**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF POONCH RAWALAKOT**

**CURRICULUM**

**OF**

**BS ZOOLOGY**

****

**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF POONCH RAWALAKOT**

**AZAD KASHMIR**

**Website:** [**www.upr.edu.pk**](http://www.upr.edu.pk)

**UNIVERSITY OF POONCH RAWALAKOT**

**Aims and Objectives of teaching at BS Zoology**

1. To equip the students of Zoology with advanced knowledge about major disciplines of Zoology. This will enable the young students to understand principles of organization and interrelation in the biological systems which are important for better planning and management of animal resources, environment, health and medicine, agriculture and population in the country.
2. To teach different methods of explorations /investigations /extracting information, organization of data and its utilization.
3. To inculcate habit of keeping abreast with latest knowledge, developments and to develop scientific aptitude.
4. To prepare the young generation to move shoulder to shoulder with other scientists of the world and meet the challenges of recent science and technology in the country.
5. To equip the students with modern technical information for taking up teaching research/managerial positions in various national and international organizations.
6. To prepare and train students for advanced studies and specialization in recently emerging important fields of Zoology such as Microbiology, Fisheries, Genetic Engineering and Wildlife.

**Contents**

1. Introduction

2. Recommendations

3. Curriculum BS 4 years (8 semesters) program in Zoology

4. Curriculum M.Sc 2 years program in Zoology

5. Curriculum M.Phil 2 years program in Zoology

6. List of External Examiners

**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF POONCH RAWALAKOT**

**INTRODUCTION**

The Department of Zoology was established in March, 2013. At present, the department offers BS 4 years, M.Sc. 2 years and M .Phil 2 years programs with different courses ranging from Microbial Biology to advanced disciplines such as Biotechnology, Molecular Biology, and Human Molecular Genetics. The department offers specializations in the field of Fisheries and Aquaculture, Physiology, Endocrinology, Toxicology, Microbiology, Wildlife and Ecology at M.Sc level. The department is committed to ensure the quality teaching and research in the different areas of Zoology which meet all the educational standards of Higher Education Commission. It is the mission of the department to produce professionally skilled and academically sound Zoologists to be helpful to resolve the challenges related to the above mentioned fields of Zoology which are useful directly or indirectly to improve quality of the human life and economy of the country. The department is devoted to enhance student's professional skills and career opportunities. Different study tours and visits are regularly being arranged to expose the students and faculty to various national and international conferences/seminars on current issues relating to the different fields of Zoology. Faculty members also actively participate and present their research works in various national and international conferences/symposia regularly. 2

To ensure the quality of teaching and research, the qualified faculty has been inducted purely on merit basis. Furthermore, the department is fully cooperating with the Quality Enhancement Cell (QEC) of the University to incorporate their recommendations for improving the standard of teaching, quality of learning and achievement of its objectives. This document contains the agenda of the Board of Studies (BOS) meeting with annexed syllabi for BS,M.Sc. and M. Phil degree programs offered in the Department of Zoology. All syllabi fulfil the required standard of Higher Education Commission.

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed agenda and Minutes of 3rd Meeting of Board of Studies**

The final meeting of Board of Studies in the discipline of Zoology was held on October 04, 2022 at Faculty of Basic and Applied Sciences University of the Poonch Rawalakot. The purpose of the meeting was to finalize the curriculum of Zoology. The following members attended the meeting.

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Name/ Designation/Address** | **DBOS** |
| **1** | **Dr. Nausheen Irshad**Incharge/Assistant ProfessorDepartment of ZoologyUniversity of the Poonch, Rawalakot | **Convener**  |
| **2** | **Prof. Dr. Muhammad Rafique Khan**Meritorious ProfessorDepartment of ZoologyUniversity of the Poonch, Rawalakot | **Member**  |
| **3** | **Dr. Majid Mahmood**Assistant ProfessorDepartment of ZoologyUniversity of the Poonch, Rawalakot | **Member / Secretory**  |
| **4** | **Dr. Ali Muhammad**Assistant ProfessorDepartment of ZoologyUniversity of the Poonch, Rawalakot | **Member**  |
| **5** | **Prof. Dr. Mazhar Qayyum**ProfessorDepartment of ZoologyPMAS-Arid Agriculture University, Rawalpindi | **Member**  |
| **6** | **Prof. Dr. Muhammad Siddique Awan** Professor / MemberDepartment of ZoologyUniversity of Azad Jammu and Kashmir, Muzaffarabad | **Member**  |
| **7** | **Dr. Muhammad Tariq**Associate ProfessorDepartment of Wildlife ManagementPMAS-Arid Agriculture University, Rawalpindi | **Member**  |
| **8** | **Dr. Nuzhat Shafi**Assistant ProfessorDepartment of ZoologyUniversity of Azad Jammu and Kashmir, Muzaffarabad | **Member** |
| **9** | **Mr. Talha Afzal** Lecturer Zoology Govt. Boys Postgraduate College Rawalakot  | **Member** |
| **10** | **Dr. Irteza Husssain** Director/ Senior Scientist/ Member DNA to Protein Technologiest Satellite Twon Rawalpindi  | **Member** |
| **11** | **Dr. Qammar Din** Associate ProfessorDepartment of Mathematics University of Poonch Rawalakot  | **Member** |
| **12** | **Nominee of Registrar**   | **Observer**  |
| **13** | **Nominee of Contrller of Examination**  | **Observer**  |
| **14** | **Nomenee of Dirctor QEC**  | **Observer**  |

After thorough and detailed deliberations, the members of Board of studies unanimously approved the curriculum of Zoology for BS, M.Sc, and M.Phil and made the recommendations as Annexed.

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Nousheen Irshad**

Assistant Professor /Incharge

Department of Zoology

University of Poonch Rawalakot

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Prof. Dr. Muhammad Rafique Khan**

Prof. Emeritus, / Member

Department of Zoology

University of the Poonch Rawalakot

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Majid Mahmood**

Assistant Professor/Member Secretolry

Department of Zoology

University of the Poonch Rawalakot

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Ali Muhammad**

Assistant Professor/Member

Department of Zoology

University of the Poonch Rawalakot

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Prof. Dr. Mazhar Qayyum**

Professor / Member

Department of Zoology

PMAS Arid Agriculture University Rawalpindi

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Prof. Dr. Muhammad Siddique Awan**

Professor / Member

Department of Zoology

University of Azad Jammu and Kashmir, Muzaffarabad

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Tariq Mahmood**

Associate Professor/ Member

Department of Zoology / Wildlife

PMAS Arid Agriculture University Rawalpindi

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Nuzhat Shafi**

Assistant Professor

Department of Zoology

University of Azad Jammu and Kashmir, Muzaffarabad

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Mr. Talha Afzal**

Lecturer Zoology

Govt. Boys Postgraduate College Rawalakot

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Irteza Husssain**

Director/ Senior Scientist/ Member

DNA to Protein Technologiest

Satellite Twon Rawalpindi

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Dr. Qammar Din**

Associate Professor

Department of Mathematics

University of Poonch Rawalakot

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Nominee of Registrar**

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Nominee of Contrller of Examination**

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**UNIVERSITY OF POONCH RAWALAKOT**

**DEPARTMENT OF ZOOLOGY**

**Proposed Agenda 3rd Meeting of Board of Studies (BOS) 2022**

|  |  |
| --- | --- |
| **Proposed agenda** | **Recommendations** |
| Approval of the scheme of studies BS-4 year Program | Approved |
| Approval of the scheme of studies MSc-2 year Program w.e.f. October, 2022 and onwards | Approved |
| Approval of the scheme of studies M. Phil Program for session 2022-2024 and onwards | Approved as per HEC requirement |
| Approval of the scheme of studies Ph. D. Program from 2022 and onwards | Approved as per HEC requirement |

**Nomenee of Dirctor QEC**

**Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF POONCH RAWALAKOT**

**PROPOSED CURRICULUM**

**FOR**

**BS 4 YEARS PROGRAM**

**IN**

**ZOOLOGY**

****

**DEPARTMENT OF ZOOLOGY**

**THE UNIVERSITY OF POONCH RAWALAKOT**

**AZAD KASHMIR**

**Website:** [**www.upr.edu.pk**](http://www.upr.edu.pk)

**ANNEXURE-I**

**CURRICULUM FOR BS-4 YEARS PROGRAM IN ZOOLOGY**

**DEPARTMENT OF ZOOLOGY**

**UNIVERSITY OF POONCH RAWALAKOT**

**INTRODUCTION**

Zoology as a subject is multidisciplinary in nature, involving study of organisms and their genetic, morphological and physiological attributes, their surrounding environment, and their role in conservation of environment. Zoology is a combination of various disciplines such as Molecular Biology, Biochemistry, Genetics, Physiology, Ecology, Developmental Biology, Microbiology, Parasitology, Entomology, Freshwater Biology, Fisheries, and Wildlife etc. This subject has significant role in human resources development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.

**Eligibility Criteria:** F. Sc. Pre medical/ A level.

**Aims and Objectives of Teaching Zoology at Bs-4 Year**

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

**Scheme of Studies for BS-4 Years (8 Semesters) Program in Zoology w.e.f. Fall 2022 and Onward**

Duration 8-12 Semesters

Total credits Hours 136

**YEAR-I**

**SEMESTER-I (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Credits** | **Status**  |
| ENG-3101 | English-I  | 3(3-0) | Compulsory |
| COM-3102 | Introduction to Computer | 2(1-1) | Compulsory |
| MAT-3103 | Mathematics-I | 2(2-0) | Compulsory |
| BOT-3101 | Diversity of plants | 3(2-1) | General |
| CHM-3101 | Foundation Chemistry | 3(3-0) | General |
| ZOO-3101 | Principles of Animal Life-I | 3(2-1) | Foundation |
|  | **Total Credits** | **16** |  |

**SEMESTER-II (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Credits** | **Status**  |
| ENG-3201 | English-II | 3(3-0) | Compulsory |
| ISL-3202 | Islamic Studies/Ethics | 2(2-0) | Compulsory |
| STA-3203 | Introduction to Statistics | 2(2-0) | Compulsory |
| BOT-3201 | Plant Systematics, Anatomy and development | 3(2-1) | General |
| CHM-3201 | Inorganic Chemistry | 3(2-1) | General |
| ZOO-3202 | Principles of Animal Life-II | 3(2-1) | Foundation |
|  | **Total Credits** | **16** |  |

**Year-II**

**SEMESTER-III (Cr. 18)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course title** | **Credits** | **Status**  |
| ENG-4302 | Report writing | 3(3-0) | Compulsory |
| PKS-4301 | Pakistan Studies | 2(2-0) | Compulsory |
| BOT-4301 | Cell Biology, Genetics and Evolution | 3(2-1) | General |
| CHM-4301 | Physical Chemistry | 3(2-1) | General |
| ZOO-4303 | Animal Diversity-I (Inverteberates) | 3(2-1) | Foundation |
| ZOO-4304 | Animal Form and Function-I | 3(2-1) | Foundation |
|  | **Total Credits** | **17** |  |

**SEMESTER-IV (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status**  |
| ARB-4401 | Arabic | 3(3-0) | Compulsory |
| BOT- 4401  |  Plant Physiology and Ecology | 3(2-1) | General |
| CHM-4401 | Inorganic Chemistry | 3(2-1) | General |
| ZOO-4405 |  Animal Diversity-II (Verteberates) | 3(2-1) | Foundation |
| ZOO-4406 | Animal Form and Function-II | 3(2-1) | Foundation |
|  | **Total Credits** | **15** |  |

**YEAR-III**

**SEMESTER-V (Cr. 18)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status**  |
| ZOO-5501 | Cell and Molecular Biology | 4(3-1) | Compulsory |
| ZOO-5502 | Animal Physiology | 4 (3-1) | Compulsory |
| ZOO-5503 | Genetics | 4(3-1) | Compulsory |
| ZOO-5504 | Environmental Biology | 4(3-1) | Compulsory |
| ZOO-5505 | Zoogeography | 2(2-0) | Compulsory |
|  | **Total Credits** | **18** |  |

**SEMESTER VI (Cr. 18)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course title** | **Credits** | **Status** |
|  ZOO-5601 | Biochemistry | 4(3-0) | Compulsory |
|  ZOO-5602 | Developmental Biology  | 4(3-1) | Compulsory |
|  ZOO-5603 | Principles of Animal Taxonomy | 2(1-1) | Compulsory |
|  ZOO-5604 | Biostatistics | 2(2-0) | Compulsory |
|  ZOO-5605 | Paleontology and Evolution | 4(3-1) | Compulsory |
|  ZOO-5606 | Molecular Biology | 3 (2-1) | Compulsory |
|  | **Total Credits** | **18** |  |

**YEAR-IV**

**SEMESTER–VII (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status**  |
| ZOO-6701 | Research Methods and Reports | 2(2-0) | Compulsory |
| ZOO-6702 | Biological Techniques | 3(1-2) | Compulsory |
| ZOO-6710 | General Microbiology  | 3(2-1) | Compulsory |
|  | Elective-III | 3(2-1) | Elective |
|  | Elective-IV | 3(2-1) | Elective |
|  | Elective-V | 3(2-1) | Elective |
|  | **Total Credits** | **17** |  |

**YEAR-IV**

**SEMESTER-VIII (Cr. 15)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status** |
| ZOO- 6801 | Animal Behaviour | 3(2-1) | Compulsory |
| ZOO- 6806 | Economic Zoology | 3(2-1) | Compulsory |
|  | Elective-III | 3(2-1) | Elective |
|  | Elective-IV | 3(2-1) | Elective |
|  | Elective-V | 3(2-1) | Elective |
| ZOO-6822 | Comprehensive examination (Written + Oral) | \*Q/NQ | Compulsory |
| ZOO-6822 | Thesis | 6(0-6) | Elective |
| Note: students who will not opt for thesis, will have to opt 3 elective courses\* The student have to qualify both written and oral with atleast 50% marksQ=Qualified; NQ= Not qualified |
|  | **Total Credits** | **15** |  |

**16+ 16+17+15+18+18+17+15=137**

**LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY VII SEMESTER**

|  |  |  |
| --- | --- | --- |
| **Course code** | **Course Title** | **Credit Hrs.** |
| ZOO-6702 | Biological Techniques | 3(1-2) |
| ZOO-6703 | Immunology | 3(2-1) |
| ZOO-6704 | Biodiversity and Wildlife | 3(2-1) |
| ZOO-6705 | Basic Human Genetics | 3(2-1) |
| ZOO-6706 | Endocrinology  | 3(2-1) |
| ZOO-6707 | Fisheries and Aquaculture | 3(2-1) |
| ZOO-6708 | General Biotechnology | 3(2-1) |
| ZOO-6709 | General Entomology | 3(2-1) |
| ZOO-6710 | General Microbiology  | 3(2-1) |
| ZOO-6711 | General Parasitology | 3(2-1) |
| ZOO-6712 | General Toxicology | 3(2-1) |
| ZOO-6713 | Helminthology | 3(2-1) |
| ZOO-6714 | Hematology | 3(2-1) |
| ZOO-6715 | Histology | 3(2-1) |
| ZOO-6716 | Industrial and Microbial Biotechnology | 3(2-1) |
| ZOO-6717 | Invertebrata | 3(2-1) |
| ZOO-6718 | Limnology-A | 3(2-1) |
| ZOO-6719 | Neurophysiology | 3(2-1) |
| ZOO-6720 | Principles of Fish Biology | 3(2-1) |
| ZOO-6721 | Principles of Herpetology | 3(2-1) |
| ZOO-6722 | Principles of Parasitology | 3(2-1) |
| ZOO-6723 | Reproductive Physiology | 3(2-1) |

|  |  |  |
| --- | --- | --- |
| **Course Code** | **Course Title** | **Credit****Hrs.** |
| ZOO- 6801 | Animal Behaviour | 3(2-1) |
| ZOO- 6802 | Animal Pests and Disease Producing Organisms | 3(2-1) |
| ZOO- 6803 | Applied Microbiology | 3(2-1) |
| ZOO-6804 | Wildlife Parasitology | 3(2-1) |
| ZOO- 6805 | Bioremediation and Environmental Biotechnology | 3(2-1) |
| ZOO- 6806 | Economic Zoology | 3(2-1) |
| ZOO- 6807 | Clinical Endocrinology | 3(2-1) |
| ZOO- 6808 | Environmental Issues | 3(2-1) |
| ZOO- 6809 | Fish Biology | 3(2-1) |
| ZOO- 6810 | Human Genetics | 3(2-1) |
| ZOO- 6811 | Ichthyology (Fish Morphology) | 3(2-1) |
| ZOO- 6812 | Limnology-B | 3(2-1) |
| ZOO- 6813 | Mammalogy | 3(2-1) |
| ZOO- 6814 | Medical Microbiology | 3(2-1) |
| ZOO- 6815 | Medical Parasitology | 3(2-1) |
| ZOO- 6816 | Molecular Physiology | 3(2-1) |
| ZOO- 6817 | Physiological Systems andAdaptations | 3(2-1) |
| ZOO- 6818 | Ornithology | 3(2-1) |
| ZOO- 6819 | Vector Biology | 3(2-1) |
| ZOO- 6820 | Vertebrata | 3(2-1) |
| ZOO- 6821 | Wildlife | 3(2-1) |
|  |  |  |

### \* MOLECULAR BIOLOGY Added Course instead of (**Biochemistry II)**

**COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 1st SEMESTER**

**SEMESTER-I (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Credits** | **Status**  |
| ENG-3101 | English-I  | 3(3-0) | Compulsory |
| COM-3102 | Introduction to Computer | 2(1-1) | Compulsory |
| MAT-3103 | Mathematics-I | 2(2-0) | Compulsory |
| BOT- 3104 | Diversity of Vascular plants | 3(2-1) | General |
| CHM-3105 | Foundation Chemistry | 3(3-0) | General |
| ZOO-3106 | Principles of Animal Life-I | 4(3-1) | Foundation |
|  | **Total Credits** | **17** |  |

**Note:** The course contents of courses other than zoology will be adopted as prescribed by the relevant departments/University/HEC.

|  |  |  |
| --- | --- | --- |
| **BOT-3101** | **Diversity of Plants** | **4(3-1)** |

**Aims and Objectives**

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

**Course Contents**

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

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

h) Gymnosperms (Cycas, Pinus and Ephedra)

**Practical:**

1. Culturing, maintenance, preservation and staining of microorganisms.

2. Study of morphology and reproductive structures of the types mentioned in theory.

3. Identification of various types mentioned from prepared slides and fresh collections.

**Recommended Books:**

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

|  |  |  |
| --- | --- | --- |
| **ENG-3101** | **English I**  |  **3(3-0)** |

**Objectives**

Enhance language skills and develop critical thinking.

