

**BS ZOOLOGY FOUR YEARS PROGRAM (SESSIONS 2013 AND ONWARD)**

**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF MALAKAND**



**WORKING PAPER**

**For**

**FIRST MEETING OF THE BOARD OF STUDIES**

**2013**

  
**Assistant Registrar (Academics)**  
**University of Malakand**

**DEPARTMENT OF ZOOLOGY  
UNIVERSITY OF MALAKAND**

**Chakdara, Lower Dir, Khyber Pakhtunkhwa, Pakistan**

### **INTRODUCTION**

Zoology is the scientific study of all aspects of animal life, from the microscopic single-celled protozoa to vertebrates. So far, about two million animal species have been described and many more await discovery. Scientific knowledge and understanding of animal life is crucial to our understanding of the environment. Zoology is a combination of various disciplines such as Genetics, Physiology, Ecology, Developmental Biology, Microbiology, Parasitology, Entomology, Freshwater Biology, Fisheries, and Wildlife etc. This subject has significant role in human resource development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty. University of Malakand started BS Zoology four years program in 2011. The eligibility criteria for admission to BS Zoology 4 year program is F. Sc. (Pre-medical).

### **Objectives and Outcomes**

1. To impart knowledge about the major disciplines of Zoology. It will enable the students to understand the principles of organizations and inter-relationships in the biological systems with particular reference to animal diversity.
2. To teach different methods of exploration, investigation, organization of data and its utilization in practical life.
3. To train students for advanced studies and specialization on recently emerging technological and multidisciplinary fields such as Genetic Engineering, Biodiversity, Environmental Science, Wildlife and Conservation, Fisheries and Aquaculture, Pests and Pest Management, Biotechnology, etc. After completing the degree, students will be able to apply their knowledge to their respective fields effectively.
4. To equip students with knowledge and skills for better planning and management of animal resources, environment, health, medicine, agriculture and population in the country.
5. To develop the scientific culture and demonstrate professional skills in teaching /research/ managerial positions in wide range of professions in national and international organizations.

### **Career Opportunities**

After obtaining the BS degree in Zoology, the graduates will be able to get jobs in wide range of professions including: Positions in various government and non-governmental organizations, teaching and research, administration and management, forestry, pharmaceutical, agriculture, biological control programs, integrated pest management, poultry, wildlife, aquaculture, fisheries,

livestock and strategic areas.

**Pedagogy (Teaching - Learning Methodologies)**

1. The courses will be delivered through lectures, seminars, practicals, discussions and field trips.
2. Teaching learning material will include text-books, reference books journals/periodicals, handouts and internet.
3. Using audio/ visual aids i.e., slides/ overhead transparencies / multimedia.

**Assessment and Evaluation**

Mid-term examination 30 %

Assignment and seminars 20 %

Terminal examination 50 %

  
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|-------|--|------------|-------|
| 1     | Working Paper for the 1 <sup>st</sup> Meeting  | Nil        |       |
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| 3     | Members of the Board of Studies, Department of Zoology                               | Annexure-B | 7     |
| 4     | Proposed Structure of studies for 4-year Integrated Curricula for BS in Zoology      | Annexure-C | 8     |
| 5     | Proposed courses of study for BS (four year program) in Zoology from 2013 and onward | Annexure-D | 9-84  |
| 6     | Proposed format of question paper for BS (Zoology)                                   | Annexure-E | 85    |
| 7     | List of Thesis Viva Voce Examiners for BS (Zoology)                                  | Annexure-F | 86    |
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| 9     | Any other Item with the approval of the Chair  | Nil        |       |

  
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## **DEPARTMENT OF ZOOLOGY**

**University of Malakand  
Khyber Pakhtunkhwa, Pakistan**

### **First Meeting of the Board of Studies**

#### **WORKING PAPER**

#### **Item 1 Proposed Structure of studies of 4-year Integrated Curricula for BS in Zoology**

The proposed structure of 4-year Integrated Curricula for BS in Zoology (sessions 2013 and onward) are placed for consideration and approval of the Board (Annexure C, page 8)

#### **Item 2 Proposed courses of study for BS Zoology (four years) program**

The proposed courses outlines and details for BS Zoology Program (session 2013 onward) are placed for consideration and approval of the Board (Annexure D, Pages 9-84).

#### **Item 3 Proposed Format of Question Paper for BS Zoology**

The proposed format of Question Paper for BS Zoology is placed for consideration and approval of the Board (Annexure E, Page 85).

#### **Item 4 Proposed Panels of Examiners for B.S (Zoology) Program**

The proposed list of names of Thesis Viva Voce Examiners for BS (Zoology) is placed for consideration and approval of the Board (Annexure F, Page 86).

#### **Item 5 Proposed thesis format of BS (Zoology) Program**

The proposed thesis format of BS Zoology is placed for consideration and approval of the Board (Annexure-G, Pages 87-97).

  
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## Annexure-A

### CONSTITUTION AND FUNCTIONS OF THE BOARD OF STUDIES

**The Board of Studies:** (According to the University of Malakand Statutes)

1. There shall be a separate board of studies for each subject or group of subjects, as may be prescribed by Bye-Laws
2. Each board of studies shall consist of-
  - a) The chairperson or Director of the registered institute;
  - b) All professors and Associate Professor in the University teaching Departments or institutes;
  - c) Two experts to be appointed by the Vice Chancellor;
  - d) Three teachers, other than the University teachers to be appointed by the Vice Chancellor from affiliated colleges; and
  - e) One Assistant Professor and one Lecturer to be appointed by rotation in order of seniority from the Department concerned, provided that in the case of professional subjects which are taught in the affiliated institutes/colleges only and not in the University, such as medicine, dentistry and education etc.
3. The term of office of members of the Board of Studies, other than ex-officio members, shall be two years.
4. The quorum for meeting of the Board of Studies shall be one-half of me of members, a fraction being counted as one.
5. The Chairperson of the University Teaching Departments concerned shall be the Chairperson and Convener of the Board of Studies. Where in respect of a subject there is no University Teaching Department, Chairperson shall be appointed by the Vice Chancellor.
6. The function of Board of Studies shall be-
  - To advise the authorities on all academic matters concerning instructions, publications, research and examination in the subject concerned;
  - To propose the curricula and syllabi for all degree, diploma and certificate courses in the subject concerned;
  - To suggest a panel of names of papers setters and examiners in the subjects concerned;
  - and
  - To perform such other functions as may be prescribed by By-laws

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## Annexure-B

### MEMBERS OF THE BOARD OF STUDIES, DEPARTMENT OF ZOOLOGY

Consequent upon the notification No. UOM/Acad-1/2013/7037 dated 02-05-2013 and per provision of section 4(2) of the schedule appended to the University of Malakand Regulation 2001, the Board of Studies of Department of Zoology at present is consisted of the following members.

| S. No | Name/Designation  | Address   | Status                   |
|-------|---|---|--------------------------|
| 1     | Prof. Dr. Mir Azam Khan / Dean<br>Faculty of Biological Sciences<br>4(2)a | University of Malakand                                | Convener<br>(Ex officio) |
| 2     | All Professors and Associate Professors<br>4(2)b                          | Department of Zoology, University of<br>Malakand      | Members (Ex<br>officio)  |
| 3     | Mr. Ikram Ilahi, A/P, Incharge<br>Department 4(2)(e)                      | Department of Zoology, University of<br>Malakand      | Member                   |
| 4     | Prof. Dr. Akram Shah 4(2)c  | Department of Zoology, University of<br>Peshawar      | Member                   |
| 5     | Dr. Farah Zaidi, A/P, 4(2)c   | Department of Zoology, University of<br>Peshawar      | Member                   |
| 6     | Prof. Dr. Fazali Subhani 4(2)d  | Govt Postgraduate College, Dargai,<br>Malakand Agency | Member                   |
| 7     | Mr. Nawab Ali, Lecturer 4(2)d   | Govt. Degree College, Thana,<br>Malakand Agency       | Member                   |
| 8     | Mr. Qadim Khan, A/P 4(2)d   | Govt Postgraduate College, Dargai,<br>Malakand Agency | Member                   |
| 9     | Mr. Saeed Ahmad, Lecturer 4(2)(e)   | Department of Zoology, University of<br>Malakand      | Member                   |

  
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## Annexure-C

### STRUCTURE OF STUDIES FOR 4-YEAR INTEGRATED CURRICULA FOR BS IN ZOOLOGY

The Department of Zoology University of Malakand duly adopted the structure of studies for BS Zoology (Four Years) program as recommended by the Higher Education Commission (HEC), Pakistan.

| S No         | Categories  | No. of courses | Credit Hours |
|--------------|---|----------------|--------------|
| 1            | Compulsory Requirement (No Choice)                    | 09             | 25           |
| 2            | General Courses to be chosen from other departments   | 08             | 23           |
| 3            | Discipline Specific Foundation Courses                | 09             | 34           |
| 4            | Major Courses including research project / Internship | 12             | 39           |
| 5            | Electives within the major                            | 04             | 12           |
| <b>Total</b> | -----   | <b>42</b>      | <b>133</b>   |

Total number of Credit hours            133  
Duration    4 years  
Semesters    8  
Course Load per Semester                15-19 Credit Hours  
Number of courses per Semester        5-6

  
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## Annexure-D

### PROPOSED COURSES OF STUDY FOR BS ZOOLOGY (FOUR YEARS PROGRAM) FROM 2011 AND ONWARDS

The Department of Zoology, University of Malakand has adopted the courses recommended by the Higher Education Commission, Pakistan (session 2013-onward).

#### YEAR-ONE, SEMESTER FIRST

| Subject Code | Course Title                                | Credit Hours | Page # |
|--------------|---|--------------|--------|
| Zoo-111      | English-I ( Compulsory-I)                   | 3            | 13     |
| Zoo-112      | Pakistan Studies ( Compulsory-II)           | 2            | 14     |
| Zoo-113      | Mathematics ( Compulsory-III)               | 3            | 15     |
| Zoo-114      | Plant Diversity ( General- I)               | 2 + 1        | 16     |
| Zoo-115      | General Chemistry ( General- II)            | 2 + 1        | 17     |
| Zoo-116      | Principles of Animal Life-I ( Foundation-I) | 3 + 1        | 17     |

**Total: 18**

#### YEAR ONE, SEMESTER SECOND

| Subject Code | Course Title  | Credit Hours | Page # |
|--------------|---|--------------|--------|
| Zoo-121      | English-II ( Compulsory-IV)                             | 3            | 19     |
| Zoo-122      | Islamic Studies ( Compulsory-V)                         | 2            | 20     |
| Zoo-123      | Plant Systematics, Anatomy & Development ( General-III) | 2 + 1        | 21     |
| Zoo-124      | Organic Chemistry (General-IV)                          | 2 + 1        | 23     |
| Zoo-125      | Principles of Animal Life-II (Foundation-II)            | 3 + 1        | 24     |

**Total = 15**

  
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### YEAR TWO/SEMESTER THIRD

| Subject Code | Course Title                                   | Credit Hours | Page # |
|--------------|--|--------------|--------|
| Zoo-231      | English-III (Compulsory-VI)                    | 3            | 26     |
| Zoo-232      | Introduction to Computer (Compulsory-VII)      | 1+2          | 26     |
| Zoo-233      | Cell Biology, Genetics & Evolution (General-V) | 2+1          | 27     |
| Zoo-234      | Environmental Chemistry ( General-VI)          | 2 + 1        | 28     |
| Zoo-235      | Animal Diversity-I (Foundation-III)            | 3 + 1        | 30     |

Total = 16

### YEAR TWO/SEMESTER FOURTH

| Subject Code | Course Title   | Credit Hours | Page # |
|--------------|--|--------------|--------|
| Zoo-241      | Environmental Science (Compulsory-VIII) (Univ. Optional) | 3(2+1)       | 32     |
| Zoo-242      | Plant Physiology and Ecology ( General-VII)              | 2+1          | 33     |
| Zoo-243      | Animal Diversity-II (Foundation-IV)                      | 3+1          | 37     |
| Zoo-244      | Animal Form and Function-I (Foundation-V)                | 3 + 1        | 38     |
| Zoo-245      | Animal Form and Function-II (Foundation-VI)              | 3 + 1        | 40     |

Total = 18

  
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**YEAR THREE/SEMESTER FIFTH**

| <b>Subject Code</b> | <b>Course Title</b>                    | <b>Credit Hours</b> | <b>Page #</b> |
|---------------------|--|---------------------|---------------|
| Zoo-351             | Research Methodology (General-VIII)    | 2                   | 42            |
| Zoo-352             | Developmental Biology (Foundation-VII) | 3+1                 | 43            |
| Zoo-353             | Cell & Molecular Biology (Major-II)    | 3+1                 | 44            |
| Zoo-354             | Animal Behavior (Major-III)            | 2+0                 | 45            |
| Zoo-355             | Physiology (Major-IV)                  | 3 + 1               | 45            |

**Total = 16**

**YEAR THREE/SEMESTER SIXTH**

| <b>Subject Code</b> | <b>Course Title</b>                                     | <b>Credit Hours</b> |    |
|---------------------|---|---------------------|----|
| Zoo-361             | Biological Techniques (Foundation-VIII)                 | 1+1                 | 47 |
| Zoo-362             | Evolution and Principles of Systematics (Foundation-IX) | 3+1                 | 48 |
| Zoo-363             | Biochemistry (Major-V)                                  | 3+1                 | 49 |
| Zoo-364             | Ecology (Major-VI)                                      | 3+1                 | 51 |
| Zoo-365             | Wild Life (Major-VII)                                   | 2+0                 | 52 |

**Total = 16**



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### YEAR FOUR/SEMESTER SEVENTH

| Subject Code | Course Title                               | Credit Hours | Page # |
|--------------|--|--------------|--------|
| Zoo-471      | Genetics (Major-VIII)                      | 3+1          | 53     |
| Zoo-472      | Bioinformatics (Major-IX)                  | 1+1          | 54     |
| Zoo-473      | Elective-1                                 | 2+1          | 56     |
| Zoo-474      | Special Paper (Major-X)                    | 3+1          | 56     |
| Zoo-475      | Biostatistics (Compulsory-IX)              | 2+1          | 56     |
| Zoo-476      | Research Project /Special Paper (Major-XI) | 3+0/ 2+1     | 56     |

**Total = 19**

### YEAR FOUR / SEMESTER EIGHT

| Subject Code | Course Title                                | Credit Hours | Page # |
|--------------|---|--------------|--------|
| Zoo-481      | Research Project /Special Paper (Major-XII) | 3+0/ 2+1     | 57     |
| Zoo-482      | Zoogeography and Paleontology (Major-XIII)  | 2+1          | 57     |
| Zoo-483      | Elective-II                                 | 2+1          | 58     |
| Zoo-484      | Elective-III                                | 2+1          | 58     |
| Zoo-485      | Elective-IV                                 | 2+1          | 58     |

**Total = 15**

**Eight Semesters Credit Hours: 133**

**LIST OF SPECIAL SUBJECTS**

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**LIST OF ELECTIVE SUBJECTS**

**Page # 70**

  
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**YEAR ONE /SEMESTER FIRST  
(Cr. 18)**

| Subject Code | Course Title                                | Credit Hours |
|--------------|---|--------------|
| Zoo-111      | English-I ( Compulsory-I)                   | 3            |
| Zoo-112      | Pakistan Studies ( Compulsory-II)           | 2            |
| Zoo-113      | Mathematics ( Compulsory-III)               | 3            |
| Zoo-114      | Plant Diversity ( General- I)               | 2 + 1        |
| Zoo-115      | General Chemistry ( General- II)            | 2 + 1        |
| Zoo-116      | Principles of Animal Life-I ( Foundation-I) | 3 + 1        |

**Total: 18**

**Zoo-111**

**ENGLISH-I**

**3(3+0)**

**Objectives:** Enhance language skills and develop critical thinking.

**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 verbs  
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

*Note: Extensive reading is required for vocabulary building*

**Recommended books:**

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises Third edition. Oxford University Press. 1997. ISBN 0 194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises Third edition. Oxford University Press. 1997. ISBN 0 194313506
3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 4354057 Pages 20-27 and 35-41.

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4. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 4534022.

Zoo-112

PAKISTAN STUDIES

2(2+0)

### Introduction/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 Outline

#### 1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### 2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### 3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

  
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### Books Recommended

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

Zoo-113

MATHEMATICS

3(3+0)

### Specific Objectives of the Course

To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

### Course Outline

**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

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)  
Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

Zoo-114

**PLANT DIVERSITY**

3(2+1)

**Objectives**

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

**Course Outline**

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

- a) **Viruses** (RNA and DNA types) with special reference to TMV;
- b) **Bacteria and Cyanobacteria** (Nostoc, Anabaena, Oscillatoria) with specific reference to biofertilizers, pathogenicity and industrial importance;
- c) **Algae** (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)
- d) **Fungi** (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications.
- e) **Lichens (Physcia), f) Bryophytes;** Riccia, Anthoceros, Funaria.
- g) **Pteridophytes;** Fossils and fossilization, Psilopsida (Psilotum), Lycopsida (Selaginella), Sphenopsida (Equisetum), Pteropsida (Marsilea), Seed Habit
- h) **Gymnosperms;** Cycas, Pinus, Ephedra

**Lab Outline**

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

**Recommended Books:**

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

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Zoo-115

GENERAL CHEMISTRY

3(2+1)

**Objectives:** The program is aimed that the student should learn:

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

**Contents**

Chapter 1: Atomic Structure and the Periodic Table

Chapter 2: Chemical Bonding: The Ionic Bond Model

Chapter 3: Chemical Bonding: The Covalent Bond Model

Chapter 4: Chemical Calculations: Formula Masses, Moles, and Chemical Equations

Chapter 5: Gases, Liquids and Solids

Chapter 6: Solutions

Chapter 7: Chemical Reactions

Chapter 8: Acids, Bases and Salts

Chapter 9: Nuclear Chemistry

**Practicals**

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

**Recommended Books**

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001
2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
3. Clyde Day, M. & Selbin, J., "Theoretical Inorganic Chemistry", 2<sup>nd</sup> Ed., Van Nustrand Reinhold, 1969.
4. Lee, J.D., "Concise Inorganic Chemistry", Chapman and Hall, 5<sup>th</sup> Edition, 1996.
5. Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2<sup>nd</sup> Edition, 1994.

