

**2<sup>nd</sup> MEETING OF  
THE BOARD OF STUDIES OF ZOOLOGY  
December 02, 2016**



**CENTRE FOR ANIMAL SCIENCES & FISHERIES  
UNIVERSITY OF SWAT  
PAKISTAN**

**Members of the Board of Studies  
Centre for Animal Sciences & Fisheries (CAS&F)**

<b>S.No</b>	<b>Name / Designation</b>	<b>Address</b>	<b>Status</b>
1.	Dr. Akhtar Rasool	Director/In-Charge/Assistant Professor CAS&F, University of Swat	Convenor
2.	Prof. Dr. Sayed Akram Shah	Professor, Department of Zoology, University of Peshawar, Peshawar	Member
3.	Dr. Muzafar Shah	Assistant Professor, CAS&F, University of Swat	Member
4.	Dr. Fazal Akbar	Assistan Professor, Centre for Biotechnology & Microbiology, University of Swat.	Member
5.	Dr. Muhammad Israr	Assistan Professor, Department Forensic Studeis, University of Swat.	Member
6.	Dr. Farzana Hilal	Associate Professor, Govt. Girls College, Saidu Sharif, Swat.	Member
7.	Dr. Abdul Wahab	Assistant Professor, Department of Zoology, Govt, Post Graduate Jahanzeb College, Swat.	Member
8.	Mr. Jehan Sher	Assistant Director, Madyan Fish Form, Madyan, Swat.	Member
9.	Mr. Hamid Ur Rehman	Lecturer, Centre for Animal Sciences, University of Swat, Swat.	Member

**CURRICULUM  
OF  
BS ZOOLOGY**

**SCHEME OF STUDIES FOR ZOOLOGY  
FOUR YEARS BS PROGRAM**

**SEMESTER-1**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
	<b>Compulsory-I (English-I) Functional English</b>	<b>3(3-0)</b>
	<b>Compulsory-II Pakistan Studies</b>	<b>2(2-0)</b>
	<b>Compulsory-III Mathematics</b>	<b>3(3-0)</b>
	<b>General-I Botany-I (Diversity of Plants)</b>	<b>3(2-1)</b>
<b>Zool-101</b>	<b>Foundation-I Principles of Animal Life</b>	<b>4(3-1)</b>
		<b>15</b>

**SEMESTER-2**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
	<b>Compulsory-IV English-II (Communication Skills)</b>	<b>3(3-0)</b>
	<b>Compulsory-V Islamic Studies/Ethics</b>	<b>2(2-0)</b>
	<b>General-III Psychology</b>	<b>3(3-0)</b>
	<b>General-II Chemistry-I (Inorganic Chemistry)</b>	<b>3(2-1)</b>
<b>Zool-151</b>	<b>Foundation-II Animal Diversity: Invertebrate Zoology</b>	<b>4(3-1)</b>
		<b>15</b>

**SEMESTER-3**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
	<b>Compulsory-VI English-III (Technical Writing and Presentation Skill)</b>	<b>3(3-0)</b>
	<b>Compulsory-VII Introduction to computer</b>	<b>3(2-1)</b>
	<b>General-V Botany-II (Plants systematics, Anatomy and Development)</b>	<b>3(2-1)</b>
	<b>General-IV Chemistry-II (Organic Chemistry)</b>	<b>3(2-1)</b>
<b>Zool-201</b>	<b>Foundation-III Animal Form &amp; Function-I</b>	<b>3(2-1)</b>
		<b>15</b>

**SEMESTER-4**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
	<b>Compulsory-VIII English-IV/Uni. Optional</b>	<b>3(3-0)</b>
	<b>General-VII Botany-III (Cell Biology, Genetics and Evolution)</b>	<b>3(2-1)</b>
	<b>General-VI Chemistry-III (Physical Chemistry)</b>	<b>3(2-1)</b>
<b>Zool-251</b>	<b>Foundation-IV Chordate Biology</b>	<b>4(3-1)</b>
<b>Zool-252</b>	<b>Foundation-VI Animal Form &amp; Function-II</b>	<b>3(2-1)</b>
		<b>16</b>

#### **SEMESTER-5**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
<b>Zool-301</b>	<b>Major-I Physiology</b>	<b>4(3-1)</b>
<b>Zool-302</b>	<b>Major-II Developmental Biology</b>	<b>4(3-1)</b>
<b>Zool-303</b>	<b>Elective-I Environmental Biology</b>	<b>3(2-1)</b>
<b>Zool-304</b>	<b>Foundation -VII Cell and Molecular Biology</b>	<b>4(3-1)</b>
<b>Zool-305</b>	<b>Major-III Wildlife</b>	<b>2(2-0)</b>
		<b>17</b>

#### **SEMESTER-6**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
<b>Zool-351</b>	<b>Foundation-VIII Evolution and Principle of Systematics Zoology</b>	<b>4(3-1)</b>
<b>Zool-352</b>	<b>Major-IV Genetics</b>	<b>4(3-1)</b>
<b>Zool-353</b>	<b>Foundation-IX General Biochemistry</b>	<b>4(3-1)</b>
<b>Zool-354</b>	<b>Compulsory-IX Biostatistics</b>	<b>3(2-1)</b>
<b>Zool-355</b>	<b>Elective-II Fundamentals of Endocrinology</b>	<b>3(2-1)</b>
		<b>18</b>

#### **SEMESTER-7**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
<b>Zool-401</b>	<b>Major-V Zoogeography and Palaeontology</b>	<b>3(3-0)</b>
<b>Zool-402</b>	<b>Elective-III Medical Microbiology</b>	<b>3(2-1)</b>
<b>Zool-403</b>	<b>Foundation-X Biological techniques</b>	<b>3(2-1)</b>
<b>Zool-404</b>	<b>Major-VI Parasitology</b>	<b>4(3-1)</b>
<b>Zool-405</b>	<b>Major-VII Animal Behaviour</b>	<b>3(2-1)</b>
<b>Zool-406</b>	<b>Major-VIII Research Methodology</b>	<b>2(2-0)</b>
		<b>18</b>

#### **SEMESTER-8**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
<b>Zool-451</b>	<b>Major-IX Fish Biology</b>	<b>4(3-1)</b>
<b>Zool-452</b>	<b>Elective-IV Bioinformatics</b>	<b>3(2-1)</b>
<b>Zool-453</b>	<b>Major-X Entomology</b>	<b>4(3-1)</b>
<b>Zool-454</b>	<b>Major-IX Research Projects OR Special Paper I Special Paper II</b>	<b>0-6 OR 3(3-0) 3(3-0)</b>
		<b>17</b>
		<b>17</b>

**Total credit hours: 131**

## DETAIL OF COURSES

### B.S. ZOOLOGY (4 Year program)

#### SEMESTER-I

Course No.	Title	Credit Hours
	<b>Compulsory-I (English-I) Functional English</b>	<b>3(3-0)</b>
	<b>Compulsory-II Pakistan Studies</b>	<b>2(2-0)</b>
	<b>Compulsory-III Mathematics</b>	<b>3(3-0)</b>
	<b>General-I Botany-I (Diversity of Plants)</b>	<b>3(2-1)</b>
<b>Zool-101</b>	<b>Foundation-I Principles of Animal Life</b>	<b>4(3-1)</b>
		<b>15</b>

	<b>Compulsory-I (English-I) Functional English</b>	<b>3(3-0)</b>
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#### COURSE OBJECTIVES

- 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 OUTCOMES

Students should be able to engage effectively in the following tasks and activities:

- **READ** a variety of texts critically and proficiently to demonstrate in writing or speech the comprehension, analysis, and interpretation of those texts;
- **WRITE** a literary or expository text using the conventions of Standard English as stylistically appropriate, while showing a nuanced use of language (producing such a text may include invention, work shopping, research, compiling bibliographies, drafting, peer responses, revising, and/or editing).

#### 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

### RECOMMENDED BOOKS

1. Boutin, M-C., Brinand, S., Grellet, F. 1993. Writing. Intermediate and Supplementary Skills. Oxford Fourth Impression
2. Thomson, A.J., Martinet, A.V. 2002. Practical English Grammar and Exercises 4th Ed. Oxford University Press.
3. Tomlinson, B., Ellis, R. 1992. Reading. Upper Intermediate. Oxford Supplementary Skills. Third Impression.

	<b>Compulsory-II Pakistan Studies</b>	<b>2(2-0)</b>
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### COURSE OBJECTIVES

- 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 OUTCOMES

After completion of the course the students will be able

- To **GET** knowledge about himself, the country and the world around him, significance of nation building problems, development of social and moral consciousness that should lead to healthy living in egalitarian society.

### COURSE CONTENTS

**Historical Perspective:** Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah; Factors leading to Muslim separatism; People and Land: Indus Civilization, Muslim advent, Location and geo-physical features.

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

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

### RECOMMENDED BOOKS

1. Ansar, Z. 1980. History & Culture of Sindh. Karachi: Royal Book Company.
2. Aziz, K.K. 1976. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research.
3. Burke, S.M., Ziring L. 1993. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press.
4. Javed, B. S. 1980. State and Society in Pakistan. The Macmillan Press Ltd.



5. Khalid Bin Sayeed. 1967. The Political System of Pakistan. Boston: Houghton Mifflin.
6. Lawrence, Z. 1980. Enigma of Political Development. Kent England: Wm Dawson & sons Ltd.
7. Noor ul Haq. 1993. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research.
8. Rafique A. M. 1998. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research.
9. Safdar, M. 1994. Pakistan Political Roots & Development. Lahore.
10. Safdar, M. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
11. Tahir, A. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
12. Waseem, M. 1987. Pakistan under Martial Law, Lahore: Vanguard.
13. Wayne, W. 1972. The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research.
14. Zaidi A.S. 2000. Issue in Pakistan's Economy. Karachi: Oxford University Press.

	<b>Compulsory-III Mathematics</b>	<b>3(3-0)</b>
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### **COURSE OBJECTIVES**

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

### **COURSE OUTCOMES**

Students who successfully complete this course will be able to:

- **DESCRIBE** the roles mathematics serves in Zoology and biomedical research.
- **CALCULATE** experimental data and formulate equations for biological purposes.
- **EXPLAIN** general principles of study design and its implications for valid inference.
- **ASSESS** data sources and data quality for selecting appropriate data for specific research questions.

### **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 equations, 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.

## RECOMMENDED BOOKS

1. Dolciani, M.P., Wooton, W., Beckenback, E.F., Sharron, S.1978. Algebra 2 and Trigonometry, Houghton & Mifflin.
2. Kaufmann, J.E., 2015. College Algebra and Trigonometry. 10<sup>th</sup> edition Pearson publishers, India.
3. Swokowski, E.W.1997. Fundamentals of Algebra and Trigonometry. 9th Ed., PWS-Kent Company.

	<b>General-I</b> <b>Botany-I (Diversity of Plants)</b>	<b>3(2-1)</b>
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## COURSE OBJECTIVES

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

## COURSE OUTCOMES

It will enable to the students to be **ACQUAINTED** with the latest knowledge of the plant sciences. Especially in the field of plant diversity and systematics.

## COURSE CONTENTS

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 bio fertilizers, 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), vi. Seed Habit
- i) Gymnosperms
  - i. Cycas, ii. Pinus, iii. Ephedra

## PRACTICALS

- Culturing, maintenance, preservation and staining of microorganisms.
- Study of morphology and reproductive structures of the types mentioned in theory.
- Identification of various types mentioned from prepared slides and fresh collections.

## RECOMMENDED BOOKS

1. Agrios, G.N. 2004. Plant pathology. 8<sup>th</sup> ed. Academic press London.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. 4<sup>th</sup> ed. John Wiley and Sons Publishers.
3. Andrew, H. N. 1961. Studies in Paleobotany. John Willey and Sons.
9. Hussain, F. 2012. A Text Book of Botany and Biodiversity. Pak Book Empire.
4. Ingrouille, M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
5. Lee, R.E. 1999. Phycology. Cambridge University Press, UK
10. Marti. J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP
6. Mauseth, J.D. 2003. Botany: An Introduction to Plant Biology 3rd ed., Jones and Bartlett Pub. UK
7. Prescott, L.M., Harley, J.P. and Klein, A.D. 2004. Microbiology, 3<sup>rd</sup> ed. WM. C. Brown Publishers.
11. Taylor, T.N. & Taylor, E.D. 2000. Biology and Evolution of Fossil Plants. Prentice Hall. N.Y.
8. Vashishta, B.R. 1991. Botany for degree students (all volumes). S. Chand and Company. Ltd. New Delhi.

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

<b>Zool-101</b>	<b>Foundation-I Principles of Animal Life</b>	<b>4(3-1)</b>
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## COURSE OBJECTIVES

The course aims to impart knowledge and understanding of:

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

## COURSE OUTCOMES

The students after studying this course will be able to:

- **UNDERSTAND** the scope of Zoology
- **ACQUIRED** the knowledge of cellular organization and the basic biochemical processes.
- Get **FAMILIAR** with the fundamentals of ecology and genetics.

## COURSE CONTENTS

**Scope of Zoology:** Introduction; significance and applications of zoology; animal diversity; the scientific method; environment and world resources.

**The Chemical Basis of Animal Life:** Brief introduction to biomolecules; carbohydrates, lipids, proteins, and nucleic acids.

**Cellular Organization:** Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, vacuoles; the nucleus: nuclear envelope, chromosomes and nucleolus.

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

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

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

Reproduction and Development: Types; asexual and sexual, gametogenesis, fertilization, metamorphosis, zygote and early development.