**Course Contents**

BasicsofGrammarindetail, Partsofspeechanduseofarticlesindetail, Sentencestructure, activeandpassivevoice, Practiceinunifiedsentence, Analysisofphrase, clauseandsentence structure, Transitive and intransitive verbs, Punctuation and spelling

**Comprehension**

Answers to questions on given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills:**

Urdu to English

**Paragraph writing**

 Topics to be chosen at the discretion of the teacher

**Presentation skills**

 **Introduction**

Note: Extensive readings required for vocabulary building

**Recommended books**

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492

2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506.

3. Writing.IntermediatebyMarie-ChristineBoutin,SuzanneBrinandandFrancoise Grellet.OxfordSupplementarySkills.FourthImpression1993.ISBN0194354057, Pages 20-27 and 35-41.

4. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992.ISBN 0 19 45340.

|  |  |  |
| --- | --- | --- |
| **COM-3102** | **Introduction Computer**  | **2(1-1** |

**Aims and Objectives**

The course is designed to aim at imparting a basic level appreciation program for students. After completing the course, the students must be able to the use the computer for basic purposes of preparing their personnel reports, presentation letters, viewing information on Internet (the web), sending mails, receiving mail, using internet etc.

**Course Outlines**

History,classification,basiccomponents,CPU,memory,peripheraldevices,storagemedia and devices, machine cycle, Computer Bus, Data Bus, Address Bus, Control Bus, programs and software, system software, applications oftware, operating systems, types of programming languages, compilation and interpretation, basic concept of computer networks, LAN, MAN, WAN, client /server network, peer to peer network, network topology and it types.

**Lab Outline**

Networking devices, Introduction to office tools (Microsoft word, excel and power point) ,Introduction to various operating systems, Use of internet, viewing information on internet, sending and receiving emails, searching topics on internet.

1. Brian Williams and Stacey Sawyer, Using Information Technology, Latest Edition, McGraw-Hill, ISBN: 0072260718.

2. Behrouz A. Frozen, Data Communication and Networking, Latest Edition, Alan R. Apt, ISBN:13 978-0-07-296775-3.

3. William Stallings, Computer Organization and Architecture: Designing for

Performance, Latest Edition, Prentice Hall, ISBN:0131856448

|  |  |  |
| --- | --- | --- |
| **MATH-3103** | **Mathematics I** | **2(2-0)** |

**Specific Objectives of the Course**

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

**Course Outline**

**Preliminaries:** Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. **Matrices:** Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer’s rule. **Quadratic Equations:** Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations. **Sequences and Series:** Arithmetic progression, geometric progression, harmonic progression. **Trigonometry:** Fundamentals oftrigonometry, trigonometric identities.

**Recommended Books**

1. Dolciani M. P, Wooton W, Beckenback E F, Sharron S, Algebra 2 and

Trigonometry, 1978, Houghton & Mifflin,

2. Boston (suggested text)

3. Kaufmann J. E, College Algebra and Trigonometry, 1987, PWS-Kent Company,

Boston

4. Swokowski E. W., Fundamentals of Algebra and Trigonometry (6th edition),

1986, PWS-Kent Company, Boston

|  |  |  |
| --- | --- | --- |
| **CHM-3101** | **Foundation Chemistry** | **3(3-0)** |

1. **Introduction to Inorganic Chemistry**

History and development of Inorganic chemistry

1. **The Periodic Law and Periodicity**

Modern Periodic Table; Classification of elements based on *s, p, d* and *f* orbital’s; group trends, and periodic properties in *s, p, d* and *f* block elements, i.e. atomic radii, ionic radii, ionization potential, electron affinities, electro negativities and red ox potential; anomalies in group trends and periodic properties, the uniqueness principle, the diagonal effect and the inert pair effect

**3. Introduction to Classes and Nomenclature of Organic Compounds**

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

**4.** **Chemical Bond**

Localized and delocalized chemical bonding; concept of hybridization leading to bond angles, bond lengths, bond energies and shapes of organic molecules.

**5**. **Introduction to Biochemistry**

Applications of Biochemistry, disciplines related to Biochemistry, biochemistry of the cell. Introduction to biomolecules, classification, composition and biological roles of nucleic acids, proteins, carbohydrates, lipids, vitamins and minerals

**6.** **Introduction to Physical Chemistry**

Introduction; physical states of matter.

**Recommended Books**

1. Mingos D. M. P. “Essential Trends in Inorganic Chemistry” Oxford University Press, First Indian Edition, 2004.

2. Madan R. D. “Satya Prakash’s Modern Inorganic Chemistry” S. Chand and Company Limited, 2011.

3. Rodgers G. E. “Introduction to Coordination, Solid State and Descriptive Inorganic Chemistry” McGraw-Hill, Inc.

|  |  |  |
| --- | --- | --- |
| **ZOO-3106** | **PRINCIPLES OF ANIMAL LIFE – I** | **4(3-1)** |

**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 andmolecular processes.

**3**. The structure and function of cell organelles and how common animalcell diversified in various tissues, organs and organ systems.

**4.** Biochemical mechanisms eventually generating energy for animalwork.

**5.** Animals and their relationship with their environment.

**Course Contents**

**1.** **Scope of Zoology:**

a) Introduction;

b) Significance and applications of zoology;

c) Animal diversity;

d) The scientific method;

e) Environment and world resources.

**2. Chemical Basis of Animal Life**:

Brief introduction to bio molecules;

1. Carbohydrates, b) lipids, proteins, c) nucleic acids.

**3. Cellular Organization:**

a) Structure of animal cells,

b) cell membrane,

c) cytoplasm and its organelles:

ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria,

cytoskeleton, cilia and flagella, centrioles and microtubules, vacuoles; ribosomes, endoplasmic reticulum, the nucleus: nuclear envelope,chromosomes and nucleolus.

4. **Animal tissues:**

a) Types: epithelial, connective, muscle and nervous tissue;

b) organs and organ systems**.**

**5. Enzymes**:

a) Structure, b) types; c) function and factors affecting their activity; d) cofactors and coenzymes.

**6. Energy Harvesting**:

a) Aerobic and anaerobic respiration: glycol sis, citric acid Cycle and electron transport chain; fermentation, the major source of ATP.

**7. Reproduction and Development:**

a) Types; asexual and sexual,

b) game to genesis, fertilization, metamorphosis, zygote and early development.

**8. Ecological Concepts:**

a) Individuals and Populations: Animals and their abioticenvironment; populations and limiting factors;

b) Communities and Ecosystems:Community structure and diversity; interspecific interactions. Ecosystem,types, homeostasis, biomes, food chain, food web, energy flow andthermodynamics; biogeochemical cycles;

c) Ecological problems; humanpopulation growth, pollution, resource depletion and biodiversity.

**Practicals**

1. Tests for different carbohydrates, proteins and lipids.

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

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

Note: Prepared microscopic and/or projection slides and/or CD ROMcomputer projections must be used.

3. Preparation of blood smears.

4. Plasmolysis and deplasmolysis in blood.

5. Protein digestion by pepsin.

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

7. Field observation and report writing on animals in their ecosystem (a

terrestrial and an aquatic ecosystem study).

**Recommended Books**

1. Hickman, C.P., Roberts, L.S., Keen L.S., Larson, A., I’Anson, H. and Eisenhour, D.J., Integrated Principles of Zoology, 14th Edition (International), 2004. Singapore: McGraw Hill.

2. Miller, S.A. and Harley, J.B. Zoology, 10th Edition (International), 2016. Singapore: McGraw Hill.

3. Campbell, N.A. Biology, 6 th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

4. Miller, S.A. General Zoology Laboratory Manual. 7th Edition(International), 2013. New York: McGraw Hill.

5. Hickman, C.P. and Kats, H.L., Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.

6. Molles, M.C. Ecology: Concepts and Applications. 9th Edition. 2022. McGraw Hill, New York, USA.

7. Odum, E. P. Fundamentals of Ecology. 3 rd Edition. 1994. W.B.Saunders. Philadelphia.

**COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 2ND SEMESTER**

**SEMESTER-II (Cr. 18)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course Title** | **Credits** | **Status**  |
| ENG-3201 | English-II | 3(3-0) | Compulsory |
| ISL-3202 | Islamic Studies / Ethics | 2(2-0) | Compulsory |
| STA-3203 | Statistics | 3(2-1) | Compulsory |
| BOT- 3204 | Botany-II | 3(2-1) | General |
| CHM-3205 | Organic Chemistry | 3(2-1) | General |
| ZOO-3206 | Principles of Animal Life-II | 4(3-1) | Foundation |
|  | **Total Credits** | **18** |  |

**Note:** The course contents of courses other than zoology will be adopted as prescribed by the relevant departments/University/HEC.

|  |  |  |
| --- | --- | --- |
| **BOT-3201** | **Plant Systematic, Anatomy and development**  | **4(3-1)** |

**Aims and Objectives**

To understand:

1. Various systems of classification, identification and nomenclature of higher plants.

2. Structures and functions of tissues and organs at embryonic level.

**Course Contents:**

 **Plant systematic**

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

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

**Anatomy**

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

**Development / Embryology**

Early development of plant body: Capsella bursa-pastoris, Structure and development of Anther Micro supergenes is Microgametophyte, Structure of Ovule Mega supergenes is Mega gametophyte, Endosperm formation, Parthenocarpy, Polyembryony

**Practical Anatomy**

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

**Taxonomy**

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

**Recommended Books:**

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

|  |  |  |
| --- | --- | --- |
| **ENG-3201** |  **English II** | **3(3-0)** |

**Objectives:**

Enable the students to meet their real life communication needs.

**Course Contents**

**Paragraph writing:**

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

**Essay writing:**

Introduction,

**CV and job application**:

Translation skills, Urdu to English,

**Study skills:**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension,

**Academic skills:**

Letter/memo writing, minutes of meetings, use of library and internet,

**Presentation skills**:

Personality development (emphasis on content, style and pronunciation)

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

**Communication Skills**

1. **Grammar**
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. 3rd Edition. Oxford University Press 1986. ISBN 0 19 431350 6.
3. **Writing**
4. Writing. Intermediate by Marie-ChrisitineBoutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
5. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
6. **Reading**
7. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 4534030.
8. Reading and Study Skills by John Langan
9. Study Skills by Riachard York.

|  |  |  |
| --- | --- | --- |
| **ISL-3202** |  **Islamic Studies / Ethics** | **2(2-0)** |

**Objectives**

This course is aimed at:

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

**Course contents**

Basic Concepts of Quran, History of Quran, Uloom-ul –Quran, Verses of Surah Al-Baqra Related to Faith(Verse No-284-286), Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77), Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154),Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56, 57,58.), Verses of Surah Al-Hashar (18,19,20),Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14), Life of Muhammad Bin Abdullah ( Before Prophet Hood), Life of Holy Prophet (S.A.W) in Makkah, Important Lessons Derived from the life of Holy Prophet in Makkah,Life of Holy Prophet (S.A.W) in Madina, Important Events of Life Holy Prophet in Madina, Important Lessons Derived from the life of Holy Prophet in Madina ,Basic Concepts of Hadith, History of Hadith, Kinds of Hadith, Uloom-ul-Hadith, Sunnah & Hadith, Legal Position of Sunnah, Basic Concepts of Islamic Law & Jurisprudence, History &Importance of Islamic Law & Jurisprudence, Sources of Islamic Law & Jurisprudence, Nature of Differences in Islamic Law, Islam and Sectarianism, Basic Concepts of Islamic Culture & Civilization, Historical Development of Islamic Culture & Civilization, Characteristics of Islamic Culture & Civilization, Islamic Culture & Civilization and Contemporary Issues, Basic Concepts of Islam & Science, Contributions of Muslims in the Development of Science, Quranic & Science, Basic Concepts of Islamic Economic System, Means of Distribution of wealth in Islamic Economics, Islamic Concept of Riba, Islamic Ways of Trade & Commerce, Basic Concepts of Islamic Political System, Islamic Concept of Sovereignty, Basic Institutions of Govt. in Islam, Period of Khlaft-E-Rashida, Period of Ummayyads, Period of Abbasids, Basic Concepts of Social System of Islam, Elements of Family, Ethical Values of Islam.

**Reference Books:**

1. Hameed ullah Muhammad, “Emergence of Islam” , IRI, Islamabad
2. Hameed ullah Muhammad, “Muslim Conduct of State”
3. Hameed ullah Muhammad, ‘Introduction to Islam

1) Mulana Muhammad YousafIslahi,”

1. Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.
2. Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
3. Mir Waliullah, “Muslim Jurisprudence and the Quranic Law of Crimes” Islamic Book Service (1982)
4. H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989)
5. Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001).

|  |  |  |
| --- | --- | --- |
| **CHM-3201** |  **Organic Chemistry** | **3(2-1)** |

**Properties of Organic Molecules**

Dipole moment; inductive and field effects; resonance; aromaticity; tautomerism; hyperconjugation; hydrogen bonding; acids and bases; factors affecting the strengths of acids and bases.

**Hydrocarbons**

Discussion on the preparation, properties and reactions of alkanes, alkenes, alkynes and aromatics.

**Oxygenated Hydrocarbons**

Discussion on the preparation, properties and reactions of alcohols (phenols), ethers, aldehydes, ketones, carboxylic acids and derivatives.

**Introductory Organic Spectroscopy**

Introduction to IR, UV, 1H-NMR and Mass spectrometric methods, and their usage for structure elucidation of some simple organic compounds.

**Practicals:**

Laboratory work illustrating topics covered in the lecture of CHM-3212

|  |  |  |
| --- | --- | --- |
| **ZOO-3206** |  **PRINCIPLES OF ANIMAL LIFE-II** | **4(3-1)** |

**Aims and Objectives**

The course will impart knowledge and understanding of:

**1**. Cell division and its significance in cell cycle.

**2**. Concepts and mechanisms of inheritance pattern, chromosome andgene linkage and molecular basics of genetics.

**3.** Animal behaviour and communication.

**4**. Theories of evolution, gene flow and mechanism of evolution withreference to animals and diversity.

**Course Contents**

1. **Cell Division**:

a) Cell cycles:

b) Mitosis and meiosis;

c)control of the cell cycle.

1. **Inheritance Patterns**:

a) Mendelian genetics;

b) inheritance patterns;

c) gene, structure, chemical composition and types.

1. **Chromosomes and GeneLinkage**:

a) Eukaryotic chromosomes; linkage and crossing over;

b) chromosomalaberrations.

1. **Molecular Genetics**:

a) Cellular Control: DNA: the genetic material;

b) DNA replication in prokaryotes and eukaryotes;

c) control of gene expression in eukaryotes;

d) gene mutation;

e) recombinant DNA and applications of genetic technologies.

1. **Animal Behaviour**:

a) Behaviour and its types, proximate and ultimate causes;

b) anthropomorphism;

c) development of behavior; learning; factors controlling animal behavior;

d) communication;

e) behavioral ecology;

f) social behavior.

1. **Evolution**:

a) AHistorical Perspective:

b) Theories of evolution: Lamarckism and natural selection, neo larmarckism, Darwinism, and neo Darwinian.

1. **Evolution and Gene Frequencies**:

a) Hardy-Weinberg principle;

b) evolutionary mechanisms: population size, genetic drift, gene flow,

c) de Vries mutation theory and rates of evolution,

d) polymorphism; species and speciation;

e) molecular evolution;

f) mosaic evolution.

**Recommended Books**

1. Hickman, C.P., Roberts, L.S., Keen L.S., Larson, A., I’Anson, H. and Eisenhour, D.J., Integrated Principles of Zoology, 14th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 10th Edition (International), 2016. Singapore: McGraw Hill.
3. 3. Pechenik, J.A. Biology Of Invertebrates, 7th Edition (International),2015. Singapore: McGraw Hill.

4. Kent, G.C. and Miller, S. Comparative Anatomy Of Vertebrates. 2000.New York: McGraw Hill.

5. Campbell, N.A. Biology, 6 th Edition. Menlo Park, California: 2002.Benjamin/Cummings Publishing Company, Inc.

**Practicals**

1. Study of mitosis in onion root tip.
2. Study of meiosis in grasshopper testis (students should prepare theslide).
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 bloodcell.
8. Study to demonstrate nervous or endocrine basis of behaviour(conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behaviour (documentary film be shown,honey bee, monkey group in a zoo).

Note for1-2: Prepared microscopic and/or projection slides and/or CDROM computer projections must be used).

**Recommended Books**

1. Miller, S.A. General Zoology Laboratory Manual. 7th Edition (International), 2013. New York: McGraw Hill.
2. Hickman, C.P. and Kats, H.L. Laboratory Studies In IntegratedPrinciples Of Zoology. 2000. Singapore: McGraw Hill.

|  |  |  |
| --- | --- | --- |
| **STA-3203** |  **Introduction to Statistics** | **2 (1-1)** |

**What is Statistics?**

Definition of Statistics, Population, Observations, Data, Discrete and continuous variables, Errors of measurement, Significant digits, Rounding of a Number, Collection of primary and secondary data, Sources, Editing of Data.

**Presentation of Data**

Introduction, basic principles of classification and Tabulation, Graphs and their Construction, Bar charts, Pie chart, Histogram, Frequency polygon and Frequency curve, Cumulative Frequency Polygon or Ogive, Historigram, Ogive for Discrete Variable. Types of frequency curves.

**Measures of Central Tendency**

Introduction, Different types of Averages, Quantiles, The Mode, Empirical Relation between Mean, Median and mode, Relative Merits and Demerits of various Averages. properties of Good Average, Box and Whisker Plot, Stem and Leaf Display, definition of outliers and their detection. Exercises.

**Sampling and Sampling Distributions**

Introduction, sample design and sampling frame, bias, sampling and non sampling errors, sampling with and without replacement, probability and non-probability sampling, Sampling distributions for single mean and proportion, Difference of means and proportions.

**Hypothesis Testing**

Introduction, Statistical problem, null and alternative hypothesis, Type-I and Type-II errors, level of significance, Test statistics, general procedure for testing of hypothesis.

**Recommended Books:**

1. Walpole, R. E. 1982. “Introduction to Statistics”, 3rd Ed., Macmillan Publishing Co., Inc. New York.
2. Muhammad, F. 2005. “Statistical Methods and Data Analysis”, KitabMarkaz, Bhawana Bazar Faisalabad.

**COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 3RD SEMESTER**

**Year-II**

**SEMESTER-III (Cr. 18)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course title** | **Credits** | **Status**  |
| ENG-4301 | English-III (Report writing) | 3(3-0) | Compulsory |
| PKS-4302 | Pakistan Studies | 2(2-0) | Compulsory |
| BOT-4303 | Botany-III | 3(2-1) | General |
| CHM-4304 | Analytical Chemistry | 3(3-1) | General |
| ZOO-4305 | Animal Diversity-I | 3(2-1) | Foundation |
| ZOO-4306 | Animal Form and Function-I | 4(3-1) | Foundation |
|  | **Total Credits** | **18** |  |

**Note:** The course contents of courses other than zoology will be adopted as prescribed by the relevent departments/University/HEC.

|  |  |  |
| --- | --- | --- |
| **BOT-4301** |  **Cell Biology, Genetics and Evolution** | **4(3-1)** |

**Aims and Objectives**

To understand

1. Structure and functions of cell.

2. Nature of genetic material and hereditary process.

3. Familiarization with evolutionary processes.

**Course Contents**

**a) Cell biology**

1. Structures and Functions of Bio-molecules

Carbohydrates, Lipids, Proteins, Nucleic Acids

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

3. Ultra structure of plant cell with a brief description and functions of the following organelles

Cell wall, Endoplasmic reticulum, Plastids, Mitochondria, Ribosome’s, Dictyosomes, Vacuole, Micro bodies ( Glyoxysomes and Paroxysms)

1. Nucleus: Nuclear membrane, nucleolus, ultra structure and morphology of chromosomes, cerotype analysis
2. Reproduction in somatic and embryogenic cell, mitosis and meiosis, cell cycle
3. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

**b) Genetics**

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

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

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

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

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

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

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

8**.** Introduction to germplasm conservation

**c) Evolution**

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

**Practical**

Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs

1. Measurement of cell size.
2. Study of mitosis and meiosis by smear/squash method and from prepared slides.
3. Study of chromosome morphology and variation in chromosome number.
4. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources

**Genetics**

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

**Recommended Books:**

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

|  |  |  |
| --- | --- | --- |
| **PKS-4301** |  **Pakistan Studies** | **2(2-0)** |

**Introduction/Objectives:**

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

**Course Outlines:**

1. **Historical Perspective**

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam M. Ali Jinnah. Factors leading to Muslim separatism. PEOPLE AND LAND: Indus Civilization, Muslim advent, Location and geo-physical features. GOVERNMENT AND POLITICS IN PAKISTAN: Political and constitutional phases, 1947-58, 1958-71, 1971-77, 1977-88, 1988-99 and 1999 onward, CONTEMPORARY PAKISTAN: Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan

**Books Recommended:**

1. Burki, ShahidJaved. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan’s Economy. Karachi: Oxford University Press, 2000.

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

|  |  |  |
| --- | --- | --- |
| **ENG-4302** |  **Report writing** | **3(3-0)** |

**Objectives:**

Enhance language skills and develop critical thinking

COURSE CONTENTS: PRESENTATION SKILLS: ESSAY WRITING: Descriptive, narrative, discursive, argumentative, ACADEMIC WRITING: How to write a proposal for research paper/term paper. How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency), TECHNICAL REPORT WRITING: PROGRESS REPORT WRITING. Extensive reading is required for vocabulary building.

**Recommended Books:**

Technical Writing and Presentation Skills

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

|  |  |  |
| --- | --- | --- |
| **CHM-4301** | **Physical Chemistry**  | **3(2-1)** |

**Quantum theory and structure of atom**

Bohr’s atomic model, defects of Bohr’s atomic model, classical mechanics, failure of classical mechanics, quantum mechanics, dual nature of matter, de-Broglie’s equation, Heisenberg’s uncertainty principle, limitation of Heisenberg’s uncertainty principle, concept of atomic orbitals, quantum numbers, Pauli exclusion principle, electronic distribution of elements.

**Physical states of matter**

**1. Gases**

General characteristics of gases, Gay Lussac’s law, ideal gas equation, kinetic molecular theory of gases, molecular velocities (average velocity, mean square velocity, root mean square velocity, most probable velocity), ideal and real gases, deviation of gas from ideality, derivation of kinetic gas equation, molecular collisions, collision diameter, critical phenomenon of gases, liquefaction of gases, mean free path, Vander Waal’s equation for real gases.

**2. Liquid**

General characteristics of liquids, physical properties like surface tension, viscosity, parachor value, rheochor value and their applications, refractive index, specific and molar refraction and their applications, optical activity, specific rotation, dipole moment and molecular structure.

**3. Solids**

General characteristics of solids, types of solids, isotropy and anisotropy, habit of a crystal, crystal lattice and unit cell, crystal systems and Bravis lattices.

**Chemical Thermodynamics**

Introduction, thermodynamic terms like system, surrounding, boundary of system, states and state function, internal energy, extensive and intensive properties, first law of thermodynamics, enthalpy of a system, relationship between free energy change and enthalpy change, heat capacity of gases at constant volume and at constant pressure, , heat capacities relationship, 2nd law of thermodynamics, change in free energy and equilibrium constant.

**Chemical Kinetics**

Introduction, concept of rate of chemical reaction, rate law, velocity constant, elementary and complex reaction, order and molecularity of reaction, zero, fist and second order reactions, derivation of kinetic equation for first order and 2nd order reaction when initial concentration of both reactants is same, various methods for determining the rate of chemical reaction, Arrhenius equation, Lindemmann’ s theory for unimolecular reaction, introduction to transition state theory, transition state theory for bimolecular reaction.

**Basic Electrochemistry**

Introduction, conductors and insulators, electrolytic and electronic conduction, specific conductance, measurement of specific conductance, cell constant and its determination, Ostwald’s dilution law (dependence of degree of dissociation constant on dilution), electrochemical cells, types of cells, EMF and its measurement.

**Solutions**

Introduction, types of solution, concentration units, ideal and non-ideal solutions, Raoult’s law, molecular interactions in solution, colligative properties (lowering of vapour pressure, elevation of 11 boiling point, depression of freezing point, osmotic pressure and their determination),concept of zeotropic and azeotropic mixture.

**Surface Chemistry**

Absoption and adsorption, types of adsorption, characteristics and factors which affect adsorption, applications of adsorption, catalysis, types of catalysis, enzyme catalysis, characteristics of catalysis.

**Practicals:**

• Determination of viscosity and parachor values of liquids.

• Determination of percent composition of liquid solutions viscometrically.

• Determination of refractive index and molar refractivity.

• Determination of percent composition of liquid solutions by refractive index measurements.

• Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).

• Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).

• Determination of heat of solution by solubility method.

• Determination of heat of neutralization of an acid with a base.

|  |  |  |
| --- | --- | --- |
| **ZOO-4305** | **ANIMAL DIVERSITY-I (INVERTEBRATES)** | **3(2-1)** |

###

**Course Objectives**:

1. To provide the knowledge of evolutionary/ phylogenetic relationship (from simple to the complex organisms).
2. To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.
3. To provide understanding of body organization, Feeding and Digestive system; Other Organ System;
4. To provide the description of mode of Reproduction and Development
5. To provide the information of their economic and ecological importance

**Course Learning Outcomes**:

This course will be based on following outcomes:

1. Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
2. Understand invertebrate organismal concepts in laboratory and field.
3. Demonstrate major evolutionary innovations for invertebrates with functional importance.
4. Understand how reproduction and development occured and able to breed animal in the laboratory/feild
5. Analyze economic and ecological importance of invertebrates.

**Course Contents:**

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

**INTRODUCTION**

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

**ANIMAL-LIKE PROTISTS: THE PROTOZOA**

* 1. Evolutionary perspective; Life within a single plasma Membrane;
	2. Symbiotic Life-styles.
	3. Protozoon Taxonomy; (up to Phyla, subphyla and super Classes, wherever applicable).
	4. Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure;
	5. Nutrition; Genetic Control and Reproduction; Symbiotic ciliates;
	6. Further Phylogenetic Consideration.

**MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION**

* 1. Evolutionary Prespective:
	2. Origins of Multicellularity; Animal Origins.

**Phylum Porifera**

* + 1. Characteristics and classification. Cell Types, Body Wall, and

Skeletons;

* + 1. Water Current and Body Forms;
		2. Maintenance Functions, Reproduction.

**Phylum Cnidaria (Coelenterate)**

* + 1. Characteristics and classification. The body Wall and Nematocysts:

Alteration of Generations;

* + 1. Maintenance Functions; Reproduction and
		2. Classification up to Class.

**Phylum Ctenophore;**

a. Characteristics, body organization

**THE TRIPLOBLASTIC AND WITH ACOELOMATE BODY PLAN PHYLUM PLATYHELMINTHES**

* + 1. Evolutionary Perspective; Classification up to class;
		2. The Free-Living Flatworms and the Tapeworms, adaptive modification for parasitic life style

**Phylum Numerate;** Characteristics, body organization

**Phylum Gastrotrich**; Characteristics, body organization

1. **PSEUDOCOELOMATE BODY PLAN**

**PHYLUM ASCHELMINTHS**

* + 1. Evolutionary perspective; General Characteristics; Classification up to order with External Features;
		2. Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum**Rotifera,** Phylum **Nematoda** and Phylum **Kinorhyncha**.
		3. Some Important Nematode Parasites of Humans;
1. **PHYLUM MOLLUSCA**
	* 1. Evolutionary perspective; Relationship to other animals; Origin of the

Coelom;

* + 1. Molluscan Characteristics, Classification up to class. The

Characteristics of Shell and Associated Structures,

* + 1. Feeding, Digestion, Gas Exchange, Locomotion,
		2. Reproduction and Development, Other maintenance Functions and Diversity in Gastropods, Bivalves and Cephalopods:
1. **PHYLUM ANNELIDA**
	* 1. The Metameric Body Form; Evolutionary perspective; Relationship to other animals,
		2. Metamerism and Tag-matization, Classification up to Class. External

Structure and Locomotion,

* + 1. Feeding and the Digestive system, Gas Exchange and Circulation,
		2. Nervous and Sensory Functions, Excretion,
		3. Regeneration, Reproduction and Development, in Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration.
1. **PHYLUM ARTHROPODA:**
	* 1. Evolutionary Perspective: Classification and Relationship to other

Animals;

* + 1. Metamerism and Tagmatization;
		2. The Exoskeleton; Metamorphosis;
		3. Classification up to Class; Further Phylogenetic Consideration.

**The Hexapods and Myriapods:**

* + 1. Evolutionary Perspective: Classification up to class. External

Structure and Locomotion,

* + 1. Nutrition and the Digestive system, Gas Exchange, Circulation and

Temperature Regulation,

* + 1. Nervous and Sensory Functions, Excretion, Chemical Regulation,
		2. Reproduction and Development in Hexapoda,
		3. Insects Behavior, Insect and Human;

10. **PHYLUMECHINODERMS**

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

**SOME LESSER-KNOWN INVERTEBRATES**;

a. The Lophophorates, Entoprocts, Cycliophores, and Cheatognaths.

**Practical:**

**Note:** Classification of each members of each phylum upto order with adaptions in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.

1. Study of Euglena, Amoeba, Endameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of prepared slides of sponges, spicules of songes, and their various body forms. Study of representatives of classes of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of phylum Echinodermta.
10. Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.
11. Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.
12. How to make grade-wise series for preparation of temporary and permanent slides.

**Teaching Methodology:**

* + Lecturing
	+ Written Assignments
	+ Guest Speaker
	+ Research project
	+ Presentation

**Assignments & Presentation (10%)**

**Recommended Principal Reference Book:**

1. Miller, A.S. and Harley, J.B. ; 1999 , 2002., 2007, 2009, 2012 & 2016 Zoology, 4th , 5th, 6th, 7th, 8th , 9th& 10th Edition (International), Singapore : McGraw Hill.

**Additional Readings:**

1. Schierwater, B., &DeSalle, R. (2021). Invertebrate zoology: a tree of life approach. CRC Press.
2. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
3. Mandal, F. B. (2017). Biology of Non-chordates. PHI Learning Pvt. Ltd..
4. Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition,

(International), Singapore: McGraw-Hill.

1. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2007. INTEGRATED PRINCIPLES OF ZOOLOGy, 12th& 13th Edition (International). Singapore: McGraw-Hill.
2. Sandhu, G. S. (2005). Textbook of invertebrate zoology (Vol. 1). Campus Books International.
3. Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin Cummings Publishing Company, Inc.
4. Kent, G. C. and Miller, S., 2001. COMPARATIVE ANATOMY OF VERTEBRATES New York: McGraw-Hill.

**BOOKS FOR PRACTICAL**

1. Verma, P. S. (2010). A Manual of Practical Zoology: Invertebrates. S. Chand Publishing.
2. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th

Edition (International), Singapore : McGraw-Hill.

Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore : McGraw-Hill.

|  |  |  |
| --- | --- | --- |
| **ZOO- 4306** | **ANIMAL FORMAND FUNCTION- I (A COMPARATIVE PERSPECTIVE)** | **4(3-1)** |

**Course Objectives:**

**The Objectives of the courses are:**

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

**Course Learning Outcomes:**

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

**Course Outline:**

1. **Protection, Support, and Movement:**
	1. Protection: the integumentary system of invertebrates and vertebrates;
	2. Movement and support: the skeletal system of invertebrates and vertebrates;
	3. Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates
2. **Communication I:**
	1. Nerves: Neurons: structure and function.
3. **Communication II:**
	1. Senses: Sensory reception: bar receptors, chemoreceptor, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates
	2. Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.
4. **Communication III:**
	1. The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action
	2. Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals
5. **Circulation and Immunity**:
	1. Internal transport and circulatory systems in invertebrates
	2. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells
	3. 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

**Practical:**

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales,feathers and mammalian skin.
2. Study and notes of skeleton of Labeo (*Labeo rohita)*, Frog (*Hoplobatrachus tigerinus*), Varanus (*Varanus bengalensis)*, fowl*(Gallus gallus domesticus)* andrabbit (*Oryctolagus cuniculus)*.
3. Earthworm or leech; cockroach, freshwater mussel, Channa or Catlacatla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.
4. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

5. Study of models or preserved brains of representative animals and notes on adaptations.

6. Study of nervous system of earthworm and a fish.

7. Study of endocrine system in an insect and a rabbit.

8. Study of different types of blood cells in blood smear of rabbit.

9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

**Books Recommended:**

1. Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International),Singapore: McGraw-Hill.
2. E. S Russell, 2010. Form and Function: A contribution to the history of Animal Morphology (Classic reprint)
3. Hickman, C.P., Roberts, L.S., Larson, A. 2014. Integrated Principlesof Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
4. Miller, S.A. and Harley, J.B. 2002. Zoology, 5thEd. (International),Singapore: McGraw-Hill.
5. Campbell, N.A. 2002. Biology, 6thEd. Menlo Park, California:Benjamin/Cummings Publishing
6. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. NewYork: McGraw-Hill.
7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill.
8. Prof. Dr. M. Khalid Baloch. T.book of Zoology, Animal form & function ( A comparative prespective)

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

**COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 4TH SEMESTER**

**SEMESTER-IV (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status**  |
| ARB-4401 | Arabic | 3(3-0) | Compulsory |
| BOT- 4402 | Botany-IV | 3(2-1) | General |
| CHM-4403 | Inorganic Chemistry | 3(2-1) | General |
| ZOO-4404 | Animal Diversity-II | 4(3-1) | Foundation |
| ZOO-4405 | Animal Form and Function-II | 4(3-1) | Foundation |
|  |  |  |  |
|  | **Total Credits** | **17** |  |

**Note:** The course contents of courses other than zoology will be adopted as prescribed by the relevent departments/University/HEC.

|  |  |  |
| --- | --- | --- |
| **BOT-4402** | **Environmental Biology** | **3(2-1)** |

**Aims and Objectives**

To provide updated knowledge of environmental problems and sustainable environmental management.

**Course Contents**

1. Environment: Introduction, scope, pressure

2. Pollution: definition, classification and impact on habitats

i. Air pollution: Sources and effect of various pollutants (inorganic, organic) on plants, prevention, control, remediation. Photochemical smog. Smog. Acid rain: 1. Theory of acid rain, 2. Adverse effects of acid rains. Chlorofluorocarbons and its effects.

ii. Water pollution: Major sources of water pollution and its impact on vegetation. Prevention, control remediation, eutrophication, thermal pollution.

iii. Sediments pollution: fungicide, pesticides, herbicide, major sources of soil pollution and its impact. Prevention, control remediation. Heavy metal pollution. Tanneries. Hospital waste. Treatments of sewage, sludge, and polluted waters.

iv. Noise pollution.

v. Radiation pollution (including nuclear): Measurement, classification and effects, Principle of radiation protection, waste disposal

3. Environmental Buffers. Forest: importance, deforestation, desertification and

Conservation

4. Ozone layer:

i. Formation

ii. Mechanism of depletion

iii. Effects of ozone depletion

5. Greenhouse effect: causes, impacts.

6. Range management: Types of rangelands, potential threats, sustainable management.

**Practical**

1. Examination of industrial waste water and Municipal sewage and sludge for

i. Total dissolved solids.

ii. PH and EC.

iii. BOD/COD.

iv. Chlorides, carbonate, and Nitrates.

3. Examination of water samples forms different sites for the presence and diversity of organisms.

4. Effect of air pollutants on plants.

5. Visits to environmentally compromised sites and evolution of remediation methods.

**Books Recommended:**

1. Newman, E.I. 2001. Applied Ecology. Blackwell Science. UK

2. Mooney, H.A. and Saugier, B. 2000. Terrestrial Global Productivity. Academic Press, UK.

3. Eugene, E.D. and Smith, B.F. 2000. Environmental Science: A study of interrelationships. McGraw Hill. USA.

4. French, H. 2000. Vanishing Borders: Protecting the Planet in the Age of Globalization. W.W. Norton and Company, NY.

5. Hall, C.A.S. and Perez, C.L. 2000. Quantifying Sustainable Development. Academic Press, UK.

6. Bazzaz, F.A. 2004. Plants in changing environments: Linking physiological, population, and community ecology. Cambridge Univ. Press.

7. Bush, M.B. 1997. Ecology of a changing planet. Prentice Hall, UK.

8. Marsh, M.W. and Grossa Jr., J.M. 1996 Environmental geography: Science, land use, and earth systems. John Wiley and Sons.

9. Lambers, H., T. L. Pons and F. Stuart. 2008. Plant Phyiological Ecology.

|  |  |  |
| --- | --- | --- |
| **ARB-4401**  | **Arabic**  | **3(3-0)** |

****

****

|  |  |  |
| --- | --- | --- |
| **ZOO-4404** | **Animal Diversity – II** | **3(3-0)** |

**Course Objectives**

The objectives of the course are:-

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

**Course Learning Outcomes:**

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

1. **ACQUIRE** the basic knowledge of Taxonomic characteristics of chordates.
2. **UNDERSTAND** the phylogenetic relations and diversity of Pisces, amphibians, reptiles and mammals.
3. **ANALYZE** the process of micro evolution within chordates .
4. **DEMONSTRATE** individually Phylogentic relationships of chordates and their diversity.

**Course Outline:**

1. **Protochordates**
	1. Classification of protochordates.
	2. Structure, anatomy and organ systems of Acorn worms, Urochodates and Cephalochodates
	3. Reproduction; life histories and metamorphosis of protochodates.
	4. Phylogenetic relationships.
2. **Fishes**:
	1. Vertebrate Success in Water.
	2. Phylogenetic relationships of Pisces.
	3. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli
	4. Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (Scoliodon) and Osteichthyes (*Cyprinuscarpio*and*Wallagoattu*).
3. **Amphibians**:
	1. The first terrestrial vertebrates. Characteristics of amphibians
	2. Phylogenetic relationships.
	3. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura.
	4. Structure and locomotoryadaptations,nutrition and the digestive system, circulation, gas exchange, temperatureregulation, nervous and sensory functions, excretion and
	5. Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.
4. **Reptiles**:
	1. The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.
	2. Characteristics of OrderTestudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia
	3. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous andsensory functions, excretion and osmoregulation, reproduction and development of helonia, squamata, Rhynchocephalia and crocodilian.
	4. Further phylogenetic considerations.
5. **Birds**:
	1. Classification,Feathers, flight and endothermy.
	2. Phylogenetic relationships; ancientbirds and the evolution of flight.
	3. Diversity of modern birds.
	4. 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.
	5. Migrationand navigation.
6. **Mammals**:
	1. Classification, Specialized teeth, endothermy, hair and viviparity.
	2. Diversity of mammals.
	3. Adaptations in external structure and locomotion, nutrition andthe digestive system, circulation, gas exchange, and temperature regulation,nervous and sensory functions, excretion and osmoregulation, behavior,reproduction and development.

**Practicals:**

1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
2. Visit to PMNH for the study of diversity of chordates.

**Teaching Methodology:**

* Lecturing
* Written Assignments
* Practical
* Discussion

**Text and Reference Books:**

1. Pandey, B. N., &Mathur, V. (2018). Biology of chordates. PHI Learning Pvt. Ltd..
2. Salazar, A. (2018). Advanced Chordate Zoology. Scientific e-Resources.
3. Verma, P. S. (2013). Chordate zoology. S. Chand Publishing**.**
4. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
5. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
6. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed.

(International), Singapore: McGraw Hill.

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principlesof Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.

|  |  |  |
| --- | --- | --- |
| **ZOO-4405** | **ANIMAL FORM AND FUNCTION–II (A COMPARATIVE PERSPECTIVE)** | **4(3-1)** |

**Course Objectives:**

**The Objectives of the courses are:**

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

**Course Learning Outcomes:**

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

**Course Outline:**

1. **Nutrition and Digestion:**
	1. Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion
	2. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
	3. The mammalian digestive system: gastrointestinal motility and its control
	4. Oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.
2. **Temperature and Body Fluid Regulation:**
	1. 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

* 1. Control of Water and Solutes (Osmoregulation and Excretion);

Invertebrate and Vertebrate

* 1. Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney

Functions. Reproduction and Development

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

4. **Descriptive Embryology:**

a. Fertilization; embryonic development: cleavage, and egg types; the primary germ layers and their derivatives;

 b. Echinoderm embryology;

 c. Vertebrate embryology: the chordate body plan,

 d. Amphibian embryology, development in terrestrial environments,

 e. Avian embryology, and the fate of mesoderm.

**Practicals:**

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

4. Study of stages in the development of an Echinoderm.

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

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

**Books Recommended**

 1. Pechenik, J.A. 2013. Biology of Invertebrates, 4thEd.

(International), Singapore: McGraw-Hill.

 2. Arthur, M. M. 2010. Vertebrate Embryology.

 3. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Ed. (International), Singapore: McGraw-Hill.

 4. Miller, S.A., Harley, J.B. 2002. Zoology, 5th, 6th, 7th, 8th, 9th, 10th & 11th Ed. (International),Singapore: McGraw-Hill.

 5. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

 6. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.

 7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill.

|  |  |  |
| --- | --- | --- |
| **CHM-4401** | **Inorganic Chemistry** | **3(2-1)**  |

**1. Introduction to Chemical Bonding**

Attainment of a stable configuration, types of bonds (ionic bonds, covalent bonds, coordinate bonds), oxidation number and formal oxidation number. The localized bonding approach (Introduction to valence bond theory and hybridization. The delocalized bonding approach (MOT applied to homonuclear diatomic molecules).

**2. Acids and Bases**

Concepts of acids and bases (Arrhenius, Lowry-Bronsted, Lewis and SHAB concept), relative strength of acids and bases. pH, pKa, pKb and buffer solutions and their significance. Theory of Indicators, solubility, solubility product, common ion effect and their applications.

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

General characteristics of the following group of p-block elements with reference to the aspects given against each:

Boron and Aluminum

Gradation of the characteristic properties within the group. Structures, properties and applications of electron deficient molecules such as boron hydrides and aluminium hydrides.

Carbon and Silicon

Gradation of the characteristic properties within the group). Production of pure silicon for solar energy and silicon chips. Structural aspects of ortho and metasilicates and their industrial applications.

Nitrogen and Phosphorus

Gradation of the characteristic properties within the group. Oxides of nitrogen (NO and NO2) and their role in air pollution, oxyacids (HNO2 and HNO3) of nitrogen. Industrial preparation of urea and superphosphate fertilizers.

Oxygen and Sulfur 26 Gradation of the characteristic properties within the group. Role of sulphur dioxide in air pollution. Thionic acids (H2SO3 and H2SO4) and uses of hypo in photography.

The Halogens

Gradation of the characteristic properties within the group, anomalous behaviour of fluorine. Preparation of oxyacids of halogens (HClO3 and HClO4) and their uses. Interhalogens, pseudohalogens.

The Noble Gases

Preparation, properties and uses of xenon fluorides; Commercial uses of noble gases.

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

Electronic configuration and general characteristics of d-block elements. Industrial applications of transition metals. Werner’s concept and nomenclature of coordination compounds.

5. **Introduction to Modern Materials**

Liquid crystals, engineering ceramics, fiber glass and thin films.

**PRACTICAL**

1. Laboratory Ethics and safety measures

Awareness about the toxic nature of chemicals and their handling, cleaning of glassware, safe laboratory operations

2. Qualitative analysis

Analysis of four ions (two anions and two cations) from mixture of salts

3. Quantitative analysis

a. Acid-Base Titrations (minimum 02)

b. Redox Titrations (minimum 02)

c. ComplexometricTirations (minimum 02)

4. Inorganic Preparations

a. Preparation of Ferrous sulphate

b. Preparation of Ferric alum

c. Preparation of Barium silphate

**Recommended Books**

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., “Inorganic Chemistry: Principles of Structure and Reactivity”, 4th Ed., Harper and Row, New York, 2001

2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., “Basic Inorganic Chemistry”, 3rd Ed., Wiley, New York, 1995.

3. Clyde Day, M. &Selbin, J., “Theoretical Inorganic Chemistry”, 2nd Ed., Van Nustrand Reinhold, 1969.

4. Lee, J.D., “Concise Inorganic Chemistry”, Chapman and Hall, 5th Edition,1996.

5. Shriver, D. F., Atkins, P. W. and Langford, C. H., “Inorganic Chemistry”, Oxford University Press, 2nd Edition, 1994.

6. Cartmell E. and Fowles G. W. A. “Valency and Molecular Structure” Adlard and Sons Limited 3rd Edition (1966)

7. Douglas B., McDaniel D. and Alexander J. “Concepts and Models of Inorganic Chemistry” John Wiley & Sons, Inc. 3rd Edition (1994)

8. Harvey K. B. and Porter G. B. “Introduction to Inorganic Physical Chemistry” Addison-Wesley Publishing Company, Inc. (1963)

9. Hill J. W. and Petrucci R. H. “General Chemistry” Prentice-Hall, Inc. (1996)

10. Marr G. and Rockett B. W. “Practical Inorganic Chemistry” Van Nostrand Reinhold Company. (1972)

11. Miessler G. L. and Tarr Donald A. “Inorganic Chemistry” Prentice-Hall International, Inc. Prentice-Hall International Edition (1991)

12. Moody B. “Comparative Inorganic Chemistry” Routledge, Chapman and Hall, Inc. 3rd Edition (1991)

13. Kennedy, Friedlander, “Nuclear and Radiochemistry” (latest edition).

Bassette, J., Denney, G. H. and Mendham, J., “Vogel’s Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis” English Language Book Society, 4th Edition, 1981.

Vogel, A. I., “A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis” Longman Green & Co. 1995.

**COURSE CONTENTS OF COMPULSORY FACULTY COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 5TH SEMESTER**

**YEAR-III**

**SEMESTER-V (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status**  |
| ZOO-5501 | Cell Biology | 3(2-1) | Compulsory |
| ZOO-5502 | Animal Physiology | 3(3-1) | Compulsory |
| ZOO-5503 | Basics of Genetics | 3(2-1) | Compulsory |
| ZOO-5504 | Environmental Biology | 3(2-1) | Compulsory |
| ZOO-5505 | Zoogeography | 2(2-0) | Compulsory |
| ZOO-5506 | Chemistry of Bio-Molecules | 3(2-1) | Compulsory |
|  | **Total Credits** | **17** |  |

|  |  |  |
| --- | --- | --- |
| **ZOO-5501** | **Cell Biology** | **3(2-1)** |

**Course Objectives:**

The objectives of the course are:-

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

**Course Learning Outcomes:**

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

1. **ACQUIRE** the basic concepts of cell biology.
2. **UNDERSTAND** the metabolic processes of cells in terms of cellular organelles, membranes, and biological molecules.
3. **ABILITY** to understand the role of macromolecules regulating cellular processes.
4. **FORMULATE** the critical thinking skills and knowledge on cell.

**Course Outline:**

1. **Introductioncell structure and function**
	1. Cell theory
	2. Comparison of plant and animal cells
	3. Comparison of prokaryotic and eukaryotic cells
2. **Cell membranes**
	1. Structural models
	2. Chemical composition and function
3. **Cell Organelles (structure and function)**
	1. Endoplasmic reticulum
	2. Golgi Bodies
	3. Mitochondria
	4. Lysosomes
	5. Peroxysomes
	6. Ribosome
4. **Nucleus**
	1. Structure and function
	2. Nuclear membrane
	3. Chromatin
5. **Cytoskeleton**
	1. Structure and types
	2. Function of cytoskeleton
6. **Cellular transport**
	1. Diffusion and osmosis
	2. Facilitated and active transport
	3. Endocytosis and exocytosis
7. **Cellular reproduction**
	1. Cell cycle
	2. Mitosis
	3. Meiosis

**Practical:**

1. Microscopy
2. staining techniques (Gram staining)
3. Identification of cell organelles (prepared slides)
4. Detection and quantitative determination of chromosomal DNA and RNA
5. Study of mitotic and meiotic stages (prepared slides)
6. Preparation and staining of histological slides.

**Books Recommended:**

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

 **6.** Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2007. Sinauer Associates, INC.

 7.Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach,2019

|  |  |  |
| --- | --- | --- |
| **ZOO-5102** | **Animal Physiology** | **3 (2-1)** |

**Aims and Objectives**

The course aims to:

1. Understand basic physiological mechanisms relating to membrane excitability, nerve and muscle, receptor function.
2. Understand neuro-endocrine coordination and secretions of glands.
3. Know the physiology of heart, hemodynamic system and kidney function.
4. Understand the digestive physiology and nutritive functions of gut.
5. Understand physiological regulation of temperature and its maintenance

**Course Contents**

**Central themes in Physiology:**

Homeostasis, Concepts of conformity and regulation; physiological adaptations.

**Neuro-muscular physiology:**

Cellular homeostasis, resting and action potential, synaptic transmission, muscle contraction, general sensory mechanism, cutaneous sensation, audition, vision, tast, olfaction, the motor control system, sleep and consciousness.

Muscles: Structure, types, components, muscle proteins, molecular basis of muscle contraction: sarcoplasmic reticulum and role of calcium, muscle action potentials, isometric and isotonic contraction, leverage factor, muscle fatigue.

**Cardiovascular Physiology:**

Vessels, heart, electrocardiography, cardiac rate, rhythm, and conduction disturbances, heart as a pump, cardiodynamics, hemodynamics, cardiac output and venous return, control of cardiovascular system, responses to stress.

**Respiratory physiology:**

Respiratory mechanics, gas exchange between atmosphere and the body, gas transport, pulmonary circulation, respiratory control, hypoxia.

**Renal Physiology:**

Body fluid compartment, renal tubular function, renal clearance, glomerular filtration and GFR, reabsorption and secretion, composition of urine, formation of dilute and concentrated urine, effect of ADH, Aldosterone and Atrial Natriuretic Factor on renal Physiology.

 **Gastrointestinal Physiology:**

Digestive system, the oral cavity, composition of saliva, pharynx, oesophagus, the stomach, regulation of gastric juice, small intestine, liver, regulation of bile, pancreatic and intestinal enzymes and their regulation, the colon, absorption of nutrients.

**Temperature Regulation:**

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 and Estivation.

**Practicals**

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.
2. **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.
3. **Cardiovascular Activity:** Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
4. **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.

**Recommended Books**

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

Note: Eliminate the Endocrinology topic and Practical

|  |  |  |  |
| --- | --- | --- | --- |
| **ZOO-5503** | **Basics of Genetics** | **4(3+1)** | **Compulsory** |

**Course Objectives:**

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

**Course Learning Outcome**

1. Able to define terms of genetics and apply concepts of modern transmission
2. Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.
3. Solve transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.
4. Identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored
5. Able to accurately draw the diagram and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes.
6. Describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.
7. Describe the processes of gene regulation and predict how a gene will be expressed under specific circumstances.
8. Learn and practice common genetics laboratory techniques.
9. Describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems
10. Carry out genetics laboratory and research techniques.
11. Identify the human traits and genetic diseases
12. Describe experimental results in written format both informally and in formal manuscript format
13. Able to solve problem related to population genetics

**Course Contents:**

1. **Introduction**
	1. Classical, molecular and population Genetics: Scope and importance of genetics, Forward and reverse genetics. The basic principles of Inheritance (Mendelism): Monohybrid and Dihybrid crosses

(Definition - characteristics criss-cross inheritance).

* 1. Multiple Alleles: blood groups and coat color in rabbits.
	2. Genetics of Rh factor and ErythroblastosisFoetalis.
1. **Chromosomal Basis of Inheritance:**
	1. Chromosomal theory of inheritance
	2. Interaction of genes, Epistasis, Lethality and Pleiotropism.
2. **Chromosomal Aberrations**
	1. Changes in chromosomal number, Euploidy, aneuploidy (Klinefelters syndrome, and Turners syndrome, Down syndrome and Edwards syndrome).
	2. Structural changes, insertion, deletion (Cri du chat syndrome), duplication,
	3. Inversion and translocation
3. **Pedigree Analysis:**
	* 1. Normal human chromosome complement; Karyotyping.
		2. Sex-determination and Sex-linkage:
		3. Sex determination in animals and humans,
		4. Sex linked (Hemophilia, muscular dystrophy, color blindness), sex influenced and sex limited traits,
		5. Prenatal Diagnosis: Amniocentesis and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics
4. **Chromosome mapping**
	* 1. Linkage, recombination (crossing over) and
		2. Chromosome mapping in eukaryotes.
5. **Molecular Genetics:**
	* 1. Gene Concept (classical and modern),
		2. Genetics of Viruses and Bacteria,
		3. Transposons,
		4. Mutation and DNA repair
		5. Molecular Genetic Analysis,
		6. Regulation of Gene Expression in Prokaryotes,
		7. Gene Regulation in Eukaryotes,
		8. Genetic basis of diseases, like cancer,
		9. Genetic control of animal development.
		10. The genetic control of the Vertebrate Immune System,
6. **Recombinant Technology**
	* 1. The Techniques of Molecular Genetics (elements of genetic engineering),
		2. PCR
7. **Human Genetics;**
	* 1. Single and Multifactorial Disorders:
		2. Autosomal anomalies, Pseudoautosomal genes,
		3. Single gene disorders: Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria).
		4. Complex Inheritance Patterns, Polygenic traits- Cleft lip and cleft palate,
8. **Population Genetics:**
	* 1. Hardy-Wienberg equilibrium,
		2. Systematic and Dispersive pressures, Inbreeding and heterosis

**Practical:**

1. Drosophila culture techniques: preparation and maintenance of culture
2. General morphology of Drosophila melanogaster
3. Study of polytene chromosomes from the salivary glands of Drosophila melanogaster
4. Human karyotyping from photographs prepared slides: paper cut out method
5. Study of blood group polymorphisms in local population
6. Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
7. Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc), risk estimation and genetic counselling
8. Study of quantitative traits in humans: finger prints as model of polygenic traits
9. Dermatoglyphics in normal and mentally retarded subjects
10. Human genetics problems

**Books Recommended:**

1. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics. 7th Ed., John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. 2001.Principles of Genetics. 7th Ed., WCB publishers USA.
3. Lewin, B. 2013. GENE-VIII. Oxford University Press. UK.

.

1. Willium S. Klug, 2014. Concept of Genetics, ISBN-11: 978-0321948915
2. Lewin’s Gene XI BY Jocelyn E.Krebs et al. 2013, isbn-13:978-

1449659851,ISBN-10:1449659853

1. Gene- XI by Lewin’s,2013,ISBN:978-1449659851
2. Concepts of genetics 11th edition, William S.Klug,2014,ISBN-13:9780321948915
3. Strickberger, M.W, 1985, Genetics, McMillan, N.Y.

|  |  |  |
| --- | --- | --- |
| **ZOO-5504** | **ENVIRONMENTAL BIOLOGY** | **3(2-1)** |

**Aims and Objectives:**

The main goal of this course is to enable the students to develop strong expertise in contemporaneous themes in ecological research and to be able to discuss these issues in a broad context. They will also have the expertise to update their knowledge continuously, and to design their own research in ecology.

**The course objectives are:**

1. To enable students to understand interrelationship between various Components of the environment.

2. To provide knowledge about basic concepts of major ecosystems of the world.

3. To provide knowledge about environmental pollution and environment as well as life and human activity are considered for understanding of environment and its trans disciplinary integration.

**Course Learning Outcomes:**

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

1. Discover interrelationships between various Components of the environment.

2. Interpret basic concepts of major ecosystems of the world.

3. Assess environmental pollution and environment as well as life and human activity are considered for understanding of environment.

**Course Contents:**

* Environment and homeostasis with an overview of concepts of ecosystem with emphasis on interactions in living and non-living things
* **Basic global ecosystems**: atmosphere, hydrosphere, lithosphere, ecosphere
* An overview of major ecosystem of the world: Marine, Estuarine, Freshwater, Wetlands, Tundra, Forest, Grassland and Desert
* **Community ecology:** basic concepts, community analysis, ecotones, inter-population interactions. Competitions, exotic and invasive species (Biological Invasion)
* **Ecological niche:** basic concepts and types. **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 (sulpher dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE and CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution
* **Contemporary environmental themes**: (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, desertification, deforestation and radioactivity leakage)

**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 protected areas and writing reports
9. Development of an ecological management plan of some selected area

**Teaching Methodology:**

•Lecturing

•Written Assignments

•Field Visits

**Assessment:**

 **Mid Term (40%)**

• Written (Long Questions, Short Questions, MCQs) 50%

•Presentation 20%

•Assignments 20%

 •Report Writing 10%

**Final Term (60%)**

•Written (Long Questions, Short Questions, MCQs) 50%

•Presentation 20%

•Assignments 20%

•Report Writing 10%

. **Recommended Books:**

1. Molles, M.C. 2005 Ecology: Concepts and Applications. 6thEdition, McGraw Hill, New York, USA.
2. Odum, E. P. 1994. Fundamentals of Ecology. 3rdEdition W.B. Saunders. Philadelphia.
3. Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E. and Turner, M.G., 1998. Ecology. Oxford Univ. Press, UK.
4. Slingsby, D. and Cook, C., 1986. Practical Ecology. McMillan Education Ltd. UK.
5. Chapman, J.L. and Reiss, M.J.1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.
6. Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford. UK.
7. Cox, C.B and Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6thEdition. Life Sciences

King’s College, London, UK.

|  |  |  |  |
| --- | --- | --- | --- |
| **ZOO-5505** | **Zoogeography** | **2(2-0)** | **Compulsory** |

**Aims and Objectives**

The course imparts knowledge and concepts of evolution based distribution of animals on the globe.

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**

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), Factors affecting animal distribution. Barriers and dispersal.

Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaearctic, Nearctic regions), Oriental, Ethiopian, Australian, and New tropical Regions.

Insolar fauna; (Continental, Oceanic and Ancient Islands). Palaeogeography (Theories of Continental drift and Plate tectonics).

Zoogeography of Pakistan: Fauna of land and sea; ecoregions maps of geography region.

**Recommended Books**

1. Darlington, P.J. (1963). Zoogeography, the Geographical Distribution of Animals. John Wiley, N. Y.
2. Parker, Hesse, Allee and Schmidt. (1963). Ecological Animal Geography. John Wiley, N.Y.
3. DeBeaufort, L.F. (1951). Zoogeography of the Land and Inland Waters. Sidgwick and Jackson, London.
4. Ekman, S. (1967). Zoogeography of the Sea, Sidgwick and Jackson, London.
5. Jillies, (1974). Introduction to Zoogeography, London.
6. Muller, P. (1974). Aspects of Zoogeography. W. Junk Publishers, Hague.
7. Ali, S.S. Palaeontology, Zoogeography and Wildlife Management. 1999. Nasim Book Depot, Hyderabad, India.

|  |  |  |
| --- | --- | --- |
| **ZOO-5505** | **CHEMISTRY OF BIOMOLECULES** | **3(2-1)** |

**Course Objectives:**

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

**Course Learning Outcome**

By the end of the course, students should be able to:

1. Ddemonstrate knowledge and understanding of the molecules of living cells;
2. Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition;
3. Use basic laboratory skills and apparatus to obtain reproducible data from biochemical experiments;
4. Implement experimental protocols, and adapt them to plan and carry out simple investigations;
5. Analyse, interpret, and participate in reporting to their peers on the results of their laboratory experiments;
6. Participate in and report orally on team work investigations of problembased assignments;

**Course Contents**

1. **Introduction to Macromolecules**
	* 1. Structure, types and role of various building blocks their respective macromolecules.
		2. Carbohydrates:

**Introduction**; Classification Stereoisomerism in carbohydrate,

**Structure**, types and role of monosaccharides, oligosaccharides and

* + 1. polysaccharides; Glycosaminoglycans and glycoconjugates;
		2. Carbohydrates as an information carrier molecule.
1. **Amino acids, peptides & proteins:**
	* 1. Types of amino acids & their classification;
		2. Uncommon amino acids; Acid/base behavior of amino acids.
		3. Titration curves in amino acids and their importance:
		4. Peptides & proteins;
		5. Biologically active peptides & polypeptides;
		6. Amino acid sequence in proteins & their importance; Conjugated proteins;
2. **Enzymes**

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

1. **Lipids**:

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

* 1. **Classification and important characteristics;**

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

1. **Nucleic acids**
	* 1. Nucleic acids and their types; Structure and role of various Bases in nucleic acids,
		2. Nucleoside & Nucleotides;
		3. Structure of DNA and RNA molecules;
		4. Organization and Chemistry of Double helical structure of DNA with their details.

**Practical:**

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

**Teaching Methodology:**

* Lecturing
* Written Assignments
* Guest Speaker
* Research project
* Presentation

**Books Recommended:**

1. Lehninger principle of biochemistry by David L.Nelson and Michael M.Cox

, 7th latest edition,ISBN-10:1-4641-2611-9,ISBN-13:978-14641-2611-6

1. Biochemistry by Jeremy M. Berg , John L. Tymoczko; LubertStryer ,ISBN-

10:1429229365,ISBN-13:97814229229364

1. Berg, J. M.,Tymoczko,J. L., LubertStryer. 2010. Biochemistry. 7th Ed.
2. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D, Darnell, J. 2012. Molecular Cell Biology.
3. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.
4. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet. D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.
5. Zubay, G., 1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
6. Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York.
7. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry.

McMillan Worth Publishers, New York.

1. McKee, T., McKee, J.R. 2003.Biochemistry:
2. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
3. Lodish, H., Berk, A., Zipursky, S. L., Paul.M., Baltimore D,Darnell, J. 2012.

Molecular Cell Biology.

1. McKee, T., McKee, J.R. 2003.Biochemistry:
2. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
3. Molecular cell biology W.H Freeman by Lodish, Berk, Krieger, Scott,

 Bretscher,Ploegh and Matsudaira 8th edition/latest

Edition, ISBN: 1464183392, ISBN-13:97814641183393

**Text book for Practical:**

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

**COURSE CONTENTS OF COMPULSORY FACULTY COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 6TH SEMESTER**

**SEMESTER VI (Cr. 18)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **Course title** | **Credits** | **Status** |
|  ZOO-5601 | Metabolism of Bio-Molecules | 3(3-0) | Compulsory |
|  ZOO-5602 | Developmental Biology  | 4(3-1) | Compulsory |
|  ZOO-5603 | Principles of Animal Taxonomy | 2(1-1) | Compulsory |
|  ZOO-5604 | Data Analysis  | 2(1-1) | Compulsory |
|  ZOO-5605 | Paleontology and Evolution | 4(3-1) | Compulsory |
|  ZOO-5606 | Basics of Molecular Biology | 3(2-1) | Compulsory |
|  | **Total Credits** | **18** |  |

|  |  |  |
| --- | --- | --- |
| **ZOO-5601** | **Metabolism of bio molecules** | **3(3-0)** |

**Course Objectives:**

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

**Course Learning Outcome**

By the end of the course, students should be able to:

1. Demonstrate knowledge and understanding of the principles that govern the structures of macromolecules and their participation in molecular recognition;
2. Demonstrate knowledge and understanding of the principles and basic mechanisms of metabolic control and molecular signalling;
3. Use basic laboratory skills and apparatus to obtain reproducible data from biochemical experiments;
4. Implement experimental protocols, and adapt them to plan and carry out simple investigations;
5. Analyse, interpret, and participate in reporting to their peers on the results of their laboratory experiments;
6. Build on their knowledge and understanding in tackling more advanced and specialised courses, and more widely to pursue independent, selfdirected and critical learning.

**Course Contents**

1. **Bioenergetics**
	1. Concept of Free Energy; Standard Free Energy change:
	2. Energy rich compounds and their role in metabolism.
2. **Metabolism**
3. Detailed description of Glycolysis and Catabolism of other Hexoses;
4. Regulation and Bioenergetics of Glycolysis. Anabolic role of

Glycolysis;

1. Fate of Pyruvate under Aerobic and Anaerobic conditions, Lactate and Alcoholic Fermentation;
2. Gluconeogenesis, its Regulation and significance in the tissues; Feeder Pathways in Glycolysis; Utilization of other carbohydrates in

Glycolysis;

1. 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;

1. Pentose phosphate pathway of Glucose oxidation and its major role in the animal tissues.
2. Citric acid (TCA) cycle: Conversion of Pyruvate to Acetyl CoA,

Pyruvate dehydrogenase, a multi-enzyme complex;

1. 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.
2. **Lipid metabolism**
	1. Digestion, mobilization and transport of Fats; Biosynthesis of

Triacylglycerol;

* 1. Utilization of Triacylglycerol; Oxidation of Fatty acids; Activation of

Fatty acids and their transportation to mitochondria;

* 1. Beta (ß)-Oxidation; Bioenergetics of ß-oxidation; Omega (ω)-

Oxidation pathway;

* 1. Biosynthesis of Saturated Fatty acid, Supply of raw material for palmitic acid synthesis; Fatty acid synthetase (FAS) multienzyme complex;
	2. Models of FAS system in Bacteria, Plants, vertebrate tissue and Yeast cell; Biosynthesis of unsaturated Fatty acids, Aerobic and Anaerobic pathways. Ketone bodies and their biosynthesis, utilization and role in the tissues;
1. **Cholesterol metabolism**
	1. Cholesterol biosynthesis and its Regulation; Steroid hormones, their types and main functions; Prostaglandins, their types, synthesis, inhibition and main functions.
2. **Nitrogen metabolism**
	1. Metabolic fate of amino acids; Catabolism of amino acids;

Deamination and Transamination;

* 1. Role of glutamate, glutamine and alanine in transport of ammonia in tissues;
	2. Nitrogen excretion and urea cycle; Regulation of urea cycle;
	3. Pathways of amino acid degradation showing entry points in Citric acid cycle; Decarboxylation of amino acids to biological amines.
	4. Biosynthesis of some amino acids; Incorporation of ammonia in glutamate and glutamine;
	5. Purine and Pyrimidine biosynthesis showing the sources of various atoms in both molecules.

**Teaching Methodology:**

* + Lecturing
	+ Written Assignments
	+ Guest Speaker
	+ Research project
	+ Presentation

**Books Recommended:**

1. Blanco, A., & Blanco, G. (2022). Medical biochemistry. Academic Press.
2. Rodwell, V. W. (2015). Harper’s illustrated biochemistry. McGraw-Hill Education.
3. Gropper, S. S., & Smith, J. L. (2012). Advanced nutrition and human metabolism. Cengage Learning.
4. McKee, T., & McKee, J. (2011). Biochemistry: The molecular basis of life. 5th. Oxford University Press, P.(137).
5. Chatterjea, M. N., & Shinde, R. (2011). Textbook of medical biochemistry. Wife Goes On.
6. Voet, D., & Voet, J. G. (2010). Biochemistry. John Wiley & Sons.
7. Boyer, R. F. (2002). Concepts in biochemistry (Vol. 139). Pacific Grove, CA: Brooks/Cole.
8. Oser, B. L., (Latest Edition). Hawk’s Physiological Chemistry, McGraw Hill Book Company**.**
9. David L. Nelson, and Michael M. Cox, 2005. Lehninger Principles of Biochemistry 4th Edition, Macmillan Worth Publishers, New York.

**Additional Readings:**

1. Murray, R. K., Granner, D. K., Mayer, P. A. and Rodwells, V. W., 2000. Harper’s Biochemistry, McGraw Hill Bok Company, New York.
2. Elliott, W. H. and Elliot, D. C., 2002. Biochemistry and Molecular Biology, Oxford Medical Publications, Oxford University Press.

|  |  |  |
| --- | --- | --- |
| **ZOO-5602** | **DEVELOPMENTAL BIOLOGY** | **4(3+1)** |

**Course Objectives:**

The course aims to:

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

**Course Learning Outcomes:**

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

1. **Gain** familiarity with features that make an organism model for the learning of developmental biology *e.g.,* fertilization in sea urchin with mammalian like mechanisms.
2. **Apprehend** the contributions of the sperm and the egg to form zygote
3. **Elucidate** the problems associated with cell differentiation through fate mapping.
4. **Arrange and investigate** the classical and modern experiments into

“find it”, “block it”, and “move it” categories

1. **Assess** the set of experiments that will establish whether a planned aspect is both necessary and ample to cause a developmental episode
2. **Demonstrate**the ability to label macromeres, mesomeres, and micromeres and know which cell types are derived from each of these cell layers in the early embryo (*e.g.,* primary and secondary mesenchyme, ectoderm, endoderm, and mesoderm)

**Course Outline:**

1. **Introduction**
	1. History and Basic Concepts of developmental biology
	2. Principal features of developmental biology and embryology with special emphasis on vertebrate models
	3. Origin of sexual reproduction
	4. Developmental patterns
2. **Spermatogenesis**
	1. Mammalian spermatogenesis as model for all vertebrates
	2. Spermiogenesis or (spermateliosis)
	3. The role of Sertoli and Leydig cells in spermatogenesis
	4. Hormonal control of spermatogenesis
3. **Primates Menstrual cycle**

**1. Oogenesis**

* + 1. Mechanism of oogenesis among various classes of vertebrates.
		2. Vitellogenesis
		3. Hormonal control of Vitellogenesis and oogenesis
1. **Fertilization**
	1. External & Internal Fertilization
	2. Species-specific recognition of sperm and egg
	3. Fusion of male and female gametes
	4. Polyspermy: slow and fast blocks to polyspermy
	5. Activation of egg metabolism
2. ***IN VITRO* Fertilization (IVF)**
	1. History, Steps and advantages of IVF
	2. Disadvantages and risk factors
3. **Cleavage &Blastulation**
	1. Patterns of embryonic cleavage and blastulation among different vertebrate classes
	2. Mechanism of cleavage.
4. **Gastrulation**
	1. Fate maps
	2. Gastrulation in amphibians, birds and mammals
5. **Early Vertebrate Development**
	1. Neurulation, ectoderm, mesoderm and endoderm formation
6. **Placenta and extraembryonic membranes**
7. **Cellular Basis of Morphogenesis**
	1. Differential cell affinity, cell adhesion molecules
	2. Organogenesis
	3. Mechanism of teratogenesis
8. **Aging and Regeneration in vertebrates**

**Practical:**

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

**Text and Reference Books:**

1. Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill.
3. [Scott F. Gilbert](https://www.amazon.com/Scott-F.-Gilbert/e/B001IOBLF0/ref%3Dla_B001IOBLF0_ntt_srch_lnk_1?qid=1523295374&sr=1-1)and Michael J. F. Barres. 2016.[Developmental Biology. Sinauer Associates, Sunderland, MA.](https://www.amazon.com/Developmental-Biology-Scott-F-Gilbert/dp/1605354708/ref%3Dla_B001IOBLF0_1_1?s=books&ie=UTF8&qid=1523295374&sr=1-1)
4. Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
5. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
6. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
7. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
8. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

|  |  |  |
| --- | --- | --- |
| **ZOO-5603** | PRINCIPLES OF ANIMAL TAXONOMY | 2(1-1) |

**Course Objectives:**

The course aims to:

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

**Course Contents:**

1. **Importance and application**s **of systematics:** Taxonomy in Animal science, systematics as a profession and its future perspectives.
2. **History of taxonomy**: systematics, basic terminology of systematics, theories of biological classifications.
3. **Taxonomic characters**: Kinds and weightage, micro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Species concept.
4. **Typological species concept**: Nominalist species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation,
5. **Taxonomic procedures**, taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.
6. **Formation of specific names,** brief concept of cladistics, phylogenetics. Theory and practice of cladistics and phylogenetic systematics.
7. **Systematics publications**: International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

**Practicals:**

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

**Books Recommended:**

1. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2nd Ed. Wiley-Blackwell.
2. Hill, New York.
3. Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw-Hill, New York
4. Mayr, E. *Animal Species and Evolution,* 1985.Harvard University Press.
5. Heywood, V.H. *Taxonomy and Ecology.* 1975. Academic Press, London.

Whili, M.J.D. *Modes of Speciation,* 1978. W.H. Freeman and Co., San Francisco

|  |  |  |
| --- | --- | --- |
| **ZOO-5604** | Data Analysis  | 2(1-1) |

**Aims and Objectives**

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

**Course Contents**

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

**Recommended Books**

1. Geoffery, R. Norman, David L. Streiner, Biostatistics: The Bare Essentials. 2000. B.C. Decke Inc.
2. Gerry, P. Quinn, Michael J. Keough, Experimental Design And Data Analysis For Biologists. 2002. Cambridge University Press.
3. Campbell, R. C. Statistics For Biologists. 1989. Cambridge University Press.
4. Simpson, G.G., Roe, A. and Lewonhtin, R.C. (1960). Quantitative Zoology, Harcourt Bruce and Company.
5. Sokal, R.R. and Rohlf, F.J. (1973). An Introduction to Bio-statistics, Toppan.
6. Mather, K. (1960). Statistical Analysis in Biology. Methuen.
7. Bailey, N.T.J. (1981). Statistical Methods in Biology, English University Press.

Mishra, B.N. (1982). Introduction to Practical Biostatics.

|  |  |  |
| --- | --- | --- |
| **Z00-5605**  |  **Paleontology and Evolution**  | **4(3-1)** |

###

###  **Course Objectives**:

1. To provide detailed account based on origin of life
2. To develop some basic concepts and ideas for causing evolutionary changes.
3. To determine the significance of systematics in relation to their nomenclature.

**Course Learning Outcomes**:

1. To **acquire** basic knowledge for the factors and theories related to the origin of life.
2. To **understand** the vital concepts proposed by various scientists for the appearance of life on earth. .
3. To **solve** the critical issues for the discrepancies based on origin of life.
4. To **analyze** certain issues regarding the animal phyla, classes, orders till sub-species levels.
5. **EXPLAIN** the distribution of animals on the basis of fossils record.
6. **DEVELOP** understanding regarding process of fossilization and its importance in evolutionary history of an animal and its distribution.

**Course Contents:**

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

Action of Natural Selection leading to convergence, radiation, regression and extinction.

1. **Paleontology: The Planet Earth**
	1. History, age, shells of earth
	2. Atmosphere, hydrosphere, biosphere, and lithosphere.
2. **Rocks**:
	1. Types; ligneous rocks, sedimentary rocks and metamorphic rocks.
3. **Fossil and Fossilization**
	1. Fossil types and uses of fossils, nature of fossils.
	2. Fossilization
	3. Invertebrates and Vertebrates Fossil
	4. Biostratigraphy
	5. Fossils of Pakistan
	6. Paleontologically important areas of Pakistan.
4. **Fossilization**:
	1. Geological time scale.
	2. Pre-Cambrian life.
	3. Post Cambrian life,
	4. Paleozoic life
	5. Mesozoic life
	6. Cenozoic life.
5. **Geochronometry**:
	1. radiocarbon dating, methods
	2. index fossils
	3. evolutionary history of man, elephant, horse and camel,
	4. Paleoecology, Paleomagnetism.

**Practical**:

1. Study of preserved invertebrate species and their classification to species levels.
2. Collection, preservation and identification of common species with taxonomic keys.
3. Study of molds and casts, pseudomorphs, petrified fossils.
4. Study of vertebrates fossils of evolutionary importance e.g. horse, elephant, camels and primates
5. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
6. Study of vertebrate fossils e.g. horse/elephant/camel/bovids.
7. Study and identification of Igneous, Sedimentary and Metamorphic rocks

**Text and Reference Books:**

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

5.Strickberger. M.W. Evolution. 2000. Jones and Barrett Publishers.

 Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.

6. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.

# 7. Andrew, H. Life on a Young Planet: The First Three Billion Years of Evolution on Earth - Updated Edition, March 22, 2015

|  |  |  |
| --- | --- | --- |
| **ZOO-5606** | **Basics of Molecular Biology** | **3(2-1)** |

**Course Objectives:**

To impart knowledge about chemical, physical and biological properties of nucleic acids.

To understand different molecular mechanisms and their regulation in prokaryotes and eukaryotes.

**Course Learning Outcomes:**

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

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

**Course Outline:**

1. **Introduction**
	1. Introduction to nucleic acids
	2. Chromosome structure, Chromatin,
	3. DNA forms, structures and packaging
	4. RNA types and structures
2. **Replication**
	1. DNA replication in prokaryotes
	2. Enzymology of replication
	3. DNA damage and repair
3. **Transcription**
	1. Types of RNA polymerases in prokaryotes and eukaryotes
	2. Transcription in prokaryotes
	3. Genetic Code
4. **Translation**
	1. Role of Ribosomes
	2. Mechanism of translation in prokaryotes
5. **Mutation**
	1. Types of Mutations
	2. Base-Analogue Mutagens
	3. Chemical Mutagens
6. **Gene expression and control**
	1. Control of gene expression in Prokaryotes.
	2. Lac operon model.
	3. Control of gene expression in eukaryotes.

**Practical:**

1. Isolation of DNA from human blood.
2. Restriction Fragment Length Polymorphism techniques.
3. DNA amplification through polymerase chain reaction.
4. Separation of different sized DNA fragments on agarose gel.
5. Blotting techniques (Southern ,western and northern)

**Text and Reference books:**

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

**COURSE CONTENTS OF COMPULSORY/ELECTIVE COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 7TH SEMESTER**

**YEAR-IV**

**SEMESTER–VII (Cr. 17)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status**  |
| ZOO-6701 | **Research Methods and Reports** | 2(1-1) | Compulsory |
| ZOO-6706 | Endocrinology | 3(2-1) | Compulsory |
| ZOO-6710 | General Microbiology | 3(2-1) | Compulsory |
|  | Elective-III | 3(2-1) | Elective |
|  | Elective-IV | 3(2-1) | Elective |
|  | Elective-V | 3(2-1) | Elective |
|  | **Total Credits** | **17** |  |

|  |  |  |
| --- | --- | --- |
| ZOO-6701 | **Research Methods and Reports** | 2(2-0) |

**Aims and Objectives**

The main objectives of this paper are to introduce student to the basics of research and research design in biology and to prepare them to develop and design their own research works, formulate their research manuscripts etc.

**Course Contents**

**Introduction:**Meaning of research, objectives and significance of research, research processes, criteria for good research, problems encountered by researchers in Pakistan. **Defining research problem:**Selecting research problem, techniques involved in defining a problem. Developing hypothesis. **Review of literature:** Different forms and sources of acceptable data and techniques of acquiring required literature. **Research and sampling design:**Need for research design, characteristics of a good research design, basic principles of experimental designs, Steps in sampling designs, different types of sampling designs, developing a research proposal/ plan. **Data collection:** types of data, methods of data collection, processing and analysis of data,**Writing of Research Thesis/Report and Research Paper:** (composition, arrangement and formatting); Publication of research work, finding of suitable journal, formatting and submitting of manuscript, Ethical, legal, social and scientific issues in Biological Research. Plagiarism. **Introduction to scientific research projects/funding:** Finding financial support and industry partnership. A brief idea about the funding agencies such as HEC, PSF, EU, USAID. etc.

**Practical**

Designing and developing case studies. Practice of Review of literature from different sources. Practice of writing scientific papers/ projects.

**Recommended Books**

1. Michael P. Marder, 2011. Research Methods for Science. Cambridge University Press
2. [Thomas E. Ogden](http://www.amazon.com/s/ref%3Drdr_ext_aut?_encoding=UTF8&index=books&field-author=Thomas%20E.%20Ogden), [Israel A. Goldberg](http://www.amazon.com/s/ref%3Drdr_ext_aut?_encoding=UTF8&index=books&field-author=Israel%20A.%20Goldberg), 2002. Academic Press USA
3. C.R.Kottari. 1990. Research Methodology: Methods and Techniques (2nd ed.) Ram Printograph. Delhi
4. Robert, A. Day. 1989. How to write and publish a scientific research paper. 3rd Edition.
5. Holmann, H.H. 1962. Biological research method. Olvyer and Boyd Ltd.

**LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY VII SEMESTER**

|  |  |  |
| --- | --- | --- |
|  **Course code**  | **Course Title** | **Credit Hrs.** |
| ZOO-6702 | Biological techniques | 3(1-2) |
| ZOO-6703  | Immunology | 3(2-1) |
| ZOO-6704 | Biodiversity and Wildlife | 3(2-1) |
| ZOO-6705 | Basic Human Genetics | 3(2-1) |
| ZOO-6706 | Endocrinology  | 3(2-1) |
| ZOO-6707 | Fisheries and Aquaculture | 3(2-1) |
| ZOO-6708 | General Biotechnology | 3(2-1) |
| ZOO-6709 | General Entomology | 3(2-1) |
| ZOO-6710 | General Microbiology Compulsory  | 3(2-1) |
| ZOO-6711 | General Parasitology | 3(2-1) |
| ZOO-6712 | General Toxicology | 3(2-1) |
| ZOO-6713 | Helminthology | 3(2-1) |
| ZOO-6714 | Hematology | 3(2-1) |
| ZOO-6715 | Histology | 3(2-1) |
| ZOO-6716 | Industrial and Microbial Biotechnology | 3(2-1) |
| ZOO-6717 | Invertebrata | 3(2-1) |
| ZOO-6718 | Limnology-A | 3(2-1) |
| ZOO-6719 | Neurophysiology | 3(2-1) |
| ZOO-6720 | Principles of Fish Biology | 3(2-1) |
| ZOO-6721 | Principles of Herpetology | 3(2-1) |
| ZOO-6722 | Principles of Parasitology | 3(2-1) |
| ZOO-6723 | Reproductive Physiology | 3(2-1) |
| ZOO-6724 | Wildlife Parasitology | 3(2-1) |

|  |  |  |
| --- | --- | --- |
| **ZOO-6702** | **BIOLOGICAL TECHNIQUES** | **3(1-2)** |

**Course Objectives:**

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

**Course Learning Outcome:**

 After successfully completion of this course,

1. Students must be able to identify the instrument
2. Able to use instrument for identification, measurement, fixing and cutting of tissue
3. Able to apply a practical and research skill
4. Able to operate use the lab equipment efficiently.
5. Able to collect and preserved the specimen in dry and wet form.
6. Developed expertise in Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field

**Course Contents:**

1. **Microscopy:**
	1. Principles of light microscopy. Magnification, Resolution,
	2. Types of microscopy (Bright field, Dark field, Phase Contrast)
	3. Confocal Microscopy
	4. Electron microscope: Scanning electron microscope and Transmission electron microscope (SEM and TEM).
2. **Standard unit system for weight, length, volume and Micrometery**:
	1. Diferent Measurement systems (length; surface; weight, volume, temperature), Calculations and related conversions
	2. Concentrations- percent volume; ppt; ppm - molarity, normality, molality
	3. Preparation of stock solutions of various strengths
	4. Use of stage and ocular micrometers
	5. Calibration of ocular micrometer and measurement of size animal and plant cell and nuclei
3. **Specimen preparation for optical microscopy**:
	1. Introduction to Microtomy and its types
	2. Tissue Fixation, dehydration, clearing, embedding, Section cutting

(transverse, longitudinal section)

* 1. Tissue mounting (dry mount, wet mount)
	2. Staining: Hematoxylin and Eosin staining **4. Separation and purification techniques:**
	3. Cell fractionation
	4. Centrifugation and its types
	5. Filtration and its types,
1. **Chromatography:**
	1. Chromatography: Principle, applications, types,
	2. Paper chromatography and thin layer chromatography
	3. Column chromatography
	4. High pressure liquid chromatography.
	5. Electrophoresis: Principle, applications and types (Agarose and PAGE).
2. **Spectrophotometry:**
	1. Principle, applications, types
	2. Visible/UV spectrophotometry
3. **Basic principles of Sampling and Preservation:**
	1. Sampling from soil, water, air, plants and animals
	2. Preservation of dry and wet specimens.
	3. Preservation techniques. lyophilization, preservation in ethanol, formalin etc.
4. **DNA sequencing**
	1. Polymerase chain reaction (PCR), principle and application
	2. DNA sequencing (Sanger and Maxam Gilbert).

**Practicals:**

1. Preparation of slides (dry mount and wet mount)
2. Observation of wet mounts of human cheek cells employing bright and dark field microscopy
3. Measurement of cell size: bacterial and eukaryotic Cell
4. Recording of microscopic observations with the help of camera lucida
5. Liquid handling: proper use of pipettes and 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

**Teaching Methodology:**

* Lecturing
* Written Assignments
* Guest Speaker
* Research project
* Presentation

**Books Recommended:**

1. Ghatak, K. L. (2010). Techniques and Methods in biology. PHI Learning Pvt. Ltd..
2. Yadav, P. R. (2006). Biological techniques. Discovery Publishing House.
3. Gallagher, S.R. and Wiley E.A. 2008. Current protocols essential laboratory Techniques. John Wiley & Sons Inc, USA.
4. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
5. Cheesbrough, M. 1998. District Laboratory Practice in TropicalCountries. Part I. Cambridge University Press, UK.
6. Cheesbrough, M. 1998. District Laboratory Practice in TropicalCountries. Part II. Cambridge University Press, UK.
7. Curos, M. 1997.Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
8. Curos, M. 1997.Environmental Sampling and Analysis: ForTechnician. CRC Press LLC. USA.
9. Rob Reed/ David HOLMES, Jonathan Weyers/ Allan Jones Pearson,

Practical skill in bio-molecular sciences.

1. Jones, A. Reed, R and Weyers, J. 1994. Practical skills in Biology. Longman Singapore Publishers (Pte) Ltd.

|  |  |  |
| --- | --- | --- |
| **ZOO-6703** | **Immunology** | **3(2-1)** |

**Aims and Objective**

The aim of the course is to provide a greater understanding of the role of the immune system in preventing human disease and to focus on how deficiencies in immunity can result in disease susceptibility; in addition, students study the main subject areas in biosciences and medically related research; these subject areas include biochemistry, genetics, cell and molecular biology, anatomy and physiology as related to human health disease and treatment

**Course Contents**

Cell mediated and humoral immunity, immunoglobulins, and the synthesis of antibody. Theories of antibodies synthesis. Antigenicity interaction of antigen and antibody. Hypersensitivity and its types with mechanism, classical and alternate compliment sequence, immunology in transplantation, autoimmunity to infections, immune deficiency diseases. Application of immunological phenomena in experimental biology.

**Practicals**

Antigens and elicitation of immune response. Experiments on methodology that employs immunological procedure such as radioimmuno assay.

**Recommended Books**

* 1. Roitt, M., (1979). Essential of Immunology, BlackWell, Oxford.
	2. Benecerra, B. and Unanue, F.R. (1979). Text book of Immunology.
	3. Bellanti, J.A. (1978). Immunology II, W. B. Saunders Company.
	4. Fundehberg. H. Hstites, D.P., Classwel, J. B, and Wells J. O.V. (1980). Basic and Clinical Immunology, Lang Medical Los Angelos, California.
	5. Hyde R., Hand Pathod, R.A., (1980). Immunology. Prentice Hall. Reston, Virginia.

|  |  |  |
| --- | --- | --- |
| **ZOO-6704** | **BIODIVERSITY and WILDLIFE** | **3(2-1)** |

**Course Objectives:**

The objective of this course is

1. To enable the student to understand values and objectives of wildlife conservation
2. To understand the threats to wildlife
3. To understand wildlife management rules and regulations in Pakistan
4. To understand how National and International agencies involved in conservation and management of wildlife

**Course Learning Outcomes:**

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

1. Acquire theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
2. Understand the zoo rules, protected area system Game Reserves, Wildlife Sanctuaries and National Parks,
3. Solve the threats to wildlife by applying the scientific principles and modern technologies.
4. Analyse,interpreting and synthesize data and other information about the population of wildlife
5. Evaluate the conservation management by government department, National and International organizations
6. DEMONSTRATE the ecological assessment, International conventions and importance of wildlife to certain area.

**Course Contents**

 **1 Biodiversity**

1. Levels of biodiversity
2. Status of Biodiversity;
3. Importance of Biodiversity.
4. Causes of loss of biodiversity
5. Conservation of biodiversity
6. in-situ and ex-situ conservation,
7. biotechnological intervention in biodiversity conservation,
8. **Wildlife of Pakistan**
	1. Introduction
	2. Important Definitions
	3. Identification
	4. Distribution
	5. Status
	6. Wildlife values
9. **Threatened species of Pakistan.**
10. IUCN Species status category.
11. Endangered and Endemic wildlife species of Pakistan.
12. Protected areas concept and categories,
13. Ramsar sites,
14. captive breeding,

 4 **International laws/conventions**

1. CBD,
2. CMS,
3. CITES

**Practicals**

1. Procedures for studying biodiversity, species richness, Simpson Index, Shannon and Weiner Function.
2. Bird’s population Census Techniques.
3. Mammal’s population Census Techniques.
4. Visit of Pakistan museum of natural history
5. Taxidermy of dead wildlife specimen

**Recommended Books**

1. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing and Co. London, UK.
2. [K. V. Krishnamurthy](http://www.google.com.pk/search?tbo=p&tbm=bks&q=inauthor:%22K.+V.+Krishnamurthy%22), 2003. Text Book of Biodiversity, Science Publisher USA
3. B.N. Pandey, A.P. Sharma, P.N. Pandey, P.K. Katiha and K. Jaiswal (editors), 2012. Biodiversity: Issues Threats and Conservation :   Narendra Publishing House.
4. Kumar andAsija, 2000. Biodiversity, Principles and Conservation.
5. Mary Jenking and Ann Boyce, 1987. The Diversity of Life.
6. R. Rehmani and Salim Ali: Birds Censing Techniques.
7. Roberts, T. J. The Birds of Pakistan, (Vol. II), 1992. Oxford University Press.
8. Roberts, T. J. The Mammals of Pakistan, 1997. Oxford University Press.
9. Mirza, Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
10. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley and Sons, Inc.
11. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
12. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition).McGraw Hill, New York.
13. Boyd, C.E. and Tucker, C. S. Pond Aquaculture and Water Quality Management. 1998. Boston, Kluwer Publishers Alabama.
14. Ali, S.S. Paleontology, Zoogeography and Wild-Life Management. 1999. Nasim Book Depot. Hyderabad, India.

|  |  |  |
| --- | --- | --- |
| **ZOO-6705**  | **BASIC HUMAN GENETICS**  | **3(2-1)** |

**Course 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 Learning Outcomes:**

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

1. **ACQUIRE** the basic knowledge of simple Mendelian principals and pedigree construction.
2. **UNDERSTAND** the key features involved in different mode of transmission.
3. **SOLVE** the problem by pedigree construction and evaluation
4. **ANALYZE** the pedigree and predict the mode of inheritance of any genetic disorders
5. **EVALUATE** the pedigree and possible mode of transmission.
6. **DEMONSTRATE** the families about the risk factors and probability of affected children in next generation.

**Course outline:**

1. **Introduction**
	1. Pedigree construction by using standard symbols.
	2. Mode of Inheritance of genetic disorders
	3. Autosomal dominant and autosomal recessive inheritance
	4. X linked dominant and X linked recessive Inheritance.
	5. Y linked inheritance.
	6. Mitochondrial Inheritance
2. **Genetic Linkage**
	1. Linkage Analysis
	2. Genetic mapping
	3. Physical mapping
	4. Genetic linkage and LOD score calculation
3. **Mutations**
	1. Missense mutations
	2. Nonsense mutations
	3. Silent mutations
	4. Deletion mutation
	5. Duplication mutations
4. **Prenatal Screening**
	1. Ultrasonography
	2. amniocentesis
	3. Chorionic villi sampling
	4. Fetoscopy
5. **Introduction to human Genome Project**
	1. Application and proposed benefits of Human Genome project.
	2. Ethical, legal and social Issues.
6. **Chromosomal Abnormalities**

a Aneuploidy

b Euploidy

**Practical:**

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

**Text and Reference Books:**

1. Strachan, T., A. P. Read, Human Molecular Genetics, 5th Edition, Garland Science/Taylor & Francis. 2019.
2. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st Edition, Penguin USA Paper, 2002.
3. Human genetics: concepts and applications, 11th Ed. McGraw-Hill education. 2014
4. Molecular Biology of the Cell, 6th Ed. Garland Publishing Inc. New York.2016.

|  |  |  |
| --- | --- | --- |
| **ZOO-6706** | **Endocrinology**  | **3(2-1)** |

**Course Objectives:**

1. To discuss the definition of hormone in terms of its general properties.
2. To differentiate among endocrine, paracrine and autocrine system.
3. To describe different classes and chemical structure of hormone.
4. To explain the roles of the endocrine system in maintain homeostasis, integrating growth and development, responding to environmental insult and promote successful reproduction.
5. To identify the glands, organs, tissues and cell that synthesize and secrete hormones, hormone precursors and associated compounds.
6. To describe synthesis and mode of secretion of hormone, regulation of hormone secretion of hormone, including the principles of negative and positive feedback mechanism.
7. To explain the importance of patterns of hormone secretion such as pulsatile, diurnal,cyclicle and how hormones are transported in the blood and consequences of reversible binding of many hormones by plasma proteins
8. To discuss the metabolism, clearance and excretion of hormones and their metabolic derivatives
9. To define and discuss the physiological actions of hormone relating them whenever possible to human disorders
10. To explain the consequences of under and overproduction of hormones to determine the pathophysiological basis and consequences of specific endocrine disorders.
11. To compare and contrast the different mechanism of action of hormones: i.e. those exerted by modulation of gene expression, those activated by changes in protein activity.

**Course Learning Outcome**

At the end of course the students are able to:

1. Explain the roles of the endocrine system in maintain homeostasis, integrating growth and development, responding to environmental insult and promote successful reproduction.
2. Discuss the definition of hormone in terms of its general properties.
3. Differentiate among endocrine, paracrine and autocrine system.
4. Describe different classes and chemical structure of hormone.
5. Identify the glands, organs, tissues and cell that synthesize and secrete hormones, hormone precursors and associated compounds.
6. Describe synthesis and mode of secretion of hormone.
7. Explain how the secretion of hormone is regulated, including the principles of negative and positive feedback mechanism.
8. Explain the importance of patterns of hormone secretion such as pulsatile, diurnal and cyclicle.
9. Explain how hormone are transported in the blood and consequences of reversible binding of many hormones by plasma proteins
10. Explain the basis of hormone assays and assessment of biological activity
11. Describe how hormone are metabolism, clearance and excretion of hormones and their metabolic derivatives.
12. Explain the consequences of under and overproduction of hormones to determine the pathophysiological basis and consequences of specific endocrine disorders.
13. Compare and contrast the different mechanism of action of hormones:

i.e. those exerted by modulation of gene expression, those activated by changes in protein activity.

**Course Contents:**

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 feedback, biorhythms, pathology and assessment of endocrine function;

1. **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, corticotiophins and other prolactin.

opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of varopressin and oxytocin.

1. **Thyroid gland:**

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

1. **Calciotrophic and mineral metabolism hormones:**

Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

1. **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.
2. **Adrenal medulla and catecholamines:**

Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors.

1. **Adrenal cortex:**

Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.

1. **Hypothalamic-Hypophysical-Gonadal axis in Reproduction:** Hormonal and neuronal factors and their interactions in ovarian, testicular and other reproductive targets functions.
2. **Testes:**

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

1. **Ovaries:**

Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action. The interactions in developments in estrous and menstrual cycles.

1. **Endocrinology of pregnancy:**

Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition. The interactions in transitions from childhood to reproductive and post-reproductive states.

1. **Endocirnology of lactation:**

Hormones in lactation.

1. **Endocrinology of heart, kidney, immune system:**

Growth and pineal gland.

1. **Overview of endocrine mechanisms in invertebrates.**

Study of hormones of invertebrates in concepts of growth, metamorphosis, reproduction and pheromones.

**Practicals**

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections.
2. Histological and ultrastructure features of endocrine glands; Experiments to demonstrate physiological roles of hormones of different endocrine glands.
3. Experiments to demonstrate regulation of hormones’ releases by flowchart.
4. Experiments on endocrine mechanism in vertebrates. Through flow chart to demonstrate the feedback mechanism of hormonal homeostasis.

**Recommended Books**

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

|  |  |  |
| --- | --- | --- |
| **ZOO-6707** | **FISHRIES AND AQUACULTURE**  | **3(2-1)**  |

**Course Objectives:**

The objectives of the course are:-

1. To enhance understanding about basis and principles of aquaculture.
2. To impart knowledge about modern aquaculture practices, management skills and feed requirements of various fish species.
3. To learn about issues of aquaculture effluents and environmental hazards for sustainable aquaculture production.

**Course Learning Outcomes:**

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

1. Explain basis and principles of aquaculture and its importance.
2. Employ advanced aquaculture techniques of different aquaculture production systems, management skills, species handling and husbandry practices of various species.
3. Analyze issues and various environmental hazards related to aquaculture effluents and their management.

**Course Outlines:**

1. Basis of aquaculture (scope and definitions, cultural and socio-economic basis, biological and technological basis, role in fishery management).
2. History of aquaculture and its present state.
3. Origin and growth of aquaculture.
4. National planning of aquaculture development; national priorities and aquaculture development, national resources, technology and human resources, legal and environmental factors.
5. Selection of sites for aquaculture; general considerations, land based farms, open water farms.
6. Water quantity and quality.
7. Sources of pollution and user conflicts.
8. Selection of species for aquaculture.
9. Biological characteristics.
10. Economic and market considerations.
11. Introduction to exotic species, common aquaculture species.
12. Design and construction of aquafarms.
13. Inland and coastal farms, tank and raceways, cage culture, pens and enclosures, design and construction of hatcheries.
14. Farm management; nutrition and feeds, reproduction and genetic selection, health and diseases, control of weeds, pests and predators.
15. Harvesting and post-harvest technology.
16. Marketing of aquaculture products.
17. Aquaculture practices; carps, trout and salmon culture, catfish culture, tilapias culture, shrimp and prawn culture, other finfish culture;
18. Integration of aquaculture with crop and livestock, aquaponics, hydroponics.
19. Environmental and other impacts of aquaculture.

**Practical:**

1. Pond water analysis (Physical, Chemical and Biological);
2. Pond design and components
3. Calculation of pond/tank area and volume
4. Hatchery components
5. soil and water sampling; fish feed ingredients and preparation of artificial feed; feed formulation, calculation of food quotient/Feed Conversion Ratio, Calculation of Specific growth rate (SGR); and feeding ratios
6. Identification of zooplanktons and phytoplanktons
7. Preparation of feasibility reports of modern fish farms
8. Visit of aquafarms and fish hatcheries to study aquaculture effluents and polluted sites.

**Recommended Books:**

1. Stickney R.R. 2016. Aquaculture an introductory text, CABI.
2. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf, 2015. *Aquaculture Handbook—Fish Farming and Nutrition in Pakistan.*
3. Stickney, R. R. 2009. Aquaculture an introductory text. CABI Publising, USA.
4. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India.
5. Parker, R. O. 2004. Aquaculture Science 4th Ed. Delmar Learning, London, UK.
6. John, S. L. and Paul C. S. 2003. AQUACULTURE. Farming Aquatic Animals and Plants. Blackwell Publishing, Oxford, UK.
7. NIIR 2003. Hand Book on Fisheries & Aquaculture Technology. Asia Pacific Business Press Inc., Delhi.
8. Huet, M. and Timmermans, J. (2002). Text book of Fish Culture. Blackwell Science Ltd. UK.
9. Shammi, Q.J. and Bhatnagar, S. 2002. Applied Fisheries, Agro bios, India.
10. Ali, S.S. 1999. Fresh Water Fisher Biology. Naseem Book Depot, Hyderabad.
11. Pillay, T.V.R. 2002. Aquaculture: Principles and Practices. Blackwell Science Limited. UK.

|  |  |  |
| --- | --- | --- |
| **ZOO-6708** | **GENERAL BIOTECHNOLOGY** | **3(2-1)** |

**Course Objectives:**

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

**Course outcomes:**

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

1. **COMPREHEND**about the introduction and history of biotechnology
2. **UNDERSTANDING** of core molecular genetics concepts including molecular biology, genetics, cell biology, physiology, and evolution
3. **KNOW** about basic of rDNA technology, concept and principle and application of genetic engineering, transgenic animals, cryopreservation, apoptosis, and animal cloning.

**Course Content:**

1. **Introduction**:
	1. Definitions, classes, types of modern biotechnology
	2. Historical perspective, timeline of important events in the field of biotechnology
2. **Genetics and Biotechnology**:
	1. Genome, human genome, types and size of human genome, diversity of human genome
	2. Short Tandem Repeats, nomenclature, uses of STRs, inheritance of

STRs, allele, locus, genotype, phenotype

* 1. Polymerase Chain Reaction, principle, requirements, procedures and applications, Gel electrophoresis, definition, principle, steps/methods involved, DNA ladder, allelic ladder
1. **Biotechnology and Justice**:
	1. Sources of DNA, Forensic DNA testing,
	2. Principles, techniques, types and applications
2. **Genetic Engineering**
	1. Introduction, Steps, Vectors and its types, characteristics of vectors
	2. Plasmids and its types, pBR322, pUC19, Ti-Plasmid
	3. Restriction Enzymes, Screening, Blue White Screen, Negative and Positive Control, Competent Cells, Insulin as an example, genetically modified organisms
	4. Cloning, its types of cloning, cell cloning, molecular cloning, organism cloning, applications and uses
3. **Animal and Insect Biotechnology:**
	* 1. Introduction, reasons for producing GM animals,
		2. Genetic manipulation, mammalian cloning, somatic cell nuclear transfer, procedure and uses, GM hormones and vaccines, GM insects
4. **Bioprocess Technology:**
	* 1. Introduction, requirements of bioreactors, types of bioreactors
		2. Bacterial and mammalian cell culturing, production of novel antibiotics, steps for production of antibiotics, production of industrially important chemicals
5. **Public Perception of Biotechnology:**

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

1. **Bioethics and Islamic Bioethics**:
	* 1. Introduction and principles of bioethics,
		2. Concept of bioethics in different religions, principles of Islamic bioethics

**Practicals:**

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

**Text and Reference Books:**

1. Clark, D.B., Pazdernik, N.J. (2015) Biotechnology. 2nd Edition. Academic Cell
2. [Glick,](https://www.amazon.com/Bernard-R.-Glick/e/B001K85NW6/ref%3Ddp_byline_cont_book_1) B., [Pasternak,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&text=Jack+J.+Pasternak&search-alias=books&field-author=Jack+J.+Pasternak&sort=relevancerank) J.J., [Patten,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_3?ie=UTF8&text=Cheryl+L.+Patten&search-alias=books&field-author=Cheryl+L.+Patten&sort=relevancerank) C.L. (2009) Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition. ASM Press.
3. [Freeman,](https://www.amazon.com/Scott-Freeman/e/B001IGQFHW/ref%3Ddp_byline_cont_book_1) S., [Quillin,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&text=Kim+Quillin&search-alias=books&field-author=Kim+Quillin&sort=relevancerank) K., [Allison,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_3?ie=UTF8&text=Lizabeth+Allison&search-alias=books&field-author=Lizabeth+Allison&sort=relevancerank) L. (2013) Biological Science. 5th Edition. Pearson.
4. [Schmid,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&text=Rolf+D.+Schmid&search-alias=books&field-author=Rolf+D.+Schmid&sort=relevancerank) R.D., [Schmidt-Dannert,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&text=Claudia+Schmidt-Dannert&search-alias=books&field-author=Claudia+Schmidt-Dannert&sort=relevancerank) C., [Hammelehle,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_3?ie=UTF8&text=Ruth+Hammelehle&search-alias=books&field-author=Ruth+Hammelehle&sort=relevancerank) R. (2016)

Biotechnology: An Illustrated Primer. Willey-Blackwell.

1. [Dehlinger,](https://www.amazon.com/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&text=Carolyn+A.+Dehlinger&search-alias=books&field-author=Carolyn+A.+Dehlinger&sort=relevancerank) C.A. (2014) Molecular Biotechnology. Jones & Bartlett Learning
2. Brown, T.A. (2016) Gene Cloning and DNA Analysis: An Introduction. 7th Edition. Willey-Blackwell.
3. Butler, J.M. (2009) Fundamentals of Forensic DNA Typing. Academic Press.
4. Setlow J. K. (2000). Genetic Engineering: Principles and Methods. Kluwer Academic Publishers
5. Krishna.V.S. (2007) [Bioethics and Biosafety in Biotechnology.](http://gigapedia.com/items/278633/bioethics-and-biosafety-in-biotechnology) New Age International
6. Furr, A.K. (2008) CRC Handbook of Laboratory Safety. 5th Edition. Boca Raton, FL, CRC Press
7. Smith, J. E. (2009). Biotechnology, 5th Edition, Cambridge University Press

|  |  |  |
| --- | --- | --- |
| **ZOO-6709** | **GENERAL ENTOMOLOGY** | **3(2-1** |

**Aims and Objectives**

The students will learn to identify the pest during damaging to the crop;

Students will understand methods of population estimation of the pest and application of different control strategies.

**Course Contents**

**Introduction;**

Phylum Arthropoda and its classification

External and internal morphology and physiology with particular reference to a typical insect.

Metamorphosis and its types.

Insect classification, salient characters of insect orders and families

Economic importance with examples of each family.

**Practicals**

Characters of classes of Arthropoda; collection, identification and preservation of insects.

External and internal morphology of typical insects.

Temporary mounts of different types of appendag(es of insects; types of metamorphosis

**Recommended Books**

1. Elzinga, R. T. 2003. Fundamentals of Entomology. Prentice Hall.
2. Gullan, P.I. and P. S. Crauston, 1994. The insects (*an outline of Entomology*) Chapman and Hall New York.
3. Jhonson, N.F., Triplehorn, C.A. Borror and Delong’s, 2004. Introduction to the study of Insects. Brooks Cole. 7th Edition.
4. Lohar, M.K. 1998. Introductory Entomology, Kashif Publications, Hyderabad, Pakistan.
5. Main, M.S., 1990. General Entomology (4th Ed). Oxford and IBH publishing Co. Pvt. Ld. New Delhi.
6. Richards, O.W. and R. G. Davies, 1984. Imm’s General Text-book of Entomology, Vol. I. and II, 10th ed. Chapman and Hall, London, N.Y.
7. Shahid, M. 1984. Lab Mannual of General Entomology. National Book Foundation, Paksitan.
8. Tonap, G. T., 1994. Experimental Entomology, An Aid to Laboratory and Field Studies. C.B.S. Publishers and Distributors Delhi.
9. Chapman, R.F. The Insects: Structure and Function, 2000. Blackwell Science Inc., London.
10. Krebs, C. J. Ecology: The Experimental Analysist Abundance. 5th Edition. 2000. Benjamin-Cummings Publishing Company.
11. Tembhare, DB. Modern Entomology. 2002. Himalaya Publishing House, India.

|  |  |  |
| --- | --- | --- |
| **ZOO-6710** | **GENERAL MICROBIOLOGY** | **3(2-1)** |

**Aims and Objectives**

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

**Course Learning Outcomes:**

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

* Attain the fundamental knowledge regardingmicroorganisms
* Grasp the microbiological techniques and use them efficiently
* Explore the microbial diversity androle of microorganisms
* Validate practical skills in the design and execution of experiments
* Apply the scientific method of investigation and hypothesis testing

**Course Contents**

**The beginnings of Microbiology:** Discovery of the microbial world; 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 growthof bacteria:** Modes of cell division, new cell formation, Normal growth cycle of bacteria, 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. Protozoa: Ecology and importance of protozoa. Classification of protozoa.

**Practicals**

1. The culture of microorganisms: preparation and sterilization of culture media,
2. Pure culturing and cultivation of microbes (broth culture, agar slope, agar slab, streak plates, pour plates)
3. Simple, Gram, endospore, capsular, flagellar and acid-fast staining of different genera of bacteria/Vital staining and microscopic observations of protozoa

**Recommended Books**

1. Prescott's Microbiology,11th ed. (2019) by [Joanne Willey, Linda Sherwood and Christopher J. Woolverton](https://www.mheducation.com/highered/product/prescott-s-microbiology-willey-sherwood/M1259281590.html#authorbio-tab)
2. Microbiology: An Introduction, 12th ed. (2018) by [Gerard J. Tortora,](https://www.amazon.com/Gerard-J.-Tortora/e/B001H6KK3I/ref%3Ddp_byline_cont_book_1)[BerdellR. Funke,](https://www.amazon.com/Berdell-R.-Funke/e/B00J6W5ERC/ref%3Ddp_byline_cont_book_2)[Christine L. Case.](https://www.amazon.com/Christine-L.-Case/e/B001KHOZNU/ref%3Ddp_byline_cont_book_3)
3. Laboratory Experiments in Microbiology, 11th ed. (2015) by[Ted R. Johnson](https://www.google.com.pk/search?tbo=p&tbm=bks&q=inauthor:%22Ted+R.+Johnson%22)and[Christine L. Case.](https://www.google.com.pk/search?tbo=p&tbm=bks&q=inauthor:%22Christine+L.+Case%22)
4. Brock Biology of Microorganisms, 14th ed. (2014) by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock.
5. Alcamo's Fundamentals of Microbiology, 9th ed.(2012) by Jeffrey C Pommerville.
6. [Bergey'sManualofSystematicBacteriology(](http://www.springer.com/in/book/9780387950433)2012).
7. Pelczar, Jr., Chan, E.C.S. and kreig, M.R. (1986). Microbiology, McGraw Hill, London.

|  |  |  |
| --- | --- | --- |
| **ZOO-6711** | **GENERAL PARASITOLOGY**  | **3(2-1)** |

**Aims and Objectives**

 This course aims to provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, host parasite relationship and control measure. The goals of the course are to equip students with a fundamental understanding of parasitology science and competence in relevant recent parasitological techniques.

**Course Contents**

 Principles of Parasitology. Various concepts of Parasitism. Systematics, biology, pathology and control of protozoan and helminthes parasites of medical and veterinary importance. Ecology of parasites. Host-parasite relationship. Parasitic zoonoses. Immunity and resistance.

**Practicals**

 Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance. Section cutting of the infected tissues and the study of their pathology.

**Recommended Books**

1. Robberts, L. Sand Janovy John Jr. (2009). Foundation of Parasitology. 8th edition. McGraw Hill, Boston
2. Chandrasoma , P. and Taylor, C.R.(1997). Concise Pathology. Prentice Hali International Inc. New Jercy USA.
3. Facust, E. C. and Russell, P. F. (2001). Craig and Faust’s clinical Parasitology. Lea and Febiger, 8th edition London
4. Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.
5. Olsen, O. W. (1986). Animal Parasites: their life cycle and ecology. University Park Press Baltimore
6. Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
7. Robbins, S. L. Basic Pathology. W. B. Saunders Co: London, Toronto.
8. Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.
9. Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
10. Walter, J.B. and Israel, M.S. (1979). General Pathology, Charchill Living Stone Edinburgh, London and New York.

|  |  |  |
| --- | --- | --- |
| **ZOO-6712** | **GENERAL TOXICOLOGY**  | **3(2-1)** |

**Aims and Objectives**

The course provides knowledge and understanding about the nature and mode of action of different categories of toxicants.

The will be enabled to understand the differential effects of variety of toxicants on different cellular sites.

They will also learn about the procedural protocols used in toxicological studies.

**Course Contents**

* 1. History and general introduction to Toxicology; Types of Toxicology; Specialized areas in Toxicology.
	2. Classification of Toxic chemicals; Types of Exposure and Exposure response including exposure characteristics.
	3. Spectrum of undesirable effects; Variation in toxic responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Sub-acute, sub-chronic and chronic toxicity.
	4. Developmental/Reproductive toxicity; Mutagenicity; Absorption, Distribution and Excretion of toxicants.
1. Biotransformation/Disposition of toxicants; Phase-I and Phase II Biotransformation Reactions; Mechanism of Toxicity; Delivery, form the site of exposure to the target.
2. Absorption versus pre-systemic elimination; Distribution to and away form the target; Excretion versus re-absorption.
3. Toxication versus Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecule; Attribution of Target Molecules.
4. Effects of Toxicant on Target Molecules; Cellular dysfunction and resultant toxicities; Toxicant-induced cellular dysregulation; Toxic alterations of Cellular Maintenance; Repair and Dysrepair.

**Practicals**

1. Determination of LD50 values of some pesticide against any insect pest.
2. Determination of LD50 of any toxic compound in mammalian system.
3. Effect of any toxicant on body weight in mice.
4. Toxicity of some toxic compound on relative organ weight in mice.
5. Effect of toxicant on food consumption in mice.
6. Study of toxicity of any chemical on total leukocytes count.
7. Effect of toxicant on total erythrocyte count in blood of mice.
8. Effect of any toxicant on hemoglobin level in mice.
9. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice.
10. Study of liver function enzyme (Alanine Aminotransferase) activity following administration of toxic compound to experimental animals.
11. Determination of blood glucose level following toxic exposure.

**Recommended Books**

1. Klaassen, Curtis D., (1996). Casarett and Doull’s Toxicology; The Basic Science of Poisons; 5th Edition (International). McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J. A. 1995. Introduction to Toxicology, 2nd Edition. Taylor and Francis Ltd. London.

|  |  |  |
| --- | --- | --- |
| **ZOO-6713** | **HELMINTHOLOGY** | **3(2-1)** |

**Aims and Objectives**

This course aims at introducing the common parasites of man and livestock to students with a view to understanding their lifecycles, morphology, pathology, diagnosis, epidemiology and control.

**Course Contents**

 Introduction to the phylum: Platyhelminthes, Trematoda, Aspidohothria, Trematoda, Form function, Life cycle and classification of digeneans, Digenians, Strigeiformes, *Schistosoma haematobium, S. japonicum, S. mansoni* (schistosomiasis); Digenians echinostomiformes; *Fasciola hepatica, F gigantica, Paramphistomum cervi.*

**Recommended Books**

1. Chandler, C. and Read, C.P. 1961. Wiley Toppan. Introduction to Parasitology.
2. Crewe, W.H.K. 1977. A Guide to Human Parasitology, Lowis and Company Ltd.
3. Noble and Noble, 1982. Parasitology, The Biology of Animal Parasites, Lea and Febiger.
4. Beck, J. W. and Davies, J.E. 1981. Medical Parasitology Mosby Company, Toronto, London.
5. Cheesbrough, M. Medical 1987. Laboratory Manual For Tropical Medicine, Vol. I. University Press Cambridge.
6. Sood, R. 1998. Parasitology: Protozoology And Helminthology,
7. Smith, J.D. 1998. Introduction to Animal Parasitology, University Cambridge Press.
8. Roberts, L.S. and Janovy, J. Jr. 2000. Foundations of Parasitology, Brown Publishers, Chicago, London.

|  |  |  |
| --- | --- | --- |
| **ZOO-6714** | **HAEMATOLOGY** | **3(2-1)** |

**Aims and objectives**

Hematology is the study of blood, blood forming tissues and organs, and blood disorders. The aims of the course are to import the knowledge and practice to the students to specialize them in the diagnosis, treatment, and prevention of blood disorders including anemia, blood clots, bleeding disorders, and blood cancers. Because blood runs through every organ and tissue in the body, hematology has an enormous ripple effect extending to all fields of medicine.

**Course Contents**

 Introduction of blood, Constituents of blood, Function of the cellular elements of blood, Types of blood ( Jaundic, Lipemic, Hemolytic, Anemic, Normal), Erythocytes, Erythopoiesis, Effect of erythropoietin, Erythroblastosis fetalis, Anemia (Nutritional anemia, Prernicious anemia, Aplastic anemia, Renal anemia, Hemorrhagic anemia, Hemolytic anemia, Sickle cell anemia, Hypochromic anemia). Types of Polycythemia (Primary polycythemia / polycythemia vera and Secondary/ Physiological polycythemia) Types of leucocytes, Types of lymphocytes, Typical human cell count, Blood cell production (Hemopoiesis), Plasma, Composition of plasma, Importance of blood group matching before blood transfusion, Factors involved in blood coagulation and clot lysis., Platelets, Formation of a platelet plug, Role of thrombin in hemostasis, Clot pathways, Anticoagulants, Types of hemophilia, Blood doping.

**Practicals**

 Study of erythrocytes. Differential leukocytic counts in normal and immunized animals.

**Recommended Books**

1. Hoft Brand, A.V. And petit, Je. (1981). Essential of Hematology, Blackwell, Oxford.
2. Essential Haematology. Hoffbrand, A.V. and Hoffbrand, I.E. 2002. Peltit and PAH Moss
3. Haematology. Dacie and Lewis. 2002.

|  |  |  |
| --- | --- | --- |
| **ZOO-6715** |  **HISTOLOGY** | **3(2-1)** |

**Aims and Objectives**

The fundamental aim of histology is to determine how tissues are organized at all structural levels, from cells and intercellular substances to organs.

**Course Contents**

Brief introduction to cells and tissues, study of epithelial tissues, connective tissues, blood cells, lymphatic tissues and the immune system, bone and cartilage, joints, muscles. Anatomy of heart, lungs, liver, kidney, spleen, digestive tract, brain, skin and endocrine glands.

**Practicals**

Preparation and study of stained slides of different tissues of animals

**Recommended Books**

1. Eroschenko, Victor, P. (2008). Difioe’s Atlas of Histology with Functional Correlations 11th Edition. Wolters Kluwer health (India) Pvt. Ltd. New Delhi.
2. Luiz Carlos Junqueira and Jose Carneiro (2005). Basic Histology Text and Atlas 11th Edition. McGraw Hill Medical Publishing Division New York.
3. Mills, Stacey, E. (2007). Histology for Pathologists 3rd Edition. Lippincott Williams and Wilkins a Wolters Kluwe Business Philadelphia.
4. Ham, Arthur W., Cormack, David, H (1987). Ham’s Histology 9th Edition. J.B. Lippincott Company, Phlladelphla. London.
5. Arthur Smith and John Bruton (1977). A Colour atlas of Histlogical Staining Techniques. Wolfe Medical Publication Ltd. London WC2.
6. Copenhaver, Wilred M., and Kelly, Douglas E., and Wood, Richard, L (1978). The Williams and Wilkins Company/Baltimore Tokyo.
7. M. Ahsan Karim, and Khalid M. Khan, (1986). A Guide Histology Practical. Feroz Sons Lahore Pakistan.
8. Ham, Arthur W., (1969). Histology 6th Edition. J.B. Lippincott Company Philadelphia Toronto

|  |  |  |
| --- | --- | --- |
| **ZOO-6716** | **INDUSTRIAL AND MICROBIAL BIOTECHNOLOGY** | **3(2-1)** |

**Aims and Objectives**

Industrial biotechnology (IB) is the use of biological resources (including plant, algae, marine life, fungi and micro-organisms) for producing and processing of materials, chemicals and energy. Microbes are also used to produce high level of inductrial products through fermentation processes (e.g. brewing, bakery/industry) and enzyme engineering (as per securing vitamins, antibiotics and various biochemicals).

**Course Contents**

* **Application of biotechnology in industry;** biotechnology of raw ore processing (bioleaching of sulphides, carbonates, silicates etc.) accumulation of metals by microbial cells, biopulping, biofuels, microbial enhanced oil recovery; application in agriculture,
* **Food and livestock products;** biofertilization; production of cheese, probiotics, bread, single cell protein, citric acid, amino acid, acetic acid, production in drinks; microbial enzymes in industry, enzyme immobilization.
* **Significance of Industrial Microbiology;** Fermentation principles, Substrates for industrial fermentation, Regulation of primary and secondary metabolism, Problems and possibilities in fermentation scale up procedure, Product recovery and refinement.
* **Introduction to industrial biotechnology;** Biotechnology in textile, Chemical, Food, Pharmaceuticals, Agricultural industries, Industrial biocatalysts, Industrial waste, Industrial strain improvement, Screening for new metabolites.
* Recombinant DNA technology,
* Classification of microorganisms, Culture techniques, Measurement and control of microbial processes.
* Design and development of industrial bioreactors, Fermentors and controls, Bioenergy and Biofuels,
* Introduction of probiotics.

**Practicals**

* + Screening of enzymes of industrial significance.
	+ Enzyme immobilization.
	+ Production of cheese, yogurt, citric acid, amino acid and acetic acid.

**Recommended Books**

1. Nduka Okafor., Modren industrial microbiology and biotechnology. Originally published: 2007.
2. Goutam B., Jose L Adrio, Arnold Demain, Biotechnology of microbial enzymes, 1st edition. Published at 2016.
3. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
4. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
5. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
6. Yount L., Genetic Engineering, Gale group, 2002.
7. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002.
8. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001.

|  |  |  |
| --- | --- | --- |
| **ZOO-6717** | **INVERTEBRATA** | **3(2-1)** |

**Course Objectives**:

1. To provide the knowledge of evolutionary/phylogenetic relationship (from simple to the complex organisms).
2. To impart the basic taxonomic characteristics and classification of all the invertebrate phyla.
3. To provide understanding of body organization, Feeding and Digestive system; Other Organ System;
4. To provide the information of their economic and ecological importance

**Course Learning Outcomes**:

This course will be based on following outcomes:

1. Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
2. Understand invertebrate organismal concepts in laboratory and field.
3. Demonstrate major evolutionary innovations for invertebrates with functional importance.
4. Analyze economic and ecological importance of invertebrates.

**Course Contents:**

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

1. **INTRODUCTION**
	1. Classification of Organisms:
	2. Evolutionary Relationships and Tree Diagrams: Patterns of organization.
2. **ANIMAL-LIKE PROTISTS: THE PROTOZOA**
	1. Evolutionary perspective; Life within a single plasma Membrane;
	2. Symbiotic Life-styles.
	3. Protozoon Taxonomy; (up to Phyla, subphyla and super Classes, wherever applicable).
	4. Pseudopodia and Amoeboid Locomotion; Cilia and other pellicular structure;
3. **MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION**
	1. Evolutionary Prespective:
	2. Origins of Multicellularity; Animal Origins.

**Phylum Porifera**

* + 1. Characteristics and classification. Cell Types, Body Wall, and

Skeletons;

* + 1. Water Current and Body Forms;
		2. Maintenance Functions, Reproduction.

**Phylum Cnidaria (Coelenterate)**

* + 1. Characteristics and classification. The body Wall and Nematocysts:

Alteration of Generations;

* + 1. Maintenance Functions; Reproduction and
		2. Classification up to Class.

**Phylum Ctenophore;**

a. Characteristics, body organization

1. **THE TRIPLOBLASTIC AND WITH ACOELOMATE BODY PLAN PHYLUM PLATYHELMINTHES**
	* 1. Evolutionary Perspective; Classification up to class;
		2. The Free-Living Flatworms and the Tapeworms, adaptive modification for parasitic life style

5. **PHYLUM ASCHELMINTHS**

* + 1. Evolutionary perspective; General Characteristics; Classification up to order with External Features;
		2. Feeding and Digestive system; Other Organ System; Reproduction and Development including Phylum **Rotifera,** Phylum **Nematoda** and Phylum **Kinorhyncha**.
		3. Some Important Nematode Parasites of Humans;

 6. **PHYLUM MOLLUSCA**

* + 1. Evolutionary perspective; Relationship to other animals
		2. Molluscan Characteristics, Classification up to class. The Characteristics of Shell and Associated Structures,
		3. Feeding, Digestion, Gas Exchange, Locomotion,
		4. Reproduction and Developmen

 7. **PHYLUM ANNELIDA**

* + 1. Evolutionary perspective; Relationship to other animals,
		2. Feeding and the Digestive system, Gas Exchange and Circulation,
		3. Nervous and Sensory Functions, Excretion,

 d. Regeneration, Reproduction and Development

8. **PHYLUM ARTHROPODA:**

* + 1. Evolutionary Perspective: Classification and Relationship to other Animals;
		2. The Exoskeleton; Metamorphosis;

9. **PHYLUM ECHINODERMS**

1. Evolutionary Perspective: Relationship to other Animals; Echinoderm Characteristics; Classification up to class.
2. Maintenance Functions, Regeneration,
3. Reproduction, and Development

**Practical:**

**Note:** Classification of each members of each phylum upto order with adaptions in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.

1. Study of Euglena, Amoeba, Endameba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of prepared slides of sponges, spicules of songes, and their various body forms. Study of representatives of classes of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. Study of principal representatives of classes of Phylum Mollusca.
7. Study of principal representatives of classes of Phylum Annelida.
8. Study of principal representatives of classes of groups of Phylum Arthropoda
9. Study of representatives of classes of phylum Echinodermta.

**Teaching Methodology:**

* + Lecturing
	+ Written Assignments
	+ Guest Speaker
	+ Research project
	+ Presentation

**Assignments & Presentation (15%)**

**Recommended Principal Reference Book:**

1. Miller, A.S. and Harley, J.B. ; 1999 , 2002., 2007, 2009, 2012 & 2016 Zoology, 4th , 5th, 6th, 7th, 8th , 9th& 10th Edition (International), Singapore : McGraw Hill.

Additional Readings:

1. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
2. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2007. INTEGRATED PRINCIPLES OF ZOOLOGy, 12th& 13th Edition (International). Singapore: McGraw-Hill.
3. Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition,

(International), Singapore: McGraw-Hill.

1. Kent, G. C. and Miller, S., 2001. COMPARATIVE ANATOMY OF VERTEBRATES New York: McGraw-Hill.
2. Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin Cummings Publishing Company, Inc.

BOOKS FOR PRACTICAL

1. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th

Edition (International), Singapore : McGraw-Hill.

1. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore : McGraw-Hill

|  |  |  |
| --- | --- | --- |
| **ZOO-6718** | **Limnology-A** | **3(2-1)** |

**Course Objectives:**

The objectives of the course are:-

1. To enhance the concept of Limnological parametersand Lake formations.
2. To equip students with basic knowledge of limnology its origin and different types
3. To familiar students with the chemical and biological process occurring in the lakes to support aquatic life.
4. To familiar students with the importance and conservation management of lakes problems and management of fish farm

**Course Learning Outcomes:.**

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

1. **Recall**the basic knowledge ofphysico-chemical properties of lentic and lotic environment.
2. **Describe**thermal stratification, management and conservation of lakes.
3. **Relate**the inland water quality with the production of aquatic fauna.
4. **Illustrate** the basin morphometry and eutrophication of lakes.
5. **DETERMINE**the values of various physico-chemical and biological parameters of lotic and lentic water bodies.

**Course Contents:**

1. **Introduction and scope of Limnology**
	1. Introduction, History and scope
	2. Structure of aquatic ecosystems
	3. Origin of lotic and lentic waters, and estuaries
	4. Zonation
	5. Thermal stratification
	6. Eutrophication
2. **Properties of freshwater**
	1. Physical properties of water (temprature, light, color, turbidity, conductivity); chemical properties of water (pH, oxygen, CO2, salinity, dissolved solids, trace elements, nitrogen, phosphorous and sulphur cycles)
	2. Biological properties, plankton (phytoplankton, zooplankton)
	3. Methodology for collection
	4. Preservation and identification;
	5. Planktonic adaptations and diurnal migration;
	6. Factors affecting planktonic productivity
3. **Lake formation**
	1. Lake formation and basin morphometry
	2. Processes of Lake Eutrophication
	3. Sedimentation and acidification
	4. Biological productivity in lakes
	5. Lakes of Pakistan
	6. Lakes Conservation and Management.

**Practicals:**

1. Survey of lotic and lentic water bodies,
2. Water analysis of various types of inland water bodies,
3. Phytoplankton- methods of collection, identification, estimation of standing crop,
4. Study of temporary and permanent mounts of phytoplankton, Zooplankton collection, preservation and study of zooplankton mounts, Benthos collection ,
5. Collection, preservation and study of fauna and flora of various water
6. Bodies
7. Study of a lake ecosystem
8. Field visit to different Lakes.

 **Text Books:**

1. Horne, A.J. and Golman, C. R. 2000. Limnology. McGraw-Hill. Science.
2. Wetzen, R. G. and Likens, G.E. 2000. Limnological Analysis. 3rd Ed.

Springer-Verleg. New York.

1. Agarwal, S.C. 1999. Limnology. A.P.H. Public New Delhi.

**Reference Books**

1. Horne, A.J. and Golman, C. R. 2000. Limnology. McGraw-Hill. Science.
2. Wetzen, R. G. and Likens, G.E. 2000. Limnological Analysis. 3rd Ed.

Springer-Verleg. New York.

1. Agarwal, S.C. 1999. Limnology. A.P.H. Public New Delhi.
2. Boyd, C.E. 2000. Water Quality in Ponds for Aquaculture. Auburn University, Alabama, USA.
3. Boyd, C.E. and Tucker, C.S. 2000. Water Quality and Pond Soil Analyses for Aquaculture. Auburn University, Alabama, USA.
4. Lamert.1997.. Limnology. Oxford. University, UK.Mishra, R. 2002.Fresh Water Environment. Anmol Publication Pvt. Ltd., New Delhi.
5. Kestin,S.C. and Warris, P.D. 2001.Farmed fish quality. Fishing News Books, Blackwell Science Ltd.
6. Kumar, A .2003. Aquatic Ecosystems. A.P.H. Publishing Corporation, New Delhi.

|  |  |  |
| --- | --- | --- |
| **ZOO-6719** | **NEUROPHYSIOLOGY** | **3(2-1)** |

**Aims and Objectives**

The course aims to understand the basic physiological mechanