide knowledge of the chemical nature of biological macromolecules, their three-dimensional construction, and the principles of molecular recognition.

**Course Contents**

**1. Introduction to Macromolecules**

- a. Structure, types and role of various building blocks their respective macromolecules.
- b. Carbohydrates:  
Introduction; Classification Stereoisomerism in carbohydrate, Structure, types and role of monosaccharides, oligosaccharides and
- c. polysaccharides; Glycosaminoglycans and glycoconjugates.
- d. Carbohydrates as an information carrier molecule.

**2. Amino acids, peptides & proteins:**

- a. Types of amino acids & their classification.

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

### **2.1.Purification Techniques for Proteins**

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

### **2.2.OrganizatiOn of proteins:**

- a. Structural levels of proteins; Covalent structure of proteins.
- b. Function of some structural & functional proteins; Hemoglobin, Cytochrome-c: Chymotrypsin, alpha Keratin and Collagen.
- c. Proteins, their examples and role.

### **3. Enzymes**

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

### **4. Lipids:**

- a. Introduction & classification of lipids; Fatty acids, their types; Storage lipid.

#### **4.1.Classification and important characteristics**

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

### **5. Nucleic acids**

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

### **Practical:**

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

### **Books Recommended**

1. Lehninger principle of biochemistry by David L. Nelson and Michael M.Cox ,7<sup>th</sup> /latest edition,ISBN-10:1-4641-2611-9,ISBN-13:978-14641-2611-6
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko; Lubert Stryer ,ISBN-10:1429229365,ISBN-13:97814229229364

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

#### **Text book for Practical**

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

**ZOO-106**

**ANIMAL FORM AND FUNCTION-II**

**4(3+1)**

#### **Course Objectives**

##### **The Objectives of the courses are:**

1. To teach about animals' diversity adapted in different strategies for performance of their similar functions through modifications in body parts in past and present times.
2. To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions.
3. To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. To embrace the phenomena in basic structure of each system that determines its particular function.

#### **Course Outline:**

##### **1. Nutrition and Digestion:**

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

digestion

- b. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
- c. The mammalian digestive system: gastrointestinal motility and its control
- d. Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.

## **2. Temperature and Body Fluid Regulation:**

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

## **3. Reproduction:**

- a. Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction.
- b. Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes.
- c. The human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function.
- d. The human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.
- e. Cleavage and egg types.

## **Practicals**

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

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

## **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. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

**Course Objectives:**

1. To course aim to demonstrate the knowledge of skills
2. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
3. To develop basic understanding of the equipment handling/usage
4. To develop scientific technical expertise, culture and work habits.
5. To know how to collect and preserved animals

**Course Contents:****1. Microscopy:**

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

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

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

**3. Specimen preparation for optical microscopy:**

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

**4. Separation and purification techniques:**

- a. Cell fractionation
- b. Centrifugation and its types
- c. Filtration and its types

**5. Chromatography:**

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

**6. Spectrophotometry:**

- a. Principle, applications, types
- b. Visible/UV spectrophotometry

**7. Basic principles of Sampling and Preservation:**

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

## 8. DNA sequencing

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

### Practicals:

1. Preparation of slides (dry mount and wet mount)
2. Observation of wet mounts of human cheek cells employing bright and dark field microscopy
3. Measurement of cell size: bacterial and eukaryotic Cell
4. Recording of microscopic observations with the help of camera lucida
5. Liquid handling: proper use of pipettes and micropipettes
6. Hematoxylin and eosin staining
7. Gram's staining,
8. Handling of centrifuge machines
9. Paper Chromatography
10. Thin layer chromatography of amino acids
11. Spectrophotometric estimation of glucose
12. Collection and Preservation of representative animals of various phyla

### 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. Curoso, M. 1997. Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
5. Curoso, M. 1997. Environmental Sampling and Analysis: For Technician. CRC Press LLC. USA.
6. Slingsby, D., Cock, C. 1986. Practical Ecology. McMillan Education Ltd. London.
7. Rob Reed/ David HOLMES, Jonathan Weyers/ Allan Jones Pearson, Practical skill in bio-molecular sciences.
8. Gallagher, S.R. and Wiley E.A. 2008. Current protocols essential laboratory Techniques. John Wiley & Sons Inc, USA.
9. Jones, A. Reed, R and Weyers, J. 1994. Practical skills in Biology. Longman Singapore Publishers (Pte) Ltd.

## YEAR-III

### SEMESTER-V

Course Code	Course Category	Course Title	Credits
ZOO-304	MAJOR-III	Animal Behaviour	3(3+0)
ZOO-301	FOUNDATION-VIII	Biochemistry-II	3(2+1)
ZOO-302	FOUNDATION-IX	Cell Biology	3(2+1)
ZOO-305	MAJOR-IV	Wildlife	3(2+1)
ZOO-303	FOUNDATION-X	Principles of Systematics	4(3+1)
		Total Credits	<b>16</b>

**Course Objectives**

The objectives of the course are:

4. To impart knowledge about animal responses to external stimuli
5. To emphasize on different behavioural mechanisms (classical and recent concepts).
6. To explain development of behavior with suitable examples of animals.
7. To understand role of genetic and neuro-physiology in behavioural development.

**Course Content****1. Introduction**

1. **Behaviour** and its types
2. **Proximate** and **ultimate** causes of behaviour.
3. **Diversity of Behaviour** Innate Behaviour and Learned Behaviour. Innate behavior of three spined stickle back fish.
4. **Hormones** and behavior in animals.
5. **Pheromones** Discovery and Pheromones types.
6. **Social organization:** Social organization in insects and mammals.
7. **Communication in animals:** Visual, Bioacoustic, electrical, chemical and tactile.
8. **Migration**
9. **Sexual Behaviour**
10. **Parental Care**

**Text And Reference Books**

1. Dngatkin, L. A. 2012. Principles of Animal Behaviour. W.W. Nortan and Co.New York.
2. Alcock, J. 2010. Animal behaviour, an evolutionary approach. 9<sup>th</sup> Edition. Sinauer Publishers.
3. Scott, G. 2009. Essential Animal Behaviour. Wiley publishers
4. Scott, G. 2005.Essential Animal Behaviour. Blackwell Pub. New York.
5. Goodenough, J., McGuire, B., Wallace, R.A. 2001.Perspective on Animal Behaviour. John Wiley & Sons, New York.

**Course Objectives:**

1. To understand the principles of bioenergetics.
2. To know the dietary requirements of man and animals.
3. To provide knowledge of metabolism of dietary and endogenous carbohydrate, lipid, and protein.
4. To impart the knowledge of principles and major mechanisms of metabolic control and molecular signalling by hormones.

**Course Contents****1. Bioenergetics**

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

**2. Metabolism**

- a. Detailed description of Glycolysis and Catabolism of other Hexoses;



- b. Regulation and Bioenergetics of Glycolysis. Anabolic role of Glycolysis;
  - c. Fate of Pyruvate under Aerobic and Anaerobic conditions, Lactate and Alcoholic Fermentation;
  - d. Gluconeogenesis, its Regulation and significance in the tissues; Feeder Pathways in Glycolysis; Utilization of other carbohydrates in Glycolysis;
  - e. Phosphorolysis of Glycogen and Starch; Regulation of Glycogen metabolism; Utilization of dietary polysaccharides (Starch) and Disaccharides (Sucrose and Galactose). Biosynthesis of Glycogen, Starch and Sucrose;
  - f. Pentose phosphate pathway of Glucose oxidation and its major role in the animal tissues.
  - g. Citric acid (TCA) cycle: Conversion of Pyruvate to Acetyl CoA, Pyruvate dehydrogenase, a multi-enzyme complex;
  - h. Detailed description of citric acid cycle; Bioenergetics and conservation of Energy produced in the cycle. Anabolic or Biosynthetic role of citric acid cycle intermediates; Replenishing or Anaplerotic reactions and their role; Regulation of Citric acid cycle.
- 3. Lipid metabolism**
- a. Digestion, mobilization and transport of Fats; Biosynthesis of Triacylglycerol;
  - b. Utilization of Triacylglycerol; Oxidation of Fatty acids; Activation of Fatty acids and their transportation to mitochondria;
  - c. Beta ( $\beta$ )-Oxidation; Bioenergetics of  $\beta$ -oxidation; Omega ( $\omega$ )-Oxidation pathway;
  - d. Biosynthesis of Saturated Fatty acid, Supply of raw material for palmitic acid synthesis; Fatty acid synthetase (FAS) multi-enzyme complex;
  - e. Models of FAS system in Bacteria, Plants, vertebrate tissue and Yeast cell; Biosynthesis of unsaturated Fatty acids, Aerobic and Anaerobic pathways. Ketone bodies and their biosynthesis, utilization and role in the tissues;
- 4. Cholesterol metabolism**
- a. Cholesterol biosynthesis and its Regulation; Steroid hormones, their types and main functions; Prostaglandins, their types, synthesis, inhibition and main functions.
- 5. Nitrogen metabolism**
- a. Metabolic fate of amino acids; Catabolism of amino acids; Deamination and Transamination;
  - b. Role of glutamate, glutamine and alanine in transport of ammonia in tissues;
  - c. Nitrogen excretion and urea cycle; Regulation of urea cycle;
  - d. Pathways of amino acid degradation showing entry points in Citric acid cycle; Decarboxylation of amino acids to biological amines.
  - e. Biosynthesis of some amino acids; Incorporation of ammonia in glutamate and glutamine;
  - f. Purine and Pyrimidine biosynthesis showing the sources of various atoms in both molecules.

**Practical:**

1. Preparation of standard curve of proteins using Lowry's technique.
2. Estimation of tissue (liver) proteins using Lowry's technique.
3. Estimation of Free Amino Acids in Biological samples colorimetrically.
4. Separation and identification of various amino acids by paper chromatography.
5. Separation of proteins by Polycrylamide Gel Electrophoresis (PAGE).
6. Preparation of standard curve and estimation of DNA by colorimetric analysis using Diphenylamine method.
7. Preparation of standard curve and estimation of total RNA by colorimetric analysis using Orcinol method.