Zoo-116

PRINCIPLES OF ANIMAL LIFE – I

4(3+1)

**Aims and Objectives**

The course aims to impart knowledge and understanding of:

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

## Course Contents

**1. Place of Zoology in Science:** A one-world view: genetic unity, the fundamental unit of life, evolutionary oneness and the diversity of life, environment and world resources; what is zoology? The classification of animals; the scientific method.

**2. The Chemical Basis of Animal Life:** Atoms and elements: building blocks of all matter; compounds and molecules: aggregates of atoms; acids, bases, and buffers; the molecules of animals: fractional account of carbohydrates, lipids, proteins, nucleotides and nucleic acids based on their structural aspects.

**3. Cells, Tissues, Organs, and Organ System of Animals:** Structure and functions of cell membranes; various movements across membranes; cytoplasm, organelles, and cellular components: functional account of ribosomes, endoplasmic reticulum, golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, and vacuoles based on their structural aspects. The nucleus: nuclear envelope, chromosomes and nucleolus. Tissues: diversity in epithelial tissue, connective tissue, muscle tissue and nervous tissue to perform various functions. Structural integrations for functions in organs and organ systems.

**4. Energy and Enzymes: Life's Driving and Controlling Forces:** Energy and the laws of energy transformation; activation energy; enzymes: structure, function and factors affecting their activity; cofactors and coenzymes; ATP: how cells convert energy? An overview.

**5. How Animals Harvest Energy Stored in Nutrients:** Glycolysis: the first phase of nutrient metabolism; fermentation: "life without oxygen"; aerobic respiration: the major source of ATP; metabolism of fats and proteins; control of metabolism; the metabolic pool.

**6. Ecology I: Individuals and Populations;** Animals and their abiotic environment; populations; interspecific interactions.

**7. Ecology II: Communities and Ecosystems;** Community structure and diversity; ecosystems; ecosystems of the earth; ecological problems; human population growth, pollution, resource depletion and biodiversity.

## Practicals

1. Tests for different carbohydrates, proteins and lipids.

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

2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac).

**Note:** Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.

3. Plasmolysis and deplasmolysis in blood.

4. Protein digestion by pepsin.

5. Ecological notes on animals of a few model habitats.

6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

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### Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 12<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 6<sup>th</sup> Edition (International), 2005. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 5<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. Comparative Anatomy of Vertebrates, 2001. New York: McGraw Hill.
5. Campbell, N.A. Biology, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Miller, S.A. General Zoology Laboratory Manual. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
7. Hickman, C.P. and Kats, H.L., Laboratory Studies in Integrated Principles of Zoology. 2000. Singapore: McGraw Hill.
8. Molles, M.C. Ecology: concepts and Applications. 6<sup>th</sup> Edition. 2005. McGraw Hill, New York, USA.
9. Odum, E. P. Fundamentals of Ecology. 3<sup>rd</sup> Edition. 1994. W.B. Saunders. Philadelphia.
10. Slingby, D. and Cook, C., Practical Ecology. 1986. McMillan Education Ltd. UK.

### YEAR ONE /SEMESTER SECOND (Cr. 15)

| Subject Code | Course Title  | Credit Hours |
|--------------|---|--------------|
| Zoo-121      | English-II ( Compulsory-IV)                             | 3            |
| Zoo-122      | Islamic Studies ( Compulsory-V)                         | 2            |
| Zoo-123      | Plant Systematics, Anatomy & Development ( General-III) | 2 + 1        |
| Zoo-124      | Organic Chemistry (General-IV)                          | 2 + 1        |
| Zoo-125      | Principles of Animal Life-II (Foundation-II)            | 3 + 1        |

**Total = 15**

**Zoo-121**

**ENGLISH- II**

**3(3+0)**

**Objectives:** Enable the students to meet their real life communication needs.

#### Course Contents

Paragraph writing; Practice in writing a good, unified and coherent paragraph, **Essay writing;** Introduction, CV and job application, Translation skills, Urdu to English, Study skills, Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension, Academic skills; Letter/memo writing, minutes of meetings, use of library and internet, Presentation skills; Personality development (emphasis on content, style and pronunciation). **Note:** documentaries to be shown for discussion and review

### Recommended book

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 194313506.
2. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 4354057 Pages 45-53 (note taking).
3. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 194354065 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
4. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 194534030.
5. Reading and Study Skills by John Langan
6. Study Skills by Richard Yorky.

Zoo-122

ISLAMIC STUDIES

2(2+0)

### Objectives

This course is aimed at:

1. To provide Basic information about Islamic Studies
2. To enhance understanding of the students regarding Islamic Civilization
3. To improve Students skill to perform prayers and other worships
4. To enhance the skill of the students for understanding of issues related to faith and religious life.

### Detail of Courses

**Introduction to Quranic Studies;** Basic Concepts of Quran, History of Quran, Uloom-ul – Quran.

**Study of Selected Text of Holly Quran:** Verses of Surah Al-Baqra Related to Faith (Verse No-284-286), Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18), Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77), Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

**Study of Selected Text of Holly Quran:** Verses of Surah Al-Ihزاب 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.

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### **Selected Study from Text of Hadith**

**Introduction To Islamic Law & Jurisprudence:** Basic Concepts of Islamic Law & Jurisprudence, History & Importance of Islamic Law & Jurisprudence, 3. Sources of Islamic Law & Jurisprudence, Nature of Differences in Islamic Law, Islam and Sectarianism

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

**Islam & Science:** Basic Concepts of Islam & Science, Contributions of Muslims in the Development of Science, Quranic & Science.

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

**Political System of Islam:** Basic Concepts of Islamic Political System, Islamic Concept of Sovereignty

**Basic Institutions of Govt. in Islam, 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.

### **Reference Books**

1. Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
2. Hameed ullah Muhammad, "Muslim Conduct of State"
3. Hameed ullah Muhammad, 'Introduction to Islam
4. Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
5. Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic ResearchInstitute, International Islamic University, Islamabad (1993)
6. Mir Waliullah, "Muslim Jrisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
7. H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
8. Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

**Zoo-123 PLANT SYSTEMATICS, ANATOMY & DEVELOPMENT 3(2+1)**

### **Specific objectives of course**

To understand 1- various systems of classification, identification and nomenclature of higher plants, 2- Structures and functions of tissues and organs at embryonic level.

### **Course outline:**

#### **a) Plant systematics**

1. Introduction to Plant Systematics: aims, objectives and importance.
2. Classification: brief history of various systems of classification with emphasis on Takhtajan.
3. Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN).Vienna code.

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4. Morphology: a detailed account of various, orphological characters root, stem, leaf, inflorescence, flower, placentation and fruit types.
5. Diagnostic characters, economic importance and distribution pattern of the following families:
  - i. Ranunculaceae, ii. Brassicaceae (Cruciferae), iii. Fabaceae (Leguminosae), iv. Rosaceae, v. Euphorbiaceae, vii. Cucurbitaceae, vii. Solanaceae, viii. Lamiaceae (Labiatae), ix. Apiaceae (Umbelliferae), x. Asteraceae (Compositae), xi. Liliaceae (Sen. Lato), xii. Poaceae (Gramineae)

**b) Anatomy**

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

- c) Development / Embryology:** 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

**Lab Outline**

**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. Mauseth, J.D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R.C., W.D. Clarke and Vodopich, D.S. 1998. Botany. McGraw Hill Company, U.S.A.
3. Raven, P.H., Evert, R.E. and Eichhorn, S.E. 1999. Biology of Plants. W.H. Freeman and Company Worth Publishers.
5. Stuessy, J.F. 1990. Plant Taxonomy. Columbia University Press, USA.
6. Lawrence, G.H.M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
7. Panday, B.P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
8. Raymond E, S. E. Eichhorn. 2005. Esau's Plant Anatomy. Meristems cells and tissues of the plant body, 3<sup>rd</sup> ed. John Wiley & Sons. Inc.
9. Fahn, A. 1990. Plant Anatomy. Pergamon Press, Oxford.
10. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
11. Maheshwari, P.1971. Embryology of Angiosperms, McGraw Hill. New York.
12. Eames A.J. and L.H Mac Daniels. 2002. An Introduction to Plant Anatomy. Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.

13. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3<sup>rd</sup> Edition Regency Publications, New Delhi.  
14. Naik, V.N. 2005 Taxonomy of Angiosperms. 20<sup>th</sup> Reprint. Tata-Mac Graw-Hill Publishing Company, Limited New Delhi.

Zoo-124

**ORGANIC CHEMISTRY**

3(2+1)

**Introduction to Organic Chemistry**

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

**Chemical Bonding and Properties of Organic Molecules**

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

**Classes and Nomenclature of Organic Compounds**

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

**Functional Group Chemistry**

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

**Recommended Literature**

(Latest available editions of the following books)

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

**Supplementary Literature** (Latest available editions of the following books)

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1. Morrison, R. T. and Boyd, R. N., "Organic Chemistry", Prentice-Hall of India, New Delhi.
2. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry Part A: Structure and Mechanisms", Kluwer Academic /Plenum Publishers, New York.
3. Sykes, P., "A Guide Book to Mechanism in Organic Chemistry", Longman, London.
4. Hand, C. W. and Blewitt, H. L., "Acid-Base Chemistry", Macmillan Publishing Company, New York.
5. McMurry, J., "Organic Chemistry", Brooks/Cole Publishing Company, California.
6. Solomons, T. W. G. and Fryhle, C. B., "Organic Chemistry", John Wiley & Sons, New York.
7. Panico, R., Powell, W. H. and Richer, J. C., "A Guide to IUPAC Nomenclature of Organic Compounds", Jain-Interscience Press, Delhi.
8. Streitwieser Jr., A. and Heathcock, C.H., "Introduction to Organic Chemistry", Macmillan Publishing Company, New York.
9. Fox, M. A. and Whitesell, J. K., "Organic Chemistry", Jones and Bartlett Publishers, London.

**PRACTICAL:** Laboratory work illustrating topics covered in the lectures.

**Zoo-125**

**PRINCIPLES OF ANIMAL LIFE-II**

**4(3+1)**

**Aims and Objectives**

The course imparts knowledge and understanding of:

- a. cell division and its significance in cell cycle.
- b. concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
- c. animal behaviour and communication.
- d. theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

**Course Contents**

**1. Cell Division**

Mitosis, cytokinesis, and the cell cycle: an overview; control of the cell cycle; meiosis: the basis of sexual reproduction; gamete formation.

**2. Inheritance Patterns**

The birth of modern genetics; Mendelian inheritance patterns; other inheritance patterns; environmental effects and gene expression.

**3. Chromosomes and Gene Linkage**

Eukaryotic chromosomes; linkage relationships; changes in chromosome number and structure.

**4. Molecular Genetics: Ultimate Cellular Control**

DNA: the genetic material; DNA replication in eukaryotes; genes in action; control of gene expression in eukaryotes; mutations; applications of genetic technologies; recombinant DNA.

**5. Animal Behaviour**

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Four approaches to animal behaviour; proximate and ultimate causes; anthropomorphism; development of behavior; learning; control of behavior; communication; behavioral ecology; social behavior.

#### 6. Evolution: A Historical Perspective

Pre-Darwinian theories of change; Lamarck: an early proponent of evolution; early development of Darwin's ideas of evolution and evidences; the theory of evolution by natural selection; evolutionary thought after Darwin; biogeography.

#### 7. Evolution and Gene Frequencies

The modern synthesis: a closer look; the Hardy-Weinberg theorem; evolutionary mechanisms: population size, genetic drift, natural selection, gene flow, mutation, and balanced polymorphism; species and speciation; rates of evolution; molecular evolution; mosaic evolution.

#### Books Recommended

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

#### Practicals

1. Study of mitosis in onion root tip. 2. Study of meiosis in grasshopper testis (students should prepare the slide).

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

3. Problem based study of Mendelian ratio in animals.
4. Multiple alleles study in blood groups.
5. Survey study of a genetic factor in population and its frequency.
6. Study of karyotypes of *Drosophila*, mosquito.
7. Study of cytochemical detection of DNA in protozoa and avian blood cell.
8. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo)
10. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill
11. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

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**YEAR TWO /SEMESTER THIRD (Cr. 16)**

| Subject Code | Course Title                       | Credit Hours      |
|--------------|------------------------------------|-------------------|
| Zoo-231      | English-III                        | 3                 |
| Zoo-232      | Introduction to Computer           | 1+2               |
| Zoo-233      | Cell Biology, Genetics & Evolution | 2+1               |
| Zoo-234      | Environmental Chemistry            | 2 + 1             |
| Zoo-235      | Animal Diversity-I                 | 3 + 1             |
|              |                                    | <b>Total = 16</b> |

**Zoo-231**

**ENGLISH-III**

**3(3+0)**

**Objectives**

Enhance language skills and develop critical thinking

**Course Contents**

Presentation skills, Essay writing, Descriptive, narrative, discursive, argumentative academic writing. How to write a proposal for research paper/term paper. How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency). Technical Report writing, Progress report writing.

**Note:** Extensive reading is required for vocabulary building

**Recommended books**

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
4. The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

**Zoo-232**

**INTRODUCTION TO COMPUTER 3(1+2)**

**Objectives**

This course focuses on a breadth-first coverage of computer science discipline, introducing computing environments, general application software, basic computing hardware, operating systems, desktop publishing, Internet, software applications and tools and computer usage concepts; Introducing Software engineering and Information technology within the broader domain of computing, Social issues of computing.

**Course Outline**

Number Systems, Binary numbers, Boolean logic, History computer system, basic machine organization, Von Neumann Architecture, Algorithm definition, design, and implementation, Programming paradigms and languages, Graphical programming, Overview of Software

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Engineering and Information Technology, Operating system, Compiler, Computer networks and internet, Computer graphics, AI, Social and legal issues.

#### Reference Material

1. Computers: Information Technology in Perspective, 9/e by Larry Long and Nancy Long,
2. Prentice Hall, 2002 / ISBN: 0130929891
3. *An Invitation to Computer Science*, Schneider and Gersting, Brooks/Cole Thomson Learning, 2000
4. *Computer Science: An overview of Computer Science*, Sherer,

Zoo-233

CELL BIOLOGY, GENETICS & EVOLUTION

3(2+1)

#### Specific Objectives

To understand 1- structure and functions of cell, 2-nature of genetic material and hereditary process 3- familiarization with evolutionary processes.

#### Course outline

##### Cell biology

1. Structures and Functions of Bio-molecules
  - ii. Carbohydrates, iii. Lipids, iv. Proteins, v. Nucleic Acids
2. Cell: Physico-chemical nature of plasma membrane and cytoplasm
3. Ultrastructure of plant cell with a brief description and functions of the following organelles
  - i. Cell wall, ii Endoplasmic reticulum, iii. Plastids, vi. Mitochondria, v. Ribosomes, vi. Dictyosomes, vii. Vacuole, viii. Microbodies (Glyoxysomes and Peroxisomes)
4. Nucleus: Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotype analysis
5. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
6. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

##### Genetics

1. Introduction, scope and brief history of genetics. Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross, dominance and incomplete dominance.
2. Sex linked inheritance, sex linkage in *Drosophila* and man (colour blindness), XO, XY, WZ mechanisms, sex limited and sex linked characters, sex determination.
3. Linkage and crossing over: definition, linkage groups, construction of linkage maps, detection of linkage.
4. Molecular genetics; DNA replication. Nature of gene, genetic code, transcription, translation, protein synthesis, regulation of gene expression (e.g. *lac* operon).
5. Transmission of genetic material in Bacteria: Conjugation and gene recombination in *E. coli*, transduction and transformation.
6. Principles of genetic engineering / biotechnology; Basic genetic engineering techniques.

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

### **Evolution**

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

### **Lab Outline**

#### **Cell Biology**

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

#### **Genetics**

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

#### **Recommended Books**

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

Zoo-234

ENVIRONMENTAL CHEMISTRY

3(2+1)

### **Objectives of the Course**

From this course, the students should be able to:

- Understand the fundamental principles of environmental chemistry.
- Apply these principles in pollution related subjects.
- Demonstrate the understanding of environmental chemistry principles via experimental exercises in the laboratory.

### Course Outlines

Atmospheric Chemistry: The air around us, atmospheric temperature and pressure profile, Temperature inversion and photochemical smog, particulate matter in the atmosphere, Industrial pollutants, radioactivity, atmospheric aerosols, Acid rain—major sources, mechanism, control measures and effects on buildings and vegetation, Global warming—major greenhouse gases, mechanism, control measures and global impact, The stratospheric ozone—the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Water Pollution and Water Treatment: Sources of water pollution—industrial sources and agricultural sources, heavy metals contamination of water, Eutrophication, detergents and phosphates in water, water quality criteria, Water purification—primary, secondary and advanced treatment, Removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Soil Pollution: Soil and mineral resources, general principles of metal extraction, Heavy metals contamination of soil, toxicity of heavy metals, bio-accumulation of heavy metals, Organic matter in soil, Macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Revolution: Pest control, pesticides, toxicity of pesticides, integrated pest management.

Energy Production and Environment: Liquid and gaseous fuel, hydrogen economy.

Renewable Energy: Nuclear energy, solar energy, geothermal and tidal energy.

