FOUR-YEAR BS DEGREE IN ZOOLOGY

(SEMESTER SYSTEM)

w.e.f. Fall 2023



# LAHORE COLLEGE FOR WOMEN UNIVERSITY, LAHORE

### LAHORE COLLEGE FOR WOMEN UNIVERSITY, LAHORE

**4 Years BS Degree Program in Zoology**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr.**  **No.** | **Categories** | **No. of Courses** | **Credit Hours** |
| 1 | General Courses | 12 | 30 |
| 2 | Major courses | 22 | 77 |
| 3 | Elective within Major | 1 | 4 |
| 4 | Allied within Major | 3 | 12 |
| 5 | Field Experience (Internship) | 1 | 3 |
| 6 | Capstone Project | 1 | 3 |
| **Total** | | | **129** |

* Total number of credit hours 129
* Duration 4 Years
* Semester duration 16-18 weeks
* Semester 8
* Course load per semester 15-18 Credit Hours
* Number of courses per semester 5-6

**LAHORE COLLEGE FOR WOMEN UNIVERSITY, LAHORE**

**4 Years BS Degree Program in Zoology**

**SEMESTER-I**

## YEAR 1

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| GEDU-101 | **Functional English** | 3 |
| GEDU-102 | **Islamic Studies/**  **Ethics (for Non-Muslim students in lieu of Islamic studies)** | 2 |
| GEDU-103 |
| GEDU-104 | **Application of Information and Communication Technology** | 2 |
| GEDU-104P | **Application of Information and Communication Technology (Practical)** | 1 |
| ZOO-101 | Animal Diversity-I | 3 |
| ZOO-101P | Animal Diversity-I (Practical) | 1 |
| ZOO-102 | Animal Diversity-II | 3 |
| ZOO-102P | Animal Diversity-II (Practical) | 1 |
| **Total Credit Hours** | | **16** |

#### SEMESTER-II

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| **GEDU-151** | **Expository English** | 3 |
| **GEDU-152** | **Ideology and Constitution of Pakistan** | 2 |
| **GEDU-153** | **Quantitative Reasoning-I** | 3 |
| ZOO-151 | Principles of Genetics & Evolution | 3 |
| ZOO-151P | Principles of Genetics & Evolution (Practical) | 1 |
| ZOO-152 | Cell Biology | 2 |
| ZOO-152P | Cell Biology (Practical) | 1 |
| **Total Credit Hours** | | **15** |

**SEMESTER-III**

## YEAR 2

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| **GEDU-\*\*\*** | **Natural Sciences** | 2 |
| **GEDU-\*\*\*** | **Social Sciences** | 2 |
| **GEDU-\*\*\*P** | **Social Sciences (Practical)** | 1 |
| **GEDU-201** | **Quantitative Reasoning-II** | 3 |
| ZOO-201 | Principles in Animal Life | 3 |
| ZOO-201P | Principles in Animal Life (Practical) | 1 |
| ZOO-202 | Animal Form & Function-I | 3 |
| ZOO-202P | Animal Form & Function-I (Practical) | 1 |
| **Total Credit Hours** | | **16** |

#### SEMESTER-IV

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| **GEDU-\*\*\*** | **Arts and Humanities** | 2 |
| **GEDU-251** | **Entrepreneurship** | 2 |
| **GEDU-252** | **Civics and Community Engagement** | 2 |
| ZOO-251 | Animal Form and Function-II | 3 |
| ZOO-251P | Animal Form and Function-II (Practical) | 1 |
| ZOO-252 | General Biochemistry | 3 |
| ZOO-252P | General Biochemistry (Practical) | 1 |
| ZOO-253 | Biological Techniques | 2 |
| ZOO-253P | Biological Techniques (Practical) | 1 |
| **Total Credit Hours** | | **17** |

**SEMESTER-V**

## YEAR 3

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| ZOO-301 | Economic Zoology | 2 |
| ZOO-301P | Economic Zoology (Practical) | 1 |
| ZOO-302 | General Physiology | 3 |
| ZOO-302P | General Physiology (Practical) | 1 |
| ZOO-303 | Ecology | 2 |
| ZOO-303P | Ecology (Practical) | 1 |
| ZOO-304 | Evolution and Principles of Systematics | 2 |
| ZOO-304P | Evolution and Principles of Systematics (Practical) | 1 |
|  | Allied-1 | 3 |
|  | Allied-1 (Practical) | 1 |
| **Total Credit Hours** | | **17** |

#### SEMESTER-VI

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| ZOO-351 | Developmental Biology | 3 |
| ZOO-351P | Developmental Biology (Practical) | 1 |
| ZOO-352 | Genetics | 3 |
| ZOO-352P | Genetics (Practical) | 1 |
| ZOO-353 | Wild Life | 2 |
| ZOO-353P | Wild Life (Practical) | 1 |
| ZOO-354 | Animal Behaviour | 2 |
|  | Allied-2 | 3 |
|  | Allied-2 (Practical) | 1 |
| **Total Credit Hours** | | **17** |

**SEMESTER-VII**

## YEAR 4

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| ZOO-401 | Research Methodologies and Bioinformatics | 2 |
| ZOO-401P | Research Methodologies and Bioinformatics (Practical) | 1 |
| ZOO-402 | Molecular Biology | 2 |
| ZOO-402P | Molecular Biology (Practical) | 1 |
| ZOO-403 | Zoogeography & Paleontology | 2 |
| ZOO-403P | Zoogeography & Paleontology (Practical) | 1 |
| ZOO-498 | Field Experience/ Internship | 3 |
|  | Allied-3 | 3 |
|  | Allied-3 (Practical) | 1 |
| **Total Credit Hours** | | **16** |

#### SEMESTER-VIII

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| ZOO-4\* | **\*Elective Subject** | 3 |
| ZOO-4\*P | \*Elective Subject (Practical) | 1 |
| ZOO-4\* | **\*\* Special Subject (Paper A)** | 3 |
| ZOO-4\*P | \***\*** Special Subject (Paper A) (Practical) | 1 |
| ZOO-4\* | **\*\* Special Subject (Paper B)** | 3 |
| ZOO-4\*P | \***\***Special Subject (Paper B) (Practical) | 1 |
| ZOO-499 | Capstone Project | 3 |
|  |  |  |
| **Total Credit Hours** | | **15** |

**Total = 16+15+16+17+17+17+16+15 = 129 Credit Hours**

* Elective Subjects- Annexure-I

**\***\* Special Subjects- Annexure-II

**LIST OF ALLIED COURSES FOR STUDENTS OF BS ZOOLOGY**

Allied courses shall be offered to students of BS Zoology as per availability of resources and offering of concerned department.

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
|  | Inferential Statistics | 3 |
|  | Inferential Statistics (Practical) | 1 |
|  | Diversity of Plant | 3 |
|  | Diversity of Plant (Practical) | 1 |
|  | Morphology, Anatomy and Taxonomy of Plants | 3 |
|  | Morphology, Anatomy and Taxonomy of Plants  (Practical) | 1 |
|  | General Inorganic Chemistry | 3 |
|  | General Inorganic Chemistry (Practical) | 1 |
|  | Physico-Organic Chemistry-1 | 3 |
|  | Physico-Organic Chemistry-1 (Practical) | 1 |

### LIST OF ALLIED COURSES OF ZOOLOGY TO BE OFFERED TO THE STUDENTS OF OTHER DEPARTMENTS/MAJORS

Allied courses shall be offered to BS students of other departments as per availability of resources and offering of the department.

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| ZOO-101 | Animal Diversity-I | 3 |
| ZOO-101P | Animal Diversity-I (Practical) | 1 |
| ZOO-102 | Animal Diversity-II | 3 |
| ZOO-102P | Animal Diversity-II (Practical) | 1 |
| ZOO-151 | Principles of Genetics & Evolution | 3 |
| ZOO-151P | Principles of Genetics & Evolution (Practical) | 1 |
| ZOO-152 | Principles in Animal Life | 3 |
| ZOO-152P | Principles in Animal Life (Practical) | 1 |

Total No. of Credit Hours: 12

## ANNEXURE-I

**LIST OF ELECTIVE COURSES**

Students shall choose one course from the following list as per availability of resources and offering by the department.

|  |  |  |
| --- | --- | --- |
| **Course Code** | **Course Title** | **Credit**  **Hours** |
| ZOO-476 | Immunology | 3 |
| ZOO-476P | Immunology (Practical) | 1 |
| ZOO-477 | Fundamentals of Microbiology | 3 |
| ZOO-477P | Fundamentals of Microbiology (Practical) | 1 |
| ZOO-478 | Conservation Biology | 3 |
| ZOO-478P | Conservation Biology (Practical) | 1 |
| ZOO-479 | Medical Biotechnology | 3 |
| ZOO-479P | Medical Biotechnology (Practical) | 1 |
| ZOO-480 | Insects of Veterinary and Medical Importance | 3 |
| ZOO-480P | Insects of Veterinary and Medical Importance  (Practical) | 1 |
| ZOO-481 | Haematology | 3 |
| ZOO-481P | Haematology (Practical) | 1 |
| ZOO-482 | Restoration Ecology and Sustainable Development | 3 |
| ZOO-482P | Restoration Ecology and Sustainable Development  (Practical) | 1 |
| ZOO-483 | Bioinformatics | 3 |
| ZOO-483P | Bioinformatics (Practical) | 1 |

## ANNEXURE-II

**LIST OF SPECIAL SUBJECTS (PAPER A & B)**

Students shall choose two courses from the following list as per availability of resources and offering by the department.

|  |  |  |
| --- | --- | --- |
| **Course Code** | **Course Title** | **Credit**  **Hours** |
| ZOO-451 | Morphology, Physiology and Ecology | 3 |
| ZOO-451P | Morphology, Physiology and Ecology  (Practical) | 1 |
| ZOO-452 | Classification of Insects and Pest Management | 3 |
| ZOO-452P | Classification of Insects and Pest Management  (Practical) | 1 |
| ZOO-453 | General Endocrinology | 3 |
| ZOO-453P | General Endocrinology (Practical) | 1 |
| ZOO-454 | Reproductive Endocrinology | 3 |
| ZOO-454P | Reproductive Endocrinology (Practical) | 1 |
| ZOO-455 | Physiology of Coordination | 3 |
| ZOO-455P | Physiology of Coordination (Practical) | 1 |
| ZOO-456 | Physiological Systems and Adaptations | 3 |
| ZOO-456P | Physiological Systems and Adaptations  (Practical) | 1 |
| ZOO-457 | Parasitology A | 3 |
| ZOO-457P | Parasitology A (Practical) | 1 |
| ZOO-458 | Parasitology B | 3 |
| ZOO-458P | Parasitology B (Practical) | 1 |
| ZOO-459 | General Microbiology | 3 |
| ZOO-459P | General Microbiology (Practical) | 1 |
| ZOO-460 | Applied Microbiology | 3 |
| ZOO-460P | Applied Microbiology (Practical) | 1 |
| ZOO-461 | Principles of Fish Biology | 3 |

|  |  |  |
| --- | --- | --- |
| ZOO-461P | Principles of Fish Biology (Practical) | 1 |
| ZOO-462 | Fish Physiology and Breeding | 3 |
| ZOO-462P | Fish Physiology and Breeding (Practical) | 1 |
| ZOO-463 | Advanced cell and Molecular biology | 3 |
| ZOO-463P | Advanced cell and Molecular biology (Practical) | 1 |
| ZOO-464 | Molecular Mechanisms of Antimicrobial Drugs | 3 |
| ZOO-464P | Molecular Mechanisms of Antimicrobial drugs  (Practical) | 1 |
| ZOO-465 | Microbiology and Biotechnology | 3 |
| ZOO-465P | Microbiology and Biotechnology (Practical) | 1 |
| ZOO-466 | Introduction to Environment | 3 |
| ZOO-466P | Introduction to Environment (Practical) | 1 |
| ZOO-467 | Environmental Issues of Pakistan | 3 |
| ZOO-467P | Environmental Issues of Pakistan (Practical) | 1 |
| ZOO-468 | Basic Human Genetics | 3 |
| ZOO-468P | Basic Human Genetics (Practical) | 1 |
| ZOO-469 | Molecular Genetics | 3 |
| ZOO-469P | Molecular Genetics (Practical) | 1 |
| ZOO-470 | Fundamentals of Bioinformatics | 3 |
| ZOO-470P | Fundamentals of Bioinformatics (Practical) | 1 |
| ZOO-471 | Proteomics and Genomics | 3 |
| ZOO-471P | Proteomics and Genomics (Practical) | 1 |
| ZOO-472 | Principles and Kinetics of Toxicology | 3 |
| ZOO-472P | Principles and Kinetics of Toxicology  (Practical) | 1 |
| ZOO-473 | Biological Toxicology | 3 |
| ZOO-473P | Biological Toxicology (Practical) | 1 |
| ZOO-474 | Fresh Water Biology | 3 |
| ZOO-474P | Fresh Water Biology (Practical) | 1 |
| ZOO-475 | Aquatic Toxicology | 3 |
| ZOO-475P | Aquatic Toxicology (Practical) | 1 |

### LIST OF MINOR COURSES IN ZOOLOGY OFFER TO OTHER DEPARTMENTS

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| ZOO-253 | Biological Techniques | 3 |
| ZOO-253P | Practicals of Biological Techniques | 1 |
| ZOO-202 | Animal Form & Function-I | 3 |
| ZOO-202P | Practicals of Animal Form & Function-I | 1 |
| ZOO-251 | Animal Form & Function-II | 3 |
| ZOO-251P | Practicals of Animal Form & Function-II | 1 |

Total No. of Credit Hours: 12

### LIST OF MINORS FOR STUDENTS OF BS ZOOLOGY PROGRAM

Students of BS Zoology may opt any one or two of the following minors as per availability of resources and offering of concerned department.

1. Minor in Botany
2. Minor in Chemistry
3. Minor in Biotechnology
4. Minor in Geography
5. Minor in Education
6. Minor in Statistics
7. Minor in Computer Sciences
8. Minor in Environmental Sciences
   * Any department may change weightage of theory and practical credits hours, depending on the laboratory facilities available.
   * Courses of BS Zoology offered to other departments, as their allied courses will be on the availability of faculty member expertise and number of students.

## DETAIL OF COURSES FOR BS ZOOLOGY 4-YEAR DEGREE (8 SEMESTER) PROGRAM

**YEAR 1**

## SEMESTER-I

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| GEDU-101 | **Functional English** | 3 |
| GEDU-102 | **Islamic Studies/**  **Ethics (for Non-Muslim students in lieu of Islamic studies)** | 2 |
| GEDU-103 |
| GEDU-104 | **Application of Information and Communication**  **Technology** | 2 |
| GEDU-104P | **Application of Information and Communication**  **Technology (Practical)** | 1 |
| ZOO-101 | Animal Diversity-I | 3 |
| ZOO-101P | Animal Diversity-I (Practical) | 1 |
| ZOO-102 | Animal Diversity-II | 3 |
| ZOO-102P | Animal Diversity-II (Practical) | 1 |
| **Total Credit Hours** | | **16** |

#### ZOO-101 - ANIMAL DIVERSITY-I (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course aims to impart knowledge and understanding of:

* 1. The concept and status of Zoology in life sciences.
  2. The common processes of life through its chemistry, biochemical and molecular processes.
  3. The structure and function of cell organelle and how common animal cell diversified in various tissues, organs and organ systems.
  4. Biochemical mechanisms eventually generating energy for animal work.
  5. Animals and their relationship with their environment.

**COURSE CONTENTS**

**THEORY**

#### Introduction

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

#### Animal like protists: The Protozoa

Evolutionary perspective; Life within a single plasma Membrane; Symbiotic Life- styles. Protozoon Taxonomy; (up to Phyla, subphyla and super Classes, wherever applicable), Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure; Important parasites belonging to phylum Apicomplexa, Nutrition; Genetic Control and Reproduction of Symbiotic ciliates; further phylogenetic consideration.

1. **Multicellular and tissue levels of organization** Origins of Multicellularity; Animal Origins. **Phylum Porifera**

Characteristics and classification. Cell Types, Body Wall and Skeletons; Water Current and Body Forms; Maintenance Functions, Reproduction.

#### Phylum Cnidaria (Coelenterate)

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

#### Phylum Ctenophora

Characteristics, Body organization

#### The Triploblastic, Acoelomate Body Plan

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

**Phylum Nemertea;** Characteristics, body organization

**Phylum Gastrotricha**; Characteristics, body organization, body organization**, Phylum Gastrotricha**; Characteristics, body organization

#### The Pseudocoelomate Body Plan: Aschelminths Phylum Aschelminths

Evolutionary perspective; General Characteristics; Classification and External Features; Feeding and Digestive system; Other Organ System; Reproduction and Development of Phylum Nematoda, Some Important Nematode Parasites of Humans;

#### Molluscan Success

Evolutionary perspective; Relationship 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 of Gastropods, Bivalves and Cephalopods

#### Annelida: The Metameric Body Form

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 Consideration.

#### The Arthropods: Blueprint for Success

Evolutionary Perspective: Classification and Relationship to other Animals; Metamerism and Tagmatization; The Exoskeleton; Metamorphosis; Classification up to Class; Further Phylogenetic Consideration

#### The 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, Insects Behavior, Insect and Human

#### Echinoderms

Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class. Maintenance Functions, Regeneration, Reproduction, and Development in Asteroida, Ophiuroidea, Echinoidea, Holothuridea and Crinoidea;

#### BOOKS RECOMMENDED

1. *Zoology.* Miller, S.A. and Harley, J.B., 2020. 11th Edition. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. Larson, A., 2023. 19th Edition (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2010. 15th Edition. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates.* Kent, G.C. Miller, S. 2001. 9th Edition. New York. McGraw Hill.
5. *Biology.* Campbell, N.A., 2020. 12th Edition. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
6. *Modern Text Book of Zoology Vertebrates.* Kotpal, R.L. 2020. 5th Edition. Rastogi Publications, New Delhi.
7. *Integrated Principles of Zoology.* Hickman, C.P., Robert, L.C., Keen, S.L., Larson, A., Helen, L. Eisenhour, D.J. 2009*,* 17th Edition. McGraw-Hill Education, New York.

#### ZOO-101P - ANIMAL DIVERSITY-I (PRACTICAL)

1. Study of *Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, Paramecium*

as representative of animal like protists (Prepared slides).

1. Study of sponges and their various body forms.
2. Study of principle representative classes of phylum Coelentrata.
3. Study of principle representative classes of phylum Platyhelminthes.
4. Study of representative of phylum Nematoda.
5. Study of principle representative classes of phylum Mollusca.
6. Study of principle representative classes of phylum Annelida.
7. Study of principle representative classes of groups of phylum Arthropoda.
8. Brief notes on medical/economic importance of the following: *Plasmodium, Entamoeba histolitica, Leishmania*, Liver fluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.

#### BOOKS RECOMMENDED

1. *General Zoology Laboratory Manual*. Miller, S.A., 2002. 5th Edition (International) Singapore: McGraw Hill.
2. *Laboratory Studies in Integrated Principles of Zoology*. Hickman, C.P. and Kats, H.L., 2019*.* 18th Edition Singapore: McGraw Hill.

#### ZOO-102 - ANIMAL DIVERSITY-II (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The objectives of the course are:

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

#### COURSE CONTENTS THEORY

1. **Protochordates**

Classification of protochordates. Structure, anatomy and organ systems of Acorn worms, Urochodates and Cephalochodates**,** Reproduction; life histories and metamorphosis of protochodates. Phylogenetic relationships.

#### Fishes: Vertebrate Success in Water

Vertebrate Success in Water. Phylogenetic relationships of Pisces, Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli, Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes and Osteichthyes.

#### Amphibians: The First Terrestrial Vertebrates

The first terrestrial vertebrates. Characteristics of amphibians, Phylogenetic relationships, Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura, Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion, Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.

#### Reptiles: The First Amniotes

The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles, Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia

#### Birds: Feathers, Flight, and Endothermy

Classification,Feathers, flight and endothermy, Phylogenetic relationships; ancientbirds and the evolution of flight, Diversity of modern birds, Adaptation in external structure and locomotion, nutrition and the digestive system,circulation, gas exchange, and regulation, nervous and sensory systems,excretion and osmoregulation, reproduction and development, Migrationand navigation.

#### Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity

Classification, Specialized teeth, endothermy, hair and viviparity, Diversity of mammals, Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development

#### BOOKS RECOMMENDED

1. *Zoology.* Miller, S.A. and Harley, J.B., 2020. 11th Edition. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. Larson, A., 2023. 19th Edition (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2010. 15th Edition. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates.* Kent, G.C. Miller, S. 2001. 9th Edition. New York. McGraw Hill.
5. *Biology.* Campbell, N.A., 2020. 12th Edition. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
6. *Modern Text Book of Zoology Vertebrates.* Kotpal, R.L. 2020. 5th Edition. Rastogi Publications, New Delhi.
7. *Integrated Principles of Zoology.* Hickman, C.P., Robert, L.C., Keen, S.L., Larson, A., Helen, L. Eisenhour, D.J. 2009*,* 17th Edition. McGraw-Hill Education, New York.

#### ZOO-102P - ANIMAL DIVERSITY-II (PRACTICAL)

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.

#### BOOKS RECOMMENDED

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

## SEMESTER-II

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| GEDU-151 | **Expository English** | 3 |
| GEDU-152 | **Ideology and Constitution of Pakistan** | 2 |
| GEDU-153 | **Quantitative Reasoning-I** | 3 |
| ZOO-151 | Principles of Genetics & Evolution | 3 |
| ZOO-151P | Principles of Genetics & Evolution (Practical) | 1 |
| ZOO-152 | Cell Biology | 2 |
| ZOO-152P | Cell Biology (Practical) | 1 |
| **Total Credit Hours** | | **15** |

#### ZOO-151 - PRINCIPLES OF GENETICS AND EVOLUTION

**(3+1 = 3 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course imparts knowledge and understanding of:

* 1. The cell division and its significance in cell cycle.
  2. The concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
  3. The animal behaviour and communication.
  4. The theories of evolution, gene flow and mechanism of evolution with reference to animal and diversity.

#### COURSE CONTENTS THEORY

1. **Cell Division**

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

#### Inheritance Patterns

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

#### Chromosomes and Gene Linkage

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

#### 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.

#### Animal Behaviour

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

#### 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.

#### 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. *Zoology.* Miller, S.A. and Harley, J.B., 2020. 11th Edition. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. Larson, A., 2023. 19th Edition (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2010. 15th Edition. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates.* Kent, G.C. Miller, S. 2001. 9th Edition. New York. McGraw Hill.
5. *Biology.* Campbell, N.A., 2020. 12th Edition. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
6. *Modern Text Book of Zoology Vertebrates.* Kotpal, R.L. 2020. 5th Edition. Rastogi Publications, New Delhi.
7. *Integrated Principles of Zoology.* Hickman, C.P., Robert, L.C., Keen, S.L., Larson, A., Helen, L. Eisenhour, D.J. 2009*,* 17th Edition. McGraw-Hill Education, New York.
8. *Karps Cell Biology*. Karp, G. 2018. 8th Edition. John Wiley.
9. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. De Robertis,

E.D.P. 2017. 8th Edition. Lea and Febiger, United States.

1. *Genetics*. Karvita, B.A. 2009. 2nd Edition. New Age International Gardner.
2. *Principles of Genetics*. Simmons, M.J. Snustad, D.P. 2006. 8th Edition. Wiley India Pvt. Limited.
3. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.* Verma, P.S. Agarwal, V.K. 2005. 1st Edition. Chand, S. Company LTD, New Delhi.

#### ZOO-151P - PRINCIPLES OF GENETICS AND EVOLUTION (PRACTICAL)

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 of stages in the development of an Echinoderm.
9. Study of early stages in the development of a frog, chick and a mammal.

*(Note for 8-9: Prepared slides and preserved specimen and/or projection slides and or CD ROM computer projections may be used).*

1. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex

or aggression or parental behavior).

1. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

#### BOOKS RECOMMENDED

1. *Zoology Laboratory Manual*. Miller, S.A., 2002. 5th Edition (International) Singapore: McGraw Hill.
2. *Laboratory Studies in Integrated Principles of Zoology*. Hickman, C.P. and Kats, H.L., 2009*.* Singapore: McGraw Hill.

#### ZOO-152 - CELL BIOLOGY (2+1 = 3 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **Introduction to cell structure and function**

Cell theory, Comparison of plant and animal cells, Comparison of prokaryotic and eukaryotic cells

#### Cell membranes

Structural models, Chemical composition and function

#### Cell Organelles (structure and function)

Endoplasmic reticulum, Golgi Bodies, Mitochondria, Lysosomes, Peroxysomes, Ribosome

#### Nucleus

Structure and function, Nuclear membrane, Chromatin

#### Cytoskeleton

Structure and types, Function of cytoskeleton

#### Cellular transport

Diffusion and osmosis, Facilitated and active transport, Endocytosis and exocytosis

#### Cellular reproduction

Cell cycle, Mitosis, Meiosis

#### BOOKS RECOMMENDED

1. *Molecular Biology of the Cell*. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts,

K. and Watson, J.D., 2017. 7th Edition. Garland Publishing Inc., New York.

1. *Molecular Cell Biology*. Darnell J. E., Lodish, H. F. and Baltimore, D., 2021. 9th Edition. Scientific American Inc. N.Y.
2. *The Cell: A Molecular Approach*. Geoffrey M.C., Robert E.H. 2007. Sinauer

Associates, INC.

1. *Cell and Molecular Biology*. De Robertis, E. D. P. 2017. 8th edition, Lea & Febiger, New York.
2. *Essentials of Molecular Biology*. Malacinski, M. G. 2015. 4th Edition. Jones and Bartlett.
3. *Cell Biology*. Karp, G. 2010. 6th Edition. Wiley Publisher.
4. *Molecular Biology*. Weaver, Robert, F. 2011. 5th Edition, McGraw Hill.
5. *Molecular Biology: Genes to Proteins*. Burton F. T., 2007. 3rd Edition. Jones and Bartlett.
6. *Molecular Cell Biology*. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016.

W. H. Freeman Publishers, Scientific American Inc.

#### ZOO-152P - CELL BIOLOGY (PRACTICAL)

1. Microscopy
2. Staining techniques (Gram staining)
3. Identification of cell organelles (prepared slides)
4. Preparation of temporary whole mount.
5. Preparation of permanent whole mount.
6. Squash preparation of onion root tip for mitotic stages.
7. Study of mitotic and meiotic stages (prepared slides)

#### BOOKS RECOMMENDED

1. *Molecular Cell Biology.* Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016.

W. H. Freeman Publishers, Scientific American Inc.

1. *The Cell: A Molecular Approach*. Geoffrey M.C., Robert E.H. 2007, Sinauer Associates, INC.
2. *Cell and Molecular Biology, Concepts and Experiments*. Karp, J. 2005, Jhon Wiley and Sons, INC.

## YEAR 2

**SEMESTER-III**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| GEDU-\*\*\* | **Natural Sciences** | 2 |
| GEDU-\*\*\* | **Social Sciences** | 2 |
| GEDU-\*\*\*P | **Social Sciences (Practical)** | 1 |
| GEDU-201 | **Quantitative Reasoning-II** | 3 |
| ZOO-201 | Principles in Animal Life | 3 |
| ZOO-201P | Principles in Animal Life (Practical) | 1 |
| ZOO-202 | Animal Form & Function-I | 3 |
| ZOO-202P | Animal Form & Function-I (Practical) | 1 |
| **Total Credit Hours** | | **16** |

#### ZOO-201 - PRINCIPLES IN ANIMAL LIFE (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course aims to impart knowledge and understanding of:

* 1. The concept and status of Zoology in life sciences.
  2. The common processes of life through its chemistry, biochemical and molecular processes.
  3. The structure and function of cell organelle and how common animal cell diversified in various tissues, organs and organ systems.
  4. Biochemical mechanisms eventually generating energy for animal work.
  5. Animals and their relationship with their environment.

**COURSE CONTENTS**

**THEORY**

#### Place of Zoology in Science

One-world view: genetic unity, the fundamental unit of life, evolutionary oneness and the diversity of life, environment and world resources; what is zoology? Classification of animals; the scientific method.

#### The Chemical Bases 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.

#### 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 of functions in organs and organ systems.

#### 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.

#### 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.

#### Ecology I: Individuals and Populations

Animals and their abiotic environment; populations; interspecific interactions.

#### Ecology II: Communities and Ecosystems

Community structure and diversity; ecosystems; ecosystems of the earth; ecological problems; human population growth, pollution, resource depletion and biodiversity.

#### BOOKS RECOMMENDED

1. *Zoology.* Miller, S.A. and Harley, J.B., 2020. 11th Edition. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. Larson, A., 2004. 12th Edition (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2010. 15th Edition. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates.* Kent, G.C. Miller, S. 2001. New York. McGraw Hill.
5. *Biology.* Campbell, N.A., 2020. 12th Edition. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
6. *Modern Text Book of Zoology Vertebrates.* Kotpal, R.L. 2020. 5th Edition. Rastogi Publications, New Delhi.
7. *Integrated Principles of Zoology.* Hickman, C.P., Robert, L.C., Keen, S.L., Larson, A., Helen, L. Eisenhour, D.J. 2009*,* 17th Edition. McGraw-Hill Education, New York.

#### ZOO-201P - PRINCIPLES IN ANIMAL LIFE (PRACTICAL)

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.*

1. Study of the prepared slides of squamous, cuboidal, columnar epithelial tissues, adipose, connective, cartilage, bone, blood, nervous, skeletal muscle, smooths muscle and cardiac muscle tissues.

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

1. Plasmolysis and deplasmolysis in blood.
2. Protein digestion by pepsin.
3. Ecological notes on animals of a few model habitats.
4. Field observation and report writing on animals in their ecosystem (a terrestrial

and aquatic ecosystem study).

#### BOOKS RECOMMENDED

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

#### ZOO-202 - ANIMAL FORM AND FUNCTION-I (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course aims to teach the students about:

* 1. Animals diversity adapted in different ways for their functions through modification in body parts.
  2. The diversity in integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory, respiratory.

system according to strategies to survive in their specific conditions.

* 1. Organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal’s body.
  2. The basic structure of each system that determines its particular function.

#### COURSE CONTENTS THEORY

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.

#### 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.

#### Communication II: Senses

Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and hermoreceptors 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.

1. **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, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms

invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates other than birds or mammals; endocrine systems of birds and mammals.

#### Circulation, Immunity, and Gas Exchange

Internal transport and circulatory systems in invertebrates: characteristics of invertebrate coelomic fluid, hemolymph, and blood cells; transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles,birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response; gas exchange: respiratory surfaces; invertebrate and vertebrate respiratory systems: utaneous exchange, gills, lungs, and lung ventilation; human respiratory system: gas transport.

#### BOOKS RECOMMENDED

1. *Zoology.* Miller, S.A. and Harley, J.B., 2020. 11th Edition. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. Larson, A., 2023. 19th Edition (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2010. 15th Edition. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates.* Kent, G.C. Miller, S. 2001. 9th Edition. New York. McGraw Hill.
5. *Biology.* Campbell, N.A., 2020. 12th Edition. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
6. *Modern Text Book of Zoology Vertebrates.* Kotpal, R.L. 2020. 5th Edition. Rastogi Publications, New Delhi.
7. *Integrated Principles of Zoology.* Hickman, C.P., Robert, L.C., Keen, S.L., Larson, A., Helen, L. Eisenhour, D.J. 2009*,* 17th Edition. McGraw-Hill Education, New York.

#### ZOO-202P - ANIMAL FORM AND FUNCTION-I (PRACTICAL)

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).*

1. Earthworm or leech; cockroach, freshwater muscles, *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.
2. Study of models or preserved brains of representative animals and notes on adaptations.
3. Study of nervous system of earthworm and a fish.
4. Study of endocrine system in an insect and a mammal.
5. Study of different types of blood cells in blood smear.

#### BOOKS RECOMMENDED

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

## SEMESTER-IV

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| GEDU-\*\*\* | **Arts and Humanities** | 2 |
| GEDU-251 | **Entrepreneurship** | 2 |
| GEDU-252 | **Civics and Community Engagement** | 2 |
| ZOO-251 | Animal Form and Function-II | 3 |
| ZOO-251P | Animal Form and Function-II (Practical) | 1 |
| ZOO-252 | General Biochemistry | 3 |
| ZOO-252P | General Biochemistry (Practical) | 1 |
| ZOO-253 | Biological Techniques | 2 |
| ZOO-253P | Biological Techniques (Practical) | 1 |
| **Total Credit Hours** | | **17** |

#### ZOO-251 - ANIMAL FORM AND FUNCTION-II (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practical 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course deals with the:

* 1. Basis of structure and functions of animal nutrition, Digestion, homeostasis and temperature regulation, reproduction and development.
  2. It introduces the basic concepts in reproduction and development in animal kingdom.
  3. Provides knowledge about the development of chordate body plan and fate of germinal layers.

#### COURSE CONTENTS THEORY

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.

#### Temperature and Body Fluid Regulation

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

#### Reproduction and Development

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

#### Descriptive Embryology

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

#### BOOKS RECOMMENDED

1. *Zoology.* Miller, S.A. and Harley, J.B., 2020. 11th Edition. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. Larson, A., 2004. 12th Edition (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2010. 15th Edition. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates.* Kent, G.C. Miller, S. 2001. New York. McGraw Hill.
5. *Biology.* Campbell, N.A., 2020. 12th Edition. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
6. *Modern Text Book of Zoology Vertebrates.* Kotpal, R.L. 2020. 5th Edition. Rastogi Publications, New Delhi.
7. *Integrated Principles of Zoology.* Hickman, C.P., Robert, L.C., Keen, S.L., Larson, A., Helen, L. Eisenhour, D.J. 2009*,* 17th Edition. McGraw-Hill Education, New York.

#### ZOO-251P - ANIMAL FORM AND FUNCTION-II (PRACTICAL)

1. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
2. Study of respiratory system in cockroach or locust and a vertebrate representative model.
3. Study of excretory system in an invertebrate and a vertebrate representative Model
4. Study of nutritive canal in an invertebrate and a vertebrate representative (Dissection).
5. Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
6. Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
7. Study of hormonal influence of a reproductive function (Model).
8. Study of preserved advanced stages of avian and mammalian development for amniotic membranes and placenta (Model).

#### BOOKS RECOMMENDED

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

#### ZOO-252 - GENERAL BIOCHEMISTRY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course will provide in-depth knowledge about the polymerized organic compounds of life. The dynamism of the life proceeds with interconversion 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 THEORY

1. **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; nonstandard amino acids, their structure and role; peptides, their ionic behavior and amino acid composition;Heamoglobin/Myoglobin.

#### 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.

#### 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 their types

Occurrence, structure and biochemical function ofvitamins of b- complex group.

#### Bioenergetics

Concept of free energy; standard free energy change: energy rich compounds.

#### Metabolism

Detailed description of glycolysis and catabolism of any other hexose; 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; utilization of other carbohydrates in glycolysis; phosphorolysis of glycogen and starch; regulation of glycogen metabolism; utilization of dietary polysaccharides (starch) and disaccharides (sucrose and galactose). Biosynthesis of glycogen, starch and sucrose.

#### Citric acid (TCA) cycle

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

#### Electron Transport and Oxidative phosphorylation

Components of electron transport chain. Role and structure of ATP-synthase. Oxidative phosphorylation. Substrate level phosphorylation. The glycerol phosphate shuttle mechanism and malate-aspartate shuttle system.

#### Lipid metabolism

Oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis of triacylglycerol; activation of fatty acids and their transportation to mitochondria; betaoxidation; bioenergetics of beta-oxidation; omega oxidation pathway; biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; fatty acid synthetase (FAS) multienzyme complex. 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 any one amino acid from the family; incorporation of ammonia in glutamate and glutamine; purine and pyrimidine: basic synthesis reactions only.

#### BOOKS RECOMMENDED

1. *Biochemistry: The Molecular Basis of Life.* McKee, T. McKee, J.R. 2003. 3rd Edition. McGraw Hill Companies.
2. *Lehninger Principles of Biochemistry.* David L. Nelson, and Michael M. Cox, 2021. 8th Edition, Macmillan Worth Publishers, New York.
3. *Harper’s Biochemistry*, Murray, R.K., Granner, D.K., Mayer, P.A., Rodwells,

V.W. 2000*.* 25th Edition, McGraw-Hill Book Company, New York.

1. *Fundamentals of Biochemistry*. Voet, D., Voet, J.G., Pratt, C.W. 2016. 5th Edition. John Wiley and Sons, Inc., New York.
2. *Biochemistry and Molecular Biology*. Despo P., Alison S., William H., Elliott, Daphne C. Elliott. 2018. 6th Edition, Wm. C. Oxford University Press, England.
3. *Biochemistry*. Stryer, L. 1995. 4th Edition, W.H. Freeman and Company, NY. USA.

#### ZOO-252P - GENERAL BIOCHEMISTRY (PRACTICAL)

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. *An Introduction to Practical Biochemistry.* Plummer, David T. 2017*.* 4th Edition. McGraw- Hill Book Company, London.
2. *Practical Biochemistry: Principles and Techniques*. Wilson, K & Walker, J., 1994. 4th Edition, Cambridge University Press.
3. *Principles and Techniques of Biochemistry*. David, P. 2018. 8th Edition. Cambridge University Press.

#### ZOO-253 - BIOLOGICAL TECHNIQUES (2+1 = 3 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

1. To course aim to demonstrate the knowledge of skills
2. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
3. To develop basic understanding of the equipment’s handling/usage
4. To develop scientific technical expertise, culture and work habits.
5. To know how to collect and preserved animals After successfully completion of this course,
6. Students must be able to identify the instrument
7. Able to use instrument for identification, measurement, fixing and cutting of tissue
8. Able to apply a practical and research skill
9. Able to operate use the lab equipment efficiently.
10. Able to collect and preserved the specimen in dry and wet form.
11. Developed expertise in Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field

#### COURSE CONTENTS THEORY

1. **Microscopy**

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

#### Standard unit system for weight, length, volume and Micrometry

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

#### Specimen preparation for optical microscopy

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

#### Separation and purification techniques

Cell fractionation, Centrifugation and its types, Filtration and its types,

#### Chromatography

Chromatography: Principle, applications, types, Paper chromatography and thin layer chromatography, Column chromatography, High pressure liquid chromatography, Electrophoresis: Principle, applications and types (Agarose and PAGE).

#### Spectrophotometry

Principle, applications, types, Visible/UV spectrophotometry

#### Basic principles of Sampling and Preservation

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

#### DNA sequencing

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

#### BOOKS RECOMMENDED

1. *Extraction Methods for Environmental Analysis* .Dean, J. R. 1999. John Wiley and

1. *Extraction Methods for Environmental Analysis*. Dean, J. R. 2022. John Wiley and Sons Ltd. UK.
2. *District Laboratory Practice in Tropical Countries.* Cheesbrough, M. 2001. Part I. Cambridge University Press, UK.
3. *District Laboratory Practice in Tropical Countries*. Cheesbrough, M. 2001. Part II. Cambridge University Press, UK.
4. *Environmental Sampling and Analysis: Lab Manual*. Curos, M. 2018. CRC Press LLC. USA.
5. *Environmental Sampling and Analysis: For Technician*. Curos, M. 2017. CRC Press LLC. USA.

#### ZOO-253P - BIOLOGICAL TECHNIQUES (PRACTICAL)

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

#### BOOKS RECOMMENDED

1. *Practical Ecology*. Slingsby, D., Cock, C.1986. McMillan Education Ltd. London.
2. *Practical Skill in Bio-Molecular Sciences*. Rob, R., David, H. 2013. 4th Edition. Jonathan Weyers, Allan Jones Pearson,
3. *Current Protocols Essential Laboratory Techniques*. Gallagher, S.R. and Wiley

E.A. 2012. 2nd Edition. John Wiley & Sons Inc, USA.

1. *Practical Skills in Biology*. Jones, A. Reed, R and Weyers, J. 2012. 5th Edition. Longman Singapore Publishers (Pte) Ltd.