8. Quantitative analysis of Amylase activity from blood serum or liver.
9. Effect of temperature and pH on enzymatic rate of reaction.

### **Books Recommended**

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

### **Additional Readings**

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

**ZOO-302**

**CELL BIOLOGY**

**3(2+1)**

### **Course Objectives**

The objectives of the course are:-

- To explain the basic concepts of cell biology.
- To understand cellular structure, composition of the organelles, cell growth and cellular division.
- To explain how macromolecules and organelles govern the dynamic organization, function of living cells.

### **Course outline:**

- 1. Introduction to cell structure and function**
  - a. Cell theory
  - b. Comparison of plant and animal cells
  - c. Comparison of prokaryotic and eukaryotic cells
- 2. Cell membranes**
  - a. Structural models
  - b. Chemical composition and function
- 3. Cell Organelles (structure and function)**
  - a. Endoplasmic reticulum
  - b. Golgi Bodies
  - c. Mitochondria

- d. Lysosomes
- e. Peroxisomes
- f. Ribosome
- 4. Nucleus**
  - a. Structure and function
  - b. Nuclear membrane
  - c. Chromatin
- 5. Cytoskeleton**
  - a. Structure and types
  - b. Function of cytoskeleton
- 6. Cellular transport**
  - a. Diffusion and osmosis
  - b. Facilitated and active transport
  - c. Endocytosis and exocytosis
- 7. Cellular reproduction**
  - a. Cell cycle
  - b. Mitosis
  - c. Meiosis

**Practical:**

- Microscopy
- staining techniques (Gram staining)
- Identification of cell organelles (prepared slides)
- Preparation of temporary whole mount.
- Preparation of permanent whole mount.
- Squash preparation of onion root tip for mitotic stages.
- Study of mitotic and meiotic stages (prepared slides)

**Books Recommended**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6<sup>th</sup> Edition. Garland Publishing Inc., New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.
3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.
4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
5. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8<sup>th</sup> edition, Lea & Febiger, New York.

**ZOO-305**

**WILDLIFE**

**3(2+1)**

**Course Objectives**

The objective of this course is

1. to enable the student to understand philosophy and significance of wildlife conservation
2. to understand the wildlife management rules and regulations in Pakistan

3. to understand how National and International agencies are involved in conservation and management of wildlife

### **Course outline**

#### **1. Wildlife of Pakistan**

- a) Introduction
- b) Important Definitions
- c) Identification
- d) Distribution
- e) Status
- f) Conservation and Management of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan

#### **2. Philosophy and significance of wildlife conservation**

#### **3. Biodiversity and sustainability of wildlife.**

#### **4. Wildlife rules and regulations in Pakistan**

- a) Provincial Rules
- b) Federal Management of Wildlife (NCCW)

#### **5. National and International agencies involved in conservation and management of wildlife**

- a) National Organizations
- b) International Organizations

#### **6. Protected Areas in Pakistan**

- a) Sanctuaries
- b) Game Reserves
- c) National Parks

#### **7. Ramsar convention**

- a) Wetlands
- b) Ramsar Criteria
- c) Ramsar Sites

#### **8. Threatened species of Pakistan.**

- a) Vulnerable
- b) Endangered
- c) Critically Endangered

### **Practicals**

1. Visit to protected and conserved areas of Pakistan (Captive, Semi-captive and Wild Areas)
2. Visit to National Parks of Pakistan.
3. Ecological Indices
4. Animal Distribution Maps

### **Text and Reference Books**

1. Miller, A.S. and Harley, J.B., 1999 & 2002. Zoology, Latest Edition (International). Singapore: McGraw Hill.
2. Ali. S.S. 2005 Wildlife of Pakistan.
3. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
4. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
6. Roberts, T. J., 1991, 1992. The Birds of Pakistan, Vol. I and II. Oxford University Press
7. Roberts, T. J., 1997. The Mammals of Pakistan, Oxford University Press
8. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.

9. Wildlife of the Punjab, Punjab Wildlife Department.
10. Khan M. S. 2011, Amphibian and Reptiles of Pakistan
11. Mirza Z.B. 2011 Biodiversity of Pakistan.

**ZOO-303**

**PRINCIPLES OF SYSTEMATICS**

**4(3+1)**

The course aims to:

- Provide in-depth knowledge of taxonomy in animal sciences
- Develop concepts about importance of the systematics.
- Study the history of systematics with basic rules
  - Demonstrate about identifications and naming of the organisms according to international code of zoological nomenclature.

*Course Contents:*

- **Importance and applications of systematics:** Taxonomy in Animal science, systematics as a profession and its future perspectives.
- **History of taxonomy:** systematics, basic terminology of systematics, theories of biological classifications.
- **Taxonomic characters:** Kinds and weightage, micro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Species concept.
- **Typological species concept:** Nominalist 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.
- **Formation of specific names,** brief concept of cladistics, phylogenetics. Theory and practice of cladistics and phylogenetic systematics.
- **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:**

1. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2<sup>nd</sup> Ed. Wiley-Blackwell.
2. 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.

## SEMESTER–VI

Course Code	Course Category	Course Title	Credits
ZOO-309	MAJOR-VIII	Research Methodology	2(2+0)
ZOO-307	MAJOR-VI	Developmental Biology	4(3+1)
ZOO-308	MAJOR-VII	Ecology	4(2+1)
ZOO-306	MAJOR-V	Molecular Biology	3 (2+1)
ZOO-310	MAJOR-IX	Physiology	4(3+1)
		Total Credits	17

**ZOO-309**

**RESEARCH METHODOLOGY**

**2(2+0)**

### Course Objectives

The course is aims to:

- Develop research skills Provide understanding how to design scientific research, to collect data and its interpretation
- Emphasize the importance of ethics in scientific research
- Enable students to write a research proposal

### Course Contents

#### 1. Introduction:

- a. Objectives of Research, Motivations

#### 2. Research Process:

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

#### 3. Topic Selection:

- a. Problem identification for research, criteria and evaluation

#### 4. Literature review:

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

#### 5. Research Design:

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

#### 6. Aims and objectives:

- a. Research objectives, qualities of research objectives

#### 7. Material and methods:

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

#### 8. Data Analysis:

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

#### 9. Scientific Writing:

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

#### 10. Budgeting:

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

### Text and Reference Books

1. Paul Leedy, 2004, Practical Research: Planning and Design (8th, Edition), Jeanne Ellis Ormrod
2. Creswell, J. W. (2013). Research Design Quantitative Qualitative and Mixed Methods

- Approaches. Sage.
3. Hess-Biber, S. N. and P. Leavy. (2004). Approaches to Qualitative Research, A Reader on Theory and Practice. New York, Oxford University Press.
  4. Khan, J.A. (2008). Research Methodology. New Delhi: APH Publishing.
  5. Kothari, C.R., & Gaurav, G. (2014). Research Methodology: Methods and Techniques. New Delhi: New Age International.
  6. Kumar, R. (2011). Research Methodology: A Step By Step Guide for Beginners. Cornwall: SAGE Publications, Inc.
  7. Laurel, B. (2003). Design Research, Methods and Perspectives. London England, The MIT Press.
  8. Walliman, N. (2005). Your Research Project, 2nd Edition, A step by step guide for the first-time researcher. New Delhi, Vistaar Publications.

**ZOO-307**

**DEVELOPMENTAL BIOLOGY**

**4(3+1)**

### **Course Objectives**

Objectives:

The course aims to:

- Provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development
- Impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction.
- Provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis.

### **Course outline:**

#### **Introduction**

1. History and Basic Concepts of developmental biology
2. Principal features of developmental biology and embryology with special emphasis on vertebrate models
3. Origin of sexual reproduction
4. Developmental patterns

#### **Spermatogenesis**

- a. Mammalian spermatogenesis as model for all vertebrates
- b. Spermiogenesis or (spermateliosis)
- c. The role of Sertoli and Leydig cells in spermatogenesis
- d. Hormonal control of spermatogenesis

#### **Primates Menstrual cycle**

1. Oogenesis
  - a. Mechanism of oogenesis among various classes of vertebrates.
  - b. Vitellogenesis
  - c. Hormonal control of Vitellogenesis and oogenesis
2. **Fertilization**
  - a. **External & Internal Fertilization**
  - b. **Species-specific recognition of sperm and egg**
  - c. **Fusion of male and female gametes**
  - d. **Polyspermy: slow and fast blocks to polyspermy**
  - e. **Activation of egg metabolism**
3. **IN VITRO Fertilization (IVF)**
  - a. **History, Steps and advantages of IVF**
  - b. **Disadvantages and risk factors**

4. **Cleavage & Blastulation**
  - a. **Patterns of embryonic cleavage and blastulation among different vertebrate classes**
  - b. **Mechanism of cleavage.**
5. **Gastrulation**
  - a. **Fate maps**
  - b. **Gastrulation in amphibians, birds and mammals**
6. **Early Vertebrate Development**
  - a. **Neurulation, ectoderm, mesoderm and endoderm formation**
7. **Placenta and extraembryonic membranes**
8. **Cellular Basis of Morphogenesis**
  - a. **Differential cell affinity, cell adhesion molecules**
  - b. **Organogenesis**
  - c. **Mechanism of teratogenesis**
9. **Aging and Regeneration in vertebrates**

#### **Practicals:**

1. Study of the structure of gametes in some representative cases, *i.e.* frog, fish and mammal.
2. Hen's egg internal and external structural details
3. Microscopic analysis of hen's egg yolk, albumin and shell membranes
4. Study of cleavage and subsequent development from prepared slides and/or models in various animals *i.e.*, frog, mammals and chick etc.
5. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
6. Study of developmental stages of nematodes through microscopic analysis of animal dung
7. Semen analysis
8. Dactylography and its uses in developmental biology

#### **Text and Reference books:**

1. **Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.**
2. Klaus, K. 2001. Biological Development. 2<sup>nd</sup> Ed., McGraw Hill.
3. **[Scott F. Gilbert](#) and Michael J. F. Barres. 2016. Developmental Biology. Sinauer Associates, Sunderland, MA.**
4. Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
5. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
6. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
7. **Saunders, J. W. 1982. Developmental Biology, McMillan and company.**
8. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

**ZOO-308**

**ECOLOGY**

**4(3+1)**

#### **Course Objectives**

The objectives of the course are:-

1. To enable the student to understand habitat and Ecology.



2. To develop expertise in the students about the contemporary themes of Ecology and ecosystems.
3. To understand global Environmental threats and their mitigation.