### Recommended Text Books

Latest editions of the following books:

1. Collin Baird, Environmental Chemistry, W. H. Freeman and company, New York, 1995.
2. John W. Moore and Elizabeth A. Moore, Environmental Chemistry, Academic Press Inc., New York, 1976.
3. Anil Kumar De, Environmental Chemistry, Wiley Eastern Ltd. New Delhi, 1989.
4. R. W. Raiswell, P. Brimblecombe, D. L. Dent and P. S. Liss, Edward Arnold Ltd., London, 1980.
5. Staneley E. Manahan, Environmental Chemistry, Brooks, California.

**Recommended Reference Books** (Latest editions of the following books):

1. Peter O. Neill, Environmental Chemistry, Chapman and Hall, London, 1993.
2. Derek M. Elsom, Atmospheric Pollution, Blackwell Publishers, Oxford, 1992.
3. Geoffrey Lean and Don Hinrichsen, Atlas of the Environment, Helicon Publishing Ltd., Oxford, 1992.

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**Recommended Journals/Periodicals (Journals Related to):**

1. Atmospheric Chemistry.
2. Air Pollution.
3. Water Pollution.
4. Soil Pollution/Soil sciences.
5. Environmental Technology.

**Recommended World Web (Web Sites related to):**

1. Global Warming/Green House Effect.
2. Ozone depletion.
3. Acid Rain
4. Environmental Pollution
5. Energy Conservation

**Zoo-235**

**ANIMAL DIVERSITY-I**

**4(3+1)**

**Aims and Objectives**

The course is designed to provide students with:

- a. concepts of evolutionary relationship of animal kingdom.
- b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

**Course Contents**

**1. Introduction**

Classification of organisms; evolutionary relationships and tree diagrams; patterns of organization.

**2. Animal-Like Protists: The Protozoa**

Evolutionary perspective; 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.

**3. Multicellular and Tissue Levels of Organization**

Evolutionary perspective: 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.

**4. Triploblastics and Acoelomate Body Plan**

Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations.

**5. Pseudocoelomate Body Plan: Aschelminths**

Evolutionary perspective; 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.

**6. Molluscan Success**

Evolutionary perspective: 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.

#### **7. Annelida: The Metameric Body Form**

Evolutionary perspective: relationship to other animals, metamerism and tagmatization; classification up to class. External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development, in polychaeta, oligochaeta and hirudinea; further phylogenetic considerations.

#### **8. Arthropods: Blueprint for Success**

Evolutionary perspective: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations.

#### **9. Hexapods and Myriapods: Terrestrial Triumphs**

Evolutionary perspective; classification up to class. External structure and locomotion, nutrition and the digestive system, gas exchange, circulation and temperature regulation, nervous and sensory functions, excretion, chemical regulation, reproduction and development in hexapoda; insect behavior; insects and humans; further phylogenetic considerations.

#### **Books Recommended**

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

#### **Practicals**

1. Study of *Euglena*, *Amoeba*, *Entamoeba*, *Plasmodium*, *Trypanosoma*, *Paramecium* as representative of animal like protists. (Prepared slides).
2. Study of sponges and their various body forms.
3. Study of principal representative classes of phylum Coelenterata.
4. Study of principal representative classes of phylum Platyhelminthes.
5. Study of representative of phylum Rotifera, phylum Nematoda.
6. Study of principal representative classes of phylum Mollusca.
7. Study of principal representative classes of phylum Annelida.
8. Study of principal representative classes of groups of phylum Arthropoda.

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9. Brief notes on medical/economic importance of the following: *Plasmodium*, *Entamoeba histolitica*, *Leishmania*, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.
10. Preparation of permanent stained slides of the following: *Obelia*, *Daphnia*, Cestode, Parapodia of *Nereis*.

**Books Recommended**

1. Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles OF Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A., General Zoology Laboratory Manual. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

**YEAR TWO /SEMESTER FOURTH (Cr. 18)**

| Subject Code | Course Title                 | Credit Hours |
|--------------|------------------------------|--------------|
| Zoo-241      | Environmental Science        | 3(2+1)       |
| Zoo-242      | Plant Physiology and Ecology | 2+1          |
| Zoo-243      | Animal Diversity-II          | 3+1          |
| Zoo-244      | Animal Form and Function-I   | 3 + 1        |
| Zoo-245      | Animal Form and Function-II  | 3 + 1        |

**Total = 18**

**Zoo-241 ENVIRONMENTAL SCIENCE 3(2+1)**

**Objectives**

To provide students with the knowledge necessary for pollution abatement, conservation and wise use of natural resources for the benefit of society.

**Theory**

The Environmental Challenges We Face; Environmental Sustainability and Human Values; Environmental History, Politics, and Economics; Risk Analysis and Environmental Health Hazards; How Ecosystems Work; Ecosystems and Evolution; Human Population Change and the Environment; Air and Air Pollution; Global Atmospheric Changes; Freshwater Resources and Water Pollution; The Ocean and Fisheries; Mineral and Soil Resources; Land Resources; Agriculture and Food Resources; Biological Resources; Solid and Hazardous Waste; Nonrenewable Energy Resources; Renewable Energy Resources.

**Practical**

1. Testing Water for Coliform Bacteria
2. Effects of Environmental Pollutants on *Daphnia*
3. Density of Invasive Species
4. Do Plants Grow As Well in Gray Water As in Tap Water?
5. Build and Use a Turbidity Tube
6. What Do People Throw Away?
7. Solar Energy
8. The Safety of Reusing Water Bottles
9. Wind Energy
10. Test for Ozone

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11. Biodegradation of Oil
12. The Taste Test
13. Solar Water Heater
14. Population Growth in Yeast
15. How Does Acid Precipitation Affect Coleus?
16. Effects of Nitrates on Duckweed Populations
17. Seeds for the Future
18. Design a Reusable Envelope
19. Algae As Biofuel
20. Energy in Ecosystems

### Recommended Books

1. Botkin, D and Keller, E, 2000. *Environmental Science: Earth as a Living Planet*. 8th ed. John Wiley and Sons, Inc.
2. Cunningham, W P, Saigo, B W, 2001. *Environmental Science*. 6<sup>th</sup> ed. McGraw-Hill.
3. Enger, E D and Smith, B F, 1997. *Environmental Science: A Study of Interrelationships*. Mc Graw-Hill.
4. Kupchella, C E and Hyland, M C, 1986. *Environmental Science: Living within the System of Nature*. Prentice Hall.
5. Nebel, B J and Wright, R T, 1999. *Environmental Science*, 6th ed. Prentice Hall. Upper Saddle River, New Jersey.

Zoo-242

PLANT PHYSIOLOGY AND ECOLOGY

3(2+1)

### Objectives


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

### Course outline

#### a) Plant Physiology

1. Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water. Stomata regulation.
2. Mineral nutrition: Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.
3. Photosynthesis: Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions(Calvin cycle). Differences between C<sub>3</sub> and C<sub>4</sub> plants. Factors affecting this process, Products of photosynthesis.

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4. Respiration: Definition and respiratory substrates. Mechanism of Glycolysis, Krebs cycle, Electron transport Chain and oxidative phosphorylation. Anaerobic respiration. Energy balance in aerobic and anaerobic respiration, Respiratory quotients.

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

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

7. Dormancy: Definition and causes of seed and bud dormancy; methods of breaking seed dormancy. Physiological processes during seed germination. 8. Plant Movements: Classification. Tropic movements-phototropism, gravitropism and their mechanisms. Nastic movements.

#### **b) Ecology**

1. Introduction, aims and applications of ecology.

2. **Soil:** Physical and Chemical properties of soil (soil formation, texture, pH, EC, organism and organic matter etc) and their relationships to plants.

3. **Light and Temperature.** Quality of light, diurnal and seasonal variations. Ecophysiological responses.

4. **Water:** Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants.

5. **Wind:** Wind as an ecological factor and its importance.

6. **Population Ecology:** Introduction. A brief description of seed dispersal, seed bank, demography, density effects and reproductive strategy.

7. **Community Ecology:** i. Ecological characteristics of plant community, ii. Methods of sampling vegetation (Quadrat and line intercept), iii. Succession, iv. Major vegetation types of the local area.

#### **8. Ecosystem Ecology**

i. Definition, types and components of ecosystem, ii. Food chain and Food web, iii. Biogeochemical cycles, definition, types with emphasis on Nitrogen & Hydrological cycles.

#### **9. Applied Ecology**

i. Causes, effects and control of water logging and salinity with respect to Pakistan, ii. Soil erosion: types, causes and effects (wind and water), iii. Brief concept of pollution types and

effects (air, sediments and water pollution), iv. Brief introduction to biodiversity and conservation with emphasis on Pakistan.

### **Lab Outline:**

#### **a) Plant Physiology**

1. Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
2. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
3. Measurement of leaf water potential by the dye method.
4. Determination of the temperature at which beet root cells lose their permeability.
5. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a porometer/by cobalt chloride paper method.
6. Chemical tests for the Starch, Cellulose, Lignin, Proteins,
7. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram. Study of absorption spectra using spectrophotometer.
8. Estimation of oxygen utilized by a respiring plant by Winkler's method.
9. Extraction of amylase from germinating wheat seeds and study of its effect on starch breakdown.
10. Measurement of carbon dioxide production during respiration of germinating seeds by the titration method.
11. Measurement of light and temperature.
12. Effect of light and temperature on seed germination.

#### **b) Ecology**

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

### **Recommended Books:**

1. Ihsan Illahi 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
2. Witham and Devlin. 1986 Exercises in Plant Physiology, AWS Publishers, Boston.

3. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th. Ed. Sinauers Publ. Co. Inc. Calif.
4. Salisbury F.B. and Ross C.B. 1992. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
5. Hopkins, W.B. 1999. Introduction to Plant Physiology. 2nd Ed. John Wiley and Sons. New York
6. Schultz, J.C. 2005. Plant Ecology. Springer-Verlag, Berlin.
7. Ricklefs, R.E. 2000. Ecology. W.H. Freeman and Co., UK.
8. Ricklefs, R.E. 2001. The Economy of Nature. W.H. Freeman and Co., UK.
9. Barbour, M. G., J. H. Burke and W.D. Pitts. 1999. Terrestrial Plant Ecology, The Benjamin, Cumming Publishing Co. Palo Alto, California, USA.
10. Chapman, J.L. and Reiss, M.J. 1995. Ecology: Principles and Applications. Cambridge University Press.
11. Hussain F. 1989. Field and Laboratory Manual of Plan Ecology. National Academy of Higher Education, Islamabad.
12. Hussain, S.S. 1989. Pakistan Manual of Plant Ecology; National Book Foundation, Islamabad.
13. Larcher, W. 2003 Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functions Groups – Springer Verlag.
14. Krebs, C. J. 1997. Ecology. Harper and Row Publishers.
15. Smith, R. L. 1996. Ecology and Field Biology. Addison Wesley Longman, Inc., New York.
16. Smith, R. L. 1998. Elements of Ecology. Harper and Row Publishers, New York.
17. Smith, R. L. 2004. Ecology and field biology. Addison Wesley Longman, Inc., New York.
18. Subrahmanyam, N.S. and Sambamurthy, A.V.S.S. 2000. Ecology. Narosa Publishing House, New Delhi.
19. Townsend, C.R., Harper, J.L. and Begon, M.E. 2002. Essentials of Ecology. Blackwell Scientific Publications, UK.
20. Odum, E.P. 1985. Basic Ecology. W.B. Saunders.

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**Aims and Objectives**

The course provides knowledge and understanding about the different animal groups, emphasizing their phylogenetic relationships.

**Course Contents****1. Echinoderms**

Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cyclophores, and chaetognaths.

**2. Hemichordates and Invertebrate Chordates:**

Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations.

**3. Fishes: Vertebrate Success in Water**

Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

**4. Amphibians: The First Terrestrial Vertebrates**

Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations.

**5. Reptiles: The First Amniotes**

Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhychocephalia, squamata, and crocodilia; evolutionary pressures: 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.

**6. Birds: Feathers, Flight, and Endothermy**

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

**7. Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity**

Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

### Books Recommended

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

### Practicals

1. Study of a representative of Hemichordate and Invertebrate Chordate.
2. Study of representative groups of class Fishes.
3. Study of representative groups of class Amphibia.
4. Study of representative groups of class Reptilia.
5. Study of representative groups of class Aves.
6. Study of representative groups of class Mammalia.
7. Field trips to study animal diversity in an ecosystem.

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

### Books Recommended

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
2. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

**Zoo-244**

**ANIMAL FORM AND FUNCTION-I**

**4(3 + 1)**

### Aims and Objectives

The course aims to teach the students about:

- a. Animals diversity adapted in different ways for their functions through modifications in body parts.
- b. 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.
- c. Organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
- d. The basic structure of each system that determines its particular function.

## Course Contents

### 1. 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.

### 2. Communication I: Nerves

Neurons: structure and function; 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 spinal cord, spinal nerves, the brain, cranial nerves and the autonomic nervous system.

### 3. 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, hearing and equilibrium in water, skin sensors of damaging stimuli, skin sensors of heat and cold, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

### 4. 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, nemertean, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals.

### 5. 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.

## Books recommended

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

### Practicals

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of *Labeo*, *Rana tigrina*, *Varanus*, fowl and rabbit.  
*Note: Exercises of notes on the adaptations of skeletons to their function must be done.*
3. Earthworm or leech; cockroach, freshwater mussel, *Channa* or *Catla catla* or *Labeo* or any other local fish, frog, pigeon and rat or mouse and rabbits are representative animals for study in dissections.
4. Study of models or preserved brains of representative animals and notes on adaptations.
5. Study of nervous system of earthworm and a fish.
6. Study of endocrine system in an insect and a rabbit.
7. Study of different types of blood cells in blood smear of rabbit.
8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

### Books Recommended

1. Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles of Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A. General Zoology Laboratory Manual. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

Zoo-245

ANIMAL FORM AND FUNCTION-II

4 (3 + 1)

### Aims and Objectives

The course deals with the:

- a. Basis of structure and functions of animal nutrition, digestion, homeostasis and temperature regulation.
- b. It introduces the basic concepts in reproduction and development in animal kingdom.
- c. Provides knowledge about the development of chordate body plan and fate of germinal layers.

### Course Contents

#### 1. 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.

#### 2. 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.

### 3. 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

### 4. 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, the fate of mesoderm.

### Books Recommended

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

### Practicals

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

**Note for 9-10:** Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

### Books Recommended

1. Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles of Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A. General Zoology Laboratory Manual. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

**YEAR THREE / SEMESTER FIFTH (Cr. 16)**

| Subject Code | Course Title             | Credit Hours |
|--------------|--------------------------|--------------|
| Zoo-351      | Research Methodology     | 2            |
| Zoo-352      | Developmental Biology    | 3+1          |
| Zoo-353      | Cell & Molecular Biology | 3+1          |
| Zoo-354      | Animal Behavior          | 2+0          |
| Zoo-355      | Physiology               | 3 + 1        |

**Total = 16**

**Zoo-351**

**RESEARCH METHODOLOGY**

**2(2+0)**

**Objectives of course**

To enable the students to know the theoretical aspects of planning research, handling, presentation of data, writing and submission of research papers and thesis.

**Course Outline**

What is science, philosophy and theory, how to do science. Questions, hypothesis, their types, experimentation, validation, theories and laws. Research Methods (planning research, various methods, analyzing results, giving reports, etc.) research process including: formulating research questions; sampling (probability and nonprobability); measurement (surveys, scaling, qualitative, unobtrusive); research design (experimental and quasi-experimental); data analysis; and, writing the research paper, the major theoretical and philosophical underpinnings of research including: the idea of validity in research; reliability of measures; and ethics.

**Recommended Books**

1. Shank, G. D. 2002. Qualitative research : a personal skills approach. Upper Saddle River, N.J.Columbus, Ohio: Prentice Hall;Merrill/Prentice Hall.
2. Brizuela, B. M. 2000. Acts of inquiry in qualitative research. Cambridge, MA: Harvard Educational Review
3. Shank, G. D. 2001, Qualitative Research: A Personal Skills Approach

*[Handwritten Signature]*  
Assistant Registrar (Academics)  
University of Malakand

**Aims and 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 oncogenesis. The concept related to the theory in Developmental Biology will be practically demonstrated in this course. In the continuity of the animals during reproduction following the union of the traits from the parents in their gametes, the zygote proceeds through enormous phenomena of development up to their emergence resembling to the parents. The concepts of all these developmental mechanisms will be communicated to the students in this course.

**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.**

**Books Recommended**

1. Gilbert, S. F. Developmental Biology, 2006. Sinauer Associates, Sunderland, MA.
2. Balinsky, B. I. an Introduction to Embryology, 1985. Saunders.
3. Saunders, J. W. Developmental Biology, 1982. McMillan and company.
4. Oppenheimer, S.S. Introduction to Embryonic Development, 1984. Allen and Bacon.
5. Ham, R. G. and Veomett, M. J. Mechanism of Development. 1980. C. V. Mosby Co.
6. Klaus, K. Biological Development. 2<sup>nd</sup> Edition, 2001. McGraw Hill.

**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.

*[Handwritten Signature]*  
Assistant Registrar (Academics)  
University of Rajasthan

**Aims and Objectives**

Objectives of the course are to impart knowledge about the animal cell and its complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms. The various ultra-structural, molecular and functional aspects of the cells will be communicated in this course.

**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 with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus (with reference to its role in synthesis of glycoprotein), Mitochondria (with reference to its role in cellular respiration, and its significance as semi-autonomous organelle), Lysosome (with reference to its diverse roles due to hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glyoxysome (with reference to glyoxylic acid cycle).

Nucleus, chromatin, heterochromatin, euchromatin, chromosome structure with reference to 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 special reference to 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 (with reference to the specific role of Ribosomes, various factors, and posttranslational processing). Control of Gene expression in Prokaryotes.

**Books Recommended**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. Molecular Biology OF The Cell, 1989. Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H. and Balimore, D. Molecular Cell Biology, 1990. Scientific American Inc. N.Y.
3. De Robertis, E. D. P. and De Robertis Jr. E. N. F. Cell and Molecular Biology, 1987. Lea & Febiger, New York.
4. Karp, J. Cell and Molecular Biology, Concepts and Experiments, 2005. Jhon Wiley and Sons, INC.
5. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2007. Sinauer Associates, INC.

**Practicals**

1. Detection and quantitative determination of chromosomal DNA and RNA.
2. Cultural and staining of bacteria and yeast.
3. Identification of different type of blood cells in human blood through smear technique.
4. Counting of prokaryotic cells (bacteria) and blood cells by using haemocytometer.
5. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).
6. Separation of different sized DNA fragments on agarose gel.

Zoo-354

ANIMAL BEHAVIOUR

2(2+0)

**Course Contents**

Mechanism of behavior: Nervous system and behavior, hormones and behavior, biological rhythm, development of behavior, learning behavior, communication. Social organization: conflict, sexual reproduction, parental care, social system.

**Books Recommended**

1. Goodenough, J., McGuire, B. and Wallace, R.A. Perspective on Animal Behaviour. 2001. John Wiley & Sons, New York.
2. Scott, G. Essential Animal Behaviour. 2005. Blackwell Pub. New York
3. Dngatkin, L. A. Principles of Animal Behaviour. 2006. W.W. Norton and Co. New York.

Zoo-355

PHYSIOLOGY

4(3+1)

**Aims and Objectives**

The basic functional expression in animals is the membrane irritability understood in the form of nerve impulse. This course particularly imparts the concepts and mechanisms of integration in the different functional systems of the animals. These mainly constitute the mechanisms of nervous system and the hormonal system for the coordination. The motility and locomotion also contributes in the integration of the animal to its environment, therefore, also included in this section.

**Course Contents**

**Central themes in Physiology:** Structure-function relationship, Adaptations, Homeostasis, Conformity and Regulation.

**Physiological basis of Membrane Function:** Mechanisms in resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Diffusional potentials, Ion channels, Ionic mechanisms in action potentials: Roles of ion channels, Properties of action potential. Propagation of action potential in neurons; Synaptic transmission; Structure and function of electrical synapse structure and function of chemical synapse; Neurotransmitters; Synaptic receptors; Excitatory postsynaptic potentials; Inhibitory postsynaptic potentials; Presynaptic inhibitions; Integration at synapses: Facilitation, Posttetanic Potentiation.

**Receptors Physiology:** Transduction; Sensory coding; Range fractionation; Sensory adaptations;

**Mechanoreception:** Hair cell mechanism particularly in acoustico-lateralis system of vertebrates; Cutaneous receptors; Cellular and molecular mechanisms in taste and olfactory reception; Photoreception: Ultrastructure of photoreceptors, Photochemistry, Phototransduction and physiological basis of color vision; Physiological mechanisms in electroreception.

**Chemical Messenger and Regulators/Endocrine Physiology:** Types and functions of secretions. An overview of invertebrate endocrine structures, their hormones and physiological roles. An overview of hormones, their chemistry and physiological roles of Hypothalamus, Pituitary, Thyroid, Parathyroid and associated structures, Endocrine pancreas, Gastropancreatic system, Adrenal medulla (Chromaffin Tissue), Adrenal cortex, Ovary, Testis and Placenta. A generalized model account of hormone synthesis, storage and secretion (a peptide hormone

model and steroid hormones); Hormonal interactions in metabolic and developmental function; Water and electrolyte balance and reproduction. Integrated endocrine and neural responses in glycemia and calcium homeostasis and reproductive cycles; General account of hormonal regulations, hormonal turnover, recognition; Mechanisms of action in hormones involving membrane receptors and nuclear modulated gene expression; Endocrine functions of kidneys, heart and pineal gland.

**Movements and Muscles:** Structural basis of muscle contraction: molecular structures of contractile components and their interaction, sarcoplasmic reticulum, calcium and membrane mechanisms in regulation of contraction.

**Cardiovascular Mechanisms:** Electrical activity of heart: Automaticity, Rhythmicity, Electrocardiography, Kymography; Hemodynamics, Blood flow, pressures and resistance and their interrelationships. Control of cardiac activity (cardiac output) and peripheral circulation.

**Exchange of Gases:** Transport of O<sub>2</sub> and CO<sub>2</sub> between respiratory surface (the lungs) and body cells. Regulation of lungs respiration; Gas transfer in water (gills) and its regulation. Respiratory responses in extreme conditions as hypoxia; Hypercapnia in air breathing divers.

**Excretion and Osmoregulation:** Osmoregulation in aquatic and terrestrial environment. Vertebrate nephron as osmoregulatory organ: Physiological anatomy, Glomerular filtration, Tubular absorption and secretion; Nitrogenous waste products; Patterns of nitrogenous excretion and their phylogenetic development.

**Nutrition:** Regulation of digestive secretions; Physiological anatomy of digestive tract (mammalian model), Absorption of water, ions and nutrients; Potential and Movements in gastrointestinal tract; Control of motility.

**Temperature Relations:** Temperature classification of animals; Temperature relation of ectotherms in freezing and cold and warm and hot environment; Costs and benefits of ectothermy; Temperature relations of heterotherms and endotherms; Dormancy: Sleep, Torpor, Hibernation, Estivation.

### Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5<sup>th</sup> Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4<sup>th</sup> Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. Principles of Physiology, 3<sup>rd</sup> Edition. 2000. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, 10<sup>th</sup> Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. Comparative Animal Physiology. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. Animal Physiology, Adaptation and Environment, 5<sup>th</sup> Edition. 1997. Cambridge University Press, Cambridge.
7. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4<sup>th</sup> Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.

### 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.

#### Books Recommended

1. Tharp, G. and Woodman, D. Experiments in Physiology, 8<sup>th</sup> Edition. 2002. Prentice Hall, London.

#### YEAR THREE /SEMESTER SIXTH (Cr. 16)

| Subject Code | Course Title                            | Credit Hours |
|--------------|---|--------------|
| Zoo-361      | Biological Techniques                   | 1+1          |
| Zoo-362      | Evolution and Principles of Systematics | 3+1          |
| Zoo-363      | Biochemistry                            | 3+1          |
| Zoo-364      | Ecology                                 | 3+1          |
| Zoo-365      | Wild Life                               | 2+0          |

**Total = 16**

**Zoo-361**

**BIOLOGICAL TECHNIQUES**

**2(1+1)**

#### Contents (Theory and Practical)

**Microscopy:** Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, 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).

**Specimen preparation for optical microscopy.**

**Standard system for weight, length and volume.** Preparation of stock solutions of various strengths.

**Micotomy:** Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections.

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

**Separation Techniques:** Chromatography: Principle, applications, types, thin layer, paper, 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.

#### **Books Recommended**

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

**Zoo-362**

### **EVOLUTION AND PRINCIPLES OF SYSTEMATICS**

**4(3+1)**

#### **Aims and Objectives**

The course is designed to provide in depth knowledge or origin of life, and about forces responsible for evolutionary changes. The students will be taught basic rules and regulations about the identification and naming of organisms.

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

#### **Course Contents**

**Evolution:** The nature and origin to life. Evidences of evolution. (molecular, embryological & paleontological). Theories to explain the diversity of life - Modern synthetic theory.

Factors initiating elementary evolutionary changes (micro-evolution) by changing gene frequencies, mutation pressure, selection pressure, immigration and crossbreeding, genetic drift. Role of isolation in evolution. Factors of large evolutionary changes (macro/mega evolution) - allometry, orthogenesis, adaptive radiation.

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

**PRINCIPLES OF SYSTEMATICS:** 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, infraspecific category, higher categories; species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept), species mate recognition concept; non-dimensional 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.

### **Books Recommended**

#### **Evolution**

1. Ridley, M. Evolution. 1993. Blackwell Scientific Publications.
2. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. EVOLUTION. 1973. W.H. Freeman and Company.
3. Dobzhansky, T. Genetics and the Origin of Species, 1951. Columbia University Press, New York.
4. Mayr, E. Populations, Species and Evolution, 1965. Harvard University Press.
5. Moody, P.A. Introduction to Evolution, 1989. Harper and Row Publishers, New York.
6. Strickberger. M.W. Evolution. 2000. Jones & Barrett Publishers

#### **Systematic Zoology**

1. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York.
2. Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw Hill, New York
3. Mayr, E. Animal Species and Evolution, 1985. Harvard University Press.
4. Heywood, V.H. Taxonomy and Ecology. 1975. Academic Press, London.
5. Whili, M.J.D. Modes of Speciation, 1978. W.H. Freeman and Co., San Francisco.

#### **Practicals**

Study of preserved invertebrate species and their classification upto 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.

**Zoo-363**

**BIOCHEMISTRY**

**4(3+1)**

#### **Aims and Objectives**

The course will provide in depth knowledge about the polymerized organic compounds of life. The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It will deal with the inter-conversion is performed by various tools called as enzymes. Thus, in this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

#### **Course Contents**

**Amino acids, peptides and proteins:** standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; natural modifications of amino acids in proteins; non-standard amino acids, their structure and role; peptides, their ionic behavior and amino acid composition, cytochrome c; Macromolecular separation techniques in

biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation.

**Enzymes:** introduction; important characteristics of enzymes; immobilized enzymes; how enzymes work; example of enzymatic reaction; enzyme kinetics, enzyme rate of reaction and substrate concentration, how pH and temperature effect enzyme activity; kinetics of bisubstrate and multisubstrate reactions.

**Carbohydrates:** classification, types, important characteristics and structure of carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin formation; disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides.

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

**Vitamins and cofactors:** occurrence, structure and biochemical function of vitamins of b-complex group.

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

**Metabolism:** detailed description of glycolysis and catabolism of other hexoses; regulation and bioenergetics of glycolysis. Anabolic role of glycolysis; fate of pyruvate under aerobic and anaerobic conditions, lactate, acetyl CoA and ethanol formation; alcoholic fermentation; gluconeogenesis, its regulation and significance in the tissues; feeder pathways in glycolysis; utilization of other carbohydrates in glycolysis; phosphorylation of glycogen and starch; regulation of glycogen metabolism; utilization of dietary polysaccharides (starch) and disaccharides (sucrose and galactose). Biosynthesis of glycogen, starch and sucrose.


**Citric acid (TCA) cycle:** conversion of pyruvate to acetyl CoA, pyruvate dehydrogenase, a multi-enzyme complex; detailed description of citric acid cycle; bioenergetics and conservation of energy produced in the cycle. Anabolic or biosynthetic role of citric acid cycle intermediates; replenishing or anaplerotic reactions and their role; regulation of citric acid cycle.

**Lipid metabolism:** oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis of triacylglycerol; utilization of triacylglycerol; activation of fatty acids and their transportation to mitochondria; beta-oxidation; bioenergetics of beta-oxidation; oxidation of unsaturated and odd chain fatty acids; omega oxidation pathway; biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; fatty acid synthetase (FAS) multienzyme complex; biosynthesis of unsaturated fatty acids. Ketone bodies their biosynthesis, utilization and role in the tissues; cholesterol metabolism: cholesterol biosynthesis and its regulation; steroid hormones.

**Nitrogen metabolism:** metabolic fate of amino acids; catabolism of amino acids; deamination and transamination; nitrogen excretion and urea cycle; regulation of urea cycle; Biosynthesis of some amino acids; incorporation of ammonia in glutamate and glutamine; purine and pyrimidine.

### Books Recommended

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 3<sup>rd</sup> Edition, 2000. McMillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 25<sup>th</sup> Edition, 2000. McGraw Hill, New York.
3. Voet, D., Voet, J.G., and Pratt, C.W. Fundamentals of Biochemistry, 1999. 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, 1995. W.H. Freeman & Company, New York.
6. McKee, T. and McKee, J.R. Biochemistry. The Molecular Basis of Life. 3<sup>rd</sup> Edition, 2003. McGraw Hill

### Practicals

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

### Books Recommended

1. Plummer, David T. An Introduction to Practical Biochemistry, 1990. 4<sup>th</sup> Edition McGraw-Hill Book Company, London.
2. Wilson, K & Walker, J. Practical Biochemistry: Principles and Techniques, 4<sup>th</sup> Edition, 1994. Cambridge University Press.

Zoo-364

ECOLOGY

4(3+1)

### Aims and Objectives

The aim of this course is to make the students aware that all the living organisms including human beings are part of the environment, which consists of biotic and abiotic factors. The abiotic factors consist of all the physical factors while biotic factors include all the living things. However with the increase in population densities increase in productivity is also needed. High technology measures used for this purpose have caused various problems like pollution.

### Course Contents

An overview of concepts of ecosystem with emphasis on interaction and homeostasis. Basic global ecosystems (atmosphere, hydrosphere, lithosphere, ecosphere). Biogeochemical cycle: nitrogen, phosphorus, sulphur, water, carbon, nutrient. Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire. Energy: laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. Population ecology: basic population characters, growth and growth curves, population dynamics and regulations. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions. Ecological niche: basic concepts and types. An overview of major biomes of the world. Applied Ecology: Resources and their ecological management (mineral, agricultural and forest, range management, desalination and

weather modification, landscape and land use); Pollution (definition, types, cost, origin and management); water (sources, domestic and industrial pollution, heavy metals, water purification, waste water treatment); air (sulphur dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE & CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution. Radiation. Space biology. Contemporary environmental themes: (ozone depletion, acid rain, greenhouse effect and global warming, desertification, deforestation, exotic and invasive species, radioactivity leakage, environmental laws).

### Books Recommended

1. Odum, E. P. 1994. Fundamentals of Ecology. 3<sup>rd</sup> Edition W.B. Saunders. Philadelphia.
2. Molles, M.C. 2005 Ecology: Concepts and Applications. 6<sup>th</sup> Edition, McGraw Hill, New York, USA.
3. Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E. and Turner, M.G., 1998. Ecology. Oxford Univ. Press, UK.
4. Slingsby, D. and Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK.
5. Chapman, J.L. and Reiss, M.J. 1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.
6. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
7. Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford. UK.
8. Cox, C.B and Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6<sup>th</sup> Edition. Life Sciences King's College, London, UK.

### Practical

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 dynamics of grasshoppers. Adaptive features of animals in relation to food and environment. Food chain studies through analysis of gut contents. Analysis of polluted and fresh water for biotic and abiotic variations. Field visits for study of selected terrestrial habitat and writing notes. Development of an ecological management plan of some selected area.

**Zoo-365**

**WILDLIFE**

**2(2+0)**

### Course Contents

Wildlife of Pakistan, identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan. Philosophy and significance of wildlife conservation. Biodiversity and sustainability of wildlife. Wildlife rules and regulations in Pakistan. National and International agencies involved in conservation and management of wildlife. Sanctuaries, Game Reserves and National Parks in Pakistan. Ramsar convention, wetlands, endangered species of Pakistan.

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

### Books Recommended

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

### YEAR FOUR /SEMESTER SEVENTH (Cr. 19)

| Subject Code | Course Title                               | Credit Hours |
|--------------|--|--------------|
| Zoo-471      | Genetics (Major-VIII)                      | 3+1          |
| Zoo-472      | Bioinformatics (Major-IX)                  | 1+1          |
| Zoo-473      | Elective-1                                 | 2+1          |
| Zoo-474      | Special Paper (Major-X)                    | 3+1          |
| Zoo-475      | Biostatistics (Compulsory-IX)              | 2+1          |
| Zoo-476      | Research Project /Special Paper (Major-XI) | 3+0/ 2+1     |

**Total = 19**

**Zoo-471**

**GENETICS**

**4(3 + 1)**

#### Aims and Objectives

The continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc. The process of continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment. These concepts will be imparted to the students in this course.

#### Course Contents

**Classical genetics** – multiple alleles, genetics of blood groups, chromosomal basis of inheritance, interaction of genes, chromosomal changes (euploidy, aneuploidy, structural changes), sex-determination and sex-linkage, linkage, recombination and chromosome mapping in eukaryotes, quantitative inheritance. gene concept (classical and modern), genetics of viruses, bacteria, transposons.

**Molecular genetics** – analysis and techniques of molecular genetics (elements of genetic engineering), genetic basis of cancer, genetic control of animal development, the genetic control of the vertebrate immune system, complex inheritance patterns.

**Population genetics** – Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

#### Books Recommended

1. Snustad, D.P. and Simmons, M.J. Principles of Genetics. 3<sup>rd</sup> Edition, 2003. Johan Wiley and Sons Ins. New York, USA.
2. Lewin, B. GENE-VIII. 2000. Oxford University Press. UK.
3. Tamarin, R.H. Principles of Genetics. 7<sup>th</sup> Edition, 2001. WCB publishers USA.
4. Gardener, E.J., Simmons, M.J. and Snustad, D.P. Principles of Genetics. 1991. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. Genetics. 1985. McMillan, New York. USA.

#### Practicals

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

Zoo-472

BIOINFORMATICS

2(1+1)

#### Aims and Objectives:

The course provides an introduction to bioinformatics with a focus on fundamental bioinformatics problems, the tools used to compute solutions to those problems, and the theory upon which those tools are based. The students will be able to

1. Access, retrieve, and analyze bioinformatics data available from several bioinformatic databases.
2. Assess the quality of bioinformatics data available from the Internet.
3. Use standard bioinformatics tools to answer specific biological questions.
4. Understand the theories used to build the tools and their relationship to biology.
5. Critically assess solutions to bioinformatics problems.

#### COURSE CONTENTS (THEORY AND PRACTICAL)

1. **Overview of Bioinformatics:** the scope of bioinformatics, bioinformatics and internet, Useful Bioinformatics sites on Web.
2. **Data Acquisition:** Sequencing DNA, RNA and proteins, Determination of protein structure, Gene and protein expression data, Protein interaction data.
3. **Database:** Contents, Structure and Annotation: File formats, Annotated sequence databases, Genome and organism-specific databases, Miscellaneous databases.

4. **Retrieval of Biological Data:** Data retrieval with Entrez and DBGET/LinkDB, Data retrieval with SRS (sequence retrieval system).
5. **Searching Sequence Databases by Sequence similarity Criteria:** Sequence similarity searched, Amino acid substitution matrices, Database searched (FAST and BLAST), sequence filters, Interactive database searches and PSI-BLAST.
6. **Multiple Sequence Alignment:** Genes and Protein Families: Multiple sequence alignment and family relationships, protein families and pattern databases, protein domain families.
7. **Phylogenetics:** Phylogenetics, cladistics and ontology, Building phylogenetic trees, Evolution of macromolecular sequences.
8. **Sequence Annotation:** Principles of genome annotation, Annotation tools and resources.
9. **Structural Bioinformatics:** Conceptual models of protein structure, relationship of protein three-dimensional structure to protein function, The evolution of protein structure and function, Obtaining, viewing and analyzing structural data, Structural alignment, classification of proteins of known three-dimensional structure: CATH and SCOP, Introduction to protein structure prediction by comparative modeling, secondary structure prediction, advanced protein structure prediction and prediction strategies.
10. **Microarray Data Analysis:** Analysis methods, tools and resources, sequence sampling and SAGE.
11. **Proteomic Data Analysis:** Analyzing data from 2D-PAGE gels, analyzing protein spectrometry data.
12. **Higher-order System:** Modeling and reconstructing molecular pathways, protein interaction informatics, Higher-order models.
13. **Chemoinformatics in Biology:** Conventions for representing molecules, Chemoinformatics resources.
14. **Bioinformatics in Pharmaceutical industry:** Bioinformatics and drug discovery, Pharminformatics resources.
15. **Basic Principles of Computing in Bioinformatics:** Running computer software, Computer operating systems, software downloading and installation, Database management.

#### **Recommended Books**

1. Gibas, C. and Jambeck, P. Developing Bioinformatics Computer Skills. 2001. O'Reilly publishers.
2. Westhead, D.R., Parish, J.H. and Twyman, R.M. Instant Notes on Bioinformatics. 2003. Viva Books Private Limited.
3. Lest, A.M. Introduction to Bioinformatics. 2002. Oxford University Press.
4. Baxevanic, A.D. and Ouellette, B.F.F. Bioinformatics: 2004. A Practical Guide to the Analysis of Genes and Proteins, 3<sup>rd</sup> Edition. O'Reilly publishers.
5. Krane, D.E. and Raymer, M.L. Fundamental Concepts of Bioinformatics. 2002. Benjamin Cummings.
6. Moody, G. Digital Code of Life: How Bioinformatics is Revolutionizing Science, Medicine and Business. 2004. John Wiley and Sons.
7. Orengo, C. A., Jones, D.T. and Thornton, J.M. Bioinformatics: Genes, Proteins and Computers (Advanced Text) 2003. Roulledge.
8. <http://www.ncbi.nlm.nih.gov>
9. <http://www.ebi.ac.uk>
10. <http://foldoc.doc.ic.ac.uk/foldoc/index.html>
11. <http://wit.integratedgenomics.com/GOLD/>

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Zoo-473 ELECTIVE-I 3(2+1)

**Note:** To be selected from the list of Elective Subjects provided to support special paper.

Zoo-474 SPECIAL PAPER 4(3+1)

**Note:** To be selected from the list of Special Subjects provided, as special paper.

Zoo-475 BIostatISTICS 3(2+1)

**Aims and 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 analyze 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 Contents**

Introduction and scope, use of statistics in biology. Population and sample. Stages of research, types of data and methods of data collection. Data arrangement and presentation, formation of tables and charts. Measures of central tendency computation of mean, median and mode from grouped and ungrouped data. Measures of dispersion, computation of variance, standard deviation, standard error and their coefficients. Probability rules. Binomial, Poisson and normal distributions. Hypothesis testing, Student 't' test, Chi square test, Analysis of variance and LSD. Correlation and regression. Experimental designing, planning of an experiment, replication and randomization.


**Books Recommended**

1. Geoffrey, R. Norman, David L. Streiner Biostatistics: The Bare Essentials. 2000. B.C. Decker Inc.
2. Gerry, P. Quinn, Michael J. Keough, Experimental Design and Data Analysis for Biologists. 2002. Cambridge University Press.
3. Campbell, R. C. Statistics for Biologists. 1989. Cambridge University Press.

Zoo-476 RESEARCH PROJECT/INTERNSHIP 3

**Note\*:** Research project includes experimental work, thesis writing and oral exam (Viva)

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**YEAR FOUR /SEMESTER EIGHTH (Cr. 15)**

| <b>Subject Code</b> | <b>Course Title</b>           | <b>Credit Hours</b> |
|---------------------|-------------------------------|---------------------|
| Zoo-481             | Research Project              | 3                   |
| Zoo-482             | Zoogeography and Paleontology | 2+1                 |
| Zoo-483             | Elective-II                   | 2+1                 |
| Zoo-484             | Elective-III                  | 2+1                 |
| Zoo-485             | Elective-IV                   | 2+1                 |

**Total = 15**

**Zoo-481- RESEARCH PROJECT 3**

**Note\*;** Research project includes experimental work, thesis writing and oral exam (Viva)

**Zoo-482 Zoogeography and Paleontology 3(2+1)**

**Aims and Objectives:**

The course imparts knowledge and concepts of evolution mainly based on the past fossil records. The fossil records also provide the information regarding the distribution of animals in the past eras. This course provides information on the distribution of animals and their associations in the past; thus, to rationalize their relationship in the present time.

**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 (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaeartic, Nearctic regions), Oriental, Ethiopian, Australian, and New tropical Regions. Palaeogeography (Theories of Continental drift and Plate tectonics).

**Principles of Paleontology:** Earth, Shells of earth; (atmosphere, hydrosphere, biosphere and lithosphere). Rock, types of rocks (Igneous rocks, sedimentary rocks and metamorphic 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.

**Books Recommended**

**Zoogeography:**

1. Darlington, P. J. Jr. Zoogeography, 1963. John Wiley and Sons.
2. DeBeaufort, L. F. Zoogeography of the Land and Inland Waters. 1951. Sidgwick and Jackson.
3. Ali, S.S. Palaeontology, Zoogeography and Wildlife Management. 1999. Nasim Book Depot, Hyderabad, India

**Paleontology:**

1. Dunbar C.O. Historical Geology, 1969. John Wiley and Sons Inc. New York.
2. Brouwer, A. General Palaeontology, 1977. Oliver and Boyd, London.

3. Gilbert, L. I. and Colbert, E.H. Evolution of Vertebrates, 1980. John Wiley and Sons Inc. New York.
4. Ali, S.S. Palaeontology, Zoogeography and Wildlife Management. 1999. Nasim Book Depot, Hyderabad, India.

### Practicals

1. Study Of fauna of various zoogeographical regions.
2. Study of mould, cast, pseudomorph, coprolite, petrified fossils of plants and animals.
3. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
4. Study of vertebrate fossils e.g. horse/elephant/camel/bovids.
5. Study and identification of Igneous, Sedimentary and Metamorphic rocks
6. Map work for identification of various zoogeographical regions of the World.

**Zoo-483** **Elective-II** **3(2+1)**

**Note:** To be selected from the lists of Elective Subjects provided to support special paper.

**Zoo-484** **Elective-III** **3(2+1)**

**Note:** To be selected from the Lists of Elective Subjects provided to support special paper.

**Zoo-485** **Elective-IV** **3(2+1)**

**Note:** To be selected from the lists of Elective Subjects provided to support special paper.

### LIST OF SPECIAL SUBJECTS

(Each course credit Hours: 4(3+1))

1. Classification of Insects and Pest Management
2. Physiological Systems and Adaptations
3. General and Comparative Endocrinology
4. Insect morphology, physiology and ecology
5. Fish Physiology and Breeding
6. General Microbiology
7. Applied Microbiology
8. Physiology of Coordination
9. Molecular and Clinical Endocrinology

  
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**Zoo-CLASSIFICATION OF INSECTS AND PEST MANAGEMENT** **4(3+1)**

#### Aims and Objectives:

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

### Course Contents

A general account including classification of insect orders: Collembola, Orthoptera, Dictyoptera, Isoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, Coleoptera. Only diagnostic characters of the remaining insect orders: Thysanura, Diplura, Protura, Ephemeroptera, Odonata, Plecoptera, Grylloblattoidea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata, Thysanoptera, Neuroptera, Mecoptera, Tricoptera, Siphonaptera, Strepsiptera, Insects of economic importance.

Brief account of biological control, chemical control and integrated pest management: common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Household pests and their management. Knowledge of Pests of cotton, rice, sugarcane.

### Books Recommended

1. Pedigo, L.P. Entomology and Pest Management. 1991. Maxwell MacMillan.
2. Richards, O.W. and Davies, R.J. IMM'S General Textbook of Entomology. 1977. Vol-2. Chapman & Hall, London.
3. Metcalf, C.L. and Flint, W.P. Destructive and Useful Insects. 1962. McGraw Hill.

### Practicals

1. Collection, preservation and identification of insects upto families (except for the identification upto species of a few pests of great economic importance), with the help of keys/literature.

### Zoo- PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS

4(3+1)

#### Aims and Objectives:

- a. To study the details of physiological systems maintaining the homeostasis of animals.
- b. Interrelations of the systems
- c. Regulatory features of the each system's function.

#### Course Contents

**Cardiovascular System:** Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output; Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.

**Respiratory System:** Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbon dioxide; Regulation of ventilation; Respiratory responses in extreme conditions.

**Renal System:** Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostasis; Role of kidney in acid-base balance.

**Gastrointestinal System:** Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments.

**Osmoregulation:** Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments.

**Environmental Challenges:** Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetics; Energy, environment and evolution.

#### **Books Recommended**

1. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5<sup>th</sup> Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4<sup>th</sup> Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. Principles of Physiology, 3<sup>rd</sup> Edition. 2000. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E. Text Book of Medical Physiology, 10<sup>th</sup> Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. Comparative Animal Physiology. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. Animal Physiology, Adaptation and Environment, 5<sup>th</sup> Edition. 1997. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D. Experiments in Physiology, 8<sup>th</sup> Edition. 2002. Prentice Hall, London.

#### **Practicals**

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion on nutrients by enzymes and effects of factors; Study of exocrine secretion in stomach or pancreas and effects of factors. Experiments on kidney regulation of osmolality; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

#### **Zoo- ENERAL AND COMPARATIVE ENDOCRINOLOGY 4(3+1)**

##### **Aims and Objectives**

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

##### **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.

### Books Recommended

1. Greenspan, F.S. and Stewler, G.J. Basic and Clinical Endocrinology, 5<sup>th</sup> Edition. 2002. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. Williams Textbook of Endocrinology, W.D. 2008. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. Endocrinology, 4<sup>th</sup> Edition. 2001. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R. Textbook of Endocrine Physiology. 4<sup>th</sup> Edition. 2000. Oxford University Press, Oxford.
5. Neal, J.M., Basic Endocrinology: An Interactive Approach. 2000. Blackwell Science Inc., London.

### 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.

## Zoo -INSECT MORPHOLOGY, PHYSIOLOGY AND ECOLOGY 4(3+1)

### Aims and Objectives

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

### Course Contents

**General characteristics of insects.** Relationship with other Arthropods, splitting up into different evolutionary lines, Reasons for success of the insects in diverse environments.

**Hard Parts:** General segmentation, tagmatosis and organization.

**Cuticle:** Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane. Colors of insects. cuticular outgrowths and appendages sclerotization.

**Head:** cephalization, sclerites, modifications.

**Antennae:** Different modes of ingestion and types of mouth parts.

**Neck:** Sclerites.

**Thorax:** Sclerites: legs, their different modifications and functions.

**Wings:** Origin; Different regions. Development and basal attachments, main veins and their branches (generalized insects), wing coupling.

**Abdomen:** Secondary appendages and external genitalia, Flight; types of flight. Aerodynamics, fuels, endoskeleton; head, thorax and abdomen.

**Soft Parts:** Muscular system; basic structure, types of muscles; muscle contraction and its energetics, comparative structure of all the systems, e.g., digestive, excretory, respiratory, incubatory, and nervous system and their physiology.

**Sense organs:** sound and light producing organs.

**Nutritive requirements:** Fat body, exocrine and endocrine glands including pheromones and their functions.

**Reproduction:** Reproductive organs and different types of reproduction in insects, egg fertilization and maturation.

**Development:** Embryology up to dorsal closure, different types of metamorphosis, apolysis and ecdysis and the role of endocrine secretions.

**Ecology:** Carrying capacity 'r' and k selection, Food chains, predation and competition, insect defenses and adaptations, diapause insect population and community studies, insect communication.

### Practicals

Preparation of permanent slides. All the hard parts (antennae, mouth parts, wings, legs, terminal segments and genitalia). Different systems, especially digestive, reproductive of the following insects. American cockroach, Gryllus, grasshopper, housefly, butterfly, mosquito, any common beetle. Red cotton bug. Wasp and honey bee. Sympathetic nervous system of cockroach and gryllus. Salivary glands of cockroach, red cotton bug and honey bee.

### Books Recommended

1. Richards, O. W. and Davies, R. G. Imm's General Textbook of Entomology. Vol. 1, 10<sup>th</sup> Edition. 1977. Chapman & Hall, London.
2. Chapman, R.F. THE Insects: structure and function, 2000. Blackwell Science Inc., London.
3. Wigglesworth, V. B. Insect Physiology 8<sup>th</sup> Edition. 1984. Springer Publisher.
4. Robert L. Patton. W. B. Insect Physiology. 1963. Saunders Co., Philadelphia.

5. Price, W. Insect Ecology. 1997. John Wiley & Sons.
6. Krebs, C. J. Ecology: The Experimental Analysis Abundance. 5<sup>th</sup> Edition. 2000. Benjamin-Cummings Publishing Company.
7. Tembhare, Db. Modern Entomology. 2002. Himalaya Publishing House. India.
8. Southood, T.R.E. Ecological Methods. 1978. Chapman and Hall, London.
9. Yazdani, S.S., and Agarwal, M.L. Elements of Insect Ecology. 1997. Narosa Publishing House. India.

## Zoo-FISH PHYSIOLOGY AND BREEDING

4(3+)

### Aims and Objectives:

The aim of this course is to provide sufficient knowledge about all physiological phenomena in fishes. The subject provides practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture. It also emphasizes thoroughly in breeding of most culturable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons.

### Course Contents

**Fish nutrition:** Digestive system; Stomach less fishes; Stomach fishes; Digestion and absorption; Food; Plant origin; Animal origin; Feeding; fresh food; Dry concentrates; Pelleted food.

**Transportation:** Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma); Circulation; Arterial system; Venous system; Capillaries; Transport of food material.

**Respiration:** Gills; Lungs; Skin; Swimbladder; Homeostasis.

**Excretion:** Kidneys; Hypo-osmotic urine; Hyper-osmotic urine; Osmoregulation.

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

**Breeding:** Natural (seasonal); Artificial; Hormonal induced breeding; Temperature & photoperiod; control induced breeding.

**Growth:** Extensive culture (due to the consumption of natural food); Semi-intensive culture (due to natural & artificial food); Intensive culture (due to only dry concentrates).

**Fish health:** Water quality; Hygiene of fish culture facilities; Hygiene of equipments used in fish culture.

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

**Fish migration:** To nursery ground; To maturation grounds; Freshwater to marine water; Marine water to freshwater.

**Fish behaviour:** Learning and memory; Light response for maturation; Courtship behaviour; Aquarium fish behaviour

### Books Recommended

1. Kestin, S. C. and Warris, P.D. (Editors). Kestin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.
2. Saksena, D.N. Ichthyology: Recent Research Advances. 1999. Oscar Publications. India.

3. Woo, P.T.K Fish Diseases and Disorder. Vol 1. Protozoan and Metazoan Infections. 1995. CABI Publisher.
4. Brenabe, G. Aquaculture, Vol. I. 1992. Blackwell Publishing, Oxford. UK.
5. Maseke C. Fish Aquaculture. 1987. Pergamon Press, Oxford. UK.
6. Huet M. Text Book of Fish Culture: Breeding and Cultivation. 1973. Blackwell Publishing Company.
7. Hoars, W.S. Fish Physiology. 1971. Academic Press. UK.
8. Hoars, W.S. Fish Reproduction. 1969. Academic Press. UK.
9. Matty, A.J. Fish Endocrinology. 1985. Timber Press, UK.
10. Gorbman, A. Comparative Endocrinology. 1<sup>st</sup> Edition. 1983. John Wiley & Sons. UK.

### Practicals

Study of gut contents, Study of feeding modification and adaptation in fish, Study of respiratory adaptation in fish, Study of blood cells and their counts in normal and diseased fish, Study of water quality parameters (DO, NH<sub>3</sub>, hardness, alkalinity, turbidity, transparency, temperature, salinity), Study of various forms of swimbladder as hydrostatic organ, Study fecundity of various fish species, Study the effects of reproductive hormone (GnRH) on fish maturation, Diagnosis of bacterial infection in infected fish, Study of fish parasites, Visit to various fish seed hatcheries during breeding seasons

### Zoo-GENERAL MICROBIOLOGY

4(3+1)

#### Aims and Objectives:

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

#### 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.

**Viruses:** Bacteriophages and phages of other protists. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.

**Morphology and fine structure of bacteria:** Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material.

**The Cultivation of Bacteria:** Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation.

**Reproduction and growth of bacteria:** Modes of cell division, New cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content,



Determination of the dry weight of cells, The selection of a procedure to measure growth, Importance of measurement of growth.