## YEAR 3

**SEMESTER-V**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| ZOO-301 | Economic Zoology | 2 |
| ZOO-301P | Economic Zoology (Practical) | 1 |
| ZOO-302 | General Physiology | 3 |
| ZOO-302P | General Physiology (Practical) | 1 |
| ZOO-303 | Ecology | 2 |
| ZOO-303P | Ecology (Practical) | 1 |
| ZOO-304 | Evolution and Principles of Systematics | 2 |
| ZOO-304P | Evolution and Principles of Systematics (Practical) | 1 |
|  | Allied-1 | 3 |
|  | Allied-1 (Practical) | 1 |
| **Total Credit Hours** | | **17** |

#### ZOO-301 - ECONOMIC ZOOLOGY (2+1 = 3 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 30-32
2. Practicals 00
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course aims to provide knowledge about the use and importance of various animal culture techniques for human benefit. The course will equip the students to apply these techniques in the field.

#### COURSE CONTENTS THEORY

1. **Basic concepts in Economic Zoology**

Introduction, Economic importance of animals, Animals used for food, commercial products and by-products, Economic impact of pathogens and vectors, Animals used for scientific research, Animals of aesthetic importance, Pest control and management.

#### Parasitic protozoans of human and domestic animals

Economic importance, life cycles, characteristics, vectors, diseases, treatment and control strategies against parasitic protozoans, Mastigophora (Flagellates): *Giardia lamblia*, *Leishmania donovani, Trichomonas vaginalis*, *Trypanosoma cruzi*. Sarcodina (Amoeboids): *Entamoeba gingivalis*, *Entameoba histolytica*, Apicomplexa (Sporozoa): *Plasmodium falciparum*, *Toxoplasma gondii*, Ciliophora (Ciliates): *Balantidium coli*.

#### Endo-parasites of human and domestic animals

Economic importance, life cycles, characteristics, vectors, diseases, treatment and control strategies against endo-parasites, Trematodes (Blood Flukes): *Clonorchis*

*sinensis*, *Fasciolopsis buski*, *Schistosoma mansoni*, Cestodes (Tapeworms): *Echinococcus granulosus*, *Taenia sp*. *(solium, saginata, pisiformis*) *Dipylidium caninum*, Nematodes (Round Worms): *Ascaris lumbricoides*, *Enterobius vermicularis*, *Trichinella spiralis, Wuchereria bancrofti*.

#### Ecto-parasites of human and domestic animals

Economic importance, life cycles, characteristics, vectors, diseases, treatment and control strategies against ecto-parasites: Lice: Head and body louse (*Pediculus sp.*), crab or pubic louse (*Pthirus pubis*), Hemiptera: Bed bug (*Cimex sp.*), Diptera: Mosquito (*Aedes sp.*, *Culex sp.*, *Anopheles sp.*), flies (horse fly *Tabanidae*, botfly *Dermatobia hominis*), Fleas: Cat and dog fleas (*Ctenocephalides sp.*), oriental rat flea (*Xenopsylla cheopis*), Ticks: Foul tick (*Argasidae argas*), Cattle tick (*Ixodidae boophilus*), Mites: Human Scabies (*Sarcoptes scabiei*), dust mites (*Dermatophagoides sp.*).

#### Apiculture

Economic importance, life cycle, characteristics and types of honey bees within a hive (queen, workers, and drones): Varieties of honey bees: Rock bee (*Apis dorsata*), Indian bee (*Apis cerana indica*), Little bee (*Apis florea*), European or Italian bee (*Apis mellifera*), Setting up an apiary: Rearing equipment and techniques, handling of bees, artificial diet. Honey extraction techniques, Honey bee diseases and their management: Viral, bacterial and fungal diseases. Honey bee pests and parasites, Properties and economic importance of honey and other beneficial products. from the honey bee

#### Sericulture

Economic importance, life cycle and characteristics of the silkworm: Varieties of silk and silkworms: Mulberry silkworm (*Bombyx mori*), Tasar silkworm (*Antherea paphia*), Muga silkworm (*Antheraea assama*), Eri silkworm (*Attacus Ricinii*), Oak silkworm (*Antheraea pernyi*), Gaint silkworm (*Attacus alts*), Rearing of *Bombyx mori*: Rearing equipment and techniques, racks and trays, disinfectants, harvesting of cocoons, silk reeling techniques, Silkworm diseases and their management: Viral, bacterial and fungal diseases. silkworm pests and parasites, Properties and economic importance of silk and other beneficial products from the silkworm.

#### Pisciculture (Aquaculture and Fisheries)

Economic importance of fishes, prawns and pearl culture, beneficial products and by- products, diseases and their management: Qualities and types of cultivable fishes, Types of fish farming. Breeding techniques. Hatcheries. Nursery ponds, Rearing equipment and techniques used for management of fish farms, Preservation, storage and transportation of fish products and by-products, Edible Fresh water, Pond and Marine fish, Prawn culture, Pearl oysters and pearl culture

#### Dairy/Poultry Farming

Economic importance, beneficial products and by-products, diseases and their management: Economic importance of dairy and poultry farming, Indigenous and exotic breeds (domestic fowl, duck, ostrich, sheep, goat, cow), Rearing, housing and feeding, Diseases and their management.

#### BOOKS RECOMMENDED

1. *Economic Zoology.* Ravindranathan, K.R. 2003. 1st Edition. Dominent Publishers and Distributers. New Delhi. India.
2. *Principles of Wildlife Management.* Bailey, J. A. 1991. John Wiley and Sons Inc. USA.
3. *Wildlife ecology and management.* Robinson, W. L. and Bolen, E. G. 1991. McMillan Publishing Company. Cambridge, UK.
4. *A Primer of Conservation of Biology.* Primack R. B. 2000. 2nd Edition. Sinauer Associates Inc. USA.
5. *Animal Biodiversity of Pakistan.* Mirza, Z. B. 1998. 1st Edition: Printopack, Rawalpindi. Pakistan.
6. *Economic Zoology*. Shukla, G.S. and Upadhayay, V.B. 2008. 3rd Edition. Rastogi Publications, Mearut, India.

#### ZOO-301P - ECONOMIC ZOOLOGY (PRACTICAL)

1. Study the prepared slides of various types of ecto-parasites and endo-parasites.
2. Observe and study Museum specimens of vertebrate and invertebrate pests and vectors.
3. Visit to Apiary. Write a report on observations.
4. Visit to Sericulture farm. Write a report on observations.
5. Visit to a commercial Fish farm. Write a report on observations.
6. Visit Dairy/Poultry farm. Write a report on observations.

#### BOOKS RECOMMENDED

1. *Silkworm Rearing Technology: Principles and Management*. Tribhuwan Singh. 2015. Discovery Publishing House Pvt. Ltd.
2. *Introduction to Apiculture*. Akhtar, M. and Muzaffar, N., 2008. Department of Zoology, Punjab University Press, 36 pp.
3. *The Hive and the Honeybee.* Anon, 2015. Dadant & Sons. Illinois, USA.
4. *FAO Bulletins on Sericulture*. Anon, 1999. Nos. 1 & 2. FAO Office, Rome, Italy.
5. *Beekeeping for Dummies*. Blackiston, H., 2020. Wiley Publishing, Inc. Indiana, USA, pp. 303.

#### ZOO-302 - GENERAL PHYSIOLOGY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The basic functional expression in animals is the membrane irritability understood in the form of nerve impulse.

To imparts the concepts and mechanisms of integration in the different functional systems of the animals.

To illustrate the mechanisms of nervous system and the hormonal system for the coordination.

To integrate the animal to its environment, therefore, also included in this section.

#### COURSE CONTENTS THEORY

1. **Central themes in Physiology**

Structure-Function Relationship, Adaptations, Homeostasis, Conformity and Regulation.

#### Physiological basis of Neuronal 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*; *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: Ultrasttructure 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 O2 and CO2 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. *Eckert Animal Physiology: Mechanisms and Adaptations*. Randall, D., Burggren, W., French, K. and Fernald, R., 2002*.* 5th ed. W.H. Freeman and Company, New York
2. *Physiology*. Bullock, J., Boyle, J. and Wang, M.B., 2001*.* 4th Edition. Lippincott, Williams and Wilkins, Philadelphia.
3. *Principles of Physiology*.Berne, R.M. and Levy, M.N., 2000. 3rd Edition. St. Lious, Mosby.
4. *Textbook of Medical Physiology*.Guyton, A.C. and Hall, J.E., 2000. 10th Edition.

W.B. Saunders Company, Philadelphia.

1. *Comparative Animal Physiology*. Withers, P.C., 1992. Saunders College Publishing, Philadelphia.
2. *Animal Physiology, Adaptation and Environment*. Schmidt-Nelsen, K., 1997. 5th Edition.Cambridge University Press, Cambridge.

#### ZOO-302P - GENERAL PHYSIOLOGY (PRACTICAL)

1. **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. *Experiments in Physiology*.Tharp, G. and Woodman, D., 2002. 8th Edition. Prentice Hall, London.

#### ZOO-303 – ECOLOGY (2+1 = 3 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **Global Ecosystems**

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.

1. **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.

#### Radiations

Space biology. Contemporary environmental themes: ozone depletion, acid rain, green house effect and global warming, desertification, deforestation,

#### Exotic and invasive species,

Radioactivity leakage, environmental laws.

#### BOOKS RECOMMENDED

1. *Ecology.* Bowman W. Hacker S. 2023. 6th Edition. Oxford University Press, UK.
2. *Fundamentals of Ecology*. Odum, E.P., Barrett W.G. 2018, 5th Edition. Cengage Learning Publisher.
3. *Ecology: Concepts and Applications*. Molles, M.C. 2018, 8th Edition. McGraw Hill, Boston.
4. *Ecology.* 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., 2000. Oxford Univ. Press, Oxford.
5. *Practical Ecology*. Singby, D. and Cork, D., 1986. McMillan Education Ltd. UK.
6. *Ecology. Principles and Application*. Chapman, J.L. and Reiss, M.J. 2000, 3rd Edition*.* Cambridge University Press, Cambridge.
7. *Ecology and Field Biology: Hands-on Field Package*. Smith, R.L., Smith, T.M. 2001, 6th Edition. Benjamin Cummimgs Publisher.
8. *Ecology and Quality of our Environment.* Southwick, C.H., 1976. D. Van Norstrand Co. New York.
9. *Water Quality in Warm Water Fish Ponds.* Boyd, C.E. 2010 Digitalized. Auburn University, Agricultural Experiment Station.
10. *Ecology and Environment.* Kumar, P. and Mina, U. 2018. Pathfinder Academy, India.
11. *Ecology: From Individuals to Ecosystems*. Begon, M. Colin, R. Townsend, C.R. 2021. 5th Edition. John Wiley & Sons, Inc., USA.
12. *Ecology: Evolution, Application, Integration*. David T. Krohne. 2017. 2nd Edition. Oxford University Press
13. *Learning Landscape Ecology. A Practical Guide to Concepts and Techniques*. Sarah E. Gergel, Monica G. Turner. 2017. Springer New York, NY.

#### ZOO-303P - ECOLOGY (PRACTICAL)

1. Measurement of environmental factors on land, water and air.
2. Study of different ecosystems: pond, agricultural or grassland, forest.
3. Community analysis through different sampling techniques(quadrat, transect).
4. Population dynamics of grasshoppers.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes. Development of an ecological management plan of some selected area.

#### BOOKS RECOMMENDED

1. *Practical Research: Planning and Design.* Leedy, P. D. 2019. 12th Edition. MacMillan Company Ltd. USA.
2. *Research Methodology: A Practical Approach for Beginners*. Mishra, Priyadarshini, Dalabehera, Stiti. 2022. AG Publishing House.
3. *Mastering Research Method: A Guide for Training in Research Methods*. Chua, Y.

P. 2016. 2nd Edition. World Health Organization, Manilla.

1. *Research Methods.* Burns, R. B. 2018. 4th Edition. SAGE Publications Ltd. UK.
2. *Research Design, Qualitative, Quantitative, and Mixed Methods Approaches.* John

W. Creswell and J. David Creswell Carnegie. 2018. 5th Edition (International Student Edition) SAGE Publications Ltd. UK.

1. *Hand Book of Interview Research: Context and Method.* Gubrium, J. F. and Holstein, J. A. 2002. (Editors) SAGE Publications Ltd. UK.
2. Handouts by the course tutor.

#### ZOO-304 - EVOLUTION AND PRINCIPLES OF SYSTEMATICS

**(2+1 = 3 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY EVOLUTION

1. **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.

#### Macro/mega 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. Trend and rates in evolution.

#### SYSTEMATIC ZOOLOGY

1. **Contribution of systematics to Biology**

History of Taxonomy (Downward classification, upward classification, impact of the origin of species, population systematics, current trends); Microtaxonomy (brief account of various taxonomic categories i.e.,phenon, Taxon; Taxonomic categories).Brief account of species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept, species mate recognition concept; non-dimensional species concept; Multidimenstional species concept; Cohesion species concept). Difficulties in the application of biological species concepts; polytypic species, subspecies, super species, sibling species.

#### Macrotaxonomy; 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. *Evolution*.Ridley, M., 1993*.* Blackwell Scientific Publications.
2. *Evolution*. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W., 1973.

W.H. Freeman and Company.

1. *Genetics and the Origin of Species*.Dobzhansky, T.Columbia University Press, NY.
2. *Populations, Species and Evolution*. Mayr, E. Harvard University Press.
3. *Introduction to Evolution*.Moody, P.A., 1989. Harper and Row Publishers, NY.
4. *Evolution.*Strickberger. 2000. Jones & Barrett Publishers

#### SYSTEMATIC ZOOLOGY

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

#### ZOO-304P - EVOLUTION AND PRINCIPLES OF SYSTEMATICS (PRACTICAL)

1. Study of preserved invertebrate species and their classification upto class level.
2. Collection, preservation and identification of common species with the help of keys.
3. Preparation of keys for the identification of specimens.

#### BOOKS RECOMMENDED

1. *Phylogenetics: Theory and Practical Practice of Phylogenetic systematics*. Wiley,

E. O. and Lieberman, B. S. 2011. 2nd Ed. Wiley-Blackwell.

## SEMESTER-VI

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| ZOO-351 | Developmental Biology | 3 |
| ZOO-351P | Developmental Biology (Practical) | 1 |
| ZOO-352 | Genetics | 3 |
| ZOO-352P | Genetics (Practical) | 1 |
| ZOO-353 | Wild Life | 2 |
| ZOO-353P | Wild Life (Practical) | 1 |
| ZOO-354 | Animal Behaviour | 2 |
|  | Allied-2 | 3 |
|  | Allied-2 (Practical) | 1 |
| **Total Credit Hours** | | **17** |

#### ZOO-351 - DEVELOPMENTAL BIOLOGY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 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 THEORY

1. **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 (Emphasis on the germ layers only)

#### Cellular Basis of Morphogenesis

Differential cell affinity, cell adhesion molecules, and mechanism of teratogenesis

#### Organogenesis

A brief account; Origin and migration of germ cells in vertebrates (One representative organ from each germ layer).

#### Hormones as Mediators of Development; Regeneration in Vertebrates.

**BOOKS RECOMMENDED**

1. *Developmental Biology*. Gilbert, S. F., 2000. Sinauer Associates, Sunderland, MA.
2. *An Introduction to Embryology*. Balinsky, B. I., 1985. W.B.Saunders and Co.
3. *Development Biology*. Saunders, J. W. 1982. McMillan and Co.
4. *Introduction to Embryonic Development*. Oppenheimer, S.S., 1984. Allen and Bacon.
5. *Modern Embryology*. Bodemer, C. W., 1968. Holt, Rinehart and Winston.
6. *Mechanism of Development*. Ham,R. G.and Veomett, M. J., 1980. C.V. Mosby Co.
7. *Development*. Berril, N. J. and Karp, G., 1978. McGraw Hill.
8. *Biological Development*. Klaus, K. 2001. 2nd Ed., McGraw-Hill

#### ZOO-351P - DEVELOPMENTAL BIOLOGY (PRACTICAL)

1. Study of gametes structure in some representative cases, i.e., fowl and mammal.
2. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc.
3. Study of fertilization, early development of frog through models/slides.
4. Preparation and study of serial sections of mice or chick embryos.
5. Application of microsurgical techniques on chick embryos *in vitro*.
6. Preparation and staining of histological slides.

#### BOOKS RECOMMENDED

1. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill
2. *Developmental Biology*. Scott F. Gilbert and Michael J. F. Barres. 2016. Sinauer Associates, Sunderland, MA.
3. *Life Unfolding: How the Human Body Creates Itself*. Jamie. A. Davies. 2014. Oxford University Press, USA.

#### ZOO-352 - GENETICS (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **Introduction**

Classical genetics, molecular genetics, population genetics; classical genetics, Multiple alleles, genetics of blood groups,

#### Chromosomal basis of inheritance

Interaction of genes, chromosomal changes (euploidy, aneuploidy, structural changes),

#### Pedigree analysis

Sex- determination and sex-linkage, linkage,

#### Chromosomal mapping

Recombination and chromosome mapping in eukaryotes,

#### Quantitative inheritance

Gene concept (classical and modern),

#### Molecular genetics

Genetics of viruses, bacteria, transposons, molecular genetic analysis,

#### Recombinant technology

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. *Principles of Genetics*. Snustad, D.P. and Simmons, M.J. 2006. 8th Edition. Johan Wiley and Sons Inc. New York, USA.
2. *Gene-XI*. Lewin, B. 2014. 11th Edition. Jones and Bartlett Learning.
3. *Principles of Genetics*. Tamarin, R.H. 2004. 7th Edition, McGraw-Hill Companies.
4. *Genetics.* Strickberger, M.W. 2015, 3rd Edition. McMillan, N.Y. USA.
5. *Theoretical Genetics,* Goldschmidt, R. B. 2022. University of California Press.
6. *Our Genes, Our Choices: How Genotype and Gene Interactions Affect Behavior*. Goldman, D. 2023. Elsevier.
7. *Genetics and Molecular Biology*. Schieif, R. 1993. 2nd edition, Robert Schleif, Department of Biology, The Johns Hopkins University Baltimore, Maryland.
8. *Genetics and Genomics in Medicine*. Strachan, T., Lucassen, A. 2022. CRC Press.

#### ZOO-352P – GENETICS (PRACTICAL)

1. Study of mitosis in onion root tips (preparation and prepared slides).
2. Study of meiosis in grasshopper testes (preparation and prepared slides).
3. Determination of human blood groups.
4. Study of salivary gland chromosomes of *Drosophila melanogaster.*
5. General morphology of *Drosophila melanogaster*
6. Human Pedigree analysis problems
7. Human genetics problems
8. Probability problems. Tossing of coins. X2 test

#### BOOKS RECOMMENDED

1. *Principles of Genetics*. Gardener, E.J., Simmons, M.J. and Snustad, D.P. 2006, 8th Edition. John Wiley and Sons Inc. New York, USA.
2. *Concept of Genetics*. William, S.K., Michael, R., Cummigs, Charlotte, A., Spencer, Michael, A. 2014. 11th Edition. Pearson. SBN-11: 978-0321948915.

#### ZOO-353 - WILD LIFE (2+1 = 3 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

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

#### COURSE CONTENTS THEORY

1. **Wildlife of Pakistan**

Introduction, mportant Definitions, Identification, Distribution, Status, Conservation and Management of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan.

#### Wildlife Conservation

Philosophy and significance.

#### Biodiversity and sustainability of wildlife

Threats to biological diversity, Threats to wildlife in Pakistan, Human impact on species extinction: Habitat destruction, Pollution, Effects of industrial and agricultural development and urbanization on wildlife, Invasive species.

#### Wildlife rules and regulations

Wildlife rules and regulations in Pakistan, National and International agencies involved in conservation and management of wildlife.

#### Protected Areas in Pakistan

Conservation and management of wildlife, Zoos, Botanical gardens, Sanctuaries, Game Reserves, National Parks.

#### Ramsar convention

Wetlands and Wetland management, Ramsar Criteria, Ramsar Sites.

#### Threatened species of Pakistan

Vulnerable, Endangered, Critically Endangered, Migratory birds in Pakistan.