**Course outline:**

**1. Energy**

- a. Basic Concepts of and Types of Ecology
- b. Laws of thermodynamics, primary and secondary productions
- c. Trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.

**2. Biogeochemical cycle:**

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

**3. Limiting factors**

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

**4. Global ecosystems:**

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

**5. Population ecology**

6. Basic population characters, Growth and Growth Curves, Population Dynamics and Regulations.

**7. Community ecology**

Basic concepts, Community Analysis, Ecotones, Inter-population Interactions.

**8. Applied Ecology:** resources and their ecological management;

Mineral, Agricultural Desalination, Weather Modification, Forest and Range Management, Landscape and Land use.

**9. Pollution:**

Definition, Types, Water, Air, Land and Noise, Sources and Management.

10. **Radiation ecology:** Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Kyoto protocol, Radioactivity leakage, Environmental laws).

**11. Exotic and Invasive Species**

Desertification, Deforestation, exotic and invasive species

**Practical:**

1. Population Sampling Techniques (Quadrat, Line Transact, Point count, Focal Scan and Capture and Recapture Method).
2. Study of different Ecosystems (Fresh Water, Terrestrial, Marine/Mountain/ Desert).
3. Ecological Notes.

4. Measurements of physical Factors of different Ecosystems.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.
9. Experimental design and approaches in ecological research; writing a research project
10. Development of an ecological management plan of some selected area

**Text and Reference books:**

1. Molles, M.C. 2005. Ecology: Concepts and Applications. 6<sup>th</sup> Ed., McGraw Hill, New York, USA.
2. Cox, C.B., Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6<sup>th</sup> Ed., 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. 3<sup>rd</sup> 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-306**

**MOLECULAR BIOLOGY**

**3(2+1)**

**Course Objectives**

1. To impart knowledge about chemical, physical and biological properties of nucleic acids.
2. To understand different molecular mechanisms and their regulation in prokaryotes and eukaryotes.

**Course outline:**

**1. Introduction**

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

**2. Replication**

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

**3. Transcription**

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

**4. Translation**

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

**5. Mutation**

- a) Types of Mutations

- b) Base-Analogue Mutagens
  - c) Chemical Mutagens
- 6. Gene expression and control**
- a. Control of gene expression in Prokaryotes.
  - b. Inducible and repressible operons.
  - c. Control of gene expression in eukaryotes.

**Practicals**

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

**Text and Reference books:**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6<sup>th</sup> Edition. Garland Publishing Inc., New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.
3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.
4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
5. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8<sup>th</sup> edition, Lea & Febiger, New York.

**ZOO-310**

**PHYSIOLOGY**

**4(3+1)**

**OBJECTIVES:**

- Understand on the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals e.g. membrane excitability, exchange of respiratory gases, removal of nitrogenous wastes tissue, osmotic and organ physiological mechanisms underlying animal homeostasis and temperature effects.
- Grasp the development of performing the function developed at molecular and cellular level in the complexity of the animals such as chemical & nervous integration, respiratory and excretory functions.
- Know the strategy acquired to perform the functions in diverse environment such as in dry & aquatic and cold and hot at molecular and cellular level and regulations to achieve strategy by chemical and nervous regulation at organ levels.
- Comprehend the concepts in homeostasis and integration in sustaining the life in constantly changing conditions.

**Course Outline**

**Concept of Physiology**

1. Principles of Homeostasis and conformity
2. Principles of regulation and adaptation

**Membrane Physiology:**

1. Ionic distribution across membrane
2. Resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Ion channels.

**Nerve and Muscle Physiology:**

1. Action potentials in neurons
2. Electrical and chemical synaptic transmission
3. Neurotransmitters in communications
4. Receptors of neurotransmitters in diverse physiological responses
5. Excitatory and inhibitory postsynaptic potentials
6. Neuronal networks and their role in nervous integration
7. Muscles: Structure, types, components, muscle proteins
8. Molecular basis of muscle contraction
9. Sarcoplasmic reticulum and role of calcium
10. Neuromuscular interaction at cell and molecular level muscle
11. Types of muscle contractions and muscle fatigue.

**Endocrine Physiology:**

1. Hormones of invertebrates and specifically of arthropods for the functions in their modes of life.
2. Hormones of various vertebrates' endocrine organs and comparison of their roles in adaptability of mode of life.
3. Mechanisms of hormone actions, hormone receptors, signal transduction and hormonal coordination.

**Cardiovascular Physiology:**

1. Electrical activity of heart; self-excitability and auto-rhythmicity of myogenic heart.
2. Neurogenic heart and their expression.
3. Electrocardiography and Kymography.
4. Hemodynamics, Relationship between blood flow, pressure and resistance. Their role in performance of the function in variety of vertebrates.
5. Control of cardiac activity, cardiac output and peripheral circulation.

**Respiratory Physiology:**

1. Mechanism of respiratory gases exchange in aquatic and terrestrial respiratory structures.
2. Control of respiration and stimulus factors in various animals.
3. Respiration adaptations in hypoxia and percapnia etc.
4. Air breathing and respiratory adaptations diver animals.

**Excretory Physiology:**

1. Strategy of mammalian large glomerular filtration and reabsorption in nitrogenous excretion.
2. Patterns of nitrogenous excretion in various animals and their phylogenetic significance.

**Physiology of Nutrition:**

1. Adaptation of nutritive canal for digestion and absorption of nutrients in different animals specifically the vertebrates.
2. Regulation of digestive secretions.
3. Mechanisms of water, ions and nutrients absorptions and their significances in diverse groups.
4. Potential and Movements in gastrointestinal tract and control of motility.

Practicals:

### Respiration and Circulation

1. Study of respiratory pigments in various animals and haemoglobins in various vertebrates.
  2. Normal cardiac activity in amphibian model, effect of temperature, effect of drug, heart block, tetanization of heart.
  3. Measurement and effects of various factors on blood pressure. Blood pressure alteration in exercise.
  4. Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), Nerve and Muscle
1. Study of salient features of electromyography
  2. Study of excitable and contractile properties of a nerve-muscle preparation.

### Nervous System:

1. Study of brains in different animals in relation to complexity of functions.
2. Study of human brain model and different areas eliciting behaviours.
3. Videos study on 1 and 2 studies.

### Hormones System:

1. Video studies on the effects of hormones in breeding season behaviours of various behaviours.
2. Study through clinics data on the insulin and glycemia in type1 and type 2 diabetic subjects.

### Text/Reference Books

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

## YEAR-IV

### SEMESTER-VII

Course Code	Course Category	Course Title	Credits
ZOO-/ ZOO-499	MAJOR-X	Special Paper 1 (Group A)/ Thesis	3(2+1)/0+3
ZOO-311	MAJOR-XI	Genetics	4(3+1)
ZOO-	ELECTIVE-I	Special Paper 2 (Group A)s	3(2+1)
ZOO-312	ELECTIVE-II	Biotechnology	4(3+1)
ZOO-313	COMPULSORY-IX	Biostatistics	4(3+1)
		Total Credits	<b>18</b>

ZOO- SPECIAL PAPER 1 (GROUP A)/THESIS 3(2+1)/3(0+3)

ZOO- SPECIAL PAPER 2 (GROUP A) 3(2+1)

Students will choose one paper from Group A given in the table below and will take a research.

Students not opting for research will choose two papers from Group A.

Students will opt for the same specialized papers in both semesters.

Course Code	Group A
ZOO-314	Entomology A (Morphology, Physiology and Taxonomy)
ZOO-315	Parasitology A (Protozoology and immunology)
ZOO-316	Fisheries A (Ichthyology)
ZOO-317	Herpetology A (Biology of Amphibians)
ZOO-318	Vaccinology A (Introduction to Vaccine)
ZOO-319	Virology A (Fundamentals of Virology)

**ZOO-311**

**Genetics**

**4(3+1)**

**Course Objectives:**

1. To understand the terms and basic concepts of genetics, providing a conceptual framework for future reference
2. To provide understanding about the continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc.
3. To develop the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment
4. To understand how traits are inherited and to use this understanding in analyses (to solve problems and complete pedigrees)
5. To understand probability concepts and use these concepts to solve problems (including basic statistical problems)
6. To understand how genetic problems may lead to disease or lethality
7. To understand the molecular basis of genetics (including such topics as replication, transcription, translation, and mutation)
8. To understand mechanism of repair and molecular genetic analysis
9. To understand the workings and importance of major genetics techniques such as PCR
10. To understand current issues regarding genetics (e.g., cloning, use of transgenic organisms)
11. To understand Mendelian and non-Mendelian pattern of inheritance in human
12. To understand the workings and uses of population genetics technique

**Course Contents:**

1. Introduction
  - a. Classical, molecular and population Genetics: Scope and importance of genetics, Forward and reverse genetics. The basic principles of Inheritance (Mendelism): Monohybrid and Dihybrid crosses (Definition - characteristics criss-cross inheritance).
  - b. Multiple Alleles: blood groups and coat color in rabbits.
  - c. Genetics of Rh factor and Erythroblastosis Foetalis.
2. Chromosomal Basis of Inheritance:
  - a. Chromosomal theory of inheritance
  - b. Interaction of genes, Epistasis, Lethality and Pleiotropism.
3. Chromosomal Aberrations
  - a. Changes in chromosomal number, Euploidy, aneuploidy (Klinefelters syndrome, and Turners syndrome, Down syndrome and Edwards syndrome).