**Ecological Concepts:** Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles, and limiting factors, populations and communities, human population growth, pollution, resource depletion and biodiversity.

## PRACTICALS

- Tests for different carbohydrates, proteins and lipids.
- Study of the prepared slides of epithelial tissue (squamous, cuboidal, and columnar), connective tissue (adipose, cartilage, bone, and blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac).
- Plasmolysis and deplasmolysis in blood. Preparation of blood smears.
- Protein digestion by pepsin.
- Ecological notes on animals of a few model habitats.
- Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

## RECOMMENDED BOOKS

1. Hickman, C.P. and Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S. and Larson, A. 2004. Integrated Principles of Zoology, 12th Ed. (International), Singapore: McGraw Hill.
3. Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece. 2016. Campbell Biology. 11th Ed. Pearson Publishing. Chesterton Mill, French's Road, Cambridge, CB4 3N.
4. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
5. Miller, S.A. and Harley, J.B. 2005. Zoology, 6th Ed. (International), Singapore: McGraw-Hill.
6. Molles, M.C. 2005. Ecology: Concepts and Applications. 6th Ed. McGraw Hill, New York, USA.
7. Odum, E. P. 1994. Fundamentals of Ecology. 3rd Ed. W.B. Saunders. Philadelphia.

## SEMESTER-2

Course No.	Title	Credit Hours
	<b>Compulsory-IV English-II (Communication Skills)</b>	<b>3(3-0)</b>
	<b>Compulsory-V Islamic Studies/Ethics</b>	<b>2(2-0)</b>
	<b>General-III Psychology</b>	<b>3(3-0)</b>
	<b>General-IV Chemistry-I (Inorganic Chemistry)</b>	<b>3(2-1)</b>
<b>Zool-151</b>	<b>Foundation-II Animal Diversity: Invertebrate Zoology</b>	<b>4(3-1)</b>
		<b>15</b>

	<b>Compulsory-IV English-II (Communication Skills)</b>	<b>3(3-0)</b>
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### COURSE OBJECTIVES

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

### COURSE OUTCOMES

The students after studying this course will be able to:

- **ANALYZE** and interpret texts written in English, evaluating and assessing the results in written or oral arguments using appropriate support;
- **DESIGN** and create texts for a variety of purposes and audiences, evaluating and assessing the effectiveness and meaning of such texts
- **SPEAK** clearly, effectively, and appropriately in a public forum for a variety of audiences and purposes.

### 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*

### RECOMMENDED BOOKS

1. Boutin, Marie-Christine, Brinandm, S., Grellet, F. 1993. Writing: Intermediate. Oxford Supplementary Skills. Fourth Impression.
2. Langan, J. Reading and Study Skills by Richard York.

3. Nolasco, R. 1992. Writing: Upper-Intermediate. Oxford Supplementary Skills. Fourth Impression. (Particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
4. Thomson, A.J., Martinet, A.V. 1986. Practical English Grammar Exercises 2. 3rd Ed. Oxford University Press.
5. Tomlinson, B., Ellis, R. 1991. Reading. Advanced. Oxford Supplementary Skills. Third Impression.

	<b>Compulsory-V Islamic Studies/Ethics</b>	<b>2(2-0)</b>
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### **COURSE OBJECTIVES**

- Provide Basic information about Islamic Studies
- Enhance understanding of the students regarding Islamic Civilization
- Improve Students skill to perform prayers and other worships

### **COURSE OUTCOMES**

The students after studying this course will be able to:

- **GET** knowledge of issues related to faith and religious life.
- **ACQUIRE** the understanding of Islamic Civilization

### **COURSE CONTENTS**

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

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

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

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

**Islamic History:** Period of Khlaft-E-Rashida; Period of Ummayyads; Period of Abbasids

**Social System of Islam;** Basic Concepts of Social System of Islam; Elements of Family; Ethical Values of Islam.

### RECOMMENDED BOOKS

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

	<b>General-II Psychology</b>	<b>3(3-0)</b>
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### COURSE OBJECTIVES

- The main aim is to familiarize students with history, main concepts, methods, and theoretical frameworks in psychology.
- The course will help students appreciate the human nature and its related concepts, thereby will gain insight into human behaviour and human relationships.

### COURSE OUTCOMES

After successful completion of this course the students will be able to:

- Have a **GRASP** over basic concepts and theoretical perspectives explaining human behaviour.
- **APPRECIATE** the complexity of human behaviour and relationships.
- **UNDERSTAND** psychology as science and empirical methods used for understanding different aspects of human behaviour.

## **COURSE CONTENTS**

### **Introduction to Psychology**

- a. Nature and Application of Psychology with special reference to Pakistan.
- b. Historical Background and Schools of Psychology (A Brief Survey)

### **Methods of Psychology**

- a. Observation
- b. Case History Method Experimental Method
- c. Survey Method
- d. Interviewing Techniques

### **Biological Basis of Behaviour**

- a. Neuron: Structure and Functions
- b. Central Nervous System and Peripheral Nervous System
- c. Endocrine Glands

### **Sensation, Perception and Attention**

- a. Sensation
  - (I) Characteristics and Major Functions of Different Sensations
  - (II) Vision: Structure and functions of the Eye.
  - (III) Audition: Structure and functions of the Ear.
- b. Perception
  - (I) Nature of Perception
  - (II) Factors of Perception: Subjective, Objective and Social
  - (III) Kinds of Perception:
  - (IV) Spatial Perception (Perception of Depth and Distance)
  - (V) Temporal Perception; Auditory Perception.
- c. Attention
  - (I) Factors, Subjective and Objective
  - (II) Span of Attention
  - (III) Fluctuation of Attention
  - (IV) Distraction of Attention (Causes and Control)

### **Motives**

- c. Definition and Nature
- d. Classification

**Primary** (Biogenic) Motives: Hunger, Thirst, Defecation and Urination, Fatigue, Sleep, Pain, Temperature, Regulation, Maternal Behaviour, Sex

**Secondary** (Sociogenic) Motives: Play and Manipulation, Exploration and Curiosity, Affiliation, Achievement and Power, Competition, Cooperation, Social Approval and Self Actualization.



## **Emotions**

- a. Definition and Nature
- b. Physiological changes during Emotions (Neural, Cardial, Visceral, Glandular), Galvanic Skin Response; Pupillometrics
- c. Theories of Emotion
- d. James Lange Theory; Cannon-Bard Theory
- e. Schachter –Singer Theory

## **Learning**

- a. Definition of Learning
- b. Types of Learning: Classical and Operant Conditioning Methods of Learning: Trial and Error; Learning by Insight; Observational Learning

## **Memory**

- a. Definition and Nature
- b. Memory Processes: Retention, Recall and Recognition
- c. Forgetting: Nature and Causes

## **Thinking**

- a. Definition and Nature
- b. Tools of Thinking: Imagery; Language; Concepts
- c. Kinds of Thinking
- d. Problem Solving; Decision Making; Reasoning

## **Individual differences**

- a. Definition concepts of;
- b. Intelligence, personality, aptitude, achievement

## **RECOMMENDED BOOKS**

1. Atkinson R. C., & Smith E. E. (2000). Introduction to psychology (13thed.). Harcourt Brace College Publishers.
2. Fernald, L.D., & Fernald, P.S. (2005). Introduction to psychology. USA: WMC Brown Publishers.
3. Glassman, W. E. (2000). Approaches to psychology. Open University Press. Hayes, N. (2000). Foundation of psychology (3rded.). Thomson Learning. Lahey, B. B. (2004). Psychology: An introduction (8th Ed.). McGraw-Hill Companies, Inc.
4. Leahey, T. H. (1992). A history of psychology: Main currents in psychological thought. New Jersey: Prentice-Hall International, Inc.
5. Myers, D. G. (1992). Psychology. (3rd Ed.). New York: Wadsworth Publishers.
6. Ormord, J. E. (1995). Educational psychology: Developing learners. Prentice- Hall, Inc.

	<b>General-III Chemistry-I (Inorganic Chemistry)</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

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

### **COURSE OUTCOMES**

It will enable the students to

- **ACQUAINTED** with the latest knowledge of the inorganic chemistry.
- **UNDERSTAND** the properties of elements, their interaction in inorganic molecules/compounds.
- **IMPLEMENTS** these learning in chemical industry.

### **COURSE CONTENTS**

#### **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, electronegativities and redox potential.

#### **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 centre bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding.

#### **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.

#### **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.

### **PRACTICALS**

- Laboratory Ethics and safety measures Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations
- Qualitative analysis of four ions (two anions and two cations) from mixture of salts
- Quantitative analysis Laboratory work illustrating topics covered in the lecture

## RECOMMENDED BOOKS

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

<b>Zool-151</b>	<b>Foundation-II</b> <b>Animal Diversity: Invertebrate Zoology</b>	<b>4(3-1)</b>
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### COURSE OBJECTIVES

The course is designed to provide students with:

- Taxonomic characteristics and classification of each phylum
- Concepts of evolutionary relationship of animal kingdom
- Knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life

### COURSE OUTCOMES

This course will enable the students to:

- **UNDERSTAND** cell cycle and the different types of cell division.
- **UNDERSTAND** the fundamentals of genetics and evolution
- **LEARN** about animal behaviour

### COURSE CONTENTS

**Introduction:** Architectural pattern of an animal, taxonomy and phylogeny, major subdivisions of animal kingdom with evolutionary perspective.

**Animal-Like Protists:** The Protozoa; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations.

**Multicellular and Tissue Levels of Organization:** origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum Cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum Ctenophora; further phylogenetic considerations.

**Triploblastics and Acoelomate Body Plan:** Phylum Platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; Phylum Nemertea; Phylum Gastrotricha; further phylogenetic considerations.

**Pseudocoelomate Body Plan:** Aschelminths: general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of Phylum Rotifera and Phylum Nematoda; Phylum Kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations.

**Molluscan Success:** relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations.

**Annelida:** The Metameric Body Form: relationship to other animals, metamerism and tagmatization; External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development in different classes; further phylogenetic considerations.

**Arthropods:** Blueprint for Success: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations; phylogeny and adaptive diversification.

**Echinoderms:** relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development; further phylogenetic considerations.

**Lesser Invertebrates:** The lophophorates, entoprocts, cycliophores, and chaetognaths.

## PRACTICALS

- Museum study of representative Phyla, Permanent slide preparations
- Study of *Euglena*, *Amoeba*, *Entamoeba*, *Plasmodium*, *Trypanosoma*, *Paramecium* as representative of animal like protists. (Prepared slides).
- Study of sponges and their various body forms.
- Study of principal representative classes of Phylum Cnidaria, Phylum Platyhelminthes, Phylum Rotifera, Phylum Nematoda, Phylum Mollusca, Phylum Annelida, Phylum Arthropoda.
- Brief notes on medical/economic importance of the following:
- *Plasmodium*, *Entamoeba histolitica*, *Leishmania*, Liver fluke, Tapeworm, Earthworm,
- Silkworm, Citrus butterfly.

## RECOMMENDED BOOKS

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

### SEMESTER-3

Course No.	Title	Credit Hours
	<b>Compulsory-VI English-III (Technical Writing and Presentation skill)</b>	<b>3(3-0)</b>
	<b>Compulsory-VII Introduction to computer</b>	<b>3(2-1)</b>
	<b>General-V Botany-II (Plants systematics, Anatomy and Development)</b>	<b>3(2-1)</b>
	<b>General-IV Chemistry-II (Organic Chemistry)</b>	<b>3(2-1)</b>
<b>Zool-201</b>	<b>Foundation-III Animal Form &amp; Function-I</b>	<b>3(2-1)</b>
		<b>15</b>

	<b>Compulsory-VI English-III (Technical Writing and presentation skill)</b>	<b>3(3-0)</b>
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#### COURSE OBJECTIVES

- Enhance language skills of students
- Develop critical thinking among students

#### COURSE OUTCOMES

After completion of this course students will be able to

- **WRITE** a thesis-driven essay using the conventions of standard English (as stylistically appropriate) by following a process-oriented model of writing which may include invention, work-shopping, annotated bibliography, drafts, editing, peer responses, and/or revisions;

#### 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*

#### RECOMMENDED BOOKS

1. Kirszner. L.G., Mandell, S. R. Patterns of College Writing. 4th Ed. By St. Martin's Press.
2. Langan, J. 2004. College Writing Skills McGraw-Hill Higher Education.
3. Neulib, J., Cain, K. S., Ruffus, S., Scharon, M. (Editors). Reading. The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. (A reader that will give students exposure to the best of twentieth century literature).

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

	<b>Compulsory-VII Introduction to computer</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

- To get familiarize with computer, its programs and utilities

### **COURSE OUTCOMES**

After completion of this course the students will be able to:

- **UNDERSTAND** the meaning and basic components of a *computer* system.
- **LEARN** about the components of a computer, the power of computers, computer software, and networks and the Internet.

### **COURSE CONTENTS**

History of computer systems, Generation of computers  
Introduction to Computer, Computer Environment and Desktop  
Partitions, File and Folder  
Taskbar, Task Manager and Computer Devices Manager  
Enabling and Disabling Devices

What is a System? What is a number system? How many number systems we do have?  
Inter Conversion of Number Systems

Role of Number System in Daily Life Computing, Role of Number System in  
Computer

What is Algorithm? How do we design Algorithm? How do we implement  
Algorithm?

What is software? Difference between software and Program. What is software  
Engineering? Application Software

What is Programming? What are Programming Paradigms or Types of Programming?  
What are the available Programming Languages? Basic Programming Using C++

What is Graphical Programming? Types and Categories of Software. Operating  
Systems Software

Computer Network and Internet, Internet Vs Intranet and Extranet, Client, Server,  
Standalone Computers, Network Topologies

## PRACTICALS

- Assembling Different Parts of Computer
- Installing Microsoft Windows/operating system, software
- How to use MS Office (MS word, PowerPoint, Excel)
- Internet browsing through different search engines.
- Developing a number system
- Practicing Algorithm for Some Common Problems
- Developing a Program that can say hello 2 you.
- Developing a Network Between 2 Computers

	<b>General-IV</b> <b>Botany-II (Plants systematics, anatomy and development)</b>	<b>3(2-1)</b>
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## COURSE OBJECTIVES

To understand various systems of classification, identification and nomenclature of higher plants, Structures and functions of tissues and organs at embryonic level.

## COURSE OUTCOMES

It will enable the students to

- **ACQUAINTED** with the latest knowledge of the plant sciences.
- **UNDERSTAND** the anatomy and developments of plants and its importance in plants sciences, plant pathology and different ecological processes.

## COURSE CONTENTS

### Plant systematics

Introduction to Plant Systematics: aims, objectives and importance.

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

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

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

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

Ranunculaceae, Brassicaceae (Cruciferae), Fabaceae (Leguminosae), Rosaceae, Euphorbiaceae, Cucurbitaceae, Solanaceae, Lamiaceae (Labiatae), Apiaceae (Umbelliferae), Asteraceae (Compositae), Liliaceae (Sen. Lato), Poaceae (Gramineae)

### Anatomy

Cell wall: structure and chemical composition, Concept, structure and function of various tissues like: Parenchyma, Collenchyma, Sclerenchyma, Epidermis (including stomata and trichomes), Xylem, Phloem, Meristem: types, stem and root apices, Vascular cambium

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



dicot stem, periderm

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

### **Development / Embryology**

Early development of plant body:

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

## **PRACTICALS**

### **Anatomy**

- Study of stomata, epidermis,
- Tissues of primary body of plant
- Study of xylem 3-dimensional plane of wood.
- T.S of angiosperm stem and leaf.

### **Taxonomy**

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

## **RECOMMENDED BOOKS**

1. Eames A.J. and L.H Mac Daniels. 2002. An Introduction to Plant Anatomy. Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.
2. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
3. Gurcharan Singh. 2010. Plant systematics: an integrated approach. 3<sup>rd</sup> edition, Science Publishers new Delhi, India
4. Lawrence, G.H.M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
5. Mauseth, J.D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
6. Moore, R.C., W.D. Clarke and Vodopich, D.S. 1998. Botany. McGraw Hill Company, U.S.A.
7. Naik, V.N. 2005 Taxonomy of Angiosperms. 20<sup>th</sup> Reprint. Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.
8. Panday, B.P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
9. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3<sup>rd</sup> Edition Regency Publications, New Delhi.
10. Raven, P.H., Evert, R.E. and Eichhorn, S.E. 1999. Biology of Plants. W.H. Freeman and Company Worth Publishers.
11. 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.
12. Stuessy, T.F. 1990. Plant Taxonomy. Columbia University Press, USA.
13. Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellog, Peter F. Stevens, Michael J. Donoghue. 2015. Plant Systematics: A Phylogenetic Approach. Sinauer Associates. 4<sup>th</sup> Edition. Sinauer Associates.

	<b>General-V</b> <b>Chemistry-II (Organic Chemistry)</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

- To acquire basic concepts of electronic structure and be able to apply them to solve problems from various areas of organic chemistry, including stereochemistry, reactivity patterns and synthesis.

### **COURSE OUTCOMES**

Students will gain an understanding of:

- The hybridization and geometry of atoms and the three-dimensional structure of organic molecules
- The reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry
- An understanding of nucleophiles, electrophiles, electronegativity, and resonance
- The prediction of mechanisms for organic reactions
- How to use their understanding of organic mechanisms to predict the outcome of reactions

### **COURSE CONTENTS**

#### **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.

## PRACTICALS

Qualitative analysis of compounds with different functional groups  
synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

## RECOMMENDED BOOKS

2. Ahluwalia, V. K. and Goyal, M., "A Text Book of Organic Chemistry", Narosa Publishing House, New Delhi
3. Bailey Jr., P. S. and Bailey, C. A., "Organic Chemistry-A Brief Survey of Concepts and Applications", Prentice-Hall, New Jersey.
4. Bansal, R. K., "Organic Reaction Mechanisms", Tata McGraw-Hill Publishing Company Ltd., New Delhi.
5. Carey, F. A., "Organic Chemistry", McGraw-Hill, New York.
1. Clayden, J., Greeves, N., Warren, S. and Wothers, P., 2001. Organic Chemistry. Illustrated edition, Oxford University Press, New York.
6. Finar, I. L., "Organic Chemistry", Vol. 1, Pearson Education, Delhi.
7. Loudon, G. M., "Organic Chemistry". 2015. 6<sup>th</sup> edition. Oxford University Press, New York
8. March, J., "Advanced Organic Chemistry", John Wiley & Sons, New York.
9. Pine, S. H., "Organic Chemistry", National Book Foundation, Islamabad.
10. Sorrell, T. N., "Organic Chemistry. 2005. 2<sup>nd</sup> edition. Viva Books Private Ltd., New Delhi.

<b>Zool-201</b>	<b>Foundation-III Animal Form &amp; Function-I</b>	<b>3(2-1)</b>
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## COURSE OBJECTIVES

The course aims to teach the students about:

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

## COURSE OUTCOMES

Upon successful completion of this course, students should be able to:

- **LEARN** animal classification and phylogenies.
- **ASSESS** the strength and weaknesses of current classification systems as they apply to invertebrate animals.

- **LEARN** about the anatomy and physiology of different invertebrate groups
- **UNDERSTAND** the structure/function relationships and reproductive strategies among different invertebrate phyla.

## COURSE CONTENTS

**Protection, Support, and Movement:** Protection: the integumentary system of invertebrates and vertebrates; movement and support: the skeletal system of invertebrates and vertebrates; movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates

**Communication I: Nerves: Neurons:** structure and function; neuron-neuron communication: introductory accounts of resting membrane potential, action potential (nerve impulse) and transmission of the action potential between cells; invertebrate and vertebrate nervous systems: the ventral nerve cord and ganglia, the vertebrate brain, the spinal cord, cranial and spinal nerves; autonomic nervous system.

**Communication II: Senses:** Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygrometers, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates; lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

**Communication III: The Endocrine System and Chemical Messengers:**

Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action; some hormones of porifera, cnidarians, platyhelminthes, nemertans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals.

**Circulation, Immunity, and Gas Exchange:** Internal transport and circulatory systems in invertebrates: characteristics of invertebrate coelomic fluid, hemolymph, and blood cells; transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and

Mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response; gas exchange: respiratory surfaces; invertebrate and vertebrate respiratory systems: cutaneous exchange, gills, lungs, and lung ventilation; human respiratory system: gas transport.

## PRACTICALS

- Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
- Study and notes of skeleton of *Labeo*, *Rana tigrina*, *Varanus*, fowl and rabbit.  
*Note: Exercises of notes on the adaptations of skeletons to their function must be done.*
- Earthworm or leech; cockroach, freshwater mussel, *Channa* or *Catla* or *Labeo* or any other local fish, frog, pigeon and rat or mouse and rabbits are representative animals for study in dissections.
- Study of models or preserved brains of representative animals and notes on adaptations.
- Study of nervous system of earthworm and a fish.

- Study of endocrine system in an insect and a rabbit.
- Study of different types of blood cells in blood smear of rabbit.
- Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
- Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

### **RECOMMENDED BOOKS**

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

**SEMESTER-4**

Course No.	Title	Credit Hours
	<b>Compulsory-VIII English-IV/Uni. Optional</b>	<b>3(3-0)</b>
	<b>General-VI Botany-III (Cell Biology, Genetics and Evolution)</b>	<b>3(2-1)</b>
	<b>General-VII Chemistry-III (Physical Chemistry)</b>	<b>3(2-1)</b>
<b>Zool-251</b>	<b>Foundation-IV Chordate Biology</b>	<b>4(3-1)</b>
<b>Zool-252</b>	<b>Foundation-V Animal Form &amp; Function-II</b>	<b>3(2-1)</b>
		<b>16</b>

	<b>Compulsory-VIII English-IV/Uni. Optional</b>	<b>3(3-0)</b>
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**COURSE OBJECTIVES AND OUTCOMES**

Study Skills is a collection of study techniques that will make students' learning more effective. The subject, thus, will have its impact on the whole degree program of the students.

**COURSE CONTENTS****A. Study Habits, Study Place, Study Time (Time Management)****B. Concentration****C. Motivation****D. Note- Taking & Note Making Techniques**

-----Techniques: Symbols, abbreviations, mind maps etc.

-----Reading Notes

-----Lecture Notes

**E. Using Library**

---The Card Catalogue

--- using the card catalogue efficiently

--- The Call Slip

--- Reference Works

----Encyclopaedias

---- Yearbooks

--- Dictionaries

--- Atlases

--- Bibliographies

--- Some Common Reference Works

--- Periodicals

--- The Readers Guide

**F. Using Dictionary**

- How to find a word
- Word Grammar
- Pronunciation
- Idioms
- Common Spelling Problems

**G. Reading Skills**

- Intensive Reading
- Extensive Reading
- Reading Surveys
- Sub Skills in Reading**

- Vocabulary
- Inference
- Coherence
- Cohesion
- Close exercises
- Skimming
- Scanning
- Predicting
- Organization

**H. Writing Skill**

- Writing paragraph: Topic Sentence, Support, Conclusion.
- Types of paragraph: Paragraph of Analysis, Paragraph of Description, Paragraph of Comparison and Contrast, Paragraph of analogy, Paragraph of Definition.
- Punctuation Marks
- Discourse Markers
- Essay: Definition & Types

**J. Writing an Outline**

**K. Learning the Vocabulary of English**

- Word Formation
- Changing Parts of Speech
- Present and Past Participles as Adjectives
- Word Stems
- Guessing Meanings from Context
- Recording the Meanings of Words
- Fixing the Meanings of Words

**L. Preparing for Examination**

- How to prepare for Examinations
- Physical Preparation
- Emotional Preparation

- Review Preparation
- How to take an Examination
- Types of Examinations
- Objective Examinations
- Subjective (or Essay-Type) Examinations

## RECOMMENDED BOOKS

1. Buzan, T. (1982) Use Your Head (Rev .Ed.)
2. Grellete, F. (1981) Developing Reading Skills, Cambridge.
3. Jordon. R.R Academic Writing Course, London: Collins.
4. Nuttal. (1981) Teaching Reading Skills in a FL. London.
5. Pineas, A (1982) Writing in English, New York: Macmillan.
6. Wallace, M.J. (1980) Study Skills in English. Cambridge: Cup
7. Yorkey, R.C. (1970) Study Skills for Students of English as a Second Language

	<b>General-VI Botany-III (Cell Biology, Genetics and Evolution)</b>	<b>3(2-1)</b>
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## COURSE OBJECTIVE

To understand

- Structure and functions of cell
- Nature of genetic material and hereditary process
- Familiarization with evolutionary processes.

## COURSE OUTCOMES

It will enable to the students to be

**ACQUAINTED** with the latest knowledge of the plant sciences.

**UNDERSTAND** the genetics of plants and different cellular process in plants at molecular level.

**USE** the techniques to understand the evolutionary process took places in plants.

## COURSE CONTENTS

### Cell biology

Structures and Functions of Bio-molecules Carbohydrates, Lipids, Proteins, Nucleic Acids

Cell: Physico-chemical nature of plasma membrane and cytoplasm.

Ultrastructure of plant cell with a brief description and functions of the following organelles, Cell wall, Endoplasmic reticulum, Plastids, Mitochondria, Ribosomes, Dictyosomes, Vacuole, Microbodies (Glyoxysomes and Peroxisomes)

Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis

Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle

Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.



## **Genetics**

Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.

Sex linked inheritance, sex linkage in *Drosophila* and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex linked characters, sex determination.

Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.

Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. *lac* operon).

Transmission of genetic material in Bacteria: Conjugation and gene recombination in *E.coli*, transduction and transformation.

Principles of genetic engineering/biotechnology; Basic genetic engineering techniques.

Application of genetics in plant improvement: Induction of genetic variability (gene mutation, recombination), physical and chemical mutagens, selection, hybridization and plant breeding techniques. Development and release of new varieties.

Introduction to germplasm conservation

## **Evolution**

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

## **PRACTICALS**

### **Cell Biology**

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

### **Genetics**

- Genetic problems related to transmission and distribution of genetic material.
- Identification of DNA in plant material. Carmine/orcein staining.
- Study of salivary gland chromosomes of *Drosophila*.

## RECOMMENDED BOOKS

1. Carroll, S.B., Grenier, J.K. and Welnerbee, S.d. 2001. From DNA to Diversity - Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
2. Cecie Starr and Ralph Taggart. 2015. Cell Biology and Genetics (Biology: The Unity and Diversity of Life), Volume 1. 14 Edition, Cengage Learning Publishers.
3. Dashek. 2017. Plant cells and their organelles. John Wiley & Sons Publishers, U.K
4. Dyonsager, V.R. (1986). Cytology and Genetics. Tata and McGraw Hill Publication Co. Ltd, New Delhi.
5. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
6. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
9. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
10. Strickberger, M. W. 2000. Evolution. Jones & Bartlet Publishers Canada
11. Strickberger, M.V. (1988), Genetics, MacMillan Press Ltd., London.

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

	<b>General-VII Chemistry-III (Physical Chemistry)</b>	<b>3(2-1)</b>
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### COURSE OBJECTIVES

To provide the key knowledge base and laboratory resources to prepare students for careers as professionals in the field of chemistry, for graduate study in chemistry, biological chemistry and related fields,

### COURSE OUTCOMES

Students will gain an understanding of:

- Concepts in thermodynamics, different thermodynamic quantities such as heat and work and how they are measured, related or transformed from one to the other
- States of matter and how they depend on temperature and pressure as well as how they co-exist in phase equilibria
- Chemical equilibrium and its relationship with thermodynamic quantities
- The transport of ions and thermodynamic functions with applications to electron transfer in biological systems
- Chemical kinetics; how reaction rates are measured and represented in rate laws, and applications of chemical kinetics in studying enzyme mechanisms
- Basic quantum chemistry and atomic structures of atoms
- Chemical bonding from the valence bond model and molecular orbital theory

## **COURSE CONTENTS**

### **Physical States of Matter**

Ideal and real gases, equations of state, critical phenomenon and critical constants. Molecules in motion: collision diameter and mean free path. Physical properties of liquids: surface tension, viscosity, refractive index etc. and their applications. Brief account of interactions among the molecules in liquids. Packing of atoms in solids. Unit cells and crystal systems. Method of crystal structure analysis. Brief account of polymers and composite materials with special emphasis on superconductors, semi-conductors etc. Introduction to plasma.

### **Chemical Thermodynamics**

Laws of thermodynamics and their applications. Thermodynamic functions: internal energy, enthalpy, entropy and free energy. Relation between thermodynamic functions. van't Hoff's equation. Heat capacities, concept of entropy and probability.

### **Chemical Kinetics**

Rate of reaction. Rate law, order and molecularity of the reactions. Zero, first and second order reactions. Determination of reaction order and its rate constant. Effect of temperature on the reaction rate. Concepts of chemical equilibrium. Le-Chatelier's principle and its applications. Elementary concepts underlying complex and fast reactions.

### **Solution Chemistry**

Ideal and non-ideal solutions. Raoult's and Henry's laws and their applications. Molecular interactions in solutions. Colligative properties. Distillation and concept of azeotropic mixture.

### **Surface Chemistry**

Concept of interfaces. Adsorption and adsorption isotherms: Freundlich and Langmuir adsorption isotherms. Catalysis, colloids emulsion and their industrial applications.

### **Electrochemistry**

Basic concepts of electrochemistry. Ions in solution. Measurement of conductance and Kohlrausch's law. Debye-Hueckel theory and activity coefficient. Application of conductance measurement. Electrode potential. Electrochemical cell. Application of electrode potential

## **PRACTICALS**

- Determination of viscosity and parachor values of liquids.
- Determination of percent composition of liquid solutions viscometrically.
- Determination of refractive index and molar refractivity.
- Determination of percent composition of liquid solutions by refractive index measurements.
- Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).
- Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
- Determination of heat of solution by solubility method.
- Determination of heat of neutralization of an acid with a base.
- Kinetic study of acid catalyzed hydrolysis of ethyl acetate.

- Determination of partition coefficient of a substance between two immiscible liquids.

### RECOMMENDED BOOKS

1. Alberty R. "Physical Chemistry" 17<sup>th</sup> ed., John Wiley and Sons (1987).
2. Atkins, P.W. "Physical Chemistry" 6<sup>th</sup> ed., W.H. Freeman and Co. New York (1998).
3. Barrow G.M. "Physical Chemistry" 5<sup>th</sup> ed., McGraw Hill (1992).
4. Brain S.E. "Basic Chemical Thermodynamics" 4<sup>th</sup> ed., E.L.B.S. Publishers (1990).
5. Laidler K.J. "The World of Physical Chemistry" 1<sup>st</sup> ed., Oxford University Press (1993).
6. Laidler K.J., John H.M. and Bryan C.S. "Physical Chemistry" 4<sup>th</sup> ed., Houghton Mifflin Publishing Company Inc.(2003).
7. Peter P.A. "Chemical Thermodynamics" Oxford University Press (1983).

<b>Zool-251</b>	<b>Foundation-IV Chordate Biology</b>	<b>4(3-1)</b>
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### COURSE OBJECTIVES

The course aims to:

- Provide understanding about taxonomic characteristics and classification of each phylum
- Develop concepts of evolutionary relationship of animal kingdom
- Provide knowledge and understanding about the different animal groups with special emphasis on their phylogenetic relationships

### COURSE OUTCOMES

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

- **COMPREHEND** the evolution of chordates and the basic phylogenetic relationships of the major groups of vertebrates.
- **UNDERSTAND** and analyse the adaptive changes that have occurred in aquatic vertebrates.
- **RECOGNISE**, describe, and point out the external and internal features that characterise the major groups of modern day vertebrates.
- **DEMONSTRATE** the results of additional reading around the subject.
- communicate knowledge and findings clearly both orally and in writing

### COURSE CONTENTS

**Protochordates:** Structure, anatomy and organ systems; reproduction; life histories and metamorphosis; phylogenetic relationships; further phylogenetic considerations.

**Fishes:** Vertebrate Success in Water: phylogenetic relationships; Agnatha and Gnathostomata: locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

**Amphibians:** The first terrestrial vertebrates: phylogenetic relationships; Caudata, Gymnophiona, and Anura; Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and

sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations.

**Reptiles:** The First Amniotes: cladistic interpretation of the amniotic lineage; Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodylia; adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

**Birds:** Feathers, flight and endothermy: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation.

**Mammals:** Specialized teeth, endothermy, hair and viviparity; diversity of mammals; adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behaviour, reproduction and development.

### **PRACTICALS**

Museum study of: Protochordates, Pisces, Amphibia, Reptilia, Aves, Mammalia, Field trips to study animal diversity in an ecosystem.

### **RECOMMENDED BOOKS**

1. Campbell, N.A. Biology, 9th Ed. 2011. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
2. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.
3. Hickman, C.P., Roberts, L.S., Larson, A. 2011. Integrated Principles of Zoology, 15th Ed. (International). Singapore: McGraw Hill.
4. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. Latest edition New York: McGraw Hill.
5. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.

<b>Zool-252</b>	<b>Foundation-V Animal Form &amp; Function-II</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

The course aims to teach the students about:

- The course provides understanding of the basis of structure and functions of animal nutrition, digestion, homeostasis and temperature regulation.
- Introduce the basic concepts in reproduction and development in animal kingdom.
- Impart knowledge about the development of chordate body plan and fate of germinal layers.

### **COURSE OUTCOMES**

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

- **UNDERSTAND** the physiological role of a range of structures and systems in animal nutrition, digestion and homeostasis.
- **DESCRIBE** basic concepts in reproduction and development and compare the fate of germinal layers across the animal kingdom.

## COURSE CONTENTS

**Nutrition and Digestion:** Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion; animal strategies for getting and using food, diversity in digestive structures of invertebrates and vertebrates; the mammalian digestive system: gastrointestinal motility and its control, oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.

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

**Reproduction and Development:** Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction; sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes; the human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function; the human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.

**Descriptive Embryology:** Fertilization; embryonic development: cleavage, and egg types; the primary germ layers and their derivatives; echinoderm embryology; vertebrate embryology: the chordate body plan, amphibian embryology, development in terrestrial environments, avian embryology and fate of mesoderm.

## PRACTICALS

- Study of excretory system in an invertebrate and a vertebrate representative (Model).
- Study of nutritive canal in an invertebrate and a vertebrate representative (Dissection).
- Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
- Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
- Study of hormonal influence of a reproductive function (Model).
- Study of preserved advanced stages of avian and mammalian development for amniotic membranes and placenta (Model).
- Study of stages in the development of an Echinoderm.

- Study of early stages in the development of a frog, chick and a mammal.

### **RECOMMENDED BOOKS**

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

## SEMESTER-5

Course No.	Title	Credit Hours
Zool-301	Major-I Physiology	4(3-1)
Zool-302	Major-II Developmental Biology	4(3-1)
Zool-303	Elective-I Environmental Biology	3(2-1)
Zool-304	Foundation -VI Cell and Molecular Biology	4(3-1)
Zool-305	Major-III Wildlife	2(2-0)
		17

Zool-301	Major-I Physiology	4(3-1)
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### COURSE OBJECTIVES

The course aims

- Provide information about the physiological mechanisms underlying animal functions.
- Enable students to understand neuro-endocrine coordination, physiology of heart, hemodynamic and kidney function.
- Impart information on respiratory function and gut physiology
- Give understanding about the mechanism of homeostasis, physiological regulation of temperature and its maintenance

### COURSE OUTCOMES

Students who successfully complete this course should will be able to

- **UNDERSTAND** diversity of physiological mechanisms present in a wide range of animal taxa.
- **PINPOINT** basic principles of the major physiological systems.
- **ARTICULATE** their knowledge of animal physiology to others.

### COURSE CONTENTS

**Central themes in Physiology:** Structure-function relationship, Adaptations, homeostasis.

**Physiological basis of Membrane Function:** Mechanisms in resting membrane potentials: Electro genic ion pump, Donnan equilibrium, Roles of ion channels, action potential in neurons; Synaptic transmission; Structure and function of electrical and chemical synapse; Neurotransmitters; Synaptic receptors; Post tetanic Potentiation.

**Receptors Physiology:** Transduction; Sensory coding; Sensory adaptations; Mechano reception: Hair cell mechanism, Cutaneous receptors; Taste, olfactory, Photo, electro, Mechano Reception



**Movements and Muscles:** Structural, Physiology, regulation of muscle contraction: molecular structures

**Cardiovascular Mechanisms:** Electrical activity of heart. Automaticity, Rhythmicity, Electrocardiography, Kymography; Hemodynamics

**Exchange of Gases:** Transport and Regulation of O<sub>2</sub> and CO<sub>2</sub> between respiratory surface (the lungs) and body cells

**Excretion and Osmoregulation:** Osmoregulation in aquatic and terrestrial environment. Vertebrate nephron, Glomerular filtration, Tubular absorption and secretion; Nitrogenous waste products

**Nutrition:** Regulation of digestive secretions; Physiological anatomy of digestive tract

**Temperature Relations:** Temperature classification of animals; ectotherms, heterotherms, endotherms; Dormancy: Sleep, Torpor, Hibernation, Estivation

## PRACTICALS

- Muscle and Neuromuscular Activity: Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of stimulus strength, effect of stimulus frequency (tetany), effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human
- Excitability, Sensation and Behaviour: Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology
- Cardiovascular Activity: Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure
- Respiration and Exercise: Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure, glycemia altered by exercise
- Endocrine and Reproductive Mechanisms: Effect of insulin on glycemia, study of stages in estrous cycle.

## RECOMMENDED BOOKS

1. Berne, R.M. and Levy, M.N. Principles of Physiology, 7<sup>th</sup> Edition. 2017. St. Louis, Mosby
2. Bullock, J., Boyle, J. and Wang, M.B. PHYSIOLOGY, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia
3. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia
4. David R, Warren B, Eckert Animal Physiology: Mechanisms and Adaptations 4ed. 2009. W.H. Freeman and Company
5. Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, 13<sup>th</sup> Edition. 2016. W.B. Saunders Company, Philadelphia
6. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5th Edition. 2002. W.H. Freeman and Company, New York
7. Schmidt-Nelsen, K. animal physiology, adaptation and environment, 5th Edition. 1997 Cambridge University Press, Cambridge.
8. Tharp, G. And Woodman, D. Experiments In Physiology, 8th Edition. 2002. Prentice Hall, London

9. Withers, P.C. Comparative Animal Physiology. 1992. Saunders College Publishing, Philadelphia

<b>Zool-302</b>	<b>Major-II Developmental Biology</b>	<b>4(3-1)</b>
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### **COURSE OBJECTIVES**

The course will provide detailed knowledge about the:

- Principal features of development, cellular basis of morphogenesis,
- Mechanisms of cellular differentiation and concepts of induction in development. It will provide understanding of the mechanisms of organogenesis, factors controlling growth and organogenesis.
- Concept related to the theory in developmental biology will be practically demonstrated in this course.

### **COURSE OUTCOMES**

Upon successful completion of this course, students should be able to:

- **UNDERSTAND** and master basic concepts of developmental biology.
- **UNDERSTAND** how fertilization and cleavage occur
- **UNDERSTAND** the process and consequence of gastrulation, mesoderm induction and neural induction.
- **UNDERSTAND** basic concepts of organogenesis, regeneration, aging, gene expression and regulation

### **COURSE CONTENTS**

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

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

**Cleavage:** Patterns of embryonic cleavage, mechanism of cleavage

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

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

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

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

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

### **PRACTICALS**

- Study of structure of gametes in some representative cases, i.e., frog, fish, fowl and mammal.
- Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc.

- Study of fertilization, early development of frog through induced spawning under laboratory conditions.
- Preparation and study of serial sections of frog or chick embryos.
- Application of microsurgical techniques on chick embryos in vitro.
- Preparation and staining of histological slides

### RECOMMENDED BOOKS

1. Balinsky, B. I. An introduction to embryology, 1985. Saunders
2. Brian K. Hall. Bones and Cartilage: Developmental Skeletal Biology.2008. Academic Press.
3. Gilbert, S. F. Developmental Biology, 2006.Sinauer Associates Sunderland, MA
4. Ham, R. G. and Veomett, M. J. Mechanism of development.1980. C. V. Mosby Co
5. Klaus, K. Biological Development. 2nd Edition, 2001.Mc Graw Hill
6. Oppenheimer, S.S. Introduction to embryonic development, 1984. Allen and Bacon
7. Saunders, J. W. Developmental Biology, 1982. McMillan and company
8. Schatten.H, onstantinescu.G. Comparative reproductive biology. 2007. Wiley-Blackwell
9. Wassarman. P.M. Advances in Developmental Biology, Volume 2a .2009. Elsevier Science.

<b>Zool-303</b>	<b>Elective-I Environmental Biology</b>	<b>3(2-1)</b>
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### COURSE OBJECTIVES

- Enable students to develop strong expertise in contemporaneous themes in ecological research
- Develop critical thinking and to discuss about advanced topics in population, community and ecosystem ecology as well as in biodiversity research.
- Develop expertise to update their knowledge continuously, and to design their own research in ecology.

### COURSE OUTCOMES

This course will enable the students to:

- **OBTAIN** an understanding of basic ecological principles with an emphasis on animal ecology and population biology.
- **UNDERSTAND** how critical abiotic and biotic factors influence living organisms and ecology at the physiological, population, and community scales.

### COURSE CONTENTS

**Energy:** laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. Biogeochemical cycle: nitrogen, phosphorus, sulphur, water, carbon, nutrient. Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire.

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

**Population ecology:** basic population characters, growth and growth curves, population dynamics and regulations. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions.

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

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

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

## **PRACTICALS**

- Measurement of environmental factors on land, water and air.
- Study of different ecosystems: pond, agricultural or grassland, forest.
- Community analysis through different sampling techniques (quadrat, Transect),
- Population studies mark and recapture method, statistical analysis of field data.
- Adaptive features of animals in relation to food and environment.
- Food chain studies through analysis of gut contents.
- Analysis of polluted and fresh water for biotic and abiotic variations.
- Field visits for study of selected terrestrial habitat and writing notes.
- Experimental design and approaches in ecological research; writing a research project
- Development of an ecological management plan of some selected area.

## **RECOMMENDED BOOKS**

1. Chapman, J.L., Reiss, M.J. 1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.
2. Cox, C.B., Morre, D. 2016. Biogeography: An Ecological and Evolutionary Approach, 9th 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. Molles, M.C. 2015. Ecology: Concepts and Applications. 7th Ed., McGraw Hill, New York, USA.
5. Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford. UK.
6. Odum, E. P. 1994. Fundamentals of Ecology. 3rd Ed. W.B. Saunders. Philadelphia.
7. Slingsby, D., Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK.

<b>Zool-304</b>	<b>Foundation -VI Cell and Molecular Biology</b>	<b>4(3-1)</b>
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### **COURSE OBJECTIVES**

To impart knowledge about:

- The cell and its organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.
- Various ultra-structural, molecular and functional aspects of the cells.

### **COURSE OUTCOMES**

Upon satisfactory completion of this course, the student will be able to:

- **EXPLAIN** how the structure and chemistry of nucleic acids relate to their functions, relative stability and interactions with proteins.
- **UNDERSTAND** the regulation of proteins and nucleic acids interaction
- **COMPARE & CONTRAST** mechanisms of DNA replication, transcription, translation, repair, recombination, gene regulation, RNA processing in prokaryotes and eukaryotes.
- **APPLY** molecular knowledge to identify human genetic disorders and to understand underlying molecular mechanism

### **COURSE CONTENTS**

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

**Cytoskeleton:** Microfilaments, Microtubules, Intermediate filaments.

**Cytoplasmic Organelles:** Membrane system, structural and functional commonalities. Ultrastructure, chemical composition and functions of Endoplasmic Reticulum and their role in protein synthesis and drug metabolism, Golgi apparatus its role in synthesis of glycoprotein, Mitochondrial respiration and its significance as semi-autonomous organelle; Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, Glyoxysome with reference to glyoxylic acid cycle.

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

**Replication:** mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with emphasis on DNA polymerases, concept of replicons etc.,

**Transcription:** variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved, RNA splicing, split genes, concept of ribozymes and posttranscriptional processing, RNA transduction, Genetic code, point mutations.

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

## PRACTICALS

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

## RECOMMENDED BOOKS

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

<b>Zool-305</b>	<b>Major-III Wildlife</b>	<b>2(2-0)</b>
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## COURSE OBJECTIVES

The students will learn:

- About wildlife, distribution pattern world over
- Regarding wildlife of Pakistan, threatened, endangered species
- Modern techniques used in animal tracking, data collection
- How to protect, maintain, control and preserve the health and environment of wildlife.

## COURSE OUTCOMES

Students after completing this course will be able to:

- **DEMONSTRATE** knowledge of the distribution pattern and main components of wildlife management.
- **DEMONSTRATE** the status of wildlife in Pakistan.
- **DESCRIBE** the main management tools and techniques used by wildlife managers to assist in their work.

## **COURSE CONTENTS**

Wildlife: Animal occurrence, protection, needs of animals, maintenance, and the habitat.

Techniques: Ground and aerial tracking, GPS, radiotelemetry, maps etc.

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

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

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

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

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

## **RECOMMENDED BOOKS**

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

## SEMESTER-6

Course No.	Title	Credit Hours
Zool-351	Foundation-VII Evolution and Principle of Systematics Zoology	4(3-1)
Zool-352	Major-IV Genetics	4(3-1)
Zool-353	Foundation-VIII General Biochemistry	4(3-1)
Zool-354	Compulsory-IX Biostatistics	3(2-1)
Zool-355	Elective-II Fundamentals of Endocrinology	3(2-1)
		18

Zool-351	Foundation-VII Evolution and Principle of Systematics Zoology	4(3-1)
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### COURSE OBJECTIVES

The course aims to:

- Provide in-depth knowledge of origin of life
- Develop concepts about forces responsible for evolutionary changes
- Study the importance and history of systematics with basic rules and regulations about the identification and naming of organisms

### COURSE OUTCOMES

On the end of this course, the students should be able to:

- **EXAMINE, SUMMARISE** and **INTEGRATE** central ideas underpinning evolutionary patterns and processes from the molecular to the macro scale.
- **DETERMINE** the principles on which the existing taxonomic system of naming is based.

### COURSE CONTENTS

**Evolution:** Evidence of evolution. Theories to explain the diversity of life. Lamarckism, Darwinism and special Creation.

Modern synthetic theory.

Factors initiating elementary evolutionary changes (micro – evolution) by changing gene frequencies, mutation pressure, selection pressure, immigration and crossbreeding, genetics drift. Role of isolation.

Factor of large evolutionary changes (macro – evolution) allopatry orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of selection, Selection patterns, laboratory and field example regarding action of Natural Selection. Action of Natural



Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry. Sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory. Trend and rates in evolution

**Systematic Zoology:** Contribution of systematics to Biology, History of Taxonomy (Downward classification, upward classification, impact of the origin of species, population systematics, current trends); Microtaxonomy, phenon, Taxon; Taxonomic categories: specific category, intraspecific category, higher categories; species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept), species mate recognition concept; nondimensional species concept; Multidimensional species concept; Cohesion species concept; Difficulties in the application of biological species concepts; polytypic species, subspecies, super species, sibling species; study of major type of variation within a single population. Speciation and taxonomic decision, various types of characters, cladistic analysis, Macrotaxonomy; different kinds of taxonomic characters; Taxonomic collection and identification; definitions of Synonym, Homonym, Keys; Evolution of the theory of Nomenclature; interpretation and application of the code (stability, priority, first revisor principle) range of authority of code; concept of availability, type method formation of specific names.

## **PRACTICALS**

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

## **RECOMMENDED BOOKS**

1. Dobzhansky, T. Genetics and the Origin of Species, 1951. Columbia
2. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. Evolution. 1973. W.H. Freeman and Company
3. Ernst Mayr and Peter D. Ashlock. 1991. Principles of Systematic Zoology. McGraw-Hill,
4. Mayer, E. and Asblock, P.D. Principles of Systematiczoology. 1991
5. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York
6. Mayr, E. Animal Species and Evolution, 1985. Harvard University Press.
7. Mayr, E. Populations, Species and Evolution, 1965. Harvard
8. McGraw Hill, New York
9. Moody, P.A. Introduction to Evolution, 1989. Harper and Row Publishers, New York
10. Nicholas H. Barton, Jonathan A. Eisen, Derek E.G. Briggs, Davis; David B. Goldstein and Nipam H. Pate. 2007. Origin and Evolution of Life. Cold Spring Harbor Laboratory Press, New York, US.
11. Ridley, M. Evolution. 1993. Blackwell Scientific Publications
12. Strickberger. M.W. Evolution. 2000. Jones & Barrett Publishers
13. University Press
14. University Press, New York

15. Heywood, V.H. Taxonomy and Ecology. 1975. Academic Press, London
16. Whili, M.J.D. Modes of Speciation, 1978. W.H. Freeman and Co., San Francisco
17. Winston. J. Describing Species. 1999. Columbia University Press
18. Fastovsky.D.E, Weishampel.D.B. The Evolution and Extinction of the Dinosaurs. 2005. Cambridge University Press

<b>Zool-352</b>	<b>Major-IV Genetics</b>	<b>4(3-1)</b>
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### **COURSE OBJECTIVES**

The course aims 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.
- 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.

### **COURSE OUTCOMES**

On satisfying the requirements of this course, students will have the knowledge and skills to:

- **DESCRIBE** the flow of genetic information from DNA to RNA to protein.
- **DESCRIBE** and apply the principles of Mendelian genetics.
- **EXPLAIN** the key concepts in population, evolutionary and quantitative genetics including: the basis of genetic variation; heritability; Hardy-Weinberg Equilibrium; roles of migration, mutation.
- **UNDERSTAND** the range of molecular laboratory techniques used routinely in human forensic analysis and population genetic analysis including sex typing, DNA profiling, Single Nucleotide Polymorphism (SNP) detection and DNA sequencing.

### **COURSE CONTENTS**

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

Multiple Alleles: blood groups and coat colour in rabbits.

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

**Pedigree Analysis:** Normal human chromosome complement; Karyotyping. Sex-determination and Sex-linkage: Sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes.

**Molecular Genetics:** Elements of genetic engineering; genetic basis of diseases, like cancer, genetic control of animal development.

**Human Genetics;** Single and Multifactorial Disorders: Autosomal anomalies, Pseudo autosomal genes, (e.g. Down syndrome, Edwards syndrome and), Single gene disorders Gene mutation and disorders; autosomal single gene disorders (Sickle cell

anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria). Definition - characteristics crisscross inheritance. Polygenic traits - Cleft lip and cleft palate,

Sex-linked Chromosomal anomalies: Klinefelters syndrome, and Turners syndrome.

Sex-influenced inheritance: Haemophilia, muscular dystrophy, colour blindness.

Prenatal Diagnosis: Amniocentesis and choriovillus sampling – Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics.

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

### PRACTICALS

- Mitosis (Onion root tips.)
- Meiosis (Grass hopper testes)
- Blood groups.
- Salivary gland Chromosomes of *Drosophila melanogaster*
- General morphology of *Drosophila melanogaster*
- Human Pedigree analysis problems
- Human Genetics problems
- Probability problems. Tossing of coins. X2 test
- Study of transformed bacteria on the basis of antibiotic resistance.

### RECOMMENDED BOOKS

1. Gardener, E.J., Simmons, M.J., Snustad, D.P. 2006. Principles of Genetics. 8<sup>th</sup> Edition. John Wiley and Sons Ins. New York, USA.
2. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. 2017. GENE-XII. Oxford University Press. UK.
3. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics. 7<sup>th</sup> Ed., John Wiley and Sons Ins. New York, USA.
4. Strickberger, M.W. 2014. Genetics. McMillan, New York. USA.
5. Tamarin, R.H. 2004. Principles of Genetics. 7th Ed revised. WCB Publishers USA.

<b>Zool-353</b>	<b>Foundation-VIII General Biochemistry</b>	<b>4(3-1)</b>
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### COURSE OBJECTIVES

The course aims to:

- Provide in-depth knowledge about the polymerized organic compounds of life.
- Develop an understanding about the dynamism life as it proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work.
- Understand that inter-conversion is performed by various tools called as enzymes.
- Enable students to know how organisms harvest of energy for growth, duplication etc.

### COURSE OUTCOMES

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

- **UNDERSTAND** the basic cellular structure

- **UNDERSTAND** the special properties of water and how the aqueous environment influences the behaviour of biological macromolecules.
- **UNDERSTAND** amino acids, their chemical properties and their organization into polypeptides and proteins.
- **IDENTIFY** the levels of structure in proteins and describe the stabilization of these structures.
- **DESCRIBE** the structure and mechanism of representative enzymes in biochemical pathways.
- **DESCRIBE** the primary catabolic and anabolic pathways pertaining to the following molecular classes: Carbohydrates, Fats and lipids, Amino Acids, Steroids.

## COURSE CONTENTS

**Amino acids, peptides and proteins:** standard amino acids, their structure and classification; non-standard amino acids, their structure and role; peptides, polypeptides, protein properties & structures

Nitrogen metabolism: metabolic fate of amino acids; catabolism of amino acids; deamination and transamination; nitrogen excretion and urea cycle

**Enzymes:** introduction; important characteristics of enzymes; how enzymes work; classification of enzymes, enzyme rate of reaction and substrate concentration, how pH and temperature effect enzyme activity.

**Carbohydrates:** classification, types, important characteristics and structure of carbohydrates

Description of glycolysis and catabolism of other hexoses; fate of pyruvate under aerobic and anaerobic conditions; utilization of other carbohydrates in glycolysis; phosphorolysis of glycogen and starch.

**Lipids:** fatty acids, their types and major characteristics. Oxidation of fatty acids; digestion, biosynthesis of triacylglycerol; beta-oxidation; Ketone bodies their biosynthesis, cholesterol metabolism

**Vitamins and cofactors:** occurrence, types and properties.

**Bioenergetics:** concept of free energy; standard free energy change: energy rich compounds.

## PRACTICALS

- Preparation of standard curve for glucose by *ortho*-Toluidine method.
- Tests for detection of carbohydrates in alkaline and acidic medium.
- Tests for detection of Disaccharides.
- Detection of Non-Reducing sugars in the presence of Reducing sugars.
- Demonstration of Acid Hydrolysis of Polysaccharide.
- Separation and identification of various types of sugars, fatty acid and amino acid Thin Layer Chromatography (TLC).
- Determination of pKa values of an amino acid by preparation of titration curves.
- Biochemical tests for detection of different amino acids.
- Separation of various protein fractions by precipitation method.
- Demonstration of differential solubility of lipids in various solvents.
- Quantitative analysis of phospholipids by estimation of inorganic phosphorous.
- Quantitative analysis of Amylase activity from blood serum or liver.

- Study on the effect of temperature on the enzymatic rate of Reaction

## RECOMMENDED BOOKS

1. Nelson, D. L. and Cox, M.M. Lehninger principles of biochemistry, International Edition, 2017. McMillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 30<sup>th</sup> Edition, 2015. McGraw Hill, New York.
3. Voet. D., Voet, J.G., and Pratt, C.W. Fundamentals of Biochemistry, 5<sup>th</sup> edition, 2016. John Wiley and Sons, Inc., New York.
4. Zubay, G. BIOCHEMISTRY, 4<sup>th</sup> Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
5. Lubert, S. Biochemistry, 4<sup>th</sup> Edition, 1999. W.H. Freeman & Company, New York.
6. McKee, T. and McKee, J.R. Biochemistry, the Molecular Basis of life. International 16<sup>th</sup> Edition, 2016. McGraw Hill.

<b>Zool-354</b>	<b>Compulsory-IX Biostatistics</b>	<b>3(2-1)</b>
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## COURSE OBJECTIVES

- The course will provide knowledge about the importance and use of statistics in life sciences. It will help the students to understand the methods to analyse data pertaining to their research work and to assess the significance of their experimental designs.
- After this course students will be able to apply basic statistical procedures for analysis of data for practical and research.

## COURSE OUTCOMES

Students who successfully complete this course will be able to:

- **DESCRIBE** the roles biostatistics serves in Zoology and biomedical research.
- **EXPLAIN** general principles of study design and its implications for valid inference.
- **ASSESS** data sources and data quality for selecting appropriate data for specific research questions.
- **TRANSLATE** research objectives into clear, testable statistical hypotheses.
- **DESCRIBE** basic principles and the practical importance of key concepts.
- **APPLY** numerical, tabular, and graphical descriptive techniques commonly used to characterize and summarize data.
- **IDENTIFY** appropriate statistical methods to be applied in each research setting.
- **DIFFERENTIATE** between quantitative problems that can be addressed with standard, commonly used statistical methods and those requiring input from a professional biostatistician.

## COURSE CONTENTS

**Introduction:** branches of statistics, scope and importance of the subject

**Data:** Population and sample, variable, categorical and non-categorical data, scales of measurements, errors of measurements

**Presentation of data:** descriptive statistics, tabulation of data, parts of table, construction of table

**Frequency distribution:** Empirical FD, relative FD, Cumulative FD, class frequency, class limits, class boundaries, class mark, class interval

**Graphical presentation:** diagrams and graphs, pictogram, histogram, line chart, histogram, applications and uses of histogram, construction of histogram, comparison of data using histogram, bar chart, multiple bar chart, pie chart, Gantt chart, timeline, info graph, pedigree chart

**Measures of Central Tendency:** types of averages, arithmetic mean for grouped and ungrouped data, harmonic mean for grouped and ungrouped data, geometric mean for grouped and ungrouped data, median, quartiles, deciles, percentiles, mode, advantages and disadvantages of arithmetic mean, harmonic mean, geometric mean, median and mode

**Measures of Dispersion:** range, grouped and ungrouped data, coefficient of range, mean deviation of grouped and ungrouped data, coefficient of mean deviation, standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data

**Probability:** 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

**Tests of Significance:** t-test, types, ANOVA, uses

## **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, info gram
- 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
- T-test
- ANOVA

## **RECOMMENDED BOOKS**

1. Belle V. B, Fisher, L.D., Heagerty, P.J., Lumley, T. (2004) Biostatistics – A methodology for the health sciences. 2nd Edition. Wiley-Interscience
2. Campbell, M.J., Swinscow, T.D.V. (2009) Statistics at Square One. 11th Edition. BMJ Books.

3. Field A. (2013) Discovering Statistics with IBM SPSS Statistics. 4th Edition. SAGE Publication Ltd.
4. Quinn, G. (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press

<b>Zool-355</b>	<b>Elective-II</b> <b>Fundamental of Endocrinology</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

- General concepts and principles of chemical coordination.
- The details of the endocrine mechanisms in relation to various functions such as reproduction and lactation.
- Recent trends of endocrinology in relation to diversified function.
- Comparative studies of endocrine mechanisms in various invertebrates and vertebrates.

### **COURSE OUTCOMES**

After studying this course, the students should be able to:

- **DISCUSS** the definition of a hormone in terms of its general properties.
- **DESCRIBE** the different classes and chemical structures of hormones.
- **IDENTIFY** the glands, organs, tissues and cells that synthesize and secrete hormones, hormones receptor, hormones precursors and associated compounds.
- **EXPLAIN** the roles of the endocrine system in maintaining homeostasis, integrating growth and development.
- **EXPLAIN** the biosynthesis of hormones and the regulation, activation and inhibition of different enzymatic pathways

### **COURSE CONTENTS**

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feedback, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system.

Hypothalamus and pituitary: Hypothalamic hormones: Origin, chemistry and actions; Anterior pituitary & hormones: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.

Thyroid gland: Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.

Calcitropic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides.

Adrenal Medulla and Catecholamines: Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors. Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.

Testes: Androgenic tissue: Structure and chemistry; Transport, metabolism and mechanism of action.

Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action.

Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition. Endocrinology of Lactation: Hormones in lactation. Endocrinology of Heart, Kidney, Immune system: Growth and pineal gland. Functional Diversity of Hormones in Vertebrates. Overview of Endocrine Mechanisms in Invertebrates.

## **PRACTICALS**

- Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc.
- Histological and ultra-structure features of endocrine glands;
- Experiments to demonstrate physiological roles of hormones of different endocrine glands
- Experiments to demonstrate regulation of hormones' releases. Experiments to demonstrate functional diversity of hormones in different vertebrates.
- Experiments on endocrine mechanism in vertebrates.

## **RECOMMENDED BOOKS**

1. David G. Gardner, Dolores Shoback. 2017. Greenspan's Basic and Clinical Endocrinology, 10th Edition. McGraw-Hill Education.
2. DeGroot, L.J., Jameson, J.L. Endocrinology, 4th Edition. 2001. W.B. Saunders, Philadelphia.
3. Giffin, J.E. and Ojeda, S.R. Textbook of Endocrine Physiology. 4th Edition. 2000. Oxford University Press, Oxford.
4. Greenspan, F.S. and Stewler, G.J. basic and clinical endocrinology, 5th Edition. 2002. Prentice Hall International Inc., London.
5. Neal, J.M., Basic Endocrinology: An Interactive Approach. 2000. Blackwell Science Inc., London.
6. WILLIAMS textbook of Endocrinology (13th edition). 2016. Elsevier



## SEMESTER-7

Course No.	Title	Credit Hours
Zool-401	Major-V Zoogeography and Palaeontology	3(3-0)
Zool-402	Elective-III Medical Microbiology	3(2-1)
Zool-403	Foundation-IX Biological techniques	3(2-1)
Zool-404	Major-VI Parasitology	4(3-1)
Zool-405	Major-VII Animal Behaviour	3(2-1)
Zool-406	Major-VIII Research Methodology	2(2-0)
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Zool-401	Major-V Zoogeography and Palaeontology	3(3-0)
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### COURSE OBJECTIVES

The course aims to:

- Provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time.
- Impart knowledge and concepts of evolution mainly on the basis of fossil record.
- Give understanding that fossil record also provide information about the distribution of animals in the past eras.

### COURSE OUTCOMES

Upon successful completion of this course, students will be able to

- **OBSERVE** and examine the anatomy, morphology, and evolutionary history of invertebrate animals, and protists commonly found as fossils.
- **UNDERSTAND** of the internal and external factors governing and limiting a species distribution.
- **GET** knowledge of speciation, dispersal, isolation, and extinction processes as they affect a taxon's distribution.
- **ABLE** to locate, characterize, and differentiate the major biomes the planet

## **COURSE CONTENTS**

### **Zoogeography**

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

Animal distribution: cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution, barriers and dispersal.

Zoogeographical regions: zoogeographic division and boundaries, geographic ranges, physical features, climates, faunas and affinities of Palaearctic, Nearctic regions, Oriental, Ethiopian, Australian, and Neotropical Regions, insular fauna

Paleogeography: Theories of continental drift and plate tectonics; Pangea.

**Principles of Palaeontology:** Earth, Shells of earth; (atmosphere, hydrosphere, biosphere and lithosphere). Rock, types of rocks, Fossil, types and uses of fossils, nature of fossils. Processes of fossilization. Geological time scale. Pre-Cambrian life. Post Cambrian life (Palaeozoic life, Mesozoic life, Cenozoic life). Geochronometry (Uranium/Lead dating, radiocarbon dating, methods), evolutionary history of man, elephant, horse and Camel, Paleoecology, Paleomagnetism.

### **RECOMMENDED BOOKS**

1. Ali, S.S. Palaeontology, zoogeography and wildlife management. 1999. Nasim Book Depot, Hyderabad, India
2. Brouwer, A. general palaeontology, 1977. Oliver and Boyed, London
3. Cain, A.J 1963. Animal Species and their Evolution, Hutchinson's University Library, London.
4. Dobzhansky, T. Genetic and the Origin of Species, Columbia University Press, New York.
5. Dobzhansky, T., 1970 Genetics of the Evolutionary Process, Columbia University Press, New York.
6. Dobzhansky, T., Ayala, F.J Stebbins G.I and Valentine, J.W., 1973. Evolution. W.H. Freeman and Company.
7. Dunbar C.O. Historical geology, 1969. John Wiley and sons Inc. New York
8. Gilbert, L. I. and Colbert, E.H. Evolution of vertebrates, 1980. John Wiley and sons Inc. New York
9. Mayr, E. Populations, Species and Evolution, Harvard University Press.
10. Moody, P.A, 1989. Introduction to Evolution, Harper and Row Publisher, New York.
11. Ridley, M., 1993. Evolution. Blackwell Scientific Publications.
12. Sheppard, P.M., 1958. Natural Selection and Heredity, Hutchison University Library, London.
13. Syed Sabir Ali. 2015. Zoogeography Palaeontology and Wildlife Management. Naseem Book Depot.

<b>Zool-402</b>	<b>Elective-III Medical Microbiology</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

- Define principles of microbial taxonomy, structure, physiology, genetics, immunology and pathogenesis;
- Develop a knowledge of microbial organisms and their relevance of infectious diseases;
- Understand the principles of prevention and treatment of pathogenic microorganism infection in humans.
- Familiar skill of the laboratory use in diagnose infections, including appropriate specimen collection and selection of tests.
- Develop the ability to manipulate the laboratory tests to identify pathogenic microorganisms.
- Understand the principles of the laboratory tests in diagnosis and identification of pathogenic microorganisms.

### **COURSE OUTCOMES**

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

- **COMPARE** different microbial diseases, including the properties of different types of pathogens, and the mechanisms of pathogenesis.
- **SUMMARIZE** the role of the host in infectious disease, including natural barriers to infection, innate and acquired immune responses to infection, and inflammation.
- **SPECIFY** the role of ecology and evolution in the spread of infectious diseases, comparing the role of transmission, population size and susceptibility, and virulence in endemic disease, epidemic disease, emerging diseases, and bioterrorism.

### **COURSE CONTENTS**

The beginnings of Microbiology; Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology  
Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual  
Microbiology and medicine antimicrobial agents, mode of action, bacterial pathogen and associated diseases. Infective syndromes and diagnostic procedures. Strategy of antimicrobial therapy.

Introduction: Host-parasite interactions.

Determination of pathogenicity and molecular mechanisms of pathogenesis.

Chemotherapy and drug resistance.

Study of bacterial infections with emphasis on mechanisms of pathogenesis of the following groups: *Streptococcus*, *Staphylococcus*, *Niesseria*, *Pseudomonas*, *Corynebacterium*, *Bordetella*, *Vibrio*, Enterobacteraceae, *Clostridium*, *Bacillus*, *Campylobacter*, *Aeromonas* and *Helicobacter*, *Legionella*, *Mycobacterium*, *Actinomyces/ Nocardia*, *Chlamydia* and *Mycoplasma*.

Zoonotic infections: Study of viral and rickettsial diseases including epidemic and endemic, typhus, AIDS, Hepatitis. Poxviruses and Herpes viruses.

Protozoan infections with emphasis on Leishmaniasis and Toxoplasmosis.

Pathogenesis of mycotic infections with particular emphasis on mycetoma. Classical and newly emerging pathogens.

## **PRACTICALS**

- Collection and transportation & microscopic examination of clinical samples.
- Infections of ear, nose, throat, eye, GIT, urogenital tract (swabs).
- Isolation and identification of selected micro-organisms.
- Antibiotic assays by disc diffusion methods and dilution method.
- Determination of MIC and MBC.
- Antibacterial activity of serum.
- Agglutination test (Widal test).
- Precipitation tests.
- Urine analysis (physical, chemical and microbiological)

## **RECOMMENDED BOOKS**

1. Cowan, S. T., Steel, K. J., Barrow, G. I and Feltham, R. K. A. 2004. Cowan and Steel's Manual for the Identification of Medical Bacteria, 3rd Edition, Cambridge University Press, U.S.A.
2. Hawkey, P and Lewis, D. 2004. Medical Bacteriology: A Practical Approach. 2nd Edition, Oxford University Press, U.K.
3. Mims, C., Dockrell, H., Goering, R., Roitt, I Wakelin, D. and Zuckerman, M. 2007. Medical Microbiology. 3rd Edition .Mosby Co., M.O.
4. Murray, P. R., Rosenthal, K. S., Pfaller, M. A. and Rosenthal, K. S. 2005. Medical Microbiology, Elsevier Health Science, N.Y.
5. Murray, Baron, Pfaller, Tenover, Tenover, Tenover, Tenover, Tenover, Tenover, Tenover, Tenover. 2011. Manual of Clinical Microbiology by 10th Ed. ASM Press USA.
6. Brooks, G., Carroll, K.C., Butel, J., Morse, S., 2013. Jawetz Melnick& Adelbergs Medical Microbiology 26th Edition McGraw-Hill Companies. North America

<b>Zool-403</b>	<b>Foundation-X Biological Techniques</b>	<b>3(2-1)</b>
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## **COURSE OBJECTIVES**

The course aims to:

- Develop scientific technical expertise, culture and work habits.
- Familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
- Develop basic understanding of the equipments usage

## COURSE OUTCOMES

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

- **IDENTIFY** different parts of a microscope, list different types of microscopes and their functions.
- **DESCRIBE** the basic principles of light microscopy and electron microscopy.
- **DESCRIBE** the uses, principles and preparation of samples for photometry, colorimetry, chromatography, centrifugation and electrophoresis.
- **OPERATE** different types of microscopes in the laboratory.
- **PREPARE** microscope slides of specimens such as plant and animal cells, thin and thick smears for detection of tissue parasites and squash of soft specimens.
- **OPERATE** laboratory equipment such as photometer, colorimeter, paper and thin layer chromatography, conductometer and centrifuge.

## COURSE CONTENTS

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

**Micrometry and Morphometry:** Use of stage and ocular micrometer.

Calibration of ocular micrometer. Size measurement (length, width, diameter).

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

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

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

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

**Spectrophotometry:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.

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

## PRACTICALS

- Observation of wet mounts of human cheek cells employing bright and dark field microscopy
- Measurement of cell size: bacterial and eukaryotic
- Recording of microscopic observations with the help of camera Lucida
- Liquid handling: proper use of pipettes and micropipettes
- Histological preparations: skeletal muscle, intestine liver and testes

- Handling of centrifuge machines
- Thin layer chromatography of amino acids
- Spectrophotometric estimation of glucose
- Spectrophotometric estimation of total proteins
- Preservation of representative animals of various phyla
- Electrophoretic separation of proteins
- Electrophoretic separation of DNA

### RECOMMENDED BOOKS

1. Aysha Divan and Janice Royds. 2013. Tools and Techniques in Biomolecular Science. Oxford University Press.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: For Technician. CRC Press LLC. USA.
5. Curoso, M. 1997.Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
6. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
7. P.R. Yadav. 2006. Biological Techniques. Discovery Publishing House
8. Slings by, D., Cock, C.1986. Practical Ecology. McMillan Education Ltd. London.

<b>Zool-404</b>	<b>Major-VI Parasitology</b>	<b>4(3-1)</b>
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### COURSE OBJECTIVES

This course will

- Introduction to general parasitology
- provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance
- knowledge about their pathology, host parasite relationship and control measures

### COURSE OUTCOMES

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

- **UNDERSTAND** and explain the concept of parasitism, host-parasite relationship, and explain epidemiology, lifecycle, pathogenesis, transmission, control and treatment of various human and veterinary parasite.
- **DEMONSTRATE** practical skills in fundamental parasitological techniques.
- **PRESENT** and interpret results obtained from using these techniques.

## COURSE CONTENTS

**Introduction to parasitology:** Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals. Careers in parasitology. Some basic definitions. Parasitic ecology and evolution. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms. Acquired immune response in vertebrates. Immunity in invertebrates. Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship. Parasitic protozoa, form, function and classification.

**Pathology of Helminths:** Host parasite relationships and control of parasitic helminths with particular reference to Helminths of medical and veterinary importance.

Arthropods, Vectors of diseases. Parasitic insects; bugs, fleas, flies, mosquito, lice, ticks and mites.

## PRACTICALS

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

## RECOMMENDED BOOKS

1. Becks, J.W. and Davies, J.E. Medical parasitology. 3<sup>rd</sup> Edition. 1981. C.V. Mosby Company, Toronto, London
2. Becks, J.W. and Davies, J.E. Medical parasitology. 3<sup>rd</sup> Edition. 1981. C.V. Mosby Company, Toronto, London
3. Cheesbrough, M. Medical laboratory manual for tropical medicine. Vol.I. 1987. University Press Cambridge
4. Cheesbrough, M. Medical laboratory manual for tropical medicine. Vol.I. 1987. University Press Cambridge
5. Hausman, K. and Hulsmann, N. T. Protozoology, 2<sup>nd</sup> Edition.1996. Medical Publishers, Inc. New York
6. Noble, E.R. and Noble, G.A. Parasitology. The biology of animal parasites. 5<sup>th</sup> Edition. 1982. Lea and Febiger Publisher
7. Roberts, L.S. and Janovy, J. Foundation of parasitology, 8<sup>th</sup> Edition. 2008. McGraw Hill Book Co
8. Roberts, L.S. and Janovy, J. Foundation of parasitology, 8<sup>th</sup> Edition. 2008. McGraw Hill Book Co
9. Rollinson. D, Hay. S. I.Advances in Parasitology, Volume 69. 2009. Academic Press
10. Smyth, J.D. Introduction to animal parasitology. 1994. Cambridge University Press
11. Smyth, J.D. Introduction to animal parasitology.1994. Cambridge University Press

12. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W. VETERINARY parasitology. 2000. Longman Scientific and Technical publications, Longman Group, UK

<b>Zool-405</b>	<b>Major-VII Animal Behaviour</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

- The course will provide broader knowledge about behaviour of animals, its genetic basis and environmental and experience related shaping
- impart knowledge about different kinds of behaviour and social and aggressive interactions
- provide knowledge about reproductive and sexual behaviours

### **COURSE OUTCOMES**

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

1. **OUTLINE** the basic knowledge about animal behaviours
2. **ASSOCIATE** various external stimuli to the behaviours they impart in animal.
3. **RELATE** daily activities of animals to their behaviour.
4. **DETERMINE** the importance of genetic and neurophysiological basis animal behaviour in animal biology
5. **PREDICT** various actions of animals and associate them with history of various behavioural patterns present in the animal kingdom.
6. **INTEGRATE** concepts of behaviour and its development in animals.

### **COURSE CONTENTS**

Foundations of animal behaviour: ethology, classical ethology Development of behaviour: innate mechanisms, imprinting Kinds of behaviour: innate, conditioned, complex behaviour patterns, habituation. Mechanisms of behaviour: Nervous system and behaviour, hormones and behaviour, Social behaviour: agonistic, altruistic, kinship, mating, ritualization, dominance, territoriality Biological rhythms: circadian clocks, clock genes etc. Social organization: conflict, sexual behaviour, reproduction and fitness, parental care, social system. Animal Communication: chemical attraction, in moths, honey bees, communication displays, pheromones etc.

### **PRACTICALS**

- Locomotory behaviour of small animals, earthworm, garden snails etc.
- Ear pinna reflex responses in domestic cats
- Preparation of skinner box or maze for study of mouse or rat behaviour
- Mother-pup bond in mice and rats
- Infant killing behaviour
- Pecking behaviour of chickens
- Hiding behaviour of chicks



- Observation of birds' nests and study of parental behaviour
- Altruistic behaviour in monkeys

## RECOMMENDED BOOKS

1. Dngatkin, L. A. 2012. Principles of Animal Behaviour.W.W. Norton and Co.New York.
2. Goodenough, J., McGuire, B., Wallace, R.A. 2001.Perspective on Animal Behaviour. John Wiley & Sons, New York.
3. John Alcock. 2010. Animal behaviour, an evolutionary approach. 9th Edition. Sinauer Publishers.
4. Parsad S. 2004. Animal Behaviour. CBS Publishers and Distributors. India
5. Scott, G. 2005.Essential Animal Behaviour. Blackwell Pub. New York.
6. Scott, G. 2009. Essential Animal Behaviour. Wiley publishers

Zool-406	Major-VII (Research Methodology)	2(2-0)
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## 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 OUTCOMES

On completion of this course, the students should be able to:

- **UNDERSTAND** a general definition of research design.
- **IDENTIFY** the overall process of designing a research study from its inception to its report.
- Become **FAMILIAR** with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- **KNOW** the primary characteristics of quantitative research and qualitative research.
- **IDENTIFY** a research problem stated in a study.
- Become **FAMILIAR** with how to write a good introduction to an educational research study.
- **DISTINGUISH** a purpose statement, a research question or hypothesis, and a research objective.

## COURSE CONTENTS

**Introduction:** Objectives of Research, Motivations

**Research Process:** research methods vs research methodology, scientific method, types of research, general steps involved in research, problems of research in Pakistan

**Topic Selection:** problem identification for research, criteria and evaluation

**Literature review:** importance and sources, referencing and citation, bibliography, plagiarism

**Research Design:** Parts, important features, important concepts in research design

**Aims and objectives:** research objectives, qualities of research objectives

**Material and methods:** bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources

**Data Analysis:** Processing, statistics in research, hypothesis testing, t-tests and ANOVA

**Scientific Writing:** Difference between thesis/report/synopsis/research proposal, parts of synopsis/project proposal, parts of thesis/report

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

## **RECOMMENDED BOOKS**

1. Creswell, J. W. (2013). Research Design Quantitative Qualitative and Mixed Methods Approaches. Sage.
2. Hess-Biber, S. N. and P. Leavy. (2004). Approaches to Qualitative Research, A Reader on Theory and Practice. New York, Oxford University Press.
3. Khan, J.A. (2008). Research Methodology. New Delhi: APH Publishing.
4. Kothari, C.R., & Gaurav, G. (2014). Research Methodology: Methods and Techniques. New Delhi: New Age International.
5. Kumar, R. (2011). Research Methodology: A Step By Step Guide for Beginners. Cornwall: SAGE Publications, Inc.
6. Laurel, B. (2003). Design Research, Methods and Perspectives. London England, the MIT Press.
7. Paul Leedy, 2004, Practical Research: Planning and Design (8th, Edition), Jeanne Ellis Ormrod
8. Walliman, N. (2005). Your Research Project, 2nd Edition, A step by step guide for the first-time researcher. New Delhi, Vistaar Publications.

## SEMESTER-8

Course No.	Title	Credit Hours
Zool-451	Major-IX Fish Biology	4(3-1)
Zool-452	Elective-IV Bioinformatics	3(2-1)
Zool-453	Major-X Entomology	4(3-1)
Zool-454	Major-IX Research Project OR Special Paper I Special Paper II	0-6 OR 3(3-0) 3(3-0)
		17

Zool-451	Major-IX Fish Biology	4(3-1)
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### COURSE OBJECTIVES

- To disseminate the history, needs and importance of fish culture
- To elaborate the basic components of pond fish culture
- To describe the cultureable fish species and their biology
- To impart knowledge regarding pond fertilization and feeding of fish

### COURSE OUTCOMES

At the end of this course, the student will be able to

- **GAIN** Knowledge on the morphology and anatomy of fishes.
- **IDENTIFY** information sources and vocabulary ichthyologists use to describe zoogeographic patterns of fishes.
- **SUMMARIZE** current knowledge regarding evolution of fish and their behaviours.
- **EVALUATE** hypotheses for the evolution of fish life history strategies, foraging behaviour, and reproductive cycles.

### COURSE CONTENTS

Fish morphology: Head (size, shape, and orientation); Scales (types, arrangements, coloration, scale less fishes); Operculum; Fins, fin rays and fin spine (dorsal, pectoral, caudal, anal); Barbel (upper lip barbels, lower lip barbels);

Anatomy: Skeleton (skull, backbone, spines); Brain and spinal cord; Gills (Number, size, arrangements); vital organs (heart, liver, and kidney); Viscera and mesenteries (swim bladder, stomach, spleen, pancreas, intestine, gonads).

Systematic: Identification of fishes up to; Families; Order; Genus; Species; Feeding groups of fishes; Herbivore; Plankton eater; Larvivore; Carnivore; Voracious;

Reproduction: Gonads; Testes and ovaries; Maturation; Reproductive cells (egg and sperm); Artificial fertilization of sex cells.

Breeding: Nature (seasonal); Artificial; Hormonal induced breeding; Temperature & photoperiod; control induced breeding, Courtship behaviour.

Introduction to fisheries and aquaculture:

National and International trends. Water quality parameters (abiotic: temperature, light, salinity, pH, turbidity, etc.) and their effects on fish health and production. Biotic parameters (plankton, insects, aquatic vegetation, etc.) of ponds, lakes, rivers and impacts on fish growth. Induced breeding. Fish diseases and their control. Fishing gears, fishing techniques, fishing communities. Fish preservation, processing, transportation and marketing.

## **PRACTICALS**

- Fish dissection to expose different systems.
- Microscopic study of gills.
- Age determination of fish based on different type of scales.
- Study of gut content of various groups of fishes.
- Collection, preservation and identification of freshwater fish species using fish identification keys.
- Physico-chemical analysis of water quality parameters including (DO, NH<sub>3</sub>, hardness, alkalinity, turbidity, transparency, temperature, salinity etc.).
- Study of blood cells and their counts in normal and diseased fish, Diagnosis of infection in infected fish, study of fish parasites,
- Visit to various fish seed hatcheries during breeding seasons for observation of induced spawning.
- Artificial feed formulation for Fishes.

## **RECOMMENDED BOOKS**

1. Brenabe, G. Aquaculture, Vol. I. 1992. Blackwell Publishing, Oxford. U.K.
2. Brenabe, G. Aquaculture, Vol. I. 1992. Blackwell Publishing, Oxford. UK.
3. Gorbman, A. Comparative Endocrinology. 1<sup>st</sup> Edition. 1983. John Wiley & Sons. UK.
4. Hoars, W.S. Fish Physiology. 1971. Academic Press. UK.
5. Hoars, W.S. Fish Reproduction. 1969. Academic Press. UK.
6. Huet M. Text Book of Fish Culture: Breeding and Cultivation. 1973. Blackwell Publishing Company.
7. Huet. M. Text Book of Fish Culture: Breeding and Cultivation. 1973. Blackwell publishing Company.
8. Kestin, S. C. and Warris, P.D. (Editors). Kestin Farmed Fish Quality, 2002 Blacwell Science, Oxford, UK.
9. Kestin, S. C. and Warris, P.D. (Editors). Ketin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.
10. Maseke C. Fish Aquaculture. 1987. Pergamon Press, Oxford. UK.
11. Matty, A. J. Fish Endocrinology. 1985. Timber Press, UK.
12. Paul J.B. HartJohn D. Reynolds. 2002. Handbook of Fish Biology and Fisheries: Fish Biology. Wily publisher.
13. Quentin Bone, Richard Moore 2008. Biology of Fishes. Taylor and Francis Group
14. Saksena, D.N. Ichthyology: Recent Research Advances. 1999. Oscar Publications India,

15. Woo, P.T.K Fish Diseases And Disorder. Vol 1. Protozoan and Metazoan Infections. 1995. CABI Publisher.
16. Woo, P.T.K. Fish Diseases and Disorder. Vol 1. Protozoan and Metazoan Infections. 1995. CABI Publsiher.

<b>Zool-452</b>	<b>Elective-IV Bioinformatics</b>	<b>3(2-1)</b>
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### **COURSE OBJECTIVES**

The course will provide:

- An introduction to bioinformatics with a focus on fundamental bioinformatics problems,
- Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

### **COURSE OUTCOMES**

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

- **GAIN** an understanding of the basic concepts of Bioinformatics.
- **EXPLAIN** the basics of bioinformatics and computational biology.
- To **USE** bioinformatics search tools on the internet for mining data, pairwise and multiple sequence alignments and predict protein structures.

### **COURSE CONTENTS**

**Introduction:** introduction to computers, software, hardware, operating systems, Bioinformatics, Scope of bioinformatics, useful websites, aims of bioinformatics, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools

**Biological databases:** data and information, databases, data acquisition, NCBI, major DNA databases around the world, major protein databases in the world, primary protein sequence databases, secondary protein databases, tertiary protein databases, protein structure databases, specialized databases, genome and organism databases, miscellaneous databases

**Genome mapping:** genetic and linkage mapping, physical mapping

**Gene family:** introduction, types, protein family, types of protein families, Globin family as an example, globin genes and chains, evolution of globin proteins in human, combination and types of globin proteins in human

**Data Retrieval:** searching sequence databases, FASTA format, retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data

**Primer Designing:** primer and probe, qualities of primer, general rules for primer designing, websites used for primer designing

**Sequence Alignment:** importance and significance of alignment, methods for sequence alignment, local and global alignment, pair-wise local alignment, uses of local alignment

**BLAST:** introduction, types, uses, algorithm, BLAST Scores

**Amino Acid Matrices:** amino acids and their symbols, amino acid scoring matrices, PAM and BLOSUM, comparison of PAM and BLOSUM

**Multiple Sequence Alignment:** Introduction, tools for MSA, uses and importance

**Phylogenetic analysis:** introduction, interpretation, rooted and unrooted tree, phylogenetic methods, tree terminology, comparison of methods, software

**Protein Structure Prediction:** homology modelling, threading, *ab initio* modelling, motivation to acquire structure, protein 3D structure, software/databases

**Molecular Docking:** introduction, steps, importance and uses

**Microarrays:** gene expression, differential expression, DNA chips, principle of microarray, types, steps of a microarray experiment, qualitative interpretation of results, applications of microarray, advantages and disadvantages of microarray

## PRACTICALS

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

## RECOMMENDED BOOKS

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. Gibas, C. and Jambeck, P. (2001) *Developing Bioinformatics Computer Skills*. O'Reilly publishers.
3. Krane, D.E. and Raymer, M.L. (2002) *Fundamental Concepts of Bioinformatics*. Benjamin Cummings.
4. Lesk, A. (2014) *Introduction to Bioinformatics*. 4<sup>th</sup> Edition. Oxford University Press
5. Pevsner, J. (2015) *Bioinformatics and Functional Genomics*. 3<sup>rd</sup> Edition. Willey-Blackwell
6. Primerose, S.B. (2004) *Genomics: Applications in Human Biology*. Willey-Blackwell
7. Rastogi, S.C., Mendiratta, N., Rastogi, P. (2011) *Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery*. PHI publishing.
8. Selzer, P., Marhofer, R. and Rohwer, A. (2008) *Applied Bioinformatics: An Introduction*. Springer publishing, Germany.
9. Westhead, D.R., Parish, J.H., Twyman, R.M. (2003) *Instant Notes on Bioinformatics*. Viva Books Private Limited.

## Websites

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

4. <http://www.ensemble.org>

<b>Zool-453</b>	<b>Major-X Entomology</b>	<b>4(3-1)</b>
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### **COURSE OBJECTIVES**

- The students will learn to identify the pests damaging to the crops
- understand methods of population estimation of the pest
- become aware of the applications of different control strategies

### **COURSE OUTCOMES**

This course will enable the students to:

- **UNDERSTAND** insect adaptation and evolutionary processes.
- Learn the basic external morphology of insects and how it is used in classification.
- **LEARN** the basic internal anatomy of insects, and how it is adaptive.
- **DESCRIBE** the life cycles of important insect groups.
- **UNDERSTAND** commonly accepted phylogenetic models for arthropods.
- **UNDERSTAND** how insects adapt behaviourally and ecologically.

### **COURSE CONTENTS**

Basic Entomology:

Morphology and Physiology:

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

Insect Taxonomy and Ecology:

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

Principal of apiculture, sericulture and lac culture. Study and identification of pests of agriculture, stored grain and house holds. Genera characteristics, life cycle and habits of insects of medical and veterinary importance. Study of various insect-borne diseases.

### **PRACTICALS**

- Dissection of insects' cockroach, grasshopper, red cotton bug, butterfly, honey bee, yellow wasp, house fly and mosquito, to expose their internal anatomy. Preparation of mouth parts, Antennae, wings, legs and genitalia of different insects. To study the whole mounts of collembolan, silverfish, thrips, aphids, lice and fleas.
- Collection, identification and preservation of different pests and other insects of medical and veterinary importance. Study of sericulture and apiculture. Operation of various types of sprayers. Dusters, fumigation, emulsions. Preparation of insecticide emulsion in different concentration. The record of

laboratory and fieldwork will be maintained and presented at the time of examination.

### RECOMMENDED BOOKS

1. Atwal, A.S. (1984) Agricultural pests of india and south east asia. Kalyani Publishers Delhimms, A.D. (1957)
2. Imms, A.D (1957) A General Textbook of Entomology. 9<sup>th</sup> ed. Revised by O. W. Richards and R.G. Davies, (1957)
3. Imms' General Textbook of Entomolgy. Vol.1 10<sup>th</sup> ed. Chapman & Hall. Reprinted in India in 1993. 418 pp. Borro, D.J. & Deolong, D.M. (1971)
4. James L. Nation Sr. 2016. Insect Physiology and Biochemistry, Third Edition 3rd Edition. CRC Press.
5. Pedigo, L. P. 2003. Entomology and Pest Management. 4th ed. Pearson Education, Singapore, Pvt. Ltd.
6. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi.

<b>Zool-454</b>	<b>Major-IX Research Project OR Special Paper I Special Paper II</b>	<b>0-6 OR 3(3-0) 3(3-0)</b>
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**RESEARCH PROJECT AND THESIS WILL BE OFFER TO TOP 10 STUDENTS ONLY, HAVING CGPA  $\geq$  3.00. WHILE TO THE REMAINING STUDENTS SPECIAL SUBJECTS WILL BE OFFER.**



## **LIST OF SPECIAL COURSES (adopted from HEC curriculum 2012-13)**

The courses listed below will be taught as special subjects provided there is no overlap of the course contents studied earlier.

Animal adaptations	Histology
Animal communication	Ichthyology
Animal pests and disease producing organisms	Immunology
Aquaculture	Insect bioacoustics
Arachnology	Insect biochemistry and physiology
Fundamentals of human genetics	Insect pathology
Behavioural ecology	Insects of veterinary and medical importance
Biodiversity and wildlife	Invertebrate paleontology
Biodiversity of inland and terrestrial molluscs	Limnology
Biology and control of vertebrate pests	Mammalogy
Biomedical technology	Microbiology and biotechnology
Biotechnology	Microbiology of extreme environment
Biotechnology in aquaculture	Molecular biology
Cancer biology	Molecular genetics
Clinical biochemistry	Neurobiology
Comparative developmental biology	Ornithology
Conservation biology	Pharmacological and pathological endocrinology
Ecological genetics	Physiology of coordination
Economic zoology	Physiological systems and adaptations
Elements of stratigraphy and structural geology	Physiology of functional systems
Endocrinology	Population biology
Entomology (classification of insects and pest management)*	Principles and kinetics of toxicology
Entomology (morphology, physiology and ecology)	Fundamentals of fish biology
Environmental issues	Principles of parasitology
Environmental physiology	Quantitative zoology
Environmental pollution	Reproductive biology
Environmental toxicology	
Fish bioenergetics	
Fish culture	
Fish ecology	
Fish endocrinology	
Fish health management	
Fish feeding management	
Fish physiology and breeding	
Fundamentals of microbiology	
General and comparative endocrinology	
Helminthology and host-parasite relationship	
Hematology	
Herpetology	



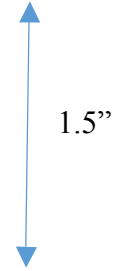
**Proposed format for research proposal, Synopsis  
BS/MSc/M.Phil for Approval. This format has been  
adopted from Advanced Studies and Research Board,  
University of Swat approved synopsis format for MPhil  
and PhD.**

### **Thesis format**

- Font style will be Time new Roman through the thesis
- From introduction the line space will be double
- Use A4 page
- The hard coating will be blue in color
-



**Title (14, bold, Uppercase, line space 1.5)**



1.5"



1.5"

Left margin 1.5"  
margin 1"

Right

**NAME OF STUDENT**

**(14, bold, uppercase)**

**(16, bold, uppercase, 1.5 line space)**

**CENTRE FOR ANIMAL SCIENCES AND FISHERIES,**

**UNIVERSITY OF SWAT**

**SESSION**

**Title (14, bold, Uppercase, line space 1.5)**



**By**

**NAME (14, BOLD, UPPERCASE)**

**A thesis submitted in partial fulfilment of the requirements for the degree of**

**..... (12, bold)**

**CENTRE FOR ANIMAL SCIENCES AND FISHERIES,**

**UNIVERSITY OF SWAT**

**SESSION**

## **Declaration of Originality (16, bold)**

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It is certified that the research work contained in this research project titled "**Title**" has been carried out and completed by **Name** under my supervision during his BS studies in the subject of Zoology.

Date

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Name  
Research Supervisor

Submitted Through

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Name  
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## **Certificate of Approval**

This is to certify that the work contained in this thesis titled " **Title**" carried out by **Name** in our opinion is fully adequate, in scope and quality, for the degree of BS Zoology from Centre for Animal Sciences and Fisheries, University of Swat. (12, regular)

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## Dedication

**ACKNOWLEDGEMENT (bold, 14)**

(12, regular)

**NAME (12, bold)**

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## **LIST OF ABBREVIATIONS**

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ACL	Anthroponotic Cutaneous Leishmaniasis
CL	Cutaneous Leishmaniasis
DML	Diploma in Medical Laboratory
DNA	Deoxyribonucleic Acid
KP	Khyber Pakhtoon Khawa

**ABSTRACT (14, bold uppercase)**

(12, Regular)



**INTRODUCTION (14, bold, uppercase)**

(12, regular, double line space)

First order heading (12, bold, uppercase)

Second order headings are ***BOLD ITALIC CAPITALS***

Third order headings are **left indented bold Small Letters**

Fourth order headings are **left indented *bold Italic Small Letters***

**REVIEW OF LITERATURE**

**MATERIALS AND METHODS**

**RESULTS**

**DISCUSSION**

**REFERENCES**

Use the references style as Pakistan Journal of Zoology