#### BOOKS RECOMMENDED

1. *Zoology.* Miller, A. S. and Harley, J. B., 2000. 5th Edition. McGraw-Hill, Singapore.
2. *Integrated principles of Zoology.* Hickman, C. P., Roberts, L. S. and Larson, A. 2001. 11th Edition. McGraw- Hill, Singapore.
3. *Principles of Wildlife Management.* Bailey, J.A. 1986. John Wiley & Sons Inc. USA.
4. *Wildlife Ecology and Management.* Robinson, W.L. Bolen, E.G. 1984. McMillan Publishing Company. Cambridge, UK.
5. *Mammals of Pakistan.* Roberts, T.1. 1977. Ernest Benon Ltd. London. UK.
6. *The Birds of Pakistan.* Roberts, T.J. 1992. Vol. 1. Oxford University Press. UK.
7. *The Birds of Pakistan.* Roberts, T.J. 1998. Vol. II. Oxford University Press. UK.
8. *A Handbook of Birds of India and Pakistan,* Ali, S. and Ripley, S. D., 1973. Oxford University Press, London, UK.
9. *A Primer of Conservation of Biology.* Primack R. B. 2000. 2nd Edition. Sinauer Associates Inc. USA.
10. *Animal Biodiversity of Pakistan.* Mirza, Z. B. 2004. Latest Edition: Printopack, Rawalpindi. Pakistan.
11. *Principles of Environmental Science.*Cunningham, W.P. and Cunningham ,M.I. 2004. 2nd Edition. McGraw chill Company. USA.

#### ZOO-353P - WILD LIFE (PRACTICAL)

1. Visit to animal diversity of parks in Lahore.
2. Animal distribution maps (birds and mammals) of Pakistan.
3. Study of biodiversity in different ecozones of Pakistan.

#### BOOKS RECOMMENDED

1. *Wildlife Ecology, Conservation and Management*. Anthony R.E.S., John M.F., Graeme C. 2014. 3rd Edition. John Wiley and Sons Inc. USA.
2. Cunningham, W. P. and Cunningham, M. I. 2004. *Principles of Environmental Science.* 2nd Edition. McGraw Chill Company. USA.
3. *Amphibian and Reptiles of Pakistan*. Khan M. S. 2011.
4. *Study on Biology, Ecology and Conservation Status of Captive Animals in Lahore Zoo*. Manzoor, F. and al-Arifa, N. 2020.
5. *Biodiversity of Pakistan*. Mirza Z. B. 2011.
6. *Fundamentals of Ecology*. Odum, E.P., Barrett W.G. 2018, 5th Edition. Cengage Learning Publisher.
7. Wildlife of the Punjab, Punjab Wildlife Department.

#### ZOO-354 - ANIMAL BEHAVIOUR (2+0 =2 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 30-32
2. Practicals 00
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

To teach the students

The concept of physiological mechanism. Functional aspects in animal life. The design of mechanism in nervous and hormonal co-ordination. Physiological mechanism in manifestation of behaviour.

#### COURSE CONTENTS THEORY

1. **Introduction**

Behaviour and its types, Proximate and ultimate causes of behavour, Development of behavior and impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses, Physiology of behavior in changed

environments.

#### Hormones and behavior in animals

Innate behavior and innate releasing mechanisms; built in programmed performance by offspring to that of parents. Innate behavior of three spined stickle back fish. Learned behavior and its mechanisms; quick learners’ vs slow learners. Concept of animal cognition; key to understand and develop multiple behavioural choices. Ecological and genetics to maintain animal behavior. Concept of territoriality and defense in animals.

#### Circadian rhythms

Circadian rhythms and concept of bio-rhythmicity in animals. Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities, Costs and benefit ratios in behavior; successful foragers and winners of predator-prey relationships. Altruism and parental sacrifice to nurture the young, Competition for resources; survival of the most suitable individuals; evolutionary arms races in behavior.

#### Social organization in animals and concept of group living

Benefits and losses. Aggression, appeasement and selfish individuals, Social organization in insects and mammals.

#### Communication in animals

Visual, Bioacoustic, electrical, chemical and tactile, Various types of chemical signals in animals’ behavior and their importance in ecosystems.

#### BOOKS RECOMMENDED

1. *Principles of Animal Behavior*. Dngatkin, L.A. 2012. W.W. Nortan and Co., New York.
2. *Animal Behavior, An Evolutionary Approach*. Alcock, J. 2010. 9th Edition. Sinauer Publishers.
3. *Essential Animal Behavior*. Scott, G. 2009. Wiley publishers.
4. *Essential Animal Behavior.* Scott, G. 2005. Blackwell Pub. New York.
5. *Perspective on Animal Behavior*. Goodenough, J., McGuire, B., Wallace, R.A. 2001. John Wiley & Sons, New York.

## YEAR 4

**SEMESTER-VII**

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit Hours** |
| ZOO-401 | Research Methodologies and Bioinformatics | 2 |
| ZOO-401P | Research Methodologies and Bioinformatics (Practical) | 1 |
| ZOO-402 | Molecular Biology | 2 |
| ZOO-402P | Molecular Biology (Practical) | 1 |
| ZOO-403 | Zoogeography & Paleontology | 2 |
| ZOO-403P | Zoogeography & Paleontology (Practical) | 1 |
| ZOO-498 | Field Experience/ Internship | 3 |
|  | Allied-3 | 3 |
|  | Allied-3 (Practical) | 1 |
| **Total Credit Hours** | | **16** |

#### ZOO-401 - RESEARCH METHODOLOGIES AND BIOINFORMATICS

**(2+1 = 3 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 15-16
2. Practicals 00
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course aims to:

* 1. Provide an understanding of the techniques and concepts of the qualitative and quantitative research.
  2. Illustrate stages and techniques of formulating research questions, designing different experiments, studies and surveys to collect data according to the nature of the research and resources available.
  3. Revise the statistical methods of data collection and analysis.
  4. Explain analysis techniques to summarize and organize data into meaningful form.
  5. Provide an introduction to data analysis using statistical software packages for the computer i.e. WINDOWS and SPSS.
  6. Explain the principles and methods of report, thesis writing and data presentation. g.This course will also provide 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.

#### COURSE CONTENTS THEORY

1. **The nature and role of research**

Research and information, Conceptual foundations of research, Ethics of research, Research problems; hypothesis and objectives, Finding a problem to investigate, Primary and secondary data source; literature review.

#### Data collection/ Qualitative and quantitative methods of inquiry

Principles and methods; research methods in natural sciences, Sampling concepts and statistics, Sampling and survey designs and questionnaires, Using case studies, Choosing appropriate research approaches and methods.

#### Statistical methods and data analysis

Chi-square, Correlation, Simple regression, Analysis of variance, t-test, Reliability and validity, Use of statistical software packages for the computer i.e., WINDOWS, SPSS and GENSTAT.

#### Presenting research

The qualitative and quantitative research report writing, interpreting the results, reporting the findings of the survey, the presentation and format of the report and thesis on a special topic.

#### Assignments

Written protocol for a survey or experiment on current environmental issues.

#### Introduction to Bioinformatics

Scope of bioinformatics, useful websites, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools, Human genome project

#### Biological databases

Data and types of data, data acquisition, Major DNA databases around the world, NCBI, BOLD, DDBJ, Major protein databases, protein sequence and structure databases, genome and organism databases, Non-sequence databases, Pubmed

#### Genome mapping

Genetic and linkage mapping, physical mapping, Gene family, Phylogenetic analysis

#### Data Retrieval

Searching sequence databases, FASTA format, retrieval of nucleotide sequence data, retrieval of protein sequence and structure, retrieval of map data, predicting 3D structure of protein, Computing the sequence.

#### BOOKS RECOMMENDED

1. *Introduction to Research Methods.* 2000. 4th ed. Burns, R. B. SAGE Publications Ltd. UK.
2. *Focus Group in Social Research.* 2001. Bloor, M., Frankland, J., Thomas, M. and Robson, K. SAGE Publications Ltd. UK.
3. *Hand Book of Interview Research: Context and Method.* 2002. Gubrium, J. F. and Holstein, J. A. (editors) SAGE Publications Ltd. UK.
4. *Qualitative Research Through Case Studies.* 2001. Travers, M. SAGE Publications Ltd. UK.
5. *Doing Qualitative Research: A Practical Hand Book*. 2000. Silverman, D. SAGE Publications Ltd. UK.
6. *Practical Research: Planning and Design.* 1985. 3rd Edition. Leedy, P. D. MacMillan Company Ltd. USA.
7. *Health Research Methodologies: A Guide for Training and Research Methods.*

2001. 2nd Edition. World Health Organization, Manilla.

1. Handouts by the course tutor.
2. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. Baxevanis, A.D., Ouellette, B.F.F. 2011. John Wiley & sons, Inc.
3. *Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery.* Rastogi, S.C., Mendiratta, N., Rastogi, P. 2011. PHI publishing.
4. *Applied Bioinformatics: An Introduction.* Selzer, P., Marhofer, R. and Rohwer, A. 2008. Springer publishing, Germany.
5. *Fundamental Concepts of Bioinformatics.* Krane, D.E. and Raymer, M.L. 2002. Benjamin Cummings.

#### ZOO-401P - RESEARCH METHODOLOGIES AND BIOINFORMATICS (PRACTICAL)

1. Classification of an organism using NCBI.
2. Retrieving FASTA sequence for nucleotide and protein.
3. Retrieving disease gene information.
4. Searching gene families.
5. Primer Designing.
6. BLASTing a nucleotide / amino acid sequence.
7. Multiple Sequence Alignment using different amino acids / nucleotide sequences.
8. Microarrays data retrieval from the web.

#### BOOKS RECOMMENDED

1. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. Baxevanis, A.D., Ouellette, B.F.F. 2011. John Wiley & sons, Inc.
2. *Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery*. Rastogi, S.C., Mendiratta, N., Rastogi, P. 2011. PHI publishing.
3. *Applied Bioinformatics: An Introduction.* Selzer, P., Marhofer, R. and Rohwer, A. 2008. Springer publishing, Germany.
4. *Fundamental Concepts of Bioinformatics*. Krane, D.E. and Raymer, M.L. 2002. Benjamin Cummings.

#### WEBSITES

1. [http://www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov/)
2. [http://www.ebi.ac.uk](http://www.ebi.ac.uk/)
3. [http://www.rcsb.org](http://www.rcsb.org/)
4. [http://www.ensemble.org](http://www.ensemble.org/)

#### ZOO-402 - MOLECULAR BIOLOGY (2+1 = 3 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **Introduction**

Introduction to nucleic acids, Chromosome structure, Chromatin, DNA forms, structures and packaging, RNA types and structures

#### Replication

DNA replication in prokaryotes, DNA replication in eukaryotes, Enzymology of replication, DNA damage and repair

#### Transcription

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

#### Translation

Role of Ribosomes, Mechanism of translation in prokaryotes and eukaryotes, Various factors, and posttranslational processing

#### Mutation

Types of Mutations, Base-Analogue Mutagens, Chemical Mutagens

#### Gene expression and control

Control of gene expression in Prokaryotes, Inducible and repressible operons, Control of gene expression in eukaryotes.

#### BOOKS RECOMMENDED

1. *Molecular Biology of the Cell*. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts,

K. Watson, J.D., 2017, 7th Edition. Garland Publishing Inc., New York.

1. *Molecular Cell Biology*. Darnell J. E., Lodish, H. F. and Baltimore, D., 2021. 9th Edition. Scientific American Inc. N.Y.
2. *The Cell: A Molecular Approach*. Geoffrey M.C., Robert E.H. 2007. Sinauer Associates, INC.
3. *Cell and Molecular Biology*. De Robertis, E. D. P. 2017. 8th Edition, Lea and Febiger, New York.
4. *Essentials of Molecular Biology*. Malacinski, M. G. 2015, 4th Edition. Jones and Bartlett.
5. *Cell Biology*. Karp, G. 2010, 6th Edition. Wiley Publisher.
6. *Molecular Biology*. Weaver, Robert, F. 2011. 5th Edition. McGraw Hill.
7. *Molecular Biology: Genes to Proteins*. Burton F. T. 2007. 3rd Edition. Jones and Bartlett.
8. *Molecular Cell Biology*. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016.

W. H. Freeman Publishers, Scientific American Inc.

#### ZOO-402P - MOLECULAR BIOLOGY (PRACTICAL)

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

#### BOOKS RECOMMENDED

1. *Molecular Cell Biology.* Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016.

W. H. Freeman Publishers, Scientific American Inc.

1. *The Cell: A Molecular Approach*. Geoffrey M.C., Robert E.H. 2007. Sinauer Associates, INC.
2. *Cell and Molecular Biology, Concepts and Experiments*. Karp, J. 2005. Jhon Wiley

and Sons, INC.

#### ZOO-403 - ZOOGEOGRAPHY AND PALAEONTOLOGY

**(2+1 = 3 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

**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 (Palaearctic and Nearctic regions), Oriental, Ethiopian, Australian, and Newtropical 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 (lgneous 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). A brief history of the Siwaliks. Geochronometry (Uranium/Lead dating, radiocarbon dating, Fission track dating and palaeomagnetism).

#### BOOKS RECOMMENDED ZOOGEOGRAPHY

1. *Zoogeography.*Darlington, 1963. John Wiley and Sons Inc. USA.
2. *Zoogeography of the Land Inland Waters*. 1951.DeBeaufort, Sidgwick and Jackson.
3. *Palaeontology, Zoogeography and Wildlife Management*.1999.S.S. Ali.

#### PRINCIPLES OF PALEONTOLOGY

1. *Historical Geology.* C.O. Dunbar, 1969. John Willey and Sons Inc. New York.
2. *General Palaeontology*. Brouwer, A., 1977. Oliver and Boyed, London.
3. *Evolution of vertebrates*. Gilbert, Colbert, E.H., 1980. John Willey & Sons Inc.
4. *Palaeontology, Zoogeography and Wildlife Management*.1999.S.S. Ali.

#### ZOO-403P - ZOOGEOGRAPHY AND PALAEONTOLOGY (PRACTICAL)

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

#### BOOKS RECOMMENDED

1. Beddard, F. E. 2008. A text book of zoogeography.Bibliobazar, LLC.
2. Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup & Sons. Delhi.
3. Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
4. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.

## SEMESTER-VIII

|  |  |  |
| --- | --- | --- |
| **Course No.** | **Course Title** | **Credit**  **Hours** |
| ZOO-4\* | **\*Elective Subject** | 3 |
| ZOO-4\*P | \*Elective Subject (Practical) | 1 |
| ZOO-4\* | **\*\* Special Subject (Paper A)** | 3 |
| ZOO-4\*P | \***\*** Special Subject (Paper A) (Practical) | 1 |
| ZOO-4\* | **\*\* Special Subject (Paper B)** | 3 |
| ZOO-4\*P | \***\*** Special Subject (Paper B) (Practical) | 1 |
| ZOO-499 | Capstone Project | 3 |
|  |  |  |
| **Total Credit Hours** | | **15** |

**SEMESTER-VIII**

#### ZOO-4\*: ELECTIVE SUBJECT

**(3+1 = 4 Credit Hours)**

#### (From the approved list of courses ANNEXURE-I)

**ZOO-4\*: SPECIAL SUBJECT (PAPER A)**

#### (3+1 = 4 Credit Hours)

**(From the approved list of courses ANNEXURE-II)**

#### ZOO-4\*: SPECIAL SUBJECT (PAPER B)

**(3+1 = 4 Credit Hours)**

**(From the approved list of courses ANNEXURE-II)**

# ANNEXURE-I: ELECTIVE SUBJECTS

#### ZOO-476 – IMMUNOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### COURSE CONTENTS THEORY

1. **Immunology**

Immunobiology, Immunophysiology, Immunopathology.

#### Immunity

Natural and acquired immunity, Active and passive immunity.

#### Antigens and elicitation of immune responses, Cell mediated and humoral.

1. **Immunoglobulins**

Synthesis of antibodies, Theories of antibodies synthesis.

#### Antigenecity

Interactions of antigens and antibodies, Factors affecting immune response; nature of antigens, genetic constitution of individuals and route of administration.

#### Detection and application of antigen-antibody reactions

*in vivo* and *in vitro* reactions.

#### Monoclonal antibodies

Major histocompatibility complex.

#### Cellular basis of immune response

Origin of lymphocytes, Primary and secondary lymphoid organs, Specific response of individual lumphocytes to antigenic stimulation, Histological features of immune response.

#### Hypersensitivity

Immediate hypersensitivity (anaphylaxis, antibody dependent cytotoxicity, Immune- complex mediated disease and stimulatory hypersensitivity), Delayed type or cell mediated hypersensitivity.

#### Immunological tolerance and autoimmunity, autoimmune diseases.

1. **Immunopotentiation and immunosupression.**

#### Transplantation immunology

Tumor immunology, Immunity against infectious diseases, Immuno deficiency diseases, Immunity and malnutrition.

#### Immunization

Immunization procedures, Vaccines.

#### ZOO-476P - IMMUNOLOGY (PRACTICAL)

1. Study of different types of leucocytes in: Blood, Bone marrow, Spleen and Thymus in mammals.
2. Estimations of total serum proteins, albumins and globulin concentrations in mammalian blood.
3. Differentiation of globulin proteins in blood serum of mouse by electrophoresis.
4. Diagnosis of immunoglobulin proteins by enzyme linked immunosorbant assay (ELISA).
5. Isolation of lymphocytes and resetting technique.
6. Antigen-antibody reaction by agglutination and precipitation reaction.
7. Antigen antibody reaction by using adjuvant.
8. Diagnosis of typhoid fever by Widal test.
9. Visit to pathological laboratory and report writing.

#### BOOKS RECOMMENDED

1. *Essential immunology.*Roitt, I. 1990. 2nd ed. Black well Scientific Publications. Oxford, UK.
2. *Basic and clinical immunology.*Stites, D. P., Stobo, J. D., Fudnberg, H. H. and Wells, J. V. 1990. Lange Medical Publications, USA.
3. *Park's text book of preventive and social medicine.* Park, K. 2002. 2nd ed. *MIS*

Barnarsid, India.

1. *Essentials of haematology.*Hoff - Brand, A. B. and Pedit, J. E. 1981. Black well Scientific Publications. Oxford, UK.

#### ZOO-477 - FUNDAMENTALS OF MICROBIOLOGY

**TEACHING AND LEARNING STRATEGIES**

* 1. Lectures 30-32
  2. Practicals 10-15
  3. Assignments/ Presentations one per student
  4. Discussions/ Tutorials one per week

#### (3+1 = 4 Credit Hours)

**AIMS AND OBJECTIVES**

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

**COURSE CONTENTS**

**THEORY**

#### Introduction

History of microbiology, Microbes influencing our lives, Characterization and identification of microorganisms.

#### Virology

Structure of virus, Characteristics of virus, Virus-host cell interaction, Viral replication, Transformation, Transmission of transforming viruses, Mechanism of pathogenicity; virus cultivation and propagation.

#### Morphology and fine structure of bacterium

Size, Shape and arrangement of bacterial cells, motility, Capsules, Structure and composition of cell wall, Cytoplasmic membrane, Protoplasts, Endospore, pilus.

#### Cultivation of Bacteria

Nutritional requirements, Nutritional types of bacteria, Bacteriological media, Physical conditions required for growth.

#### Pure culture and growth characteristics

Pure culture, Methods of isolating pure culture, maintenance and preservation of pure culture, Cultural characteristics.

#### Growth and Metabolism

Growth of microbial population, measurement of microbial growth, growth rate, growth curve, determination of number of cells by direct microscopic count, Plate count method, membrane filter count,Turbidimetric method, determination of cell

mass by measurement of growth.

#### Microbial Ecology

Distribution and activities of microorganisms in natural systems, Role of bacteria in elemental cycles and plant interaction of microbial communities with their biotic and abiotic environment microbial role in global carbon cycle.

#### Soil microbiology

Soil environment, Microbial flora of soil, Bacteria, Fungi, Algae, Rhizosphere, Biogeochemical activities of microorganisms in soil.

#### Air microbiology

Microbial content of air, Indoor air, Outdoor air.

#### Water microbiology

Microbiology of sea, Lakes and ponds, Rivers and streams, Microbes of domestic water, Microbes of sewage water.

#### Food microbiology

Microbial spoilage of foods, Food poisoning, Food infection, Factors effecting the spoilage of food (water, pH, oxygen, nutrients, physical structure of food), Botlism food poisoning, Mycotoxins, Food preservation (drying, refrigeration, irradiation, canning).

#### Medical microbiology

Sources and communicability of diseases, Communicable diseases, Non- communicable diseases, Chain of infection, Etiological agents, Specificity, Source and reservoirs of etiological agents, Methods of transmission.

#### Normal microbial flora

Significance of normal microbial flora, Origin of normal Microbial flora, Microbial flora of skin, Microbial flora of gastrointestinal tract, Microbial flora of genito- urinary tract, Sterile sides of human body, Mechanism of bacterial pathogenity.

#### ZOO-477P - FUNDAMENTALS OF MICROBIOLOGY (PRACTICAL)

* 1. Isolation of microorganisms from air.
  2. Isolation of microorganisms from water.
  3. Isolation of microorganisms from soil.
  4. To study the morphology of moulds.
  5. To study physical characteristics of bacterial colonies.
  6. To study bacteria of different morphology.
  7. Different techniques for the isolation of microorganisms.
  8. Gram staining of mouth flora.
  9. To study bacterial motility by hanging drop method.
  10. Negative staining of bacteria.
  11. Acid fast staining of bacteria.
  12. Staining of bacterial capsules.
  13. To study different sterilization techniques.Isolation of spore forming bacteria from powdered milk
  14. Staining of endospores of bacteria. .
  15. To study viable counting of bacteria.

#### BOOKS RECOMMENDED

1. *Medical Microbiology.* Khan, A. M. 2001. 151 ed. Time Publishers Pakistan.
2. *Environmental Microbiology* Vamam, A. H. and Malcolm, G. M. 2000.*.* 1st ed. Manson Publishing Ltd. USA.
3. *Introductory Microbiology.* Fredrick, C. R. and Charles, E. M. 1983. 151 ed.

Merrill Publishing Company USA.

1. *Microbiology.* Pelczar, M. J. Chan, E. C. and King, N. R. 1986. 51h ed. McGraw- Hill, Inc. New York.
2. *Laboratory Experiments in Microbiology.* Jhonson, T. R. and Case, C. L. 1992. 3rd ed. The Banjamin/Cummings Publishing Company, USA.
3. *Plant and microbial biotechnology Research, NO.3.* Wang, K., Herrera-Eastrella

A. and Montagu, M. V. 1995. Cambridge University, Press, UK.

#### ZOO-478 - CONSERVATION BIOLOGY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

* 1. Lectures 30-32
  2. Practicals 10-15
  3. Assignments/ Presentations one per student
  4. Discussions/ Tutorials one per week

#### COURSE CONTENTS THEORY

* + 1. **Conservation**

Conservation biology's interdisciplinary approach, Need of Conservation biology, Philosophical background of conservation biology.

#### Extinction and economics

Losing something of value, Patterns of extinction, Ecological Economics: Common property resources, Direct economic values, Consumptive use value, Productive use value, Indirect economic values, Non-consumptive use value, Option value, Existence value, Environmental ethics Rate of extinction: Human caused extinctions, Extinction rates in water and on land, Extinction rates on islands, Island biogeography and modern extinction rates, Causes of extinction: Habitat destruction, Habitat fragmentation, Habitat degradation and pollution, Over exploitation, Invasive species, Diseases, Vulnerability to extinction.

#### Conservation at the population and species level

Conserving species by conserving populations: The problems of small populations, Loss of genetic variability, Effective population size, Demographic variation, Environmental variation and catastrophes, Extinction vortices, Monitoring populations, Population Viability Analysis, the meta populations, Establishment of new populations: Considerations for successful programmes, Social behavior of released animals, New populations and the law, *Ex situ* conservation strategies: Zoos, Aquarium, Botanical gardens and arboretums, Conservation categories of species, Legal protection of species.

#### ZOO-478P - CONSERVATION BIOLOGY (PRACTICAL)

1. To study a critically endangered species of Pakistan: The Blind Indus Dolphin

*(Platanista minor).*

1. To study the endangered mammalian fauna of Pakistan.
2. To study the endangered bird fauna of Pakistan.
3. To study the endangered reptilian fauna of Pakistan.
4. To study the endemic species of Pakistan.
5. To study the biodiversity of the Arabian Sea and the threats to the biodiversity.
6. To study a critically endangered species of the world: The Giant Panda.

#### BOOKS RECOMMENDED

1. *A Primer of Conservation Biology.* Primack, R. B. 2000. 2nd ed. Sinauer Associates Inc. Publishers Sunderland, USA.
2. *Biogeography: An ecological and evolutionary approach.*Cox, C. B. and Morre,

P. D. 2000. 6th ed. Life Sciences King's College London, UK.

1. *Illustrated Handbook of Biodiversity of Pakistan.* Mirza, Z. B. 1998. Printopack. Rawalpindi, Pakistan.
2. *Biodiversity An Introduction.* Gaston, K. J. and Spicer, J. I. 1998. 15t ed. Blackwell Science Ltd. UK.
3. *Environmental Science: System and solution.*1998.McKinny, M. L. and Schoch,

M. R. 1sted. Jones and Bartlett Publications, USA.

1. *Pakistan Manual of Plant Ecology.* Hussain, S.S. 1992. 1 st ed. National Book Foundation, Pakistan.
2. *The Biosphere.* Bradbury, I. K. 1998. 1st ed. John Wiley and Sons Inc.UK.

#### ZOO-479 - MEDICAL BIOTECHNOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### COURSE CONTENTS THEORY

1. **Introduction to the medical biotechnology**

The role of medical biotechnology, Medical biotechnology; an interdisciplinary pursuit, Scope for use, Public perception, Medical biotechnology and developing world.

#### The principles of cloning DNA in medical biotechnology

General principles and strategies for cloning, Cloning tools, The enzymology of *in vitro* DNA recombination, Vectors used for cloning, Sythesis of DNA for cloning, Reaching the gene via mRNA and protein, Synthesis of complete gene, Reporter genes, The determination of base sequence in DNA( brief account).

#### Gene cloning techniques for mammalian cells

Methods of transfection, (Ca++ phosphate co-precipitation method, DEAE-Dextran method, Electroporation, Protoplast fusion. Liposomes as vectors for gene transfer,Direct transformation of mammalian cells; Microinjuction. Requirement for gene expression. Expression of mammalian genes in prokaryotic and eukaryotic systems, Basic techniques of animal cell culture and their applications, Expression of cloned genes in animal cells: Transgenic Animals (brief account).

1. **Molecular biological techniques for rapid diagonosis of disease** Spectrophotometeric and UV spectroscopic analysis of nucleic acids, Agarose gel electrophoresis, Pulsed/field gel electrophoresis, Hybridization, Foot printing, Reverse transcriptase, Site directed mutagenesis, Restriction fragment length polymorphism (RFLP), 2 - dimensional gel electrophoresis. DNA finger printing, Enzyme linked immunosorbant assay (ELISA), Diagnostic Polymerase chain reaction (PCR), Types of Polymerase chain reaction, Optimization of PCR conditions, Rapid amplification of cDNA ends (RACE), Other applications of PCR, Gene therapy.

#### Medical biotechnological approach to study various types of diseases (Infectious and Genetic)

Tuberculosis, Typhoid, Hepatitis C, Thalassemia, Chromosomal anomalies, Other mutations,

Prenatal diagnosis of anaemias; a molecular basis for inherited disease, Mapping a genetic disease, Forensic science.

#### Applied medical biotechnology

Pharmaceutical and biopharmaceuticals, Vaccines and monoclonal antibodies, Preparation of monoclonal antibodies, Applications of monoclonal antibodies, Vaccine productions, Potential Vaccines: Hepatitis B, Whooping cough, Chlomydia, Herpes, AIDS, Vaccine for leprosy, Virus vaccines, Antigens purification, Screening of antibiotics, Mode of action of selected antibiotics, Human insulin, Human growth hormone, Factors vm, Lymphokines (Interferon, interleukins) Somatostatin, Colony stimulating factor, Blood factor vm for hemophilia, Erthropoietin, Epidermal growth factor, Tissue Plasminogen Activator (TP A), Tumor necrosis factor; Ceredase, Cancer.

#### Biosafety Regulation

Introduction to genetically manipulated organisms (GMOs), Release of genetically engineered microbes in the environment, Biosafety management, Debate on the safety work in medical biotechnology.

#### ZOO-479P - MEDICAL BIOTECHNOLOGY (PRACTICAL)

* 1. Introduction to preparative procedures used in medical biotechnology.
  2. Preparation of DNA.
  3. Preparation of electrophoresis buffers.
  4. Preparation and loading of agarose gel.
  5. Sizing of DNA samples using 'λ- Hind III markers.
  6. Plasmid minipreparation by alkaline lysis method.
  7. Preparation of different buffers and concetrations for PCR reagents.
  8. *In vitro* amplification of DNA by polymerase chain reaction (PCR).
  9. Use of PCR for diagnosis of typhoid by *targetingfli* C gene.
  10. Use of PCR for diagnosis of hepatitis B.
  11. Use of PCR for diagnosis of tuberculosis.
  12. Study of various mammalian genetic disorders by karyotyping techniques.
  13. Western blotting of insulin protein.
  14. ELISA based diagnostics.
  15. Bioavailability of serum.
  16. Visit of medical biotechnological lab.

#### BOOKS RECOMMENDED

1. *Biosafety Management*. Mitchell, R. 2000.1st ed. Virginia Polytechnic InstitutePublication. USA.
2. *Molecular Cloning (A laboratory manual).*Sambrook, J., Fritsch, E. F. and Maniatis,

T. 1989. 2nd ed. Cold Spring Harbour Laboratory Press, UK.

1. *PCR-Protocols (A guide tomethods and applications).* Inns, M. A., Gleaned, D. H., Sninsky, 1. and White, T. J. 1990. Academic Press, UK.
2. *Living resources for biotechnology.* Doyle, A., Hay, R. and Kirsop, B. E.1990.Cambridge University Press, Cambridge, UK.
3. *Animal biotechnology.* Murray Moo, Y. 1989. Pergamon Press Oxford, UK.
4. *Gene cloning and manipulation.* Howe, C. 1995. Cambridge University Press, Cambridge, UK.
5. *Understanding DNA and gene cloning.* Drlica, K. 1996. John Wiley & Sons Inc. USA.
6. *Principles of tissue Engineering.* Lanza, R.P., Langer, R. and Vacanti, 1. 2000. 2ndEdition. Academic Press, California, USA.
7. *Recombinant DNA Vaccines: Rationale and Strategy.* Isaacson, R. E. 1992. Marcel

Dekker, Inc, New York, USA.

1. *Genetics: From Genes to Genomes*. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. and Veres, R.C. 2008. 3rd edition. McGraw-Hill Companies, Inc. Avenue of Americans, New York.*Introduction to Genetic Analysis.* Griffiths, A. J. F., Wessler, S.R.., Lewontin, R.C. and Carroll, S. B. 2008. 9th edition.

W.H. Freeman and company, USA, New York.*Basic Biotechnology.* Ed. Ratledge,

C. and Kristiansen, Bjorn. 2006. 3rd edition. Cambridge University Press, New York.

1. *Introduction to Genetic Engineering*. Nicholl, D.S.T. 1996. Cambridge University Press, New York.
2. *Principles of Gene Manipulation and Genetics.* Primrose, S.B. and Twyman, R. M. 2006. 7th edition. Blackwell Publishing, USA.

#### ZOO-480 - INSECTS OF VETERINARY AND MEDICAL IMPORTANCE

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

* 1. Lectures 30-32
  2. Practicals 10-15
  3. Assignments/ Presentations one per student
  4. Discussions/ Tutorials one per week

#### COURSE CONTENTS THEORY

1. **General introduction to medical and veterinary entomology**

Phylum arthropoda, salient features of insects, classification, general morphology and physiology of insects, modifications in mouthparts and appendages of insects, metamorphosis and its types.

#### Insects of medical and veterinary importance

Mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks: life cycles, diseases and their control.

1. Insect venoms; bees, wasps, ants. Insect toxins, arthropod allergens.
2. Insect pest management: definition, principles and methods of insects control, components of pest management, techniques, general measures to control insects, economics of pest management.

#### ZOO-480P - INSECTS OF VETERINARY AND MEDICAL IMPORTANCE (PRACTICAL)

1. Techniques of collection and preservation of insects.
2. Collection, identification and classification of insects of veterinary and medical Importance.
3. Preparation of slides of mouthparts and appendages of different Insects.
4. Morphometric studies of different Insects and their life cycle.
5. Field studies and report writing to observe different Insects and their life cycles.

#### BOOKS RECOMMENDED

1. *Entomology.* Roy, D. N. and Brown, A.W.A .2004. Biotech .Books, New Delhi.
2. *Introduction to Parasitology.* Chandler, A.C. and Read, C.P. 1961.10th ed. Wiley Toppan, New York, USA
3. *Vector ConlJ19l.* Rozendael, J. A. 1999. A I. T. B. S. publishers, New Delhi.
4. *Medical Entomology.* Service, M.W. 1996. Chapman and Hall, USA
5. *Entomology and Pest Management.* Pedigo, L. P. 2003. 4th ed. Pearson Education, Singapore, Pvt. Ltd.

#### ZOO-481 – HAEMATOLOGY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### COURSE CONTENTS THEORY

1. Blood cell formation, Erythropoises and general aspects of anemia, Hyper chromic

anemia and iron overload, Megaloblastic anemia and other meroblastic anemia, Hemolytic anemia.

1. Genetic disorders of Hemoglobin.
2. Leukopoises, Lymphocytes and their benign disorders, granulocytes and monocytes.
3. Platelets, blood coagulation and hemostasis, bleeding disorders caused by vascular and platelet disorders.

#### ZOO-481P – HAEMATOLOGY (PRACTICAL)

1. Total erythrocyte and lymphocyte counts
2. Study of granulocytes and leukocytes
3. Differential leukocytes
4. Comparison of blood counts of diseased (Anemia) and healthy individuals.
5. Morphological alterations in erythrocytes in various disease conditions like sickle cell anemia etc.

#### BOOKS RECOMMENDED

1. *Essential Haematology*. Hoffbrand, A.V. and Hoffbrand,I.E. 2002. Peltit and PAH Moss
2. *Haematology.* Dacie and Lewis. 2002.

#### ZOO-482 - RESTORATION ECOLOGY AND SUSTAINABLE

**DEVELOPMENT (3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

### AIMS AND OBJECTIVES

The course will:

Enable the students to identify the main candidates (wetlands, lakes, rivers, forests, etc) for conservation. Help the students to develop approaches for conservation such as designing and management of protected areas. Make the students able to play the role of

an active conservation biologist.

#### COURSE CONTENTS THEORY

* 1. **Conservation at the community level**

Protected Areas: Existing protected areas, the effectiveness of protected areas, Establishment priorities for protection, International agreements. Designing protected Areas: Reserve size, minimizing edge and fragmentation effects, Habitat corridors, Landscape ecology and Park design. Managing protected areas: Habitat management, Park management and people. Outside protected areas: Wildlife outside parks, Strategies for success, Ecosystem management. Restoration ecology: Restoration ecology in practice. Main candidates for ecological restoration: Wet lands, Lakes, urban areas, Prairies, Tropical dry forests. Restoration ecology and the future of conservation. Government action: local legislation, national legislation.

#### Conservation and sustainable development

Traditional societies and sustainable development; Conservation ethics of traditional societies, Local people and their governments, Biological diversity and cultural diversity, Conservation efforts involving traditional societies. International approaches to conservation and sustainable development: The Earth summit, Funding sustainable development programmes, International funding, Funding in developing countries, International development banks and ecosystem damage. An agenda for the future. The role of conservation biologist.

#### ZOO-482P - RESTORATION ECOLOGY AND SUSTAINABLE DEVELOPMENT (PRACTICAL)

1. To study the principles of reserve design.
2. To study the classification of protected areas (IUCN 1994).
3. Visits to the national parks of Pakistan and report writing.
4. The Ramsar convention on wetlands for Pakistan.
5. To review and study the measures of protecting precious biodiversity in Pakistan with particular reference to national and international conservation programmes.
6. To study and review the threats to biodiversity of Himalayan forests.
7. To study different types of Ex *situ* conservation strategies.

#### BOOKS RECOMMENDED

1. *A Primer of Conservation Biolog.* Primack, R. B. 2000. 2nd ed. Sinauer Associates Inc. Publishers Sunderland, USA.
2. *Biogeography: An ecological and evolutionary approach.* Cox, C. B. and Morre,

P. D. 2000. 6th ed. Life Sciences King's College London, UK.

1. *Illustrated Handbook of Biodiversity of Pakistan.* Mirza, Z. B. 1998. Printopack.Rawalpindi, Pakistan.
2. *Biodiversity An Introduction.* Gaston, K. J. and Spicer, J. I. 1998. 15t ed. Blackwell Science Ltd. UK.
3. *Environmental science:System and solution.*1998.McKinny, M. L. and Schoch,

M. R. 1sted. Jones and Bartlett Publications, USA.

1. *Pakistan Manual of Plant Ecology.*Hussain, S.S. 1992. 1 st ed. National Book Foundation, Pakistan.
2. *The Biosphere.* Bradbury, I. K. 1998. 1st ed. John Wiley and Sons Inc.UK

#### ZOO-483 - BIOINFORMATICS (2+0 = 2 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 30-32
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

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

#### COURSE CONTENTS THEORY

1. **Overview of Bioinformatics**

The scope of bioinformatics, bioinformatics and internet, Useful Bioinformatics sites on Web.

#### Data Acquisition

Sequencing DNA, RNA and proteins, Determination of protein structure, Gene and protein expression data, Protein interaction data.

#### Database

Contents, Structure and Annotation: File formats, Annotated sequence databases, Genome and organism-specific databases, Miscellaneous databases.

#### Retrieval of Biological Data

Data retrieval with Entrez and DBGET/LinkDB, Data retrieval with SRS (sequence retrieval system).

#### 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.

#### Multiple Sequence Alignment

Genes and Protein Families: Multiple sequence alignment and family relationships, protein families and pattern databases, protein domain families.

#### Phylogenetics

Phylogenetics, cladistics and ontology, Building phylogenetic trees, Evolution of macromolecular sequences.

#### Sequence Annotation

Principles of genome annotation, Annotation tools and resources.

#### 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.

#### Microarray Data Analysis

Analysis methods, tools and resources, sequence sampling and SAGE.

#### Proteomic Data Analysis

Analyzing data from 2D-PAGE gels.

#### Higher-order System

Protein interaction informatics.

#### Bioinformatics in Pharmaceutical industry

Bioinformatics and drug discovery.

#### 15. Basic Principles of Computing in Bioinformatics

Running computer software, Computer operating systems, software downloading and installation.

#### RECOMMENDED BOOKS

1. *Bioinformatics, a practical guide to the analysis of genes and proteins.* Baxevanis,

A.D. and Ouellette, B.F.F, 2005. John Wiley & sons, Inc.

1. *Developing bioinformatics computer skills*. Gibas, C. and Jambeck, P. 2001. O’Reilly publishers.
2. Westhead, D.R., Parish, J.H. and Twyman, R.M. 2003.Viva Books Private Limited.
3. *Instant notes on bioinformatics*. Lest, A.M. 2002.Oxford University Press.
4. *Bioinformatics:A practical guide to the analysis of genes and proteins.* Baxevanic,

A.D. and Ouellette, B.F.F. 2004.3rd Edition. O’Reilly publishers.

1. *Fundamental concepts of Bioinformatics.* Krane, D.E. and Raymer, M.L. 2002. Benjamin Cummings.
2. *Digital code of life: how bioinformatics is revolutionizing science, medicine and business.* Moody, G. 2004. John Wiley and Sons.
3. *Bioinformatics: genes, proteins and computers (advanced text*) Orengo, C. A., Jones, D.T. and Thornton, J.M.2003. Roultledge.
4. [http://www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov/)
5. [http://www.ebi.ac.uk](http://www.ebi.ac.uk/)
6. <http://foldoc.doc.ic.ac.uk/foldoc/index.html>
7. <http://wit.integratedgenomics.com/GOLD/>

**ANNEXURE-II: SPECIAL SUBJECTS**

**Special Subject: ENTOMOLOGY**

#### ZOO-451 - MORPHOLOGY, PHYSIOLOGY AND ECOLOGY

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **General characteristics of insects**

Relationship with other Arthropoda, 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. 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.

#### ZOO-451P - MORPHOLOGY, PHYSIOLOGY AND ECOLOGY (PRACTICAL)

1. Preparation of permanent slides. All the hard parts (terminal segments, wings, antennae, legs, mouth parts and genitalia).
2. Study of the different systems, especially digestive, reproductive of the following insects. American cockroach, *Gryllus*, grasshopper, housefly, butterfly, mosquito, any common beetle. Red cotton bug. Wasp and honeybee. Sympathetic nervous system of cockroach and *Gryllus.*
3. Study of the salivary glands of cockroach, red cotton bug and honeybee.

#### BOOKS RECOMMENDED

1. *General Text Book of Entomology.* Imm. Richards and Davies, Vol.1.
2. *The Insects: Structure and Function*, Chapman.2000.
3. *Insect Physiology*.Wiggles Worth,
4. *Insect Physiology.* Pattons.
5. *Insect Ecology*. Price.
6. *Ecology: The Experimental Analysist Abundance*. Krebs.
7. *Modern Entomology.* Tembhare, 1997.
8. *Ecological Methods.* Southhood, T.R.E. 1978.
9. *Elements of Insect Ecology.*Yasbani, S.S., and Agarwal, M.L.1997.

#### ZOO-452 - CLASSIFICATION OF INSECTS AND PEST MANAGEMENT

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **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, Meco- ptera, 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.

#### ZOO-452P - CLASSIFICATION OF INSECTS AND PEST MANAGEMENT (PRACTICAL)

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.

#### BOOKS RECOMMENDED

1. *Entomology and Pest Management.* Pedigo, L.P., 1991. Maxwell Mc Millan.
2. *Imm's General Textbook of Entomology*. Richards, O.W. and Davies, R.J., 1977. Vol-2
3. *Destructive and Useful Insects*. Metcalf, C.L. and Flint, W.P., 1962. Mc Graw-Hill.

## Special Subject: ENDOCRINOLOGY

#### ZOO-453 - GENERAL ENDOCRINOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

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

#### COURSE CONTENTS THEORY

1. **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 feed back, 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 proopiomelanocortin 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.

#### Calciotrophic 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.

#### ZOO-453P - GENERAL ENDOCRINOLOGY (PRACTICAL)

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc;
2. Histological and ultra structure features of endocrine glands.
3. Experiments to demonstrate physiological roles of hormones of different endocrine glands.
4. Experiments to demonstrate regulation of hormones releases.
5. Experiments to demonstrate functional diversity of hormones in different vertebrates.
6. Experiments on endocrine mechanism in vertebrates.
7. Demonstration of endocrine glands in a mammal (mouse).
8. Effect of hormones on glycemia and calcemia;
9. Effect of thyroxine on oxygen consumption;
10. Effect of androgen on accessory sex organs and of estrogens on target tissues;
11. Study of estrous cycle and effects of the hormones.

#### BOOKS RECOMMENDED

1. *Basic and clinical endocrinology*.Greenspan, F.S. and Strewler, G.J., 2002. 5th Edition. Prentice Hall International Inc., London.
2. *Williams Textbook of Endocrinology*, Wilson, J.D., Foster, D.W., Kronenberg,

H.M. and Larsen, P.R., 1998. 9th Edition. W.D. Saunders Company, Philadelphia.

1. *Endocrinology*.DeGroot, L.J., Jameson, J.L. *et al*., 2001. Vol.I, II, III, 4th ed. W.B.Saunders, Philadelphia.
2. *Textbook of Endocrine Physiology.* Giffin, J.E. and Ojeda, S.R., 2000. 4thEdition. Oxford University Press, Oxford.
3. *Basic Endocrinology: An interactive approach.* Neal, J.M., 2000. Blackwell Science Inc., UK.

#### ZOO-454 - REPRODUCTIVE ENDOCRINOLOGY (3+1= 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

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

#### COURSE CONTENTS THEORY

1. **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.

#### Endocirnology of Lactation

Hormones in lactation.

#### Endocrinology

Heart, Kidney, Immune system: Growth and pineal gland.

#### ZOO-454P - REPRODUCTIVE ENDOCRINOLOGY (PRACTICAL)

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

#### BOOKS RECOMMENDED

1. *Basic and clinical endocrinology*, Greenspan, F.S. and Strewler, G.J., 2002. 5th Edition. Prentice Hall International Inc., London.
2. *Williams Textbook of Endocrinology*.Wilson, J.D., Foster, D.W., Kronenberg,H.M. and Larsen, P.R., 1998. 9thEdition. W.D. Saunders Company, Philadelphia.
3. *Endocrinology.*DeGroot, L.J., Jameson, J.L. *et al*., 2001. Vol.I, II, III, 4th ed. W.B. Saunders, Philadelphia.
4. *Textbook of Endocrine Physiology*.Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Oxford University Press, Oxford.
5. *Basic Endocrinology: An interactive approach*. Neal, J.M., 2000. Blackwell Science Inc., London.

## Special Subject: PHYSIOLOGY

#### ZOO-455 - PHYSIOLOGY OF COORDINATION (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

* 1. To study the details of nervous and hormonal coordination at molecular and cellular level in animal.
  2. Bio synthetics, secretary and regulatory aspects of coordination.

#### COURSE CONTENTS THEORY

1. **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.

#### 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.

#### 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 energetic; Energy, environment and evolution.

#### ZOO-455P - PHYSIOLOGY OF COORDINATION (PRACTICAL)

1. Recording of action potentials on oscilloscope and effects of various factors on its characters;
2. Experiments on the study of heart in frogs.
3. Study of blood pressure in various physiological states.
4. Study of electrocardiograms
5. Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential.
6. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves.
7. Experiments on sensory organs study.
8. Experiments on characteristics of skeletal muscle contractions;
9. Responses of intestinal muscles and effect of drugs.

#### BOOKS RECOMMENDED

1. *Eckert Animal Physiology: Mechanisms and Adaptations*. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. 5th ed. W.H. Freeman and Company, NY. 2.*Physiology*. Bullock, J., Boyle, J. and Wang, M.B., 2001. 4th edition. Lippincott, Williams and Wilkins, Philadelphia.

1. *Principles of Physiology.*Bernes, R.M. and Levy, M.N., 2000. 3rd edition. St. Lious, Mosby.
2. *Textbook of Medical Physiology*.Guyton, A.C. and Hall, J.E., 2000. 10th Edition.

W.B. Saunders Company, Philadelphia.

1. *Comparative Animal Physiology*. Withers, P.C., 1992. Saunders College Publishing, Philadelphia.
2. *Animal Physiology, Adaptation and Environment.*Schmidt-Nelsen, K., 1997. 5th edition. Cambridge University Press, Cambridge.
3. *Experiments in Physiology*. Tharp, G. and Woodman, D., 2002. 8th Edition.Prentice Hall, London.

#### ZOO-456 - PHYSIOLOGICAL SYSTEMS & ADAPTATIONS

**(3+1=4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

* 1. To study the details of physiological systems maintaining the homeostasis of animals.
  2. Interrelations of the systems
  3. Regulatory features of the each system’s function

#### COURSE CONTENTS THEORY

1. **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.

#### ZOO-456P- PHYSIOLOGICAL SYSTEMS & ADAPTATIONS (PRACTICAL)

1. Blood coagulation study.
2. Determination of oxygen consumption in fish and mouse & effects of factors.
3. Demonstration of respiratory volume and pulmonary function tests.
4. Experiments on digestion on nutrients by enzymes and effects of factors.
5. Study of exocrine secretion in stomach or pancreas and effects of factors.
6. Experiments on kidney regulation of osmolality; Urine analysis.
7. Study of osmoregulatory adaptations in animals inhabiting various environments;
8. Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

#### BOOKS RECOMMENDED

1. *Eckert Animal Physiology: Mechanisms and Adaptations*. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. 5th ed. W.H. Freeman and Company, New York.USA.
2. *Physiology*. Bullock, J., Boyle, J. and Wang, M.B., 2001. 4th edition. Lippincott, Williams and Wilkins, Philadelphia.
3. *Principles of Physiology.*Bernes, R.M. and Levy, M.N., 2000. 3rd edition. St. Lious, Mosby.
4. *Textbook of Medical Physiology*.Guyton, A.C. and Hall, J.E., 2000. 10th Edition.

W.B. Saunders Company, Philadelphia.

1. *Comparative Animal Physiology*. Withers, P.C., 1992. Saunders College Publishing, Philadelphia.
2. *Animal Physiology, Adaptation and Environment.*Schmidt-Nelsen, K., 1997. 5th edition. Cambridge University Press, Cambridge.
3. *Experiments in Physiology*. Tharp, G. and Woodman, D., 2002. 8th Edition. Prentice Hall, London.

## Special Subject: PARASITOLOGY

#### ZOO-457 - PARASITOLOGY A (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **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.

1. **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.

1. **Kinetoplasta**

Trypanosomes and their kin, forms of trypanosomatidae.

#### Other flagellated protozoa

Order Retortamonadita, order Diplomonadida, order Trichomonadida, order Opalinida.

#### The Amoebae

Order Amoebida, order Schizopyrenida.

#### Phylum Apicomplexa

Gregarines, Coccidia and related organisms. The apical complex, class Gregarinea, class Coccidea.

#### Phylum Apicomplexa

Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida.

#### Phylum ciliophora

Ciliated protistan parasites, class Spirotoichea, class Litostomitea, class Oligohymenophorea.

#### 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.

#### ZOO-457P - PARASITOLOGY A (PRACTICAL)

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.

#### BOOKS RECOMMENDED

1. *Foundation of Parasitology*. Roberts, L.S. and Janovy, J.2000.6th ed. McGraw Hill Book
2. *Protozoology*. Hausman, K. and Hulsmann, N. 1996, 2nd ed Thieme Medical Publishers, Inc. New York.
3. *Parasitology. The Biology of animal parasites*. Noble and Noble, 1982. 5th edition. Lea and Febiger.
4. *Medical parasitology*. Beck, J.W. and Davies, J.E., 1981. 3rd edition. The C.V. Mosby Company, Toronto, London.
5. *Medical Laboratory Manual for Tropical Medicine*. Cheesbrough, M., 1987*.* Vol.I. University Press Cambridge.
6. *Introduction to Animal Parasitology.* Smyth, J.D., 1994. Cambridge University Press.
7. *Foundations of Parasitology*. Roberts, L.S. and Janovy, J. Jr., 2005. 7th Edition.

W.M. Brown Publishers, Chicago, London, Tokyo, Toronto.

#### ZOO-458 – PARASITOLOGY B (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### COURSE CONTENTS THEORY

1. **Systematics, biology, pathology**

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

#### Systematics, morphology and biology of Arthropods causing disease or those responsible for transmission of disease

Chemical and non-chemical control of Arthropods of Medical and Veterinary importance.

#### ZOO-458P – PARASITOLOGY B (PRACTICAL)

1. Methods of collection, preservation and transportation of parasitic material.
2. Qualitative and quantitative faecal examination for helminth ova.
3. Collection, preservation and preparation of slides of local helminthes and their identification.
4. Identification of insects of medical and veterinary importance.

#### BOOKS RECOMMENDED

1. *Parasitology. The Biology of Animal Parasites*. Noble and Noble, 1982. 5th edition.Lea and Febiger.
2. *Medical parasitology*.Beck, J.W. and Davies, J.E., 1981. 3rd edition. The C.V. Mosby Company, Toronto, London.
3. *Medical Laboratory Manual for Tropical Medicine*. Cheesbrough, M., 1987Vol.I. University Press Cambridge.
4. *Introduction to Animal Parasitology*. Smyth, J.D., 1994. Cambridge University Press.
5. *Foundations of Parasitology*. Roberts, L.S. and Janovy, J. Jr., 2005*.* 7th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. *Veterinary Parasitology.*Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000 Longman Scientific and Technical publications, Longman Group, U.K.

## Special Subject: MICROBIOLOGY

#### ZOO-459 - GENERAL MICROBIOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **The beginnings of Microbiology**

Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the ausation 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 protests. 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.

#### ZOO-459P - GENERAL MICROBIOLOGY (PRACTICAL)

1. Study of bacteria, yeasts and molds, and protozoa.
2. Staining of microorganisms: Simple stains, positive staining; negative staining.
3. Demonstration of special structures by stains: Spore stain, Flagella stain.
4. Differential stains: Gram stain, Metachromatic Granule stain, Acid fast stain.
5. Culturing of microorganisms:
6. Preparation and sterilization of culture media, agar slope, agar slab, streak plates, pour plates methods.
7. Isolation of a bacterial culture.
8. Quantitative plating methods.
9. The turbidimetric estimation of microbial growth.
10. Study of bacterial viruses.

#### BOOKS RECOMMENDED

1. *Microbial Applications (complete version) Laboratory Manual in General Microbiology.* Benson, H.J. 1994. Brown Publishers, England.
2. *Microbiology*.Pelczar Jr., Chan, E.C.S. and Krieg, M.R. 986.McGraw Hill, London.
3. *Brock Biology of Microorganisms*, Madigan, M.T., Martinko, J.M. and Parker, J. 1997. Prentice-Hall, London.
4. *The Microbial World*, Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter,

R.R. 1986. Prentice Hall, London.

#### ZOO-460 - APPLIED MICROBIOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 THEORY

1. **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.

#### ZOO-460P - APPLIED MICROBIOLOGY (PRACTICAL)

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

#### BOOKS RECOMMENDED

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

## Special Subject: FISHERIES

#### ZOO-461 - PRINCIPLES OF FISH BIOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### 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 Fresh water culturable fishes in particular. It comprises morphology, anatomy, classification and some nderstanding about various feeding groups found in different water bodies. After having complete knowledge of above, students will be able to practice independently.

#### COURSE CONTENTS THEORY

1. **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 (No, size, arrangements); Vital organs (heart, liver, kidney); Viscera and mesenteries swimbladder, 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

#### ZOO-461P - PRINCIPLES OF FISH BIOLOGY (PRACTICAL)

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

#### BOOKS RECOMMENDED

1. *Kestin Farmed Fish Quality (2001)* Multiline Books
2. *Woo Fish Diseases and Disorder: Protozoan and Metazoan Infections* (1995) Pak Book Corp.
3. *Brenabe Aquaculture*, Vol. I &II (1992) Fishing News Books Ltd, England
4. C. Maseke *Fish Aquaculture* (1987) Pergamon Press, Oxford
5. M. Huet. *Text Book of Fish Culture: Breeding and Cultivation* (1986) Fishing News Books Ltd, England

#### ZOO-462 - FISH PHYSIOLOGY AND BREEDING (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The aim of this course is to provide sufficient knowledge about all physiological phenomena in fishes. The subject provides 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 fished by manipulating reproductive and endocrinological aspects during natural season as well as off seasons.

#### COURSE CONTENTS THEORY

1. **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, latelets 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 and 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 behavior.

#### ZOO-462P - FISH PHYSIOLOGY AND BREEDING (PRACTICAL)

1. Study of gut contents.
2. Study of feeding modification and adaptation in fish.
3. Study of respiratory adaptation in fish.
4. Study of blood cells and their counts in normal and diseased fish.
5. Study of water quality parameters (DO, NH3, hardness, alkalinity, turbidity, transparency, temperature, salinity).
6. Study of various forms of swimbladder as hydrostatic organ.
7. Study fecundity of various fish species.
8. Study the effects of reproductive hormone (GnRH) on fish maturation, Diagnosis of bacterial infection in infected fish.
9. Study of fish parasites.
10. Visit to various fish seed hatcheries during breeding seasons.

#### BOOKS RECOMMENDED

1. *Kestin Farmed Fish Quality* (2001) Multiline books.
2. *Ruth Freshwater Aquaculture* (2000) Multiline books.
3. *Saksena Ichthyology: Recent research advances* (1999) Multiline books.
4. *Woo Fish Diseases and Disorder: Protozoan and Metazoan Infections* (1995). Pak book corp.
5. *Brenabe Aquaculture*, Vol. I &II (1992) Fishing News Books Ltd, England.
6. *Maseke Fish Aquaculture* (1987) Pergamon Press, Oxford.
7. M. Huet. *Text Book of Fish Culture: Breeding and Cultivation* (1986). Fishing News Books Ltd, England.
8. *Hoars Fish Physiology.*
9. *Hoars Fish Reproduction.*
10. Matty *Fish Endocrinology* (1985).
11. Gorbman *Comparative Endocrinology* (1983).

## Special Subject: MOLECULAR BIOLOGY

#### ZOO-463 - ADVANVE CELL AND MOLECULAR BIOLOGY

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

Objectives of the course are to impart knowledge about:

The cell and its 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.

#### COURSE CONTENTS THEORY

1. **Introduction to cell biology**

Difference between prokaryotes and eukaryotes, Physico-chemical properties of protoplasm, Ultra-structure, chemical composition and functions of cell wall, cell membrane, cellular organelles (mitochondria, endoplasmic reticulum, golgi apparatus, lysosome, glyoxysome, nucleus, ribosomes, etc.) cytoskeleton.

#### Chromosomes

Chemical composition and molecular structure of chromosomes, Chromosome structure and function, Cell cycle and apoptosis, Cell reproduction, Signal transduction, Cell culture.

1. ***E. coli* and yeast**

As representative prokaryotic and eukaryotic models for molecular differentiation.

1. **Molecular mechanism** of Replication, Transcription and Translation, Transcriptional and translational regulation of gene expression, Regulation of gene expression in prokaryotes and eukaryotes.

#### Recombinant DNA technology

Types of recombination, Mutations and chromosomal aberrations, DNA damage and repair, Gene sequencing, Principles of recombinant DNA technology, Role of Recombinant DNA technology in economic development, Human genome project, Stem cell research.

#### ZOO-463P - ADVANVE CELL AND MOLECULAR BIOLOGY (PRACTICAL)

1. Karyotyping.
2. Study of DNA damage by physical and chemical methods.
3. Case study of chromosomal abnormalities in human and agricultural specimen.

5. Ames test for identification of mutagenic agents.

#### BOOKS RECOMMENDED

1. *Cell and Molecular Biology*. De Robertis, E. D. P and De Robertis Jr. E. M. F.

th

2001. 8 Edition. Lippincott, Williams and Wilkins Publishers.

1. *Cell and Molecular Biology; Concepts and Experiments*. Karp, G. 2000. John Wiley and Sons Publishers.
2. *Molecular and Cell Biology*. Lodish, H. 2001. W. H. Freeman and Co.
3. *Molecular Plant Biology*. Gilmartin, P. M. and C. Bowler. 2002. Vol 1 and 2. Oxford University Press. UK.

th

1. *Essentials of Molecular Biology*. Malacinski. G. M. 2003. 4

Bartlett Publishers, Massachusetts.

Edition. Jones and

1. *Molecular Biology of the Gene*. Watson J. D. 2004. Pearson Education, Singapore.
2. *Molecular Biology*. Weaver, R. F. 2005. McGraw Hill, St. Louis.
3. *Molecular Cell Biology*. Lodish, H., Matsudaira, P., Berk, A., Ploegh, H., Scott, M., Kaiser, C. A., Krieger, M., Bretscher, A., 2007. W. H. Freeman Company.
4. *Cell Biology and Histology*. Gartner , L. P., Hiatt , J. L. and Strum , J. M., 2003. Lippincott Williams and Wilkins.
5. *Cells and Life Processes*. Walker , D., 2007. Smart Apple Media.
6. *Molecular Biology of the Cell*. Alberts . B., 2007. Taylor and Francis, Inc.
7. *Cell Biology*: Pollard ,T.D.,Lippincott-Schwartz ,J.,Earnshaw ,W.C.,2007. Saunders W. B. Co.

#### ZOO-464- MOLECULAR MECHANISMS OF ANTIMICROBIAL DRUGS

**(3+1= 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course imparts knowledge and understanding of:

The mechanism of chemotherapy, form a general understanding of microbial control. Examine factors that influence microbial control and discuss major chemical methods.

#### COURSE CONTENTS THEORY

1. **Chemotherapy**

Nature and historical background of chemotherapy.

#### Paths to drug discovery

Empirical screening, observation of side effects, molecular targets and models. Range of antimicrobial targets. Chemical structure and biological activity. Molecular basis for selective action against the prokaryotes.

#### Antimicrobial agents affecting

Cell wall synthesis, Protein Synthesis, DNA/RNA synthesis and others. Cytoskeleton,

#### Antifungal & antiviral drugs

Antifungal drugs affecting cell membrane and cell wall biosynthesis in fungi. Mechanism of action of antiviral drugs, antimitotic agents, benzimidazole carbamates, alkaloids and taxol. Antiparasitic agents. Resistance mechanisms.

#### New approaches in Therapy

By the use of Blockers for: Selective microbial enzymes, substrates, and receptors. Blockers for biochemical processes, Action of antibiotics on biofilms, Drug design and delivery.

#### ZOO-464P- MOLECULAR MECHANISMS OF ANTIMICROBIAL DRUGS (PRACTICAL)

1. Isolation of antibiotic resistant bacteria from environment.
2. Effect of antibiotics on peptidoglycan content.
3. Effect of antibiotics on total soluble protein content.
4. Determination of extended spectrum beta lactamase in bacteria resistant to beta lactam antibiotics.
5. Determination of protein profile of antibiotic sensitive and resistant bacteria by Polyacrylamide Gel Electrophoresis (PAGE).
6. Effect of antibiotic on bacteria present in biofilm.

#### BOOKS RECOMMENDED

1. Greenwood, D. 2000 Antimicrobial chemotherapy. Oxford Univ. Press.
2. Greenwood ,D., Finch ,R., Davey ,P., Wilcox ,M., 2007. Antimicrobial Chemotherapy.5th Edition. Oxford University Press.
3. Franklin, Trevor J., Snow, G.A. 2005. Biochemistry and Molecular Biology of Antimicrobial Drug Action. Springer.
4. Hauser, A. R., 2007. Antibiotic Basics for Clinicians. Wolters Kluwer Health.
5. Häusler, T., 2006. Viruses VS. Superbugs A solution to the Antibiotics Crisis? Macmillan Science.
6. Greenwood, D., Finch ,R., Davey, P., Wilcox ,M., 2007. Antimicrobial Chemotherapy. Oxford University Press; 5th Rev. edition.

#### ZOO-465 - MICROBIOLGY AND BIOTECHNOLOGY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course aims to teach the students techniques regarding isolation and characterization of bacteria. It will also help the students to understand the role of the bacteria in the environment, health and agriculture.

#### COURSE CONTENTS THEORY

1. **History of microbiology**
2. **Screening of microorganisms** from environmental samples.

#### Characterization and classification of microorganisms

Cultivation, microbial growth dynamics and kinetics.

#### Pure Culture

Development of pure cultures and their preservation, inoculum development (size and physiological states), mixed cultures and substrate systems.

#### Fermentors

Types of fermentors, types of bioreactors, strain improvement through recombinant DNA technology, scale up theory.

#### Applied biotechnology

Case studies for industry, environment, health, and agriculture.

#### ZOO-465P - MICROBIOLGY AND BIOTECHNOLOGY (PRACTICAL)

1. Study of bacteria, yeasts and molds, and protozoa.
2. Microscopy, preparation and sterilization of culture media.
3. Isolation of pure cultures.
4. Microbial enumeration and growth estimations.
5. Cultural preservation techniques.
6. Development of synchronized inoculum for industrial use.

#### BOOKS RECOMMENDED

1. Pelczar Jr., chan, E. C. S. and Krieg, M. R., 1986. Microbiology, McGraw Hill, London.
2. Medigan, M. T., Mantinko, J. M. and Parker, J., 1997. Brock Biology of Microorganisms, Prentice Hall, International, Inc. USA.
3. Peltier., G. L. *A Laboratory Manual of Mic*robiology.
4. Benson, H. J. 1994. Microbiological Applications, Wm. C. Brown Publishers, USA.
5. Rehm, J. J., 1988. Biotechnology Fundamentals, VCH Publishers, New York.
6. Lee, B. H., 1996. Fundamentals of Food Biotechnology, VCH Publishers, New York.
7. Pirt, J. B., 1975. Microbes and Cell Cultivation, Blackwell Scientific Publications, London.
8. Bailey, J. E. and Ollis, D. F., 1986. Biochemical Engineering Fundamentals, McGraw Hills.
9. Watson, J. D., Tooze, J. and Kurtz, D. T., 1983. Recombinant DNA- A short course, Scientific American Books, New York.

th

1. Old, R. W. and Primrose, S. B., 1989. Principles of gene manipulation. 4

Blackwell Scientific Publications, London.

Edition,

nd

1. Molecular Cloning, 1989. A laboratory manual, 2

Laboraroty.

Edition, Cold Spring Harbor

1. Higgins, I. J., Best, D. J. and Jones, J., 1988. biotechnology; Principles and applications. Blackwell Scientific publications, London.
2. Rehm, J. J., 1988. Biotechnology; Special Microbial Process, vol. 6b, VCH Publishers, New York.
3. Demain, A. L. and Solomon, N. A., 1986. Manual of Industrial Microbiology and Biotechnology. ASM, Washington DC, USA.

## Special Subject: ENVIRONMENTAL SCIENCE

#### ZOO-466 - INTRODUCTION TO ENVIRONMENT (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGY

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student
4. Field trips/Visits 03
5. Discussion/Tutorials/Documentaries: one hour per week

#### AIMS AND OBJECTIVES

It will enable students to understand interrelationship between various components of the environment. It includes basic concepts of matter, energy, birth of universe, solar system and origin of earth,. Environmental geology and environment and life and human activity are considered for understanding of environment and its trans disciplinary integration. Introduction to geosphere, atmosphere, hydrosphere, biosphere and ecosystem provides foundations for the advance courses required for the degree programme.

#### COURSE CONTENTS THEORY

1. **Environment**

Introduction and definitions. Environmental systems; Atmosphere, Lithosphere, Hydrosphere, Biosphere, Origin and their interrelationships.

#### Environmental factors

Physical, chemical and biological factors.

#### Variety of life and environment (brief account).

1. **Environment and human interactions**

Environmental pollution; types, sources, causes and effects (brief overview).

#### Environmental issues and challenges

Deforestation, water logging, salinity, drought and desertification, Loss of natural habitat, Depletion of resources, Population and genetic diversity.

#### Environment and sustainable development.

1. **Issues of social environment**

Population growth, urbanization, migration, and poverty, Lifestyle and environment.

#### ZOO-466P- INTRODUCTION TO ENVIRONMENT (PRACTICAL)

1. Study of environment in the university campus.
2. Adaptation of animals to various environmental conditions: i) Aquatic ii) Terrestrial iii) Arboreal iv) Fossoreal v) Cursoreal vi) Parasitic
3. Adaptation of plants to various environmental conditions (i) Xerophytic ( ii) Mesophytic ( iii) Hydrophytic
4. To determine (i) brightness of light by using LUX meter ( ii) Intensity of light by using Pyronometer
5. Study of various soil profiles and determination of their moisture contents.
6. Determination of speed of air at different time intervals by using anemometer.
7. Analyzing the quality of different water samples by physical and chemical tests.
8. Study of various types of rocks and fossils.
9. To determine the amount of rain fall in different times by using simple rain gauge.
10. Visit to meteorological department and report writing.

#### BOOKS RECOMMENDED

1. *Environmental Science (Earth as a living planet).* 2000. 1st ed. Botkin, D. and Keller, E. John Wiley and Sons Inc. New York, USA.
2. *Environmental Science (The way the world works).* 1998. 1st ed. Nebel, B. J. and Wright, R. T. Prentice Hall International Inc. London, UK.
3. *Physical Geography of the Global Environment*. 1993. 1st ed. de Blij, H. J. and Muller, P.O. John Wiley and Sons Inc. New York, USA.
4. *Physical Geography (Science and systems of the human environment*). 1997. 1st ed. Strahler, A. and Strahler, A. John Wiley and Sons Inc. New York, USA.

#### ZOO-467 - ENVIRONMENTAL ISSUES OF PAKISTAN

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGY

1. Lectures: 45-48
2. Practicals: 10
3. Assignment/Presentation: 01 per student
4. Discussions/Tutorials: 01 hour per week
5. Field Trips/Visits: 02

**AIMS AND OBJECTIVES**

The course provides review of the different environmental issues including ecological, conservation, pollution, resources, population and socioeconomic issues of Pakistan. It deals with the management and planning issues using case studies. This will enable the students to identify and analyze various environmental issues critically. They will be able to draw and formulate different strategies to address the multidisciplinary issues in different countries in general and in Pakistan in particular. **COURSE CONTENTS**

#### THEORY

1. **Human population**

Human population explosion, environmental and social impacts of growing population and affluence, addressing population problems.

#### Food productionand its distribution

Hunger, malnutrition and famine.

#### Pest and pest control

Need and approach to pest control, Integrated pest management IPM).

#### Water Pollution

Human impact on water resources, Eutrophication, Combating eutrophication.

#### Sewage Pollution

Sewage hazards and sewage managements.

#### Hazardous Chemical pollution

Nature and chemical risks, pollution sources and control.

#### Major atmospheric Changes

Acid deposition, global warming/ cooling, greenhouse effect, Ozone depletion.

#### Solid Waste

Landfills, incineration, management and solutions.

#### Energy resources

Energy sources and uses; issues related to fossil fuel and nuclear power, alternate energy resources.

#### Environmental Issues in Pakistan

Ecological issues: Soil erosion, deforestation, issues related to irrigation system, natural hazards. Issues related to conservation of habitat and biodiversity: Major threats to biodiversity in Pakistan, Conservation strategies.

#### Industrial pollution

Sources and remediation.

#### Population issues

Socio-economic issues in Pakistan.

#### ZOO-467P - ENVIRONMENTAL ISSUES OF PAKISTAN (PRACTICAL)

1. Study of the various characteristics of the population with the help of the statistical data (Age profile, family size and educational status, etc).
2. Study of the types of the pesticides and their characteristics.
3. Study of the relationship between relative humidity and temperature of Lahore for a particular time period.
4. Estimation of total particulate matter in air by using air sampler.
5. Determination of Sodium and Potassium in various water samples using flame photometer.
6. Determination of Chromium, Lead and Copper in industrial effluent.
7. To study the urban environment and urban environmental issues.
8. To study the eutrophic conditions in various ponds.
9. To study noise level at different places in city (Main road crossings, Railway station, Hospital) using noise level meter.
10. To study the level of occurrence of various diseases among families of (i) Class students (ii) Low income groups (iii) High income groups.

#### BOOKS RECOMMENDED

1. *Environmental Science (Earth as a living planet).* 2000. 3rd ed. Botkin, D. B. and Keller, E. A. John Wiley and Sons Inc. New York, USA.
2. *Environmental Science (The way the world works).* 1998. 1st ed. Nebel, B. J. and Wright, R. T. Prentice Hall International Inc. London, UK.
3. *The Biosphere.* 1998. 2nd ed. Bradbury, 1. K. John Wiley and Sons Inc. UK.
4. *Environmental Science (Systems and solutions).* 1998. McKinney, M. L. and Schoch, R. M. Jones and BartItt Publications Inc. USA.
5. *Pakistan- A Descriptive Atlas (A comprehensive geo-politics course*). 2000. 1st ed. Ahmad, R. Z. Ferozsons Pvt. Ltd. Lahore Pakistan.
6. *A Geography of Pakistan Environment (Environment, people and economy).*

1993. 1st ed. Khan, F. K. Oxford University Press. New York USA.

1. Daily newspapers for current issues.

#### WEB SITES

*http://wu)w.panasia.org.sg/tcdc/pakistan* [*http://urww.*](http://urww/) *wwfpak.org/biodiversity* [*http://www.populationconnection.org*](http://www.populationconnection.org/)[*http://www.epa.org.pk*](http://www.epa.org.pk/)[*http://www.unep.org*](http://www.unep.org/)

## Special Subject: GENETICS

#### ZOO-468 - BASIC HUMAN GENETICS (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGY**

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student
4. Field trips/Visits 03
5. Discussion/Tutorials/Documentaries: one hour per week

#### AIMS AND OBJECTIVES

The objectives of the course are:-

1. To enable the students to understand basic Mendelian inheritance principles
2. To enable the students to analyze and predict mode of Inheritance of various genetic disorders.
3. To train the students to provide genetic counseling to various families in field.

#### COURSE CONTENTS THEORY

1. **Nucleic acids**

#### Genetic linkage

Family method, somatic cell hybridization, deletion mapping and duplication mapping.

#### Introduction to human genome

1. **Karyotyping**

Patterns of transmission of single gene traits: Pedigree analysis with criteria for identification of various modes of inheritance.

#### Genetic defects in prenatal development

Oncogenes and cancer, normal chromosomes, congenital malformations.

1. Introduction to Human genome project.

#### ZOO-468P - BASIC HUMAN GENETICS (PRACTICAL)

1. Pedigree analysis.
2. Karyotyping of normal and abnormal human chromosomes.
3. Screening of metabolic and other disorders.
4. Problems solving on genetic counseling.
5. Orientation with different molecular techniques including PCR, RFLP.

#### BOOKS RECOMMENDED

1. Strachan, T., A. P. Read, Human Molecular Genetics, 3rd ed., Garland Science/Taylor & Francis. 2003.
2. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st ed., Penguin USA Paper, 2002.
3. Relethford J. H., Genetics and the Search for Modern Human Origins, Wiley-Liss 2001.
4. Molecular Biology of the Cell, 4th ed. Garland Publishing Inc. New York. 2002.

#### ZOO-469 - MOLECULAR GENETICS (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGY

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student
4. Field trips/Visits 03
5. Discussion/Tutorials/Documentaries: one hour per week

#### AIMS AND OBJECTIVES

The objectives of the course are:-

1. To enable the students to understand organization of genome of various organisms
2. To develop understanding of different types of DNA damages and Repair
3. To enable the students to understand the gene expression and its control

#### COURSE CONTENTS THEORY

1. **Plant and animal viruses** (DNA and RNA)

#### Transposition

Transposable elements, detection of transposition in bacteria, types of bacterial transposons, modes of transposition in bacteria. Genetic phenomena mediated by transposons, transposable elements in prokaryotes and eukaryotes.

#### Gene expression in pro- and eukaryotes

1. **Genetic transformation (all kinds)**

Regulation of simple and complex transcription unit.

#### Current developments in molecular genetics

Molecular techniques viz. Southern, Northern and Western blotting, PCR, RFLP, AFLP’s, RAPDs, Micro-sattelites, SNPs.

#### ZOO-469P - MOLECULAR GENETICS (PRACTICAL)

1. Isolation of nucleic acids.
2. Qualitative and quantitative measurement of concentration, digestion with specific restriction enzymes and gel electrophoresis.
3. Plasmid isolation and characterization.
4. Denaturation and renaturation of DNA.
5. Orientation with different molecular techniques including PCR, RFLP, AFLPs, RAPDs, etc.

#### BOOKS RECOMMENDED

1. *Molecular Biology of the Cell*, Alberts, B., A. Johnson, J. Lewis, M. Raff, K . Roberts, and P. Walter. 4th ed. Garland Publishing Inc. New York.2002.
2. *Molecular biology of the gene*. Watson, J, D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick. Pearson Education. 2004.
3. *Molecular Genetics of bacteria*. Snyder, L. and W. Chapness. ASM, Press, 2003.
4. *Gene-VIII*. Lewin, B. Oxford University Press, Oxford, UK. 2004.

## Special Subject: BIOINFORMATICS

#### ZOO-470 - FUNDAMENTALS OF BIO-INFORMATICS

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGY

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student
4. Field trips/Visits 03
5. Discussion/Tutorials/Documentaries: one hour per week

#### 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.

#### COURSE CONTENTS THEORY

1. **Introduction to BI**

What is BI, History of BI, Uses of BI (Protein, Gene), Comparison of BI with experimental tools, Neural networks.

1. **The central Dogma** (RNA-DNA-Protein).

#### Short introduction

DNA/RNA (structure, genetic code), protein (amino acids, sequence).

#### Analyzing Protein sequence by the use of BI tools (sequence-structure- function)

Retrieving protein sequences from database, Computing physico-chemical parameters of proteins, Predicting elements of secondary structure of proteins, Predicting 3D structure of protein from sequence.

#### Analyzing the DNA/RNA sequence by the use of BI tools

Retrieving the DNA sequence from database, Computing the sequence, Identifying restriction sites, Predicting elements of DNA/RNA secondary structure, Computing the optimal alignment between two or more DNA sequences.

#### Working with a genome

Finding which genomes are available, Analyzing sequences, Locating gene homologous in genome, Displaying genomes.

#### Interpretation of DATA

**BOOKS RECOMMENDED**

1. *Bioinformatics; a practical guide to the analysis of genes and proteins.*

Baxevanis, A.D. and Ouellette, B.F.F. 2005. John Wiley & sons, Inc.

1. *Developing bioinformatics computer skills*. Gibas, C. and Jambeck, P. 2001. O’Reilly publishers.
2. *Instant notes on bioinformatics*. Westhead, D.R., Parish, J.H. and Twyman, R.M. 2003.Viva books private limited.
3. *Introduction to bioinformatics*. Lest, A.M. 2002. Oxford University Press.
4. *Bioinformatics; a practical guide to the analysis of genes and proteins.* Baxevanis, A.D. and Ouellette, B.F.F. 2004. John Wiley & sons, Inc. 3rd ed. O’Reilly publishers.
5. Fundamental concepts of bioinformatics. Krane, D.E. and Raymer, M.L. 2002. Benjamin cummings.

#### ZOO-471 - PROTEOMICS AND GENOMICS (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student
4. Field trips/Visits 03
5. Discussion/Tutorials/Documentaries: one hour per week

#### AIMS AND OBJECTIVES

This course is a fundamental course in proteomics and genomics. Lectures will cover protein/peptide separation techniques, protein mass spectrometry, bioinformatics tools, biostatistics and biological applications, which include quantitative proteomics, protein modification proteomics, interaction proteomics.

#### COURSE CONTENTS THEORY

1. **Introduction to Proteomics**

Protein Structure and Function**,** different experimental techniques in Protein separation and purification, Chemical Modifications, Sequence analysis.

#### Introduction to Post-Translational Modifications

Phosphorylation, glycosylation, acetylation, methylation etc. Different applications.

#### Introduction to Structural Proteomics

Protein Domains, Protein Cross-linking, Protein-protein interaction.

#### Proteomics in Biotechnology

1. **Introduction to genomics**

Structure and types of nucleic acids. Watson and Crick’s model of DNA. DNA Mechanism of splicing and its control, translation of the message, post translational modifications. replication: models, mechanism and enzymes of replication. Genetic code. Genome projects: microbes, plants, animals and human. Basic concepts in recombinant DNA technology. Restriction and modification system: types, enzymes, classification, nomenclature, genetics and applications. Cutting and joining of DNA molecules: isolation and purification of DNA, cutting of DNA molecules, ligation of DNA molecules, blunt ends and cohesive termini.

#### Application of bio-informatics in proteomics and genomics

Genomic and proteomic data, pair-wise sequence alignment, predicting the structure and function of DNA, RNA, and proteins from their primary sequences. Multiple sequence alignment, Construction of phylogenetic trees. Sequence analysis, genome annotation, computational evolutionary biology, , gene expression and regulation analysis, protein analysis, mutations analysis in cancer, structure prediction, modeling biological systems, high throughput image analysis.

#### ZOO-471P - PROTEOMICS AND GENOMICS (PRACTICAL)

1. Different bioinformatic tools in proteomics and genomics.

#### BOOKS RECOMMENDED

1. *A practical guide to the analysis of genes and proteins*. Baxevanis, A.D. and Ouellette, B.F.F, Bioinformatics, 2005. John Wiley & sons, Inc.
2. *Developing bioinformatics computer skills*. Gibas, C. and Jambeck, P. 2001. O’Reilly publishers.
3. *Instant notes on bioinformatics*. Westhead, D.R., Parish, J.H. and Twyman, R.M. 2003.Viva books private limited.
4. *Introduction to bioinformatics*. Lest, A.M. 2002. Oxford University Press.
5. *A practical guide to the analysis of genes and proteins*. Baxevanic, A.D. and Ouellette, B.F.F. Bioinformatics: 2004. 3rd ed. O’Reilly publishers.
6. *Fundamental concepts of bioinformatics*. Krane, D.E. and Raymer, M.L. 2002. Benjamin cummings.
7. *Basic Biostatistics: Statistics for public Health Practice.* Gerstman, B.B. 2008. Jones and Bartlett Publishers, Inc. USA.
8. *Biostatistics: The Bare Essentials.* Geoffery, R. Norman, David L. Streiner. 2000.

B.C. Decke Inc.

1. *Experimental design and data analysis for biologists.* Gerry, P. Quinn, Michael J. Keough. 2002. Cambridge University Press.
2. *Statistics for Biologists*. Richard Colin Campbell, 1989. Cambridge University Press.
3. Bioinformatics, Genomics and Proteomics, getting the big picture. 2006. Ann Finney Batiza, Infobase publishing.

## Special Subject: TOXICOLOGY

#### ZOO-472 - PRINCIPLES AND KINETICS OF TOXICOLOGY

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGY

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student

5. Discussion/Tutorials/Documentaries: one hour per week

#### AIMS AND OBJECTIVES

The course provides knowledge and understanding about the nature and mode of action of different categories of toxicants. They will also learn about the procedural protocols used in toxicological studies. The will be enabled to understand the differential effects of variety of toxicants on different cellular sites.

#### COURSE CONTENTS THEORY

1. **Measuring toxicity and assessing risk**

Introduction; chemistry of toxicants; toxicity testing methods; routes of exposure; determining the responses to varying doses of substances; time of exposure; the LD50 experiments; toxicity, hazards and risks.

#### Toxicokinetics

Introduction; pharmacokinetics and toxicokinetics; absorption: the oral, respiratory and dermal route of exposure, distribution, elimination, toxicokinetic models: mathematical models of elimination; absorption and bioavailability; contrasting kinetics of lipophilic substances.

#### Biotransformation

Introduction; Primary biotransformation (phase I reaction) Hydrolysis, oxidation, reduction, Secondary metabolism (phase II reaction) Glucuridination, Glutathione conjugation, acetylation and other phase Ii reactions, factors influencing metabolism.

#### Cellular sites of action

Introduction, interaction of toxicants with proteins, effect of toxicants on enzymes, receptors and ion channels, voltage activated ion channels and transport proteins, Effects of toxicants on lipids and nucleic acids, Mechanism of cell death; apoptosis, necrosis, stress, repair and recovery.

#### ZOO-472P - PRINCIPLES AND KINETICS OF TOXICOLOGY (PRACTICAL)

1. Study of Biotoxicity assay for LC50.
2. Study the effects of different teratogenic chemicals on the development of human/rat embryo.
3. Study the effect of Ethanol on the development of chick embryo with different doses.
4. Study the effect of Xylene on the development of chick embryo.

#### BOOK RECOMMENDED

1. *Principles of Toxicology*. Karen E. Stine and Thomas M. Brown, CRC press, Taylor and Francis Group.
2. *Toxicology*. Hans Marquardt, Siegfried, G. Schafer, Roger Mcclellan, Frank welsch, 1999, 2004, Academic press, San Diego.
3. *Principles of toxicology testing*. Frank A. Barile, CRC Press Taylor and Francis Group.
4. *Comparison of teratogenic chemicals in the rat and chick embryos*. M. Lois Murphy, C. P Dagg and David A. Karnofsky, *Pediatrics*, 19:701-714.

#### ZOO-473 - BIOLOGICAL TOXICOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGY**

1. Lectures: 45-48
2. Practicals: 10
3. Assignments/ Presentations: 01 per student

5. Discussion/Tutorials/Documentaries: one hour per week

#### AIMS AND OBJECTIVES

The course provides knowledge and understanding about the different carcinogenic, mutagenic and teratogenic agents and their mode of action and the effects of different chemicals on living cell. They will also learn about the role and mode of action of different toxicants on different organ systems.

#### COURSE CONTENTS THEORY

1. **Reproductive toxicology and teratology**

Effects of toxicants on male and female reproductive system; protective mechanisms, interference with cell division, cytotoxicity and infertility, interference with hormonal control. Effects of toxicants on development; teratogens and teratogenesis, effects of dose exposure level and timing of exposure, examples and mechanism of teratogenity.

#### Respiratory Toxicology

General principles for the effects of toxicants on the system, defense mechanism, measuring the exposure levels, deposition of gases and particulates. Immediate response to respiratory toxicants; free radical induced damage, the irritant response, involvement of immune response. Immediate response; upper and lower airways. Delayed and cumulative response to toxicants; asthma and immune- related chronic condition, COPD; bronchitis and emphysema; fibrosis and pneumoconiosis, lung cancer.

#### Cardiovascular Toxicology

Effects of toxicants on heart; arrhythmias, cardiomyopathies and other effects, myocardial infarction. Effects of toxicants on the vascular system; Atherosclerosis, vascular spasm and blood pressure. Effects of toxicants on blood; anemias, hemolysis and related disorders and effects on hemoglobin.

#### Neurotoxicology

General principles of effects of toxicants**,** BBB. Effects on electrical conduction, synaptic function (acetylcholine, Biogenic amines, aminoacid neurotransmitters and neuroactive peptides), axonopathies ( axon transport, proximal and distal axonopathies), myelinopathies, direct effects on neurons; excitotoxicity, other neurotoxicants.

#### Hepatic Toxicology

Types of toxicant induced injury; fatty liver, necrosis and apoptosis, cirrhosis and miscellaneous effects. Response to liver injury.

#### Renal Toxicology

General principles of effects on the system; damage to glomerulus, proximal and remainder of the tubule. Measurement of kidney function *in vivo* and *in vitro.*

#### Immunotoxicology

Effects of toxicants on immune system; toxcic-induced allergies, autiimmunity and immunosuppression. AIDS and antiviral drugs.

#### ZOO-473P - BIOLOGICAL TOXICOLOGY (PRACTICAL)

1. Study of Biotoxicity assay for LC50.
2. Study the effects of different teratogenic chemicals on the development of human/rat embryo.
3. Study the effect of Ethanol on the development of chick embryo with different doses.
4. Study the effect of Xylene on the development of chick embryo.

#### BOOK RECOMMENDED

1. *Principles of Toxicology*. Karen E. Stine and Thomas M. Brown, CRC press, Taylor and Francis Group.
2. *Toxicology*. Hans Marquardt, Siegfried, G. Schafer, Roger Mcclellan, Frank welsch, 1999, 2004, Academic press, San Diego.
3. *Principles of toxicology testing*. Frank A. Barile, CRC Press Taylor and Francis Group.
4. *Comparison of teratogenic chemicals in the rat and chick embryos*. M. Lois Murphy, C. P Dagg and David A. Karnofsky, *Pediatrics*, 19:701-714.

## Special Subject: LIMNOLOGY

#### ZOO-474 - FRESHWATER BIOLOGY (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

* 1. Lectures 45-48
  2. Practicals 10-15
  3. Assignments/ Presentations one per student
  4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The aims and objectives of the course are to

Develop an understanding of the life and ecosystems of freshwater environments as well as the biology and ecology of organisms found in freshwater of ponds, lakes and rivers. Nature of lotic and lentic water species as well as diversification and knowledge of the history, perspective and complexity of aquatic world. Freshwater resources of Pakistan and recent trends of aquaculture in relation to diversified aquatic organisms. Sustainable management of inland resources by examining monitoring techniques and ecological responses of freshwater organisms in association with water quality deterioration.

#### COURSE CONTENTS

**THEORY**

#### Basic concepts of Limnology

An overview of Limnology: the science of inland waters: Scope, evolution and current situation.

#### Water as a Substance

The characteristics of water, Molecular structure and properties, Specific heat, Density relationships, viscosity-Density relationships.

#### Water economy

Hydrological cycle, Evaporation and Precipitation, Runoff flow processes, Global water balance, water balance in Lake Basin.

#### Freshwater habitats

Nature of lotic and lentic habitats, Origin and classification of lotic (Rivers, streams, springs and wetlands) and lentic (Lakes, reservoirs, lagoons, floodplains and ponds) waters and thermal stratification, Physical, chemical and biological characteristics of Lentic and Lotic ecosystems.

#### Structure and productivity of aquatic ecosystems

The drainage basin concept, Diverse Characteristics of stream and river ecosystems, Lacustrine zonation and terminology, Lake ecosystem concept, Population growth and regulation, Community structure and Interrelationships, Ecological niche, Competition, Ecosystem interrelationships, Trophic structure of food cycles and Food webs in aquatic ecosystems, top-down and bottom up control of aquatic food webs, Freshwater Plankton, Zooplankton, Piscivorous animals and their trophic interactions in an aquatic ecosystem, Detritus: Dead organic matter and detrital Dynamic structure, River Continuum Concept (RCC).

#### Monitoring and management of freshwater bodies

Water quality assessment and brief description of physico-chemical parameters (temperature, light, dissolved oxygen, pH, total dissolved solids, turbidity and electrical conductivity); interrelationships among physico-chemical parameters of freshwater bodies and aquatic organisms with example of ponds; biological, physiological and ecological monitoring in limnetic communities.

#### Freshwater resources of Pakistan

Overview of water resources and renewable internal freshwater resources in Pakistan, Conservation and sustainable management of inland water resources including aquatic insects, common freshwater aquatic weeds and their control.

#### Fresh waters, the World and the Future

Introduction, Population, food supply and water, Resource use and water, Technology and water, Trends in freshwater science; new genetic technologies, Ecotoxicology, Levels of approach, Advances in monitoring techniques, Solving the problems, Treaties, Consequences of evolution, Alternative states and human societies.

#### ZOO-474P - FRESHWATER BIOLOGY (PRACTICAL)

1. Aquatic sampling techniques.
2. Introduction and basic water quality variables.
3. Studies of laboratory and field sampling methods of limnology, sampling and identification of selected aquatic organisms and demonstration of physical and chemical sampling gears and techniques used in freshwater bodies.
4. Survey of lotic and lentic water bodies; the monitoring of a lake or standing water body.
5. Studies of common zoo and phytoplankton.
6. Analysis of 98 hysic-chemical parameters like temperature, DO, pH, electrical conductivity, turbidity, light penetration, total alkalinity, salinity, Total dissolved solids (TDS), hardness and chlorides and survey report.

#### BOOKS RECOMMENDED

1. *Lake and river ecosystem*. Wetzel, R.G. 2001. Limnology: 3rd ed. Academic Press, San Deigo. California, USA.
2. *Ecology of freshwaters; A View for the Twenty-first Century*. Moss, B. 2010. 4th ed. Blackwell Publishers, UK.
3. *Ecology of aquatic systems*. Dobson, M. and Frid, C. 2009. 2nd ed. Oxford University Press.
4. *Freshwater Ecology; Concepts and Environmental Applications*. Dodds, W. K. 2002. Academic Press, San Deigo. California, USA.
5. *The lakes: Hand book of limnology and lentic ecology*. Patrick O. Sullivan and Reywards, C.S. 2008. 3rd ed. Springer, USA.
6. *Rivers*. Holmes, N. and Raven, P. 2014. Osprey Publishing, British Wildlife Publishing Ltd, UK.

#### ZOO-475 - AQUATIC TOXICOLOGY (3+1 = 4 Credit Hours) TEACHING AND LEARNING STRATEGIES

* 1. Lectures 45-48
  2. Practicals 10-15
  3. Assignments/ Presentations one per student
  4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

Understand how aquatic organisms are exposed to toxic chemicals. Identify factors affecting aquatic toxicity. Understand modes of action of toxic chemicals, types of effects from the molecular to the ecosystem level, Understanding of detoxification processes. Identify the advantages and disadvantages of various toxicity testing methods. Understand the scientific basis and limitations of water quality standards.

#### COURSE CONTENTS THEORY

1. **Introduction to Aquatic Toxicology**

Major classes of toxicants (carcinogens, mutagens, and teratogens), Similarities and differences between the toxicity of metals and organic chemicals, Sources of toxic chemicals entering the aquatic environment and exposure pathways for aquatic organisms.

#### Modes of toxic action

General concepts in Toxicology; Biological, physical, and chemical factors affecting distribution, fate, bioavailability, bio concentration, Bioaccumulation, Biotransformation and bio magnification and metabolism, Toxicity exposure pathways for aquatic organisms: Modes of toxic chemical action; enzyme inhibition and endocrine disruption, Types of toxic effects: biochemical, molecular, physiological, behavioral, population, and community.

#### Effects of Toxic chemicals on aquatic ecosystems

Bio assessment, Acid precipitation, Biological effects of acidification; Influences of pH in relation to microbial activity, crustacean diversity and aluminium accumulations in aquatic ecosystems, Metals and other inorganic pollutants, Maximum allowable concentrations of toxic metals in natural waters and associated potential human health hazards, Organic pollutants, Suspended solids, Classification of suspended solids and their possible impact on freshwater systems, Thermal pollution.

#### Toxicity testing methods

Acute and chronic responses to toxicants, Application of animal models in predicting and assessing risk to human health, Development and use of water quality standards. Detoxification methods, Use of bio indicators and risk assessment in aquatic toxicological studies, Establishing Water Quality Criteria, Case studies of toxicity (River Ravi turning into a sludge due to untreated domestic sewage, liquid industrial effluents and and agricultural waste discharges; Massive contamination of the Clark Fork River by mining Waste; Ecoestrogens: Compounds that mimic natural hormone activities, Lake Erie is dying) and toxicological assessment.

#### ZOO-475P - AQUATIC TOXICOLOGY (PRACTICAL)

1. Analysis of physico-chemical parameters of freshwater bodies exposed to toxicants.
2. Studies on effects of metal toxicity on fish survival and growth.
3. Toxicity Identification and Evaluation, Sediment Toxicity Assessment, Acute and Chronic Toxicity Tests.
4. Examination and dissection of fish collected from contaminated river to observe the toxic effects of contaminants.
5. Histopathological studies of vital body organs of fish exposed to toxicants (metals and PCBs).

#### BOOKS RECOMMENDED

1. *Techniques in aquatic toxicology*. Ostrander, G. K. 2005. CRC Press, USA.
2. *Freshwater ecology: Concepts and environmental applications*. Dodds, W. K. 2002. Academic Press, San Deigo. California, USA.
3. *Fundamentals of aquatic toxicology: Effects, environmental fate and risk assessment.* Rand, G. M. 1995. October 5, 1995 by CRC Press. USA.
4. *Seafood and freshwater toxins: Pharmacology, physiology and detection*. Botana,

L.M. 2000. New York: Marcel Dekker, Inc.

1. *Aquatic toxicology: Molecular, biochemical, and cellular perspectives.* Donald, C., Malins, Ostrander, G. K. 1994. Lewis Publishers. New York, USA.

## COURSE OUTLINE FOR ZOOLOGY ALLIED COURSES FOR STUDENTS STUDYING CHEMISTRY, BOTANY AND BIOTECHNOLOGY AND MICROBIOLOGY AS MAJOR

**YEAR 3**

## SEMESTER-V

#### ZOO-101- ANIMAL DIVERSITY-I (3 + 1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

* 1. Lectures: 45 - 48
  2. Practicals: 10 – 15
  3. Assignment/ Presentations: One per student
  4. Class Test: Once per semester

#### COURSE CONTENTS THEORY

1. **Animal Classification, phylogeny and organization**

Animal systematics, Molecular approaches to animal systematics, Evolutionary relationships and tree diagrams, Patterns of organization.

#### Animal like Protists

Life within a single plasma membrane, Phylum sarcomastigophora, phylum labyrinthomorpha, phylum apicomplexa, phylum microspore, phylum acetospora, phylum myxozoa, phylum ciliophora.

#### Multicellular and tissue levels of organization

Origin of multicellularity, Phylum porifera, phylum coelenterate, phylum ctenophore.

#### Triploblastic, acoelomate body plan

Phylum Platyhelminthes (classification up to class level).

**Pseudocoelomate body plan:** phylum nematoda.

#### Annelida: The metameric body form

Metamerism and tagmatization, class polychaeta, class oligochaeta, class hirudinea.

#### Arthropods

Metamerism and tagmatization, the exoskeleton, metamorphosis, subphylum chelicerata, class arachnida (general charcteristics), Subphylum Crustacea, class malacostraca, class branchiopoda, class copepod, class cirripeda, class diplopoda, class chilopoda.

#### Class hexapoda

External structure and locomotion, nutrition and digestive system, gas exchange, circulation and temperature regulation, nervous and sensory functions, excretion, reproduction and development.

#### Molluscan success

Origin of coelom, molluscan characteristics, class gastropoda, class bivalvia, class cephalopoda, class polyplacophora, class scaphopoda, class monoplacophora, class caudofoveata, class aplacophora.

#### The Echinoderms

echinoderm characteristics, class asteroidea, class ophiuroidea, class echinoidea, class holothuroidea, class crinoidea.

#### ZOO-101P- ANIMAL DIVERSITY-I (PRACTICAL)

* 1. Study of representatives of animal like protest (prepared slides).
  2. Study of representatives of phylum Porifera.
  3. Study of representatives of phylum Coelenterata.
  4. Study of representatives of phylum Platyhelminthes.
  5. Study of representatives of phylum Nematoda.
  6. Study of representatives of phylum Annelida.
  7. Study of representatives of phylum Mollusca.
  8. Study of representatives of phylum Echinodermata.

## SEMESTER - VI

#### ZOO-102- ANIMAL DIVERSITY-II (3+1 = 4 Credit Hours)

**TEACHING AND LEARNING STRATEGIES**

1. Lectures: 45 - 48
2. Practicals: 10 – 15
3. Assignment/ Presentations: One per student
4. Class Test: Once per semester

#### COURSE CONTENTS THEORY

1. **Phylum hemichordata and chordata**

General characteristics.

#### Early vertebrates:Pisces

Superclass agnatha (classification up to class levels), super class gnathostomata (classification up to class levels), locomotion, nutrition and digestive system, circulation and gas exchange, swim bladder and lungs, buoyancy regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development.

#### Amphibians

Order caudata, order gymnophora, order anura, external structure and locomotion, support and movement, nutrition and digestive system, circulation, Salient features and maintenance function: gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, metamorphosis, Classification and ecological adaptation.

#### First terrestrial vertebrates

Order chelonia, order rhynchocephala, order squamata, order crocodilia, external structure and locomotion, support and movement, nutrition and digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development.

#### Birds

External structure and locomotion, skeleton, muscles, flight, nutrition and digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, nesting activities, migration and navigation.

#### Mammals

Classification up to subclass level, external structure and locomotion, skull and teeth, skeleton, nutrition and digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, reproductive cycles, modes of development.

#### ZOO-102P- ANIMAL DIVERSITY-II (PRACTICAL)

1. Study of representatives of fishes.
2. Study of representatives of amphibians.
3. Study of representatives of reptiles.
4. Study of representatives of birds.
5. Study of representatives of mammals.

#### BOOKS RECOMMENDED

1. *Zoology*. Miller, S.A. and Harley, J.B., 1999 & 2002. 4th & 5th ed. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C.P., Roberts, L.S. and Larson, A., 2001. 11th ed. (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2000. 4th ed. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates*. Kent, G.C. and Miller, S., 2001*.* New York: McGraw Hill.
5. *Biology* .Campbell, N.A., 2002. 6th ed. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.

## YEAR 4

**SEMESTER-VII**

#### ZOO-151- PRINCIPLES OF GENETICS AND EVOLUTION

**(3+1 = 4 Credit Hours)**

#### TEACHING AND LEARNING STRATEGIES

1. Lectures 45-48
2. Practicals 10-15
3. Assignments/ Presentations one per student
4. Discussions/ Tutorials one per week

#### AIMS AND OBJECTIVES

The course imparts knowledge and understanding of:

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

#### COURSE CONTENTS THEORY

1. **Cell Division**

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

#### Inheritance Patterns

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

#### Chromosomes and Gene Linkage

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

#### 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.

#### Animal Behaviour

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

#### 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.

#### 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. *Zoology.* Miller, S.A. and Harley, J.B., 1999, 2002 and 2005. 4th, 5th & 6th ed. (International). Singapore: McGraw Hill.
2. *Integrated Principles of Zoology*. Hickman, C. P., Roberts, L.S. and Larson, A., 2004. 11th and 12th ed. (International). Singapore: McGraw Hill.
3. *Biology of Invertebrates.* Pechenik, J.A., 2000., 4th and 5th ed. (International). Singapore: McGraw Hill.
4. *Comparative Anatomy of Vertebrates*.Kent, G.C. and Miller, S., 2001. New York. McGraw Hill.
5. *Biology*. Campbell, N.A., 2002. 6th ed. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.

#### ZOO-151P- PRINCIPLES OF GENETICS AND EVOLUTION (PRACTICAL)

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 of stages in the development of an Echinoderm.
9. Study of early stages in the development of a frog, chick and a mammal.

*(Note for 8-9: Prepared slides and preserved specimen and/or projection slides and or CD ROM computer projections may be used).*

1. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).
2. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

#### BOOKS RECOMMENDED

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