- b. Structural changes, insertion, deletion (Cri du chat syndrome), duplication,
- c. Inversion and translocation
- 4. Pedigree Analysis:
  - a. Normal human chromosome complement; Karyotyping.
  - b. Sex-determination and Sex-linkage:
  - c. Sex determination in animals and humans,
  - d. Sex linked (Hemophilia, muscular dystrophy, color blindness), sex influenced and sex limited traits,
  - e. Prenatal Diagnosis: Amniocentesis and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics
- 5. Chromosome mapping
  - a. Linkage, recombination (crossing over) and
  - b. Chromosome mapping in eukaryotes.
- 6. Molecular Genetics:
  - a. Gene Concept (classical and modern),
  - b. Genetics of Viruses and Bacteria,
  - c. Transposons,
  - d. Mutation and DNA repair
  - e. Molecular Genetic Analysis,
    - a. Regulation of Gene Expression in Prokaryotes,
    - b. Gene Regulation in Eukaryotes,
    - c. Genetic basis of diseases, like cancer,
    - d. Genetic control of animal development.
    - e. The genetic control of the Vertebrate Immune System,
- 7. Recombinant Technology
  - a. The Techniques of Molecular Genetics (elements of genetic engineering),
  - b. PCR
- 8. Human Genetics;
  - a. Single and Multifactorial Disorders:
  - b. Autosomal anomalies, Pseudoautosomal genes,
  - c. Single gene disorders: Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria).
  - d. Complex Inheritance Patterns, Polygenic traits- Cleft lip and cleft palate,
- 8. Population Genetics:
  - a. Hardy-Wienberg equilibrium,
  - b. Systematic and Dispersive pressures, Inbreeding and heterosis

**Practical:**

1. Drosophila culture techniques: preparation and maintenance of culture
2. Identification of male and female fruit fly and isolation of virgin females
3. Study of polytene chromosomes from the salivary glands of Drosophila melanogaster
4. Mutation induction in Drosophila
5. Human karyotyping from photographs prepared slides: paper cut out method
6. Preparation of human metaphase chromosomes from blood lymphocytes
7. Study of mitosis in plants by using onion root tip cells
8. Study of meiosis in the testes of male grasshopper
9. Extraction of genomic DNA from whole blood (lymphocytes)
10. Separation of heterogeneous population of bio-molecules through electrophoresis
11. Study of blood group polymorphisms in local population

12. Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
13. Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc), risk estimation and genetic counselling
14. Study of quantitative traits in humans: finger prints as model of polygenic traits
15. Study of Barr bodies in human cell nucleus
16. Dermatoglyphics in normal and mentally retarded subjects
17. Probability problems. Tossing of coins.  $X^2$  test
18. Study of transformed bacteria on the basis of antibiotic resistance
19. PCR

### Books Recommended:

1. Snustad, D.P., Simmons, M.J. 2003. Principles of Genetics. 3<sup>rd</sup> Ed., John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. 2001. Principles of Genetics. 7<sup>th</sup> Ed., WCB publishers USA.
3. Lewin, B. 2013. GENE-VIII. Oxford University Press. UK.
4. Gardener, E.J., Simmons, M.J., Snustad, D.P. 1991. Principles of Genetics. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. 2015. Genetics. McMillan, New York. USA.(9780024181206)
6. PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
7. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.
8. William S. Klug, 2014. Concept of Genetics, ISBN-11: 978-0321948915
9. Lewin's Gene XI BY Jocelyn E.Krebs et al. 2013, isbn-13:978-1449659851,ISBN-10:1449659853
10. Gene- XI by Lewin's,2013,ISBN:978-1449659851
11. Concepts of genetics 11<sup>th</sup> edition, William S.Klug,2014,ISBN-13:978-0321948915

**ZOO-313**

**BIOSTATISTICS**

**4(3+1)**

### Course Objectives

- To provide knowledge about the importance and use of statistics in life sciences.
- To familiar students with the methods of data analysis pertaining to their research work and to assess the significance of their experimental designs.

### Course Contents

#### 1. Introduction:

- a. Definition, branches of statistics,
- b. Scope and importance of statistics

#### 2. Data:

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

#### 3. Presentation of data:

- a. Descriptive statistics
- b. Tabulation of data
- c. Parts of table and construction of table.
- d. Diagrams and graphs, pictogram, historigram, line chart, histogram, applications and uses of histogram



- e. Construction of histogram, comparison of data using histogram,
- f. Bar chart, multiple bar chart, pie chart, gantt chart, timeline, infograph, pedigree chart

**4. Frequency distribution:**

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

**5. Measures of Central Tendency:**

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

**6. Measures of Dispersion:**

- a. Range, grouped and ungrouped data, coefficient of range
- b. Mean deviation of grouped and ungrouped data. Coefficient of mean deviation.
- c. Standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data

**7. Probability:**

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

**8. Tests of Significance:**

- a. Hypothesis testing
- b. Steps of hypothesis testing
- c. Z-test
- d. t-test, types,
- e. Chi-square
- f. ANOVA, its uses and LSD
- g. Correlation
- h. Regression

**Practicals:**

- Data collection, arrangement and frequency table
- Data presentation in table, graphs (simple bar chart, multiple bar chart, component bar chart)
- Construction of timeline, pedigree chart, organogram, Gantt chart, infogram
- Calculating arithmetic mean, harmonic mean and geometric mean, median and mode from ungrouped and grouped data
- Calculating mean deviation, standard deviation and variance from ungrouped and grouped data
- Probability distribution
- z-test
- T-test
- ANOVA
- Correlation
- Regression

**Text and Reference Books**

1. Field A. (2013) Discovering Statistics with IBM SPSS Statistics. 4th Edition. SAGE Publication Ltd.
2. Belle V. B, Fisher, L.D., Heagerty, P.J., Lumley, T. (2004) Biostatistics – A methodology for the health sciences. 2nd Edition. Wiley-Interscience
3. Quinn, G. (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press
4. Campbell, M.J., Swinscow, T.D.V. (2009) Statistics at Square One. 11th Edition. BMJ Books.

**ZOO-312**

**Biotechnology**

**4(3+1)**

**Course Objectives:**

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

**Course Content:**

**1. Introduction:**

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

**2. Genetics and Biotechnology:**

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

**3. Biotechnology and Justice:**

- a. Sources of DNA, Forensic DNA testing,
- b. Principles, techniques, types and applications

**4. Genetic Engineering**

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

**5. Animal and Insect Biotechnology:**

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

**6. Bioprocess Technology:**

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

**7. Biotechnology and Medicine:**

- a. Applications, monoclonal antibodies, importance, steps for production of monoclonal antibodies

**8. Stem Cell Biotechnology:**

- a. Introduction, sources – embryonic stem cells, adult stem cells
- b. Types of stem cells based on potency, applications of stem cells

**9. Public Perception of Biotechnology:**

- a. Current issues in bioethics (Autopsy, GMOs, Stem Cells, Euthanasia, Organ Transplant, Human Cloning, IVF, Surrogacy and sperm donor, etc)

**10. Bioethics and Islamic Bioethics:**

- a. Introduction and principles of bioethics,
- b. Concept of bioethics in different religions, principles of Islamic bioethics

**Practicals:**

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

**Text and Reference Books**

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

**SEMESTER–VIII**

Course Code	Course Category	Course Title	Credits
ZOO-321	MAJOR-XII	Bioinformatics	3(1+2)
ZOO-/ ZOO-499	MAJOR-XIII	Special Paper 1 (Group B) / Thesis	3(2+1)/ 0+3
ZOO-	ELECTIVE-III	Special Paper 2 (Group B	3(2+1)
ZOO-322	ELECTIVE-IV	Microbiology	3(2+1)
ZOO-323	MAJOR-XIV	Zoogeography & Paleontology	3(3+0)
		Total Credits	<b>15</b>

ZOO- SPECIAL PAPER 1 (GROUP B)/THESIS 3(2+1)/3(0+3)

ZOO- SPECIAL PAPER 2 (GROUP B) 3(2+1)

Course Code	Group B
ZOO-325	Entomology B (Applied and Medical Entomology)
ZOO-326	Parasitology B (Helminthology and HPR)
ZOO-327	Fisheries B (Applied Ichthyology)
ZOO-328	Herpetology B (The Biology of Reptiles)
ZOO-329	Vaccinology B (Applied Vaccinology)
ZOO-330	Virology B (Viral Diseases and Their Management)

ZOO-321 BIOINFORMATICS 3(1+2)

### Course Objectives

The course will provide:

- An introduction to bioinformatics.
- To develop awareness about fundamental bioinformatics databases.
- Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

### Course Contents

#### 1. Introduction:

- a. Introduction to Bioinformatics, Scope of bioinformatics, useful websites
- b. Aims of bioinformatics, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools
- c. Human genome project

#### 2. Biological databases

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

#### 3. Genome mapping

- a. Genetic and linkage mapping, physical mapping

#### 4. Gene family:

- a. Introduction, types, protein family, Globin family as an example, globin genes and chains, evolution of globin proteins in human, combination and types of globin proteins in human.