**Pure cultures and cultural characteristics:** Natural microbial populations, selective methods; Chemical methods, Physical methods, Biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections, Cultural characteristics; Colony characteristics, Characteristics of broth cultures.

**Eukaryotic Microorganisms:** Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi. Protozoa: Ecology and importance of protozoa. Classification of protozoa.

**Prokaryotic diversity Bacteria:** Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonous and chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

**Prokaryotic Diversity:** Archaea; Extremely Halophilic archaea, Methane producing archaea: Methanogens, Hyperthermophilic archaea, Thermoplasma.

**Microbial Ecology:** Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

**Microbial metabolism:** Fuelling reactions in aerobic and anaerobic heterotrophs and autotrophs.

**Microbial metabolism:** Biosynthesis, polymerization, assembly: Methods of studying biosynthesis, synthesis of Nucleotides, Amino acids, Lipids, Porphyrins, Proteins, Polysaccharides and peptidoglycan polymerization of building blocks, Assembly of biopolymers into cellular components.

### Books Recommended

1. Benson, H.J. Microbial Applications: Laboratory Manual in General Microbiology, 1994. WMC Brown Publishers, England.
2. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. Microbiology, 1986. McGraw Hill, London.
3. Madigan, M.T., Martinko, J.M. and Parker, J. Brock Biology of Microorganisms, 1997. Prentice-Hall, London.
4. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. The Microbial World, 1986. Prentice Hall, London.

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## Zoo-APPLIED MICROBIOLOGY

4(3+1)

### Aims and Objectives:

Aims of this course to let the students know about the applications of the science of microbiology in the different fields of life. The course may initiate their interest in agricultural, industrial and/or environmental microbiology.

### Course Contents

**Control of microorganisms:** Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic agents. Microorganisms and diseases: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals. Environmental microbiology: Fundamentals of microbial ecology. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage. Microbiology of food, milk and milk products.

**Industrial Microbiology:** Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

### Books Recommended

1. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. Microbiology: A Human Perspective, 2001. McGraw Hill Higher Education.
2. Jacquelyn, G.G. Microbiology Principles and Explorations, 2001. John Wiley & Sons Inc.
3. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., Microbiology, 1986. McGraw Hill, London.
4. Benson, H.J. Microbial Applications: Lab Manual in General Microbiology, 1994. WMC Brown Publishers, UK.

### Practicals

Bacteriological examination of water. Isolation and identification of coliform bacteria and enteric pathogens. Isolation of pathogenic *Staphylococci*. Normal throat flora and reaction on blood agar. Enumeration and identification of microorganisms in urinary tract infections. Isolation and identification of microorganisms from the diseased ear. Inhibition and destruction of microorganisms by physical agents. Action of disinfectants on bacteria. Bacteriostatic action of certain dyes and drugs. Bacterial sensitivity tests (some contemporary antibiotics). Bacterial examination of food, raw milk. Surveys of microorganisms' activities based industries.

## Zoo-MOLECULAR AND CLINICAL ENDOCRINOLOGY

4 (3+1)

### Aims and Objectives:

- a. To study that degeneration diseases are the results of alterations in biochemical homeostasis regulated by endocrine system.
- b. Manifestation of degeneration diseases at molecular level.

### Course Contents

**General Mechanisms in Molecular Endocrinology:** Subcellular structure of cells secreting protein hormones; Process of hormone secretion; Transcription factors in developmental organisms in endocrine systems. Recombinant DNA technology and molecular genetics in diagnosis and treatment of endocrine diseases. Measurements of hormones: Radioimmunoassay,

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immunoradiometric, immunochemiluminometric and radioreceptor assays and their statistical procedures.

**Mechanisms of Action of Hormones:** Hormone systems and intracellular communication; Hormones acting at cell surface: Properties of hormone receptor interaction, structure, biosynthesis and turnover of membrane receptors; Hormones acting in transcription regulation: Biochemistry and molecular interaction of steroid receptor, gene expression, messenger RNA stability and metabolism in hormone action.

**Functional Pathology in Endocrine Glands:** Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, corticotrophin regulation; Pituitary Disorders: Prolactinomas, acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid Diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and Hormonal Therapy; Abnormalities of Testicular Functions and Hormonal Therapy.

**Fuel Homeostasis:** Glucose Homeostasis and Hypoglycemia; Diabetes Mellitus; Disorders of Lipoprotein Metabolism; Eating Disorders: Obesity, anorexia nervosa and bulimia nervosa.

**Development and Growth:** Disorders of growth and puberty. Endocrine Hypertension. Polyendocrine Syndromes. Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy. Geriatric Endocrinology: Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis.

### Books Recommended

1. Greenspan, F.S. and Stewler, G.J. Basic and Clinical Endocrinology, 5<sup>th</sup> Edition. 2002. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. Williams Textbook of Endocrinology, 9<sup>th</sup> Edition. 1998. W.D. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. Endocrinology, 4<sup>th</sup> Edition. 2001. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R. Textbook of Endocrine Physiology. 4<sup>th</sup> Edition. 2000. Oxford University Press, Oxford.
5. Neal, J.M. Basic Endocrinology: An Interactive Approach. 2000. Blackwell Science Inc., London.

### Practicals

Studies on recognition and response of receptors; Studies of disorders of pituitary by observing anatomical and histological features; Studies of thyroid status in deficient and excess hormone functions; Studies of type 1 and type 2 diabetes mellitus: Epidemiology of the types in population, studies of management of the type 2; Model studies of disorders of Ovarian and Testicular disorders; Model studies of obesity and anorexia; Studies of hormonal status in puberty and aging.

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## Zoo-PHYSIOLOGY OF COORDINATION

4(3+1)

### Aims and Objectives:

- a. To study the details of nervous and hormonal coordination at molecular and cellular level in animals.
- b. Biosynthetics, secretory and regulatory aspects of coordination.

### Course Contents

**Physiological Mechanisms at Cell:** Cellular membrane and transmembrane transport; resting membrane potentials; Generation and conduction of action potentials; synaptic transmission; Membrane receptors, Second messenger and signal-transduction pathways.

**Nervous System:** Organization of nervous system; General sensory system; Visual, Auditory, Vestibular and Chemical sensory system; Motor system with brainstem, Cortical, Cerebellar and basal ganglia control of posture and movements; Autonomic system and its control; Higher functions of nervous system including state of consciousness, learning, memory.

**Muscle and Movements:** Molecular basis of contraction; Muscles activity on skeleton; Adaptation of muscles for various activities; Muscles in the walls of hollow organs.

**Endocrine System:** General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroid at different stage of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

### Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5<sup>th</sup> Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4<sup>th</sup> Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. Principles of Physiology, 3<sup>rd</sup> Edition. 2000. St. Louis, Mosby.
4. Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, 10<sup>th</sup> Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. Comparative Animal Physiology. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. Animal Physiology: Adaptation and Environment, 5<sup>th</sup> Edition. 1997. Cambridge University Press, Cambridge.
7. Thorp, G. and Woodman, D. Experiments in Physiology, 8<sup>th</sup> Edition. 2002. Prentice Hall, London.

### **Practicals**

Recording of action potentials on oscilloscope and effects of various factors on its characters; Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves. Experiments on sensory organs study. Experiments on characteristics of skeletal muscle contractions; Responses of intestinal muscles and effect of drugs. Demonstration of endocrine glands in a mammal (mouse). Effect of hormones on glycemia and calcemia; Effect of thyroxin on oxygen consumption; Effect of androgen on accessory sex organs and of estrogens on target tissues; Study of estrous cycle and effects of the hormones.

  
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## LIST OF ELECTIVE SUBJECTS

**Note:** *The Course Instructor should arrange the course contents of the elective subject when he/she selects a course from the list of elective subjects.*

1. Agricultural Biotechnology
2. Analysis of Development
3. Animal Adaptations
4. Animal Behaviour
5. Animal Communication
6. Animal Pests and Disease Producing Organisms
7. Applied Microbiology
8. Aquaculture and Fisheries
9. Arachnology
10. Behavioural Ecology
11. Biochemistry of Drugs Action
12. Biology and Control of Vertebrate Pests
13. Biomedical Technology
14. Biotechnology
15. Biotechnology in Aquaculture
16. Cancer Biology
17. Clinical Biochemistry
18. Ecological Genetics
19. Economic Zoology
20. Elements of Stratigraphy and Structural Geology
21. Endocrinology
22. Environmental Physiology
23. Environmental Pollution
24. Fish Bioenergetics

  
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25. Fish Culture
26. Fish Ecology
27. Fish Endocrinology
28. Fish health Management
29. Fish Feeding Management
30. Hematology
31. Herpetology
32. Histology
33. Human Genetics
34. Ichthyology
35. Immunology
36. Insect Bioacoustics
37. Insect Biochemistry and Physiology
38. Insect Pathology
39. Insects of Veterinary and Medical Importance
40. Invertebrata
41. Invertebrate Palaeontology
42. Limnology
43. Mammalogy
44. Microbiology
45. Medical Biotechnology
46. Medical Microbiology
47. Molecular Biology
48. Microbiology of Extreme Environment
49. Neurobiology
50. Ornithology
51. Pharmacological and Pathological Endocrinology



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52. Physiology of Functional Systems
53. Population Biology
54. Principles of Genetics
55. Quantitative Zoology
- Radiation Biology
57. Reproductive Biology
58. Teratology
59. Techniques in Fisheries Research
60. Vector Biology
61. Vertebrate Palaeontology
62. Veterinary and Wildlife Parasitology
63. Wildlife Management and conservation
64. Zoological Microtechniques
65. Principle of Fish Biology
66. Principles of Parasitology
67. Toxicology
68. Protozoology
69. Vitamins and Hormones
70. Nucleic Acids
71. Principle of gene manipulation
72. Research Techniques and Instrumentation



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## **COURSE CONTENTS OF SOME ELECTIVE SUBJECTS FROM THE LIST OF ELECTIVE SUBJECT**

(Course Contents arranged and proposed by Mr. Ikram Ilahi, Assistant Professor and Head Department of Zoology, University of Malakand, and recommended by the members of the Board during the First Meeting)

### **Zoo-PRINCIPLES OF FISH BIOLOGY**

**3(2+1)**

#### **Aims and Objectives:**

The aim of this course is to enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular. It comprises morphology, anatomy, classification and some understanding about various feeding groups found in different water bodies. After having complete knowledge of above, students will be able to practice independently.

#### **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, 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;

**Ecology of fishes:** Freshwater; Brackish water ; Marine

#### **Books Recommended**

1. Kestin, S. C. and Warris, P.D. (Editors). Kestin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.
2. Woo, P.T.K Fish Diseases and Disorder. Vol 1. Protozoan and Metazoan Infections. 1995. CABI Publisher.
3. Brenabe, G. Aquaculture, Vol. I. 1992. Blackwell Publishing, Oxford. UK.
4. Huet M. Text Book of Fish Culture: Breeding and Cultivation. 1973. Blackwell Publishing Company.

#### **Practicals**

Collection, preservation and identification of freshwater fish species; Study of different organs of various fish species; Study and survey of various fish collection present in museum like Natural; History Museum at Islamabad, at G.C. Lahore & at P.U. Lahore.

### **Zoo-PRINCIPLES OF PARASITOLOGY**

**3(2+1)**

#### **Aims and Objectives:**

This course aims to provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, host parasite relationship and control measure.

## Course Contents

### Introduction to parasitology

Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals.

Camers in parasitology. Some basic definitions. Basic principles and concepts. Parasite ecology and evolution. Basic principles and concepts. 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:

Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae. Other flagellated protozoa, order Retortamonadita, order Diplomonadida, order Trichomonadida, order Opalinida. The Amoebas. Order Amoebida, order Schizopyrenida. Phylum Apicomplexa, Gregarines, Coccidia and related organisms. The apical complex, class Gregarinaea, class Coccidea. Phylum Apicomplexa, Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida. Phylum ciliophora, ciliated protistan parasites, class Spirotoichea, class Litostomitea, class Oligohymenophorea. Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa. The Mesozoa, pioneers or Degenerates. Class Rhombozoa, class orthonectida, Phylogenetic position, physiology and Host parasite relationship. Classification of Phylum Mesozoa.

**Systematics, morphology and biology of Arthropods (Causing or responsible for transmission of disease).** Chemical and non-chemical control of Arthropods of Medical and Veterinary importance.

**Pathology of Helminths:** Host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance.

### Books Recommended

1. Roberts, L.S. and Janovy, J. Foundation of Parasitology, 6<sup>th</sup> Edition. 2000. McGraw Hill Book Co.
2. Hausman, K. and Hulsmann, N. T. Protozoology, 2<sup>nd</sup> Edition. 1996. Medical Publishers, Inc. New York.
3. Noble, E.R. and Noble, G.A. Parasitology. The Biology of Animal Parasites. 5<sup>th</sup> Edition. 1982. Lea and Febiger Publisher.
4. Beck, J.W. and Davies, J.E. Medical Parasitology. 3<sup>rd</sup> Edition. 1981. C.V. Mosby Company, Toronto, London.
5. Cheesbrough, M. Medical Laboratory Manual for Tropical Medicine. Vol.I. 1987. University Press Cambridge.
6. Smyth, J.D. Introduction to Animal Parasitology. 1994. Cambridge University Press.
7. Roberts, L.S. and Janovy, J. Jr. Foundations of Parasitology. 7<sup>th</sup> Edition. 2005. W.M. Brown Publishers, Chicago, London, Tokyo, Toronto.
8. Beck, J.W. and Davies, J.E. Medical Parasitology. 3<sup>rd</sup> Edition. 1981. C.V. Mosby Company, Toronto, London.
9. Cheesbrough, M. Medical Laboratory Manual for Tropical Medicine. Vol.I. 1987. University Press Cambridge.
10. Smyth, J.D. Introduction to Animal Parasitology. 1994. Cambridge University Press.

11. Roberts, L.S. and Janovy, J. Jr. Foundations of Parasitology. 7<sup>th</sup> Edition. 2005. Wm Brown Publishers, USA.
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.

### **Practicals**

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

## **Zoo-IMMUNOLOGY**

**3(2+1)**

The immune system: organs constituting the immune system, their location in human body and basic architecture, principles and techniques of serology. The immunocompetent cells; their origin, surface markers, populations and subpopulations, antigen and antibody metabolism, cells involved in cellular sequence of events, kinetics of antibody synthesis, Antibody diversity. The role of T-cells and immunoglobulins in in the immune response. Immunologic memory: positive and negative phenomena of natural tolerance. Manifestations of antigens antibody reactions including precipitation, agglutination, complement fixation and neutralization. Basic and applications of ELISA, RIA, immunofluorescence and immunoblotting. Role of MHC in antigen presentation. Immunological disorders: Autoimmunity, immunodeficiency, Tissue rejection. Nature of tumor transplantation and immunology and immunogenetics. Resistance and immunization to infectious diseases.

### **Practicals:**

1. Techniques used in serological studies, RBS and WBC count
2. Differential Leucocytes count
3. Blood grouping
4. Agglutination tests and Precipitation tests
5. Complement fixation tests
6. ELISA tests
7. Allergy reaction tests
8. Hypersensitivity

### **Books Recommended**

1. Abbas, K. Lichtman and Jordan, S. Probe (Latest edition). Cellular and Molecular Immunology". W.B. saunders.
2. Janeway-Travers. (Lattest edition) Immunobiology. Current Biology Ltd. UK.

  
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3. Riott, IM, Delves, PJ (2001). Roitt's Essential Immunology. Blackwell Scientific Pub, London.
4. Geo f. brooks, Stephen A. Mores, Janet Butel, Janet S. Butel (2001). Jawetz, Melnick and Adelberg's Medical Microbiology McGraw-Hill Companies.
5. Kuby, J. (1996). Immunology 2<sup>nd</sup> Ed. W.H. Freeman & Co. USA.
6. Benjamini, E. Immunology. (2001).

## **Zoo-MAMMOLOGY                      3(2+1)**

### **Course Contents**

Introduction to mammals; primitive mammals; origin from reptiles, central heating system of mammals; Mammal's perfumes; milk and reproduction; parental care; evolution; society and sexual dimorphism; sons; daughters and favoritism; size and the energy crises; cost of living and diet; quantity versus quality; population explosion. The monotremes; the marsupials; the edentates; the ungulates; the insectivores; the carnivores; the rodents; the primates.

### **Practicals:**

1. Study of common laboratory and zoo mammals
2. Study of anatomy through dissections of rabbits, rats and mouse
3. Skeleton: axial and appendicular
4. Study of skulls and brain structures and capacities
5. Study of locomotory adaptations
6. Flying mammals and study of bats
7. Classification and identification
8. Collection and preservation of small mammals
9. Identification of mammals through paw patterns

### **Books Recommended:**

1. Macdonald, D. (1995). The encyclopedia of mammals. Andromeda Oxford Ltd.
2. Robberts, T.J. 1991-1992. The mammals of Pakistan. Oxford University Press, Karachi.
3. Hildebrand, M and Goslow, G. (2001). Analysis of Vertebrate structure. 5<sup>th</sup> Edition. John Wiley and Sons, Inc.
4. Linzey, D. (2001). Vertebrate Biology. McGraw Hill Co.
5. Kardong, K.V. (2002). Vertebrates. 3<sup>rd</sup> Edition. Comparative Anatomy, function and evolution. McGraw Hill Co.
6. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
7. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

8. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
9. Kent, G.C. and Miller, S. Comparative Anatomy of Vertebrates. 2001. New York: McGraw Hill.
10. Campbell, N.A. Biology, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

### Zoo-PROTOZOALOGY 3(2+1)

Structure, including ultra-structure, taxonomic significance, biology, life cycle and host parasite relationships of parasitic protozoa which will include Mastigophora: *Trypanosoma gambiense*, *Schizotrypanum cruzi*, *Leishmania donovani*; *L. tropica*; *Giardia intestinalis* and *Trichomonas vaginalis*. Sarcodina: *Entamoeba histolytica*; *E. coli*; *E. gingivalis*; *Endolimax nana* and *Acanthamoeba castellanii*. Sporozoa: Malarial parasites of man, and *Coccidia* of poultry. Ciliata: *Balantidium coli*.

#### Practicals:

1. Study of protozoa through prepared microscopic slides
2. Protozoa culturing
3. Isolation of parasitic protozoa from the guts of higher animals, slide preparation and identification
4. Soil protozoa
5. Marine and fresh water protozoa
6. Study of physiological properties of various protozoa

#### Books Recommended:

1. Brusca, R.C. and Brusca, G.J. (2002). Invertebrates. 2<sup>nd</sup> Ed. Sinauer Associate. Inc., Publishers.
2. Hickman, Jr. C.P; Roberts, L.S and Larson, A. (1998). Biology of Animals. McGraw Hill Co, Inc.
3. Ruppert, E, D and Barnes, R.D.(1994). Invertebrate Zoology. 6<sup>th</sup> Ed. Saunders College Publishing.
4. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
5. Miller, S.A. and Harley, J.B. Zoology, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
6. Pechenik, J.A. Biology of Invertebrates, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
7. Campbell, N.A. Biology, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
8. Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles OF Zoology. 2000. Singapore: McGraw Hill.

9. Miller, S.A., General Zoology Laboratory Manual. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

## **Zoo-HERPETOLOGY            3(2+1)**

### **Course Contents**

Classification and variety of forms of amphibians and reptiles. Their structure, habitats, origin, evolution, reproduction, homeostasis, relation to biotic environment, behavior, mechanisms of speciation and geographic distribution. Their food and growth and role of reptiles in keeping insects and rodent populations under control.

### **Practicals:**

1. Classification and museum study
2. Animal collection handling preservation and identification
3. Dissection of major reptiles; lizards, turtle, snake
4. Study of skeleton and adaptations
5. Behavior of reptiles

### **Books Recommended:**

1. Pough, G. 1982. Biology of Reptilia. Academic Press, London.
2. Coleman, J. and G. Olive. 1971. Introduction to Herpetology (2<sup>nd</sup> Ed.). W.H., Freeman.
3. Hildebrand, M and Goslow, G. (2001). Analysis of Vertebrate structure. 5<sup>th</sup> Edition. John Wiley and Sons, Inc.
4. Linzey, D. (2001). Vertebrate Biology. McGraw Hill Co.
5. Kardong, K.V. (2002). Vertebrates. 3<sup>rd</sup> Edition. Comparative Anatomy, function and evolution. McGraw Hill Co.
6. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
7. Romers, A.S. and Parson, T.S., (1986). The Vertebrate Body, Holt Saunders, Philadelphia.

## **Zoo-VITAMINS AND HORMONES            3(2+1)**

### **Course Contents**

Vitamins classification, chemical structure and properties: metabolism, function, effect of deficiency and excess. Hormones; structure, structure activity relationship, biosynthesis, regulation, mechanism of action and immunology of: protein and polypeptide hormones, hormone steroids, neurotransmitters, and phytohormone. Hormonal analysis (bioassay, immunoassay). Methods of isolation, purification and physicochemical characterization. Biotechnology (monoclonal antibodies, gene cloning).

**Practicals:**

1. Determination of vitamins in serum
2. Separation of steroids by TLC
3. Studies on recognition and response of receptors
4. Studies of disorders of pituitary by observing anatomical and histological features.
5. Study of thyroid status in deficient and excess hormone functions.

**Books Recommended:**

1. Darnell Jr. J., Lodish, H. and Baltimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y.
2. Zubay, G.L., (1995). Principles of Biochemistry McMillan Publishing Co.
3. Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments. 3<sup>rd</sup> Edition. John Wiley Sons, Inc., N.Y.
4. McKee, T. and McKee, J.R. Biochemistry. The Molecular Basis of Life. 3<sup>rd</sup> Edition, 2003. McGraw Hill
5. Voet. D., Voet, J.G., and Pratt, C.W. Fundamentals of Biochemistry, 1999. John Wiley and Sons, Inc., New York.
6. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 25<sup>th</sup> Edition, 2000. McGraw Hill, New York.
7. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 3<sup>rd</sup> Edition, 2000. McMillan Worth Publishers, New York.

**Zoo-TOXICOLOGY 3(2+1)****Course Contents**

Basic principles of toxicology. Absorption, distribution, storage, and elimination of toxins. Biotransformation of toxins. Toxicokinetics. Mechanisms of toxicity. Chemical, biochemical and genetic Toxins. Organ system toxicology, eco toxicology, regulatory toxicology. Toxicity assays. Risk assessment and Bioremediation.

**Books Recommended:**

1. Principles of Toxicology by Williams and Roberts
2. Toxicology by Marquardt and Schafer
3. Industrial Toxicology by William and Burson
4. Environmental Toxicology, Sethi, Iqbal, Satake and Mido
5. Medical Microbiology by Samuel Baren



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## **Zoo-NUCLEIC ACIDS            3(2+1)**

### **Course Contents**

Chromosomes and DNA, Flow of Genetic Information, Organization of Nuclear and Mitochondrial Genomes, Gene Structure, RNA Splicing, Pseudogenes, Classes of Mutations, Repetitive DNA sequences, Gene expression, Cloning of genes, Mapping of Chromosomes. Transcript Mapping, Mutation identification, Gene structure and functions.

### **Practicals:**

1. Extraction of Nucleic Acids
2. Electrophoresis of RNA and genomic DNA
3. Purification of DNA fragment from gels
4. Transformation
5. Transfection
6. Preparation of Single and Double Stranded DNA
7. Sequencing of DNA

### **Books Recommended:**

1. Garrett, Reginald H., Grisham, Charles M (1995). Molecular aspects of Cell Biology. Saunders College Publishing, Fort Worth.
2. Strachen, T., Read, A.P. (2000). Human Molecular Genetics. 2<sup>nd</sup> Wd. BIOS Scientific Publishing Ltd.
3. Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments. 3<sup>rd</sup> Edition. John Wiley Sons, Inc., N.Y.
4. Darnell Jr. J., Lodish, H. and Baltimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y.
5. Malscinski, George M. (2003). Essentials of Molecular Biology Edition 4<sup>th</sup> Jones and Bartlett Publishers, Boston.

## **Zoo-PRINCIPLES OF GENE MANIPULATION            3(2+1)**

### **Course Contents**

Introduction: Methods of creating recombinant DNA molecules (restriction enzymes). Cloning in *E.coli* plasmid as cloning vehicles, bacteriophage and cosmid vectors, cloning strategies and gene libraries, isolation of clone genes, recombinant selection and screening, expression in *E.coli* of cloned DNA molecules. Cloning in organisms of other than *E. coli*: Cloning in bacteria other than *E.coli*, cloning in yeast and other eukaryotes, cloning in plant cells, cloning in mammalian cells in cultures, cDNA, Chromosome walking for isolating long stretches of eukaryotic DNA, split genes. Micro infecting genes into animal oocytes, eggs and embryos. Application of Recombinant DNA technology in biology and medicines.



**Practicals:**

1. Construction of restriction enzymes+ Map.
2. Amplification of DNA by PCR
3. Preparation of probe for DNA analysis
4. Southern blotting and hybridization
5. Northern blotting and hybridization
6. Heat shock transformation of bacterial cell
7. Agrobacterium mediated transformation of plant cell

**Books Recommended:**

1. Bernard R. Glick & Jack J. Pasternak. (2003). Molecular Biotechnology: Principles and Applications of Recombinant DNA, Third Edition, ASM Press Washington.
2. H. Kreuzer & A. Massey. (2001). Recombinant DNA and Biotechnology, 2<sup>nd</sup> Edition, ASM Press.
3. Old, R.W. and Primrose S.C. (1995), Principles of Gene Manipulation. Blackwell Science.
4. Sambrook, Joseph; Russel, David W., (2001). Molecular cloning: a Laboratory Edition 3<sup>rd</sup> Cold Spring Harbor Laboratory Press, New York.
5. Jain, S.K. (2000). Textbook of Biotechnology: Fundamentals of molecular CBS Publishers, New Delhi.
6. Thiel, Teresa, Bissen, Shirley (2002). Biotechnology DNA to protein: a laboratory project in molecular biology, McGraw-Hill, Boston.
7. Brown, T.A. (2001) Gene Cloning and DNA analysis: an introduction. Blackwell Science Ltd. Oxford.

**Zoo-RESEARCH TECHNIQUES AND INSTRUMENTATION 3(2+1)****Course Contents**

Estimation methods for biopolymers. Chromatographies: gel filtration, ion exchange, affinity, chromatofocussing. Isoelectric focusing, HPLC, electron microscopy, Electrophoresis: polyacrylamide, SDS-polyacrylamide. Immuno-electrophoresis. Double diffusion. Spectrometers; visible, UV, IR, mass, X-ray diffraction and Atomic absorption. Beta and gamma counters.

**Books Recommended:**

1. William, B.L. and Wilson, K.A. 1983. Biologist's guide to principles and techniques of practical biochemistry. Edward Arnold.
2. Oser, B.L. 1965. Haw's physiological chemistry. McGraw Hill Book Co.
3. Work, T.S. and Work, E. 1975. Laboratory techniques in biochemistry and molecular biology. Vols. 1-3 North Holland American.

## Zoo-NEUROBIOLOGY

3(2+1)

### Course Contents

The organization of the nervous system; Electrical signals of nerve cells; Membrane permeability, Channels and Transporters; Synaptic Transmission, Neutransmitters; their receptors and effects; Intracellular signal transduction; The somatic sensory system; pain; vision; central visual pathways; the auditory system; the vestibular system; the chemical senses; lower motor neuron circuits and motor control; upper motor neuron control of the brain stem and spinal cord; modulation of movement by the basal ganglia and the cerebellum; eye movements and sensory motor integration; the visceral motor system; brain development; construction of neural circuits; modification of brain circuits as a result of experience; plasticity of mature synapses and circuits; The association cortices; Language and lateralization; sleep and wakefulness; emotions; sex, sexuality and brain; human memory.

### Practicals:

1. Cultures of embryonic neurons
2. Immunohistochemistry
3. Histology of Neuronal tissue
4. Ionic basis of resting potential
5. Sciatic nerve compound action potential
6. Introduction to intracellular recording
7. Recording of action potential on oscilloscope
8. Demonstration of nervous system organization
9. Sensory organs study
10. Experiments on characteristics of skeletal muscle contraction

### Books Recommended:

1. Purves, D., Augstein, G.J., Fitzpatrick, D., Katz, L.C., LaManta, A.S., McNamara, J.O., Williams, S.M. (2001). Neuroscience. Sinauer Associates, Inc.
2. Sheperd, G.M. (1994). Neurobiology. Oxford University Press, Inc.
3. Levitan, I.B. and Kaczmarek, L.K. (1997). The neuron: cell and molecular biology. Oxford University Press, Inc.
4. Matthews, G.G. (1998). Neurobiology. Blackwell Science.
5. Beatty, J. (2001). The human brain. Sage Publications, Inc.
6. Revest, P. and Longstaff. (1998). Molecular neurosciences. BIOS Scientific Publishers. Ltd.
7. Fitzgerald, M.J.T and Jean Folan-Curran (2002). Clinical neuroanatomy and related neurosciences. Harcourt Publishers Ltd.
8. Rafael Yuste and Arthur Konnerth (2005). Imaging in neurosciences and development: a laboratory manual. Cold spring Laboratory press.

## **Zoo-CLINICAL BIOCHEMISTRY      3(2+1)**

### **Course Contents**

Biochemistry of blood, biochemical aspects of cardiovascular, neurological and endocrine inborn errors of metabolism, immunology of human diseases immunodiagnostics, biochemical aspects of cancer etiology, clinical diagnosis and treatment, interferon discovery and implication and antibacterial agents, disease due to infection and infestation, diseases due to chemical and physical agents, genetic and constitutional factors in diseases of organs.

### **Practicals:**

1. Analysis of urine, blood
2. Determination of glycerol and cholesterols/sterols and unsaturated fatty acids
3. Estimation of urea, protein, bilirubin, calcium, phosphorus, uric acid, creatinine and analysis in serum/urine
4. Determination of vitamins in serum
5. Separation of steroids by TLC.

### **Books Recommended:**

1. Cuppings, J.N and Kremer, M. (1973). Biochemical aspects of Neurobiological disorders.
2. Hoffman, W.S. (1977). Biochemistry of Clinical Medicine, 4<sup>th</sup> Ed.

## **Zoo-MOLECULAR BIOLOGY      3(2+1)**

### **Course Contents**

Introduction: gene theory, structure of DNA, concept of gene mutation, gene structure and function. DNA replication: viral, prokaryotic and eukaryotic DNA repair, recombination, gene expression; and translation: transcription, Prokaryotic and eukaryotic biosynthesis of RNA and its regulation, initiation, elongation and termination, RNA polymerase function and modulation of its activity: promoters, operators, repressor, terminator, regulation, post transcriptional processing of tRNA, mRNA, rRNA, Bacterial protein synthesis and regulation; Eukaryotic protein synthesis and regulation, post translational modification, organelle genome.

### **Practicals:**

1. Preparation of Plasmid DNA
2. Restriction enzymes digestion of DNA
3. Separation of DNA fragments by gel electrophoresis
4. Determination of melting temperature of DNA

### **Books Recommended:**

1. Darnell Jr. J., Lodish, H. and Baltimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y.

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2. Zubay, G.L., (1995). Principles of Biochemistry McMillan Publishing Co.
3. Griffiths, Anthony J.F., Et. Al. (2002). Modern genetic analysis: Integrating genes and genomes Edition 2<sup>nd</sup> W.H. Freeman, New York.
4. Lehninger, A.L., Nelson, D.L. and Co. N.M. (2000). Principles of Biochemistry. Worth Publishers, N.Y.
5. Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments. 3<sup>rd</sup> Edition. John Wiley Sons, Inc., N.Y.

  
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## ANNEXURE-E

### FORMAT OF QUESTION PAPER

The following format of question paper setting for BS Zoology four year program (semester system) was proposed by Prof. Dr. Mir Azam Khan (Dean Faculty of Biological Sciences) and recommended by the members of Board of Studies during first meeting.

#### Format of Question Paper for Mid Term Exam (Marks 30)

##### Part I (09 Marks)

Time allowed 15 minutes

Q#01

Fill in the blanks (03 Marks)

True false (03 Marks)

Choose the correct one (03 Marks)

##### Part II (21 Marks)

Time allowed 60 minutes

Q#02 subjective (07 Marks)

Q#03 subjective (07 Marks)

Q#04 Write note on the following

a) 3.5 Marks

b) 3.5 Marks

---

#### Format of Question Paper for Terminal Exam (Marks 50)

##### Part I (18 Marks)

Time allowed: 20 minutes

Q#01

Fill in the blanks (07 Marks)

True false (07 Marks)

Choose the correct one (04 Marks)

##### Part II (32 Marks)

Time allowed: One and half hour

Q#02 subjective (08 Marks)

Q#03 subjective (08 Marks)

Q#04

a) 04 Marks

b) 04 Marks

Q#05 Write note on the following

a) 3 Marks

b) 3 Marks


c) 2 Marks

  
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## ANNEXURE-F

### LIST OF THESIS VIVA VOCE EXAMINERS FOR BS ZOOLOGY

|     |  |
|-----|--|
| 1.  | Dr. Abdul Hamid Jan, Professor in Department of Zoology, University of Peshawar                              |
| 2.  | Dr. Syed Akram Shah, Professor, Department of Zoology, University of Peshawar                                |
| 3.  | Dr. Fazli Subhani, Professor and Principal Govt Postgraduate College Dargai Malakand                         |
| 4.  | Dr. Ali Muhammad, Associate Professor, Department of Zoology, Islamia College University, Peshawar           |
| 5.  | Dr. Zahid Ali, Assistant Professor, Department of Zoology, Islamia College University, Peshawar              |
| 6.  | Dr. Anayat Ali Shajehan, Professor, Department of Zoology, University of Peshawar                            |
| 7.  | Mr. Ismail, Lecturer, Department of Zoology, Islamia College University, Peshawar                            |
| 8.  | MR. Shahid Niaz, Lecture, Department of Zollogy, Kohat University of Science and Technology (KUST)           |
| 9.  | Mr. Sanaullah, Assistant Professor, Department of Zoology, Kohat University of Science and Technology (KUST) |
| 10. | Mr. Syed Muhammad Kaleem, Lecturer, Department of Zoology, Islamia College University, Peshawar              |
| 11. | Dr. Alam Zeb Khan, Assistant Professor, Department of Biotechnology, University of Malakand                  |
| 12. | Mr. Hazrat Ali, Lecturer, Department of Biotechnology, University of Malakand                                |
| 13. | Dr. Aftab Ali Shah, Assistant Professor, Department of Biotechnology, University of Malakand                 |
| 14. | Mr. Ikram Ilahi, Assistant Professor, Department of Zoology, University of Malakand                          |
| 15. | Mr. Abdur Rehman, Lecturer, Department of Zoology, University of Malakand                                    |
| 16. | Dr. Irfan Zia Qureshi, Associate Professor, Quaid-i-Azam University, Islamabad                               |
| 17. | Mr. Saeed Ahmad, Lecturer, Department of Zoology, University of Malakand                                     |
| 18. | Mrs. Dil Naz, Lecturer, Department of Zoology, University of Malakand  |
| 19. | Mr. Ali Bahadar, Lecture, Superior Science College, Peshawar   |
| 20. | Mr. Syed Muhammad Naeem, Lecturer, Saidu Medical College, Swat   |
| 21. | Dr. Mir Azam Khan, Professor, Department of Pharmacy, University of Malakand                                 |
| 22. | Mr. Nawab Ali, Lecture, Govt. Degree College, Thana, Malakand Agency   |
| 23. | Mr. Qadim Khan, Assistant Professor, Govt Postgraduate College Dargai Malakand                               |

  
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**ANNEXURE-G**  
**PROPOSED THESIS FORMAT FOR BS (ZOOLOGY) PROGRAM**

**Thesis Writing Guidelines**  
For  
BS (*Hon 's*)



**Department of Zoology**  
**University of Malakand, Chakdara, Lower Dir, Khyber Pakhtunkhwa,**  
**Pakistan**

  
**Assistant Registrar (Academics)**  
University of Malakand

## INTRODUCTION

The BS Honor thesis is usually an independent piece of work by the student. The main purpose is to train the student to accomplish a scientific work in the field of his/her program or in the major subject. The thesis should show understanding with the subject matter, mastery of appropriate research methods and capability of scientific expression in an understandable way. The extent of the thesis is six (6) credit hours. If the length exceeds 100 pages it is good to consider whether the outline is well defined. The thesis must include a one page abstract. The abstract is annexed in the beginning of the thesis in required format. It should briefly describe the objectives, materials and methods used, the main research results and final conclusion. Thesis is a kind of expression of a person, the well written thesis, the more look and interest it will gain.

### Supervision

The topic of the thesis should be decided at the end of writing a thesis. However, it is recommended, that the topic should be discussed with and agreed upon by the supervisor. Usually a Lecturer, Assistant Professor, Associate Professor or a Professor from the department will act as a supervisor of the thesis writing.

### General Instructions

BS thesis should include the following sections:

- Title page
- Declaration page
- Certificate page
- Table of Contents
- Abstract
- Acknowledgment
- List of Figures
- List of Tables
- List of Abbreviation
- Introduction
- Materials and Methods
- Results
- Discussion
- Conclusions
- References
- Appendix



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### Layout of Thesis

The style of the thesis should be of a scientific report or textbook in the respective field. The appropriate language should be used like "It is shown...". The text should not need to be entertaining, but it should not need to be boring either. The following parameters should be used:



- Hard cover: Light Green color with title, university monogram, author name and departmental address only.
- Page: A4, Horizontal. Vertical can be used in case of tables/figures.
- Margins: Left and right 2.5, top and bottom 2.5
- Columns: single column
- Alignment: Align both edges of your text
- Page numbers: Bottom right margin. Pages should be counted from the Introduction.
- Font type and size: Times New Roman; Main text font size 12. Main headings: CAPITAL font size 14, Arial. Other headings should be 12. The 1st and 2nd category headings should be bold, lower level headings should be of normal font.
- Spacing: 1.5, Spaces in Paragraphs: Auto (before and after) paragraph.

### **Appearance of the Thesis**

The cover page should contain the name of the Thesis, the name of the author, the description (Bachelor's thesis), the date and the place (department and university). Table of contents should be given along with the page number of each item. Each main chapter should start from a new page. The thesis should be usually bound in hard covers (green) after it has been officially accepted.

### **STRUCTURE OF THE THESIS**

#### **Title Page**

The title page should include the title of the work, author name, name of the department with the name of the university, month and year of publication as shown in appendix II. It must not include the registration number of the student, or any other statement.

#### **Certification page**

A certification page include the title of the work, author name, name of the department with the name of the university and is signed by the supervisor, external examiner and chairperson of the department.

#### **Declaration page**

A duly signed declaration page should stand after the certification page stating the originality of the work carried out and accepting the responsibility of any material used in the text. The exact statement should be as under with modification of underline words only:

*"I hereby declare that the material contained in this thesis is my original work. I have not previously presented any part of this work for any other degree".*

#### **Table of Contents**

Table of contents should include all the titles from the abstract, but not the first pages of the thesis. Pages from abstract up to list of abbreviations should be numbered in Roman (I, II, III...) on right bottom of the page. Pages from introduction should be numbered in numeric (1, 2, 3....)

on right bottom of the page. In text main chapters should be separated into separate pages. Chapters should be numbered. Appendixes may be listed but general title "Appendix" should be neither numbered nor included into the total number of pages. However, individual appendixes are numbered and titled.

### **Abstract**

- An abstract should be concise (350 to 400 words) self-contained summary, should include the context, aims/objectives, methods, results, and conclusion.
- 5 - 10 keywords at the end of abstract body.

### **Acknowledgments**

An acknowledgment normally should be one page, and must stand alone. In the introduction the time and place of the performance of the work are mentioned together with possible sponsors and the purpose of the work. If more people are involved, the role of them is described in a general level. Also those persons and institutions who have involved in the study should be acknowledged. The supervisors and reviewers of the work should be acknowledged. Author can sign the acknowledgment.

### **List of Figures**

This page should present the order, page number and title of the figures contained in the dissertation.

### **List of Tables**

This page should present the order, page number and title of the tables contained in the dissertation.

### **List of Abbreviation and Definitions**

If the text includes lots of abbreviations and special terms, they should be listed with explanations. It should not be more than one page.

### **Citation in Text**

A standard international system, the Harvard System, should be used throughout the text. All citations in the text should refer to:

1. Single author: the author's name, year of publication for example (Zeb 2011).
2. Two authors: both authors' names, year of publication for example (Ilahi and Suleman 2013).
3. Three or more authors: first author's name followed by et al year of publication for example (Ilahi et al 2013).

4. Citations may be also made directly for example; "Zeb (2011) reported.....", "according to Ilahi and Suleman (2013).....", "Ilahi et al (2013) recently reported..." or "according to Ilahi et al (2013).....".

5. Multiple citations in support of a statement should be cited in bracket in chronological order separated by ";" for example (Zeb & Murkovic 2010; Zeb 2011; Ilahi et al 2012; Ilahi & Ullah 2013).

6. If two or more references have the same authors, the references should be organized by the year of publications.

7. If referred to the publications by the same author published in the same year, the references are separated by small English letters, e.g. (Zeb 2010a and Zeb 2010b).

## **CHAPTER WISE STRUCTURE OF THESIS**

### **Chapter 1: INTRODUCTION**

The introduction should normally be 10-20 pages. The purpose of the introduction should be to explain the reader about the subject of the thesis. The introduction should describe the most crucial background information related to the subject studied, including research problem, the history and state of art on the subject in a general level. The introduction should contain the brief literature review, but should not be entitled separately. Introduction should be written in Standard English language, special terms and abbreviation should be avoided.

The last paragraph of the introduction includes the aims of the work condensed into a few words or a paragraph. The main objectives should be included at the end of the introduction with a separate heading, and should be written in bullet format.

### **Chapter 2: MATERIALS AND METHODS**

In this chapter all the materials and methods should be described. This chapter should include detailed information concerning the analysis, analytical devices etc. Appropriate subheadings should be used. Methods should include the principles of the methods, detection limits, sources of errors, quality control and detailed description of the study performed. Research frame and/or the progression of the study should be described using a graph or table if needed. The conditions and order used should be included in the description. The statistical analyses used should be described in details.

### **Chapter 3: RESULTS**

Results must be presented in a logical order using sub headings. Results should be given clearly, using illustrative figures or tables. The data given in the figure or table should be briefly written in the text. The data must be either given in figure or in table form, but not in both. Attention should be paid to the accuracy of the results. The precision of the analysis determines the precision used in the results section. General rule is to use three significant numbers.

In general, discussion must not be included in the results. The discussions that can be concluded directly from the results and does not require further background information from the literature can be presented in the results. In results section no references to the literature should be made.

#### **Chapter 4: DISCUSSION**

The discussion is usually the author's interpretation of results. It also includes comparison to previously published data. In discussion author gives the reader his ideas from the study performed. Author gives his/her opinions to the reader, therefore it should be accurate. Discussion includes authors opinions, all the opinions must be based on the results from the work or from the published results by the others. Opinions that are not based on the results should not be presented.

In discussion the order of the subheadings must be considered carefully. In the beginning the possible sources for errors, the evaluation of the methods etc. can be written. After that the clearest results can be discussed. Finally, the new findings are revealed. Then all the results should be discussed. However, repetition with Chapter 3 results should be avoided. The result can be repeated shortly, a reference (e.g. Figure 2) is normally enough. Each paragraph includes one result from the study. There should normally be no need for describing the experimental setup. However, if the setup is important when comparing the results, it can be described briefly. After describing the previous knowledge, the result of the work is given in context to the results from the literature. The Author should pay attention to the following aspects: 1) does the result fit to the results from literature? 2) If not, can author explain why they do not follow the results from literature? 3) What new aspects do the results give? In discussion author should also explain the comparability of the results; if the experimental setups differ and this could explain the difference in the results this must be mentioned. Conclusions from the results are written at the end of the paragraph. Finally author should think the aims of the work and compare them with the content of the results and discussion.

Last paragraph of the discussion is the generalization. A successful study gives new observations and these observations can be generalized to create new theories. These new observations should be stressed in discussions. However, results that confirm the theories from other authors should be also mentioned, together with possible disagreements. The usability of the results should be explained, especially if the report does not include separate conclusions. Also, if the study rose up some new questions, it should be mentioned. The Author should also think how this study contributed to general knowledge of the subject studied. Too speculative or provocative discussion should be avoided. If the report includes separate chapters "conclusions", this last paragraph of the discussion can only include the key results and the conclusions from them.

#### **Conclusions**

Conclusions should be presented in discussion chapter. In conclusions the text must be condensed and no references should be given. The length of this section should be a maximum of 1-2 pages. No individual results are given, but the generalization and the importance of the results are explained. Each conclusion is given in a separate paragraph. The importance and

usability of the results, together with possible applications are explained. The possible effect to studies in the future is speculated. The Author should clearly write down those conclusions he/she wants the reader to remember from the study.

## Chapter 5: REFERENCES

The references cited in the text must be present in the bib. Unpublished results and personal communications should not be included in the reference list, but may be mentioned in the text. Citation of a reference as in press implies that the item has been accepted for publication. References should be listed alphabetically. Articles written by the same first author with different second authors should be listed according to the first author's surname and then according to the second author's surname. Articles written by the same first author with more than one co-author should be listed alphabetically according to the first author's surname and then according to the year of publication. Two or more references to the same first author with the same publication year should have a, b, c suffixed to the year.

### a) Journal Articles:

Zeb A (2011) Effects of  $\beta$ -carotene on the thermal oxidation of fatty acids. *African Journal of Biotechnology* 10, 15346-15352. **(In case of one author reference)**

Ilahi I, Ullah F (2013) Larvicidal activities of different parts of *Artemisia vulgaris* Linn. against *Culex quinquefasciatus* Say. (Diptera: Culicidae). *International Journal of Innovation and Applied Studies* 2(2), 189-195. **(In case of two or more authors reference)**

Ilahi I, Asghar A, Ali S, Khan M, Khan N (2012) Beneficial effects of *Pentanema vestitum* Linn. whole plant on the glucose and other biochemical parameters of alloxan induced diabetic rabbits. *ISRN Pharmacology*. Volume 2012, Article ID 478023, doi:10.5402/2012/478023. **(In case of In Press reference)**

### b) Reference books:

Zeb A (2012) Sea buckthorn (*Hippophae rhamnoides*. L. ssp. *turkistanica*) seed, chemical and physico-chemical properties. In: *Nuts and Seed in Health and Diseases Prevention*. Preedy V R, Watson R R, Patel V B (Eds), Elsevier Inc. USA, pp: 1003-1010.

### c) Web reference:

As a minimum, the full URL should be given and the date when the reference was last accessed. Web reference without author should not be used. Citation of wikipedia or other source without complete citation should not be used.

- Harris R (2010) Evaluating Internet research sources. Retrieved on 22 November 2010 from <http://www.virtualsalt.com/evalu8it.htm>

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**d) Conference proceedings:**

Zeb A, Murkovic M (2011) Mass spectrometric characterization of triglyceride oxidation. *Proceedings of the 2nd MS Food Day 2011*. October 19-21, University of Trieste, Italy, pp: 62-63.

**e) Magazine article in print:**

Kluger J (2008, January 28). Why we love. *Time*, 171(4), 54-60.

**f) Dissertation:**

Ullah F (2013) Larvicidal activities of different parts of *Artemisia vulgaris* Linn. against *Culex quinquefasciatus* Say.(Diptera:Culicidae). M.Sc. Dissertation, Department of Zoology, University of Malakand, Dir (Lower), Pakistan, pp: 1-34

**g) Encyclopedia:**

Sadie S, Tyrrell J (Eds.) (2002) The new Grove dictionary of music and musicians (2nd ed, Vols. 1-29). Grove, New York.

**h) Article from an online encyclopedia:**

Containerization (2008) In Encyclopedia Britannica. Retrieved May 6, 2008, from <http://search.eb.com>

**i) Encyclopedia articles:**

Kinni T B (2004). Disney, Walt (1901-1966): Founder of the Walt Disney Company. In: *Encyclopedia of Leadership*, Vol. 1, Thousand Oaks, CA, Sage Publications. pp. 345-349.

## APPENDIXES

Appendix is last part in thesis after the reference chapter. The materials from other publications should be listed in list of references. Published or accepted (In press only) papers of the author should be placed in appendix.

  
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Model Title page

**TITLE SHOULD BE HERE IN BOLD AND CAPITAL LETTERS,  
USUALLY ARIAL FONT**



**By**

**AUTHOR NAME**

**BS (Hon's)  
In  
Zoology**

**DEPARTMENT OF ZOOLOGY  
UNIVERSITY OF MALAKAND  
CHAKDARA, LOWERDIR, KHYBER PAKHTUNKHWA,  
PAKISTAN  
Year**

**Assistant Registrar (Academics)  
University of Malakand**

## Model Abstract page

Farman Ullah (2013). Larvicidal Activities of Different Parts of *Artemisia vulgaris* Linn. against *Culex quinquefasciatus* Say.(Diptera:Culicidae). M.Sc thesis, Department of Zoology, University of Malakand, pp: 1-34

### ABSTRACT

The plant *Artemisia vulgaris* is a perennial weed, belongs to the family Asteraceae, locally known as Tarkha in Dir and Swat regions of Khyber Pakhtunkhwa (K.P.K) and is traditionally used for repelling insects from granaries. The present study aimed to evaluate the larvicidal activity of methanol extracts of roots, stem and leaves of *A. vulgaris* against *Culex quinquefasciatus*. The 3<sup>rd</sup> and 4<sup>th</sup> instars larvae of *Cx. quinquefasciatus* were exposed for 24 hours to various concentrations (50, 100, 500, 1000, and 1500 ppm) of methanol extracts of different parts of *A. vulgaris*. At the concentration of 50 ppm the extracts of roots, stem and leaves caused  $9.30 \pm 2.85$  %,  $7.5 \pm 2.85$  % and  $11.65 \pm 2.85$  % respectively. At this concentration stem extracts showed weak larvicidal activity. At 100 ppm the roots, stem and leaves extracts caused  $13 \pm 10$  %,  $11 \pm 5$  % and  $17 \pm 5$  % mortality respectively. At 500 ppm the roots, stem and leaves extracts caused  $22 \pm 8.65$  %,  $17.23 \pm 10$  % and  $38.3 \pm 7.85$  % respectively. Up to the concentration of 500 ppm, all the plant parts were homogeneous in larvicidal activity ( $P > 0.05$ ). At 1000 ppm, the root, stem and leaves extract caused  $28.3 \pm 7.635$  %,  $21.65 \pm 11.545$  % and  $49.65 \pm 23.6$  % respectively. At this concentration, the leaves extract showed significantly higher larvicidal activity ( $P < 0.05$ ). At 1500 ppm the roots, stem and leaves extracts caused  $33.3 \pm 10.4$ ,  $28.3 \pm 7.6$  and  $66.3 \pm 8$  % respectively. At this concentration the larvicidal activity of leaves extract was significantly higher as compared to those of root and stem extracts ( $P < 0.05$ ). The  $LC_{50}$  value for roots extract was 9141.0 ppm, stem extract 2224.2 ppm and leaves extract 803.2 ppm. Among the methanol extracts of roots, stem and leaves, the methanol extract of leaves proved to be more toxic and efficient larvicidal against *Cx. quinquefasciatus*.

### Key words

Root, stem, leaves, Mortality,  $LC_{50}$ , 3rd instars, 4th instars

  
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## ACKNOWLEDGMENT

The guidelines were prepared according to the consent and approval of faculty members of Department, Department of Zoology, University of Malakand and are therefore highly acknowledged. The following sources were referred for compilation/preparation of the contents of these Guidelines and are therefore highly acknowledged:

- Abdul Ghafoor, Manual for Synopsis and Thesis preparation. Institute of Soil and Environmental Sciences, University of Agriculture Faisalabad, Pakistan.
- University of Tampere Finland, Instructions for writing a master's thesis and completing a master's degree. Retrieved on 25 February 2012 from <http://www.uta.fi/laitokset/kirjasto/tutkielmat/english/masterthesis.htm>.
- Cornell University Library. APA citation style. Referred on 22 February 2012 from <http://www.library.cornell.edu/resrch/citmanage/apa>
- Colorado School of Mines, Office of Graduate Studies. Thesis and Dissertation Writer's Guide (2009).
- Hannu Koponen (2008) MSc thesis writing instructions. MSc thesis. MSc degree program in Environmental Biology and Biogeochemistry, Department of Environmental Science, University of Kuopio. Retrieved on 02 March 2012 from [www.uku.fi/ebb](http://www.uku.fi/ebb)
- The hard work of Mr. Ikram Ilahi (Assistant Professor & head department of Zoology, University of Malakand), suggestion of Mr. Hazrat Ali (lecturer, department of Biotechnology, University of Malakand) and the guidance of Professor Dr. Mir Azam Khan (Dean Faculty of Biological Sciences, University of Malakand) are highly acknowledged.



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