#### 5. Data Retrieval:

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

#### 6. Primer Designing:

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

7. **Sequence Alignment:**
  - a. Importance and significance of alignment, methods for sequence alignment
  - b. Local and global alignment, pair-wise local alignment
8. **BLAST:** Introduction, types, uses, algorithm, BLAST Scores
9. **Multiple Sequence Alignment:**
  - a. Introduction, tools for MSA, uses and importance
10. **Phylogenetic analysis:**
  - a. Introduction, interpretation, rooted and unrooted tree,
  - b. phylogenetic methods, tree terminology, comparison of methods, software

#### **Practicals/Tutorials**

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

#### **Text and Reference Books**

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. Pevsner, J. (2015) Bioinformatics and Functional Genomics. 3<sup>rd</sup> Edition. Willey-Blackwell
4. Lesk, A. (2014) Introduction to Bioinformatics. 4<sup>th</sup> Edition. Oxford University Press
5. Selzer, P., Marhofer, R. and Rohwer, A. (2008) Applied Bioinformatics: An Introduction. Springer publishing, Germany.
6. Primerose, S.B. (2004) Genomics: Applications in Human Biology. Willey-Blackwell
7. Westhead, D.R., Parish, J.H., Twyman, R.M. (2003) Instant Notes on Bioinformatics. Viva Books Private Limited.
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. O'Reilly publishers.

#### **Websites**

1. <http://www.ncbi.nlm.nih.gov>
2. <http://www.ebi.ac.uk>
3. <http://www.rcsb.org>
4. <http://www.ensemble.org>

**Course Code:**

**Credit Hours:**

**Course Objectives**

The objectives of the course are:-

1. To provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time.
2. To impart knowledge and concepts of evolution mainly on the basis of fossil record.
3. To give understanding that fossil record also provide information about the distribution of animals in the past eras.

**Course outline:**

1. Paleo geography
  - a. Theories of continental drift and plate tectonics
  - b. Pangea
2. Animal distribution
  - a. cosmopolitan distribution
  - b. discontinuous distribution
  - c. isolation distribution
  - d. bipolar distribution
  - e. endemic distribution
  - f. barriers and dispersal.
3. Zoogeographical regions:
  - a. Zoogeographic Division And Boundaries
  - b. Geographic Ranges, Physical Features
  - c. Climates,
  - d. Faunas And Affinities Of Palaearctic, Nearctic Regions, Oriental, Ethiopian, Australian, And Neotropical Regions
  - e. Insular Fauna
4. Zoogeography of Pakistan:
  - (ii). Paleontology:
    5. The Planet Earth
      - a. History, age, shells of earth
      - b. atmosphere, hydrosphere, biosphere and lithosphere.
    6. Rocks:
      - a. types; Igneous rocks, sedimentary rocks and metamorphic rocks.
    7. Fossil and Fossilization
      - a. Fossil types and uses of fossils, nature of fossils.
      - b. Fossilization
      - c. Invertebrates and Vertebrates Fossil
      - d. Biostratigraphy
      - e. Fossils of Pakistan
      - f. Paleontologically important areas of Pakistan.
    8. Fossilization:
      - a. Geological time scale.
      - b. Pre-Cambrian life.
      - c. Post Cambrian life,
      - d. Paleozoic life
      - e. Mesozoic life

- f. Cenozoic life.
- 9. Paleontological Techniques
  - a. Excavation techniques
  - b. Excavation tools and techniques
  - c. Transportation and processing of fossils.
  - d. Presentation of fossils
  - e. Pre requisites for paleontological excavation.
- 10. Geochronometry:
  - a. Uranium/Lead dating
  - b. radiocarbon dating, methods
  - c. index fossils
  - d. evolutionary history of man, elephant, horse and camel,
  - e. Paleocology, Paleomagnetism.

**Text and Reference books:**

**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.

**Palaeontology:**

1. Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3<sup>rd</sup> Ed. Wiley Black, UK.
2. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3<sup>rd</sup> 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 Boyd, London.

**ZOO-322**

**MICROBIOLOGY**

**3(2+1)**

**Course Objectives**

The objectives of the course are:-

1. To provide first-hand knowledge to students in the fundamental aspects of basic microbiology
2. To impart the practical know-how about the morphology and microbial activities
3. To acquaint the students with basic techniques of sterilization, culturing and isolation of microorganisms

**Course outline:**

- **Introduction**
  - a) History of microbiology
  - b) Microbes influencing our lives
  - c) Characterization and identification of microorganisms
- **Virology**
  - a) Structure of virus, Characteristics of virus, Virus-host cell interaction
  - b) Viral replication, Transformation, Transmission of transforming viruses
  - c) Mechanism of pathogenicity; virus cultivation and propagation
- **Morphology and fine structure of bacteria**

- a) Size, Shape and arrangement of bacterial cells, motility, Capsules
- b) Structure and composition of cell wall, Cytoplasmic membrane, Protoplasts, Endospore, pili
- **Cultivation of Bacteria, Pure culture and growth characteristics**
  - a) Nutritional requirements, Nutritional types of bacteria
  - b) Bacteriological media, Physical conditions required for growth
  - c) Pure culture, Methods of isolating pure culture, maintenance and preservation of pure culture, Cultural characteristics
- **Growth and Metabolism**
  - a) Growth of microbial population, measurement of microbial growth, growth rate, growth curve
  - b) Determination of number of cells by direct microscopic count, Plate count method, membrane filter count, Turbidimetric method
  - c) Determination of cell mass by measurement of growth
- **Food and Medical Microbiology**
  - a) Microbial spoilage of foods, Food poisoning, Food infection
  - b) Factors effecting the spoilage of food (water, pH, oxygen, nutrients, physical structure of food), Botulism food poisoning, Mycotoxins
  - c) Food preservation (drying, refrigeration, irradiation, canning, pasteurization).
  - d) Sources and communicability of diseases, Communicable diseases, Non-communicable diseases
  - e) Chain of infection, Etiological agents, Specificity, Source and reservoirs of etiological agents, Methods of transmission
- **Normal Microbial Flora and Microbial Ecology**
  - a) Significance of normal microbial flora, Origin of normal Microbial flora, Microbial flora of skin, Microbial flora of gastrointestinal tract, Microbial flora of genito-urinary tract
  - b) Sterile sides of human body, Mechanism of bacterial pathogenicity
  - c) Distribution and activities of microorganisms in natural systems, Role of bacteria in elemental cycles
  - d) Plant interaction of microbial communities with their biotic and abiotic environment microbial role in global carbon cycle
- **Soil, Air and Water Microbiology**
  - a) Soil environment, Microbial flora of soil, Bacteria, Fungi, Algae, Rhizosphere, Biogeochemical activities of microorganisms in soil
  - b) Microbial content of air, Indoor air, Outdoor air
  - c) Microbiology of sea, lakes and ponds, rivers and streams, Microbes of domestic water, Microbes of sewage water.

**Practical:**

- Sterilization Techniques (Dry/Wet)
- Media Preparation
- Isolation of microorganisms from air, water, soil and plants
- Microbial Characterization
- Gram Staining
- Endospore, flagellar and capsular staining
- Microbial Count



### Text and Reference Books:

1. Microbiology: An Introduction, 12th ed. (2018) by [Gerard J. Tortora](#), [Berdell R. Funke](#), [Christine L. Case](#).
2. Prescott's Microbiology, 10th ed. (2017) by [Joanne Willey](#), [Linda Sherwood](#) and [Christopher J. Woolverton](#).
3. Environmental Microbiology: Fundamentals and Applications: Microbial Ecology (2015) by [Jean-Claude Bertrand](#), [Robert Matheron](#), [Pierre Caumette](#), [Philippe Lebaron](#), [Télesphore Sime-Ngando](#).
4. Jawetz, Melnick & Adelberg's Medical Microbiology (2015) by Barbara Detrick, James H. McKerrow, Jeffery A. Hobden, Judy A. Sakanari, Karen C. Carroll, Stephen A. Morse, Steve Miller, Thomas G. Mitchell and Timothy A. Mietzner.
5. Laboratory Experiments in Microbiology, 11th ed. (2015) by [Ted R. Johnson](#) and [Christine L. Case](#).
6. Brock Biology of Microorganisms, 14th ed. (2014) by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock.
7. Alcamo's Fundamentals of Microbiology, 9th ed. (2012) by Jeffrey C Pommerville.
8. [Bergey's Manual of Systematic Bacteriology](#) (2012).
9. Microbiology Principles and Explorations (2001) by Jacquelyn, G.G.

### SPECIAL PAPERS

#### GROUP A

### ZOO-314. INSECT MORPHOLOGY, PHYSIOLOGY AND TAXONOMY 3(2+1)

#### Course Objectives

The objectives of the course are:-

1. To establish the understanding about body structure of insects.
2. To familiarize the students about different physiological processes of insect.
3. To describe the identification characters of insects belonging to different orders.

#### Course outline:

- **Morphology**
  - a) **General characteristics of insects.** Relationship with other Arthropods, splitting up into different evolutionary lines, Reasons for success of the insects in diverse environments.
  - b) **Hard Parts:** General segmentation, tagmatosis and organization.
  - c) **Integument: Cuticle:** Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane, Cuticular outgrowths and appendages sclerotization.
  - d) **Head:** cephalization, sclerites, modifications.
  - e) **Antennae:** Typical Antenna and its types.
  - f) **Mouthparts:** Mouthparts and their types. Different modes of ingestion and types of mouthparts.
  - g) **Neck:** Sclerites.
  - h) **Thorax:** Sclerites: legs, their different modifications and functions.
  - i) **Wings:** Origin; Different regions. Development and basal attachments, main veins and their branches (generalized insects), Modifications of wings and wing coupling.
  - j) **Flight:** Types of flight.

k) **Abdomen:** Secondary appendages and external genitalia.

- **Physiology**

- a. **Soft Parts:** Muscular system; basic structure, types of muscles; muscle contraction and its energetics.
- b. **Comparative structure of all the systems**, e.g., digestive, excretory, respiratory, reproductive and nervous system and their physiology.
- c. Exocrine and endocrine glands including pheromones and their functions.
- d. **Development:** Different types of metamorphosis, apolysis and ecdysis and the role of endocrine secretions.

1. **Classification of insect orders**

Subclass: Apterygota

- a. Order Collembola
- b. Order Diplura
- c. Order Zygentoma
- d. Order Protura
- e. Order: Archaeognatha

**Subclass: Exopterygota**

- a. Order Dermaptera
- b. Order Dictyoptera
- c. Order Embiidina
- d. Order Neuroptera
- e. Order Strepsiptera
- f. Order Mantophasmatodea
- g. Order Mecoptera
- h. Order Orthoptera
- i. Order Phasmatodea
- j. Order Phthiraptera
- k. Order Plecoptera
- l. Order Psocoptera
- m. Order Siphonaptera
- n. Order Zoraptera
- o. Order Megaloptera
- p. Order Raphidioptera
- q. Order Ephemeroptera
- r. Order Odonata

**Endopterygota**

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

## Practicals

### **Part I: Morphology and Physiology**

Dissection of different insects to expose their internal anatomy.  
Preparation of mouth parts, antennae, wings, legs and genitalia of different insects.  
To study the whole mounts of Collembola, silverfish, thrips, aphids, lice and fleas.

### **Part II: Insect Taxonomy**

Preparation of killing bottles  
preservation, pinning and setting of insects.  
Study of metamorphosis and different types of insects' larvae and pupae.  
Life history of an insect.  
Classification and identification of insects.

### **Text and Reference books:**

- 1) Gullan, P. J. and Cranston, P. S., 2014. *The Insects: An Outline of Entomology*. 4<sup>th</sup> edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
- 2) Chapman, R. F., 2013. *The Insects-Structure and Function*. 5<sup>th</sup> Edition. Cambridge University Press, New York.
- 3) Ambrose, D.P., 2015. *The Insects: Structure Functions and Biodiversity*. Kalyani publishers, Ludhiana, India.
- 4) Miller, S.A., 2002. *General Zoology Laboratory Manual*. 5<sup>th</sup> Ed. (International), Singapore: McGraw Hill
- 5) Richards, O.W. and Davies, R.J. *Imm's General Textbook of Entomology*. 1977. Vol- Chapman & Hall, London.
- 6) Imms, A.D. (1957) *A General Textbook of Entomology*. 9<sup>th</sup> ed. Revised by O. W.
- 7) Richards and R. G. Davies, (1957) Reprinted with minor corrections, 1960. Methuen & Co. London. 886 pp.
- 8) Richards, O. W. and Davies, R. G. (1977) *Imms' General Textbook of Entomology*. Vol. 1. 10<sup>th</sup> ed. Chapman & Hall. Reprinted in India in 1993. 418 pp.
- 9) Borror, D. J. & DeLong, D. M. (1971) *An Introduction to the Study of Insects*. 2<sup>nd</sup> ed. Hold, Rinehart and Winston, N. York. 812 pp.
- 10) Ross, H. H. (1965) *A textbook of Entomology*. John Wiley and sons, New York.
- 11) Snodgrass, R. E. (1935) *Principles of Insect Morphology*. Mc Graw Hill New York.
- 12) Wigglesworth, V. B. (1972) *The Principles of Insect Physiology*. 7<sup>th</sup> ed. (Low-priced). English Language Book Society and Chapman & Hall, London. Reprinted 1979.
- 13) Patton, R. L. (1963) *Introduction to Insect Physiology*. Saunders, London.

## **ZOO-315. PARASITOLOGY A (PROTOZOOLOGY AND IMMUNOLOGY) 3(2+1)**

### **Course Objectives**

The objectives of the course are:-

1. To impart knowledge on various protozoan parasites affecting human and animals.
2. To understand basic principles of parasitic infection and the host immunological responses.
3. To familiarize students to differentiate among the common groups of protozoan parasites.
4. To improve their diagnostic assistance by explaining basic and advanced diagnostic techniques.
5. To provide advanced knowledge, understanding, and critical judgment appropriate for professional employment in Parasitology or a related discipline.

6. To provide a basic knowledge of the immune response and its involvement in health and disease.

### **Course Outline:**

#### **PROTOZOOLOGY**

1. Introduction
  - a) Introduction to Parasitology, Some elementary definitions, Introduction to animal associations; concept of harm; parasite hosts.
  - b) Association to other sciences, Parasitology and human well-being.
  - c) Carriers in Parasitology
2. Parasitic Protozoa
3. Morphology and taxonomy, Life cycles, host-parasite interactions, geographical distribution, reservoir hosts, methods of transmission and control, pathology, immunological aspects, diagnosis and treatment of the following protozoan parasites;
  - a. *Giardia species*
  - b. *Trichomonas species*
  - c. *Entamoeba species*
  - d. *Naegleria species*
  - e. *Trypanosoma species*
  - f. *Leishmania species*
  - g. *Plasmodium species*
  - h. *Babesia species*
  - i. *Cryptosporidium species*
  - j. *Toxoplasma species*
  - k. *Histomonas meleagridis*
4. Parasitic Zoonosis and Risk Perception of Zoonotic infections in Pakistan

#### **IMMUNOLOGY**

1. Overview and Elements of the Immune System
  - a. Medical Importance of the Immune System
  - b. How the Immune System Works: Cells and Organs of the Immune System
2. Components of Immunity
  - a) Antigen and Antibody structure and types
  - b) Antigen-Antibody Interactions
  - c) Innate and Acquired immune responses.
  - d) Infection and Immunity
  - e) Hyper sensitivity and its types
  - f) Complement system
  - g) Macrophages phagocytosis and process of antigen presentation in association with MHC Class II proteins

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.

#### **Practicals**

- a) Study of prepared slides for Protozoa of medical and veterinary importance
- b) Preparation of permanent slides and mounts of parasitic Protozoa.

- c) Analysis of human faeces and domesticated animals for the presence of protozoans by using standard laboratory techniques.
- d) Preparation of blood/exudates smears and diagnosis of blood parasites by light microscopy and rapid diagnostic tests (RDTs).

**Text and Reference books:**

1. David Rollinson. (2017). *Advances in Parasitology*. The Natural History Museum, London UK
2. Patricia Marques. (2018). *Parasitology: A Conceptual Approach*. Academic Press, Cambridge, UK.
3. K.D. Chatterjee. (2015). *Parasitology: Protozoology and Helminthology* 13<sup>th</sup> Edition.
4. Roberts, L. S and Janovy John Jr. (2015). *Foundation of Parasitology*. McGraw Hill, Boston USA.
5. Schmidt, G. D. and Robert, T. S. (2001). *Foundation of Parasitology*. The C.V. Mosby Company, Saint Louise.
6. Faust, E. C. and Russell, P. F. (2015). *Craig and Faust's clinical Parasitology*. Lea and Fibiger, London.
7. Wright, D. Bowman. (2009). *Georgis' Parasitology for Veterinarians*. WB Saunders Company, New York
8. Herbert M. Gilles. (2010). *Protozoal Diseases*. Oxford University Press
9. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt. (2017). *Roitt's Essential Immunology*, 13th Edition. Wiley-Blackwell, New York, London.

**ZOO-316**

**FISHERIES A (ICHTHYOLOGY)**

**3(2+1)**

**Course Objectives**

The objectives of the course are:-

1. To provide sufficient knowledge about all physiological phenomena in fishes.
2. To provide practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture.
3. To emphasize thoroughly in breeding of most cultivable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons.

**Course Outline**

**Introduction:** Brief history, Taxonomy, Biology of commercial food fishes of Pakistan

**Scales in fishes:** Structure, types, importance in identification, classification and age determination

**Physiology of digestion:** Food, feeding habits, absorption, conversion.

**Respiration:** Structure of gills, other types of respiration.

**Excretion & Osmoregulation:** Renal, gill, differences between fresh water & marine fishes.

**Reproduction:** Development of ovary and testes, sex differences, sexual maturity, fecundity, breeding habits, parental care.

**Diseases and their control:** Viral; Bacterial; Fungal; Parasitic; Protozoan; Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera); Annelids (leeches); Arthropods (water ticks, water flea, water mites).

**Fish migration:** To nursery ground, To maturation grounds, Freshwater to marine water.

**Fish ecology:** Effects of different factors on fish development and distribution especially the effects of temperature, light etc.

### Practicals

- Identification of common fishes of Pakistan /N.W.F.P. with the help of keys.
- Learning vernacular (local) and scientific names of common fishes of Pakistan /KP.
- Dissection of a common fish to study major anatomical features (digestive system, respiratory system, reproductive system, afferent and efferent vessels, cranial nerves.
- Fish Collection.
- Preparation and study of fish skeleton and scales

### Books Recommended

1. Kestin, S. C. and Warris, P.D. (Editors). KESTIN FARMED FISH QUALITY, 2002, Blackwell Science, Oxford, UK.
2. Saksena, D.N. ICHTHYOLOGY: RECENT RESEARCH ADVANCES. 1999. **Oscar Publications. India.**
3. Woo, P.T.K FISH DISEASES AND DISORDER. Vol 1. PROTOZOAN AND METAZOAN INFECTIONS. 1995. CABI Publisher.
4. Brenabe, G. AQUACULTURE, Vol. I. 1992. Blackwell Publishing, Oxford. UK.
5. Maseke C. FISH AQUACULTURE. 1987. Pergamon Press, Oxford. UK.
6. Huet M. TEXT BOOK OF FISH CULTURE: BREEDING AND CULTIVATION. 1973. Blackwell Publishing Company
7. Hoars, W.S. FISH PHYSIOLOGY. 1971. Academic Press. UK.
8. Hoars, W.S. FISH REPRODUCTION. 1969. Academic Press. UK.
9. Matty, A.J. FISH ENDOCRINOLOGY. 1985. Timber Press, UK.
10. Gorbman, A. COMPARATIVE ENDOCRINOLOGY. 1<sup>st</sup> Edition. 1983. John Wiley & Sons. UK

## ZOO-317      HERPETOLOGY A (BIOLOGY OF AMPHIBIANS)      3(2+1)

### Objectives

1. Understand the basic concepts of herpetology
2. Enable to know the origin and evolutionary history of amphibians and reptiles
3. Develop a vision of systematics and phylogenetics of amphibians and reptiles
4. Understand the comparative morphology of amphibians

### Course outline

**Herpetology:** definition, scope and history as a science

**Caecilia:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship

**Caudata:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship, metamorphosis

**Anura:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship, metamorphosis, defense.

### Practicals:

1. Study of major morphological characters of salamanders and frogs from preserved specimens
2. Identification of preserved specimens through keys
3. Study of developmental stages of frog from preserved material and live individuals

4. Field visits to observe amphibians in their natural habitat and take notes
5. Comparative skeletal study of frogs

#### **Books Recommended**

1. Khan, M.S. (?). Herpetology of Pakistan. 1<sup>st</sup> ed. Zoological Soc. of Pak. Lahore. Pakistan
2. Daniels, R.JR. (2005). Amphibians of Peninsular India. 1<sup>st</sup> ed. Universities Press India.
3. Frazer, J.F.D (1973). Amphibians. 1<sup>st</sup> ed. Wykeham Publications, London
4. Vitt, L.J. and Caldwell, J.P. (2013). Herpetology: an introduction to the biology of reptiles and amphibians. Academic press.
5. Wells, K.D. (2007). The ecology and behavior of amphibians. University of Chicago Press.

### **ZOO-318      VACCINOLOGY A (INTRODUCTION TO VACCINE)      3(2+1)**

#### **INTRODUCTION TO VACCINOLOGY**

Introduction to Vaccines; History of vaccines and how vaccines originated.

Types of Vaccines; live versus attenuated vaccines, DNA as a vaccine, Proteins and peptides as vaccines, how vaccines are made. Vaccine hesitancy

Introduction to vaccine related epidemiology, Vaccine immunology; Immunological memory –T and B cell memory, mucosal immunity and vaccines, An animal model for vaccines testing; Utility of mouse models in vaccine design and development. Delivery systems, Vaccine efficacy and its evaluation.

#### **Practicals:**

1. Routes of administration of Vaccine
2. Bradford assay for determining the concentration of antigen / protein
3. Dose preparation of vaccine
4. Growth of bacteria, preparation of heat killed bacteria
5. Transformation of recombinant plasmid into host cell
6. Preparation of formalin inactivated toxin
7. Determination of Anti-body titre of a vaccine by indirect ELISA

#### **Recommended books / Further reading**

1. Vaccines edited by Farhat Afrin, Hassan Hemeg and Hani ozbak (2017) printed in Croatia Dajana pemac
2. WHO, UNICEF, World Bank. State of the world's vaccines and immunization, 3<sup>rd</sup> edition. Geneva, World Health Organization, 2009.
3. Vaccinology: Principles and Practice edited by W. John W. Morrow, Nadeem A. Sheikh, Clint S. Schmidt, D. Huw Davies 2012 Blackwell publishing limited.
4. Experimental Animal Models of Human Diseases: An Effective Therapeutic Strategy edited by Bartholomew Ibeh 2018 published by intechOpen.
5. Janeway's Immunobiology Kenneth Murphy, Paul Travers, Mark Walport, Pater walter Taylor & Francis Group, 22-Jun-2010

#### **JOURNALS**

- Vaccines
- Expert Review of Vaccines.
- Human Vaccines.

- Human vaccines and Immunotherapeutics
- Clinical and Experimental Vaccine research
- Genetic Vaccines and Therapy.
- Human Vaccines and Immunotherapeutics.
- Journal of Immune Based Therapies and Vaccines.
- Journal of Vaccines and Vaccination.

## **ZOO- 319      VIROLOGY A (FUNDAMENTALS OF VIROLOGY)**

**3(2+1)**

### **Course Objectives**

This course will help the students to know about the basics of virology, the emerging field. The course may initiate their interest in the basic structure, classification, transmission and replication of viruses of bacteria, plants, vertebrates and invertebrates.

### **Course Outline**

Introduction to Virology: The nature of viruses. Why study viruses? A brief history of virology. The nature of viruses.

Virus Structure and Assembly: The Structure of Virus. Characteristics of capsids, Viral envelopes, Virus genome, Virion assembly.

Virus Classification: Principle of virus Taxonomy, Nomenclature and classification of viruses.

Transmission of Viruses: Routes and Modes of viral transmission. Transmission of Plant, vertebrates and invertebrates' viruses.

The Virus Life Cycle: The virus attachment and entry to the cell. Transcription, Translation and Transport, The virus genome replication.

Subviral particles: Prion, Viroids.

Methods of studying viruses

Safety Measure in a Lab dealing with infectious agents especially viruses.

### **PRACTICALS**

Safety Measure in Virology Lab. Biological sample collection for virus study. Detection of antigen/ antibodies of DNA and RNA viruses through available Rapid test devices. Culture of Influenza viruses in Chicken embryos.

### **BOOKS RECOMMENDED (Latest Editions)**

1. Hewlett MM, Camerini D, Bloom DC. 2021. Basic Virology 4<sup>th</sup> Edition. Wiley Blackwell USA.
2. Flint SJ, Racaniello VR, Enquist LW, Skalka AM. 2009. Principles of Virology 3<sup>rd</sup> Edition. ASM Press USA.
3. Dimmock NJ, Easton AJ and Leppard KN. 2016. Introduction to Modern Virology, 7<sup>th</sup> Edition. Blackwell Publishing Ltd USA.
4. Carter JB and Saunders VA. 2007. Virology, Principles and Applications. John Wiley & Sons Ltd England.
5. Jawetz, Melnick and Adelberg. 2012. Medical Microbiology, 24<sup>th</sup> Edition. Prentice Hall, Upper Saddle River, New Jersey USA.

## **GROUP B**

## **ZOO-325                      APPLIED AND MEDICAL ENTOMOLOGY**

**3(2+1)**

### **Course Objectives**

The objectives of the course are:-

1. To introduce the insect pests of major crops of Pakistan.



2. To familiarize the students with various control strategies of insects.
3. To introduce the students about various insect borne diseases.

### **Course Outline**

**Introduction:** Applied Entomology an introduction, Economic Importance of Insects, Biotic Potential and Environmental Resistance, Biological Equilibrium, Factors and Reasons of Insect Success, Why Insects become Pest.

**Insect Control Strategies:** Natural Control, Artificial Control; Physical and Mechanical, Cultural, Biological, Chemical, Legislative, genetic and Autocidal, IPM.

**Pest of Agricultural Importance:** Pests of Cotton, Rice, Sugarcane, Wheat, Maize, Fruit and Stored grain Pest.

**Pest of Medical Importance:** Mosquitoes, Sandflies, Midges, Myiasis causing flies, Fleas, Louse, Fleas, Bed bugs and Scabies etc.

### **Practical:**

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

### **Text and Reference books:**

- 1) Atwal, A.S., 2015. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
- 2) Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
- 3) Chapman, R. F., 2013. The Insects-Structure and Function. 5th Edition. Cambridge University Press, New York.
- 4) Gullan, P. J. and Cranston, P. S., 2014. The Insects: An Outline of Entomology. 4<sup>th</sup> edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
- 5) Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
- 6) Imms, A.D. (1957) A General Textbook of Entomology. 9th ed. Revised by O. W.
- 7) Metcalf, G. L. & Flint, W.P. (1962) Destructive and useful insects. Mc Graw Hill New York.

## **ZOO-326. HELMINTHOLOGY AND HOST PARASITE RELATIONSHIP. 3(2+1)**

### **Course Objectives**

The objectives of the course are:-

- To impart knowledge on various trematodes, cestodes and nematodes affecting human and animals.
- To understand basic principles of host parasite interaction.
- To familiarize students with morphological criteria to differentiate the most common helminthes.
- To improve their diagnostic capability by explaining basic and advanced diagnostic exercises using a compound microscope

## Course outline:

### HELMINTHOLOGY

#### 1. Introduction

- Taxonomy, etiology and biology of helminthes parasites.

#### 2. Class Cestoda (Tapeworms)

1. Etiology, Pathology and pathogenesis, diagnosis, treatment and control of the following Cestodes;
2. *Diphyllobothrium latum*
3. Sparganosis
4. *Taenia saginata* & *T. solium*
5. *Echinococcus granulosus* & *E. multilocularis*
6. *Hymenolepis nana*
7. *Dipylidium caninum*

#### 3. Class Trematoda (Flukes)

Etiology, Pathology and pathogenesis, diagnosis, treatment and control of the following Trematodes;

- *Schistosoma mansoni*, *S. japonicum*, *S. haematobium*  
*Fasciola hepatica*
- *Fasciolopsis buski*
- *Dicrocoelium dendriticum*
- *Paragonimus westermani*
- *Colanorchis sinensis*
- *Heterophyes heterophyes*

#### Monogenetic Trematodes:

- *Dactylogyus vastator*
- *Gyrodactylus*
- *Diplozoon paradoxum*

#### 4. Class Nematoda

Etiology, Pathology and pathogenesis, diagnosis, treatment and control of the following Nematodes;

- a. *Trichuris trichiura*
- b. *Trichenella spiralis*
- c. *Strongyloides stercoralis*
- d. *Ancylostoma duodenale*
- e. *Necator americanus*, Creeping eruption
- f. *Ascaris lumbricoides*
- g. *Toxocara canis*
- h. *Enterobius vermicularis*
- i. *Wuchereria bancrofti*, *Brugia malayi*
- j. *Onchocerca volvulus*
- k. *Loa loa* and *Dracunculus medinensis*.

### HOST-PARASITE RELATIONSHIP

- Host parasite relationship: as associative organization between two organisms
- Structural aspects of the association interface
- Nutrient exchanges in associations
- Physiological and regulatory interactions: between associates
- Behavioural Aspects of organism associations
- Ecology and evolution of intimate associations

- Biology of Arthropods (Vector born) causing disease or those responsible for transmission of disease

#### Practicals:

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

#### Text and Reference books:

1. David Rollinson. (2017). Advances in Parasitology. The Natural History Museum, London UK
2. [Patricia Marques](#). (2018). [Parasitology: A Conceptual Approach](#). Academic Press, Cambridge, UK.
3. K.D. Chatterjee. (2015). Parasitology: Protozoology and Helminthology 13<sup>th</sup> Edition.
4. Roberts, L. S and Janovy John Jr. (2015). Foundation of Parasitology. McGraw Hill, Boston USA.
5. Schmidt, G. D. and Robert, T. S. (2001). Foundation of Parasitology. The C.V. Mosby Company, Saint Louise.
6. Faust, E. C. and Russell, P. F. (2015). Craig and Faust's clinical Parasitology. Lea and Fibiger, London.
7. Wright, D. Bowman. (2009). Georgis' Parasitology for Veterinarians. WB Saunders Company, New York

**ZOO-327**

**FISHERIES B (APPLIED FISHERIES)**

**3(2+1)**

#### Course Objectives

The objectives of the course are:-

1. To increase the understanding of fin fish and shell fish aquaculture
2. To teach about different aquaculture species, their rearing facilities and management by using basic techniques
3. To impart knowledge about site selection and construction of fish farm.
4. problems and management of fish farm

#### Course Contents:

1. **Introduction:** Introduction to fish, fishery and aquaculture, History and present status of aquaculture (National and International), Introduction and biology of cultivable fin and shell fishes. Introduction to aquatic resources of Pakistan (Lentic and lotic environment).
2. **Fish Culture:** Designing, construction, fertilization, manuring, stocking and harvesting of a fish pond

3. Study of native and exotic fishes of Pakistan; Shellfish & fin fish; Fishing gears and crafts/nets used in Pakistan; Fish ways; construction & importance. .
4. Bye products of fish industry; Methods of processing fish such as drying, salting smoking, curing, freezing etc;
5. Study of fish parasites, common diseases and enemies of fishes.
6. Pollution and its effect on fish population;
7. Methods of population estimation by direct count, catch effort, mark re-capture method, tagging of fish;
8. Artificial propagation induced spawning techniques;
9. Marketing strategies; transport of fish and seed;
10. Major problems of fishermen in Pakistan.

### Practicals

- Collection and identification of various freshwater fish species
- Visit and studying of fish pond Components.
- Visit to fish hatchery and integrated fish farming.
- Determination of Water quality parameters (Physical, chemical and biological)
- Fish feed ingredients and formulation of fish feed
- Artificial Fish breeding and various life stages observations
- Fish parasite slide preparation
- Fish Age determination from scales, opercula, otolith and back calculation from bones
- Fish market visit
- Visit to fish feed mill
- Visit to head works/reservoirs etc.

### Books Recommended:

1. Metha, V. 2009. Fisheries and Aquaculture Biotechnology. 2<sup>nd</sup> Ed. Campus Books International, New Delhi, India.
  2. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India.
  3. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
  4. Pandey, B. N., S. Deshpande and P. N. Pandey. 2007. Aquaculture. APH Publishing Corporation, New Delhi, India.
  5. Parker, R. O. 2004. Aquaculture Science 4<sup>th</sup> Ed. Delmar Learning, London, UK.
  6. Chakraborty, C. and A. K. Sadhu. 2001. Biology, Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Dya Publishing House, New Delhi, India.
  7. Gjedrem T. and Baranski M. 2009. Selective breeding in Aquaculture: An Introduction. Springer, USA
  8. NIIR 2003. Hand Book on Fisheries & Aquaculture Technology. Asia Pacific Business Press Inc., Delhi.
  9. Pillay, T. V. R. 2002. Aquaculture: Principles and Practices. Blackwell Sciences Limited. UK.
  10. Huet, M. and Timmermans, J. (2002). Text book of Fish Culture. Blackwell Science Ltd. UK.
  11. Shammi, Q.J. and Bhatnagar, S. 2002. Applied Fisheries, Agro bios, India.
- Ali, S.S. 1999. Fresh Water Fisher Biology. Naseem Book Depot, Hyderabad.

**ZOO-328      HERPETOLOGY B (THE BIOLOGY OF REPTILES)**

**3(2+1)**

### Course Objectives

1. Understand the comparative morphology of reptiles
2. Enable to know the origin and evolutionary history of reptiles
3. Develop a vision of systematics and phylogenetics of and reptiles

#### 4. Understand the comparative anatomy of reptiles

##### **Course outline**

**Lizards:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship

**Snakes:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship, metamorphosis

**Turtles and tortoises:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship, metamorphosis, defense.

**Crocodylians:** morphology and general characters, taxonomy and systematics, origin and phylogeny, zoogeographic distribution, habits and habitat, reproductive strategies and courtship, metamorphosis, defense.

##### **Practicals:**

1. Study of major morphological characters of reptiles from preserved specimens
2. Identification of preserved specimens through keys
3. Comparative skeletal study of lizards and snakes
4. Field visits to observe reptiles in their natural habitat and take notes

##### **Books Recommended**

1. Mattison, C. (1992). Lizards of the World. Blandford Press.
2. Alderton, D. (1988). Turtles and tortoises of the world. Blandford Press, London
3. Alderton, D. (1991). Crocodiles and Alligators of the world. Blandford Press, London
4. Gunther, Albert (1964). Reptiles of British India. Oxford and IBH Publishing Co., New Delhi
5. Vitt, L.J. and Caldwell, J.P. (2013). Herpetology: an introduction to the biology of reptiles and amphibians. Academic press.

#### **ZOO-329                      VACCINOLOGY B (APPLIED VACCINOLOGY)                      3(2+1)**

General Immunization practices; pediatric vaccines; intro to the vaccine preventable pediatric diseases and vaccines included in national immunization program (BCG, OPV, IPV, Pentavalent vaccine (Diphtheria, Tetanus, Pertussis, Hep B, Hib pneumonia and Meningitis), Measles, Rota virus Vaccine. Vaccines in Vaccine preventable diseases; Vaccines in Prophylaxis and treatment, anthrax vaccines, cholera vaccines, influenza vaccine, rabies vaccine, corona vaccines.

##### **Practicals;**

1. ELISA
2. Visit to a Hospital / Vaccination center
3. Calculating the effectiveness and efficacy of a vaccine, sample data from a tertiary care health center.
4. Determination of antibody titer for Rabies vaccine
5. Determination of antibody titer for a recombinant protein (Vaccine)
6. Neutralization assay
7. Seminar / presentation by an expert of public health or epidemiologist

##### **Recommended books / Further reading**

1. Review of medical microbiology and immunology Warren, E. levinson Peter Chin-Hong, Elizabeth Joyce, Jesse Nussbaum, Brian Schwartz 15<sup>th</sup> Edition 2018. McGraw Hill Education.

2. Epidemiology and Prevention of Vaccine-Preventable Diseases, 13th Edition E-Book Jennifer Hamborsky, MPH, MCHES, Andrew Kroger, MD, MPH, Charles (Skip) Wolfe Public Health Foundation, 19-Oct-2015
3. Vaccinology: Principles and Practice edited by W. John W. Morrow, Nadeem A. Sheikh, Clint S. Schmidt, D. Huw Davies 2012 Blackwell publishing limited.
4. Janeway's Immunobiology Kenneth Murphy, Paul Travers, Mark Walport, Pater walter Taylor & Francis Group, 22-Jun-2010 .
5. Short Protocols in Immunology illustrated edition John E. Coligan. 2005 Wiley

## **JOURNALS**

- Vaccines
  - ELSEVIER Immunobiology
  - Expert Review of Vaccines.
  - Human Vaccines.
  - Human vaccines and Immunotherapeutics
  - Clinical and Experimental Vaccine research
  - Genetic Vaccines and Therapy.
  - Human Vaccines and Immunotherapeutics.
  - Journal of Immune Based Therapies and Vaccines.
6. Journal of Vaccines and Vaccination.

**ZOO-330**

**VIRAL DISEASES AND THEIR MANAGEMENT 3(2+1)**

### **Course Objectives**

This course will help the students to know about the specific viral infection/diseases. The course may initiate their interest in understanding the pathogenesis, treatment strategies and vaccine production for important viruses.

### **Course Outline**

Viruses and Disease, Laboratory diagnosis of virus infection.

Immune system and virus Neutralization. Acute, Chronic, Persistent and Latent infection

Overview of Animal Viral Diseases:

Foot and Mouth diseases, Blue Tongue, Influenza, Bird flu, Swine flu, Poxvirus

Overview of Human Viral Diseases (Polio, Measles, Chickenpox, Common cold, Flu, Dengue, Herpes, Hepatitis, AIDS, COVID-19)

Viruses and Cancer

Prion Diseases

Prevention of Viral Diseases (Vaccines)

Antivirals Treatment

Horizons in medical Virology

### **Practicals**

Virus specific IgM and IgG antibodies detection for viral infection. Viral DNA and RNA Isolation from biological samples. DNA virus amplification and detection by PCR. cDNA synthesis of RNA virus and amplification by PCR. Gel electrophoresis

### **Books Recommended (Latest Editions)**

1. Collier L, Kellam P. and Oxford J. 2016. Human Virology, 5<sup>th</sup> Edition. Oxford University Press, Oxford UK.
2. Dimmock NJ, Easton AJ and Leppard KN. 2016. Introduction to Modern Virology, 7<sup>th</sup> Edition. Blackwell Publishing Ltd USA.
3. Jawetz, Melnick and Adelberg. 2003. Medical Microbiology, 24<sup>th</sup> Edition. Prentice Hall, Upper Saddle River, New Jersey USA.
4. RA. Goldsby, TJ. Kindt and B. Osbourne. 2018. Kuby Immunology, 5<sup>th</sup> Edition. W.H. Freeman, New York USA.
5. Zuckerman AJ, Banatvala JE, Schoub BD, Griffiths PD, Mortimer P. 2009. Principles and Practice of Clinical Virology. 6<sup>th</sup> Edition. Wiley Blackwell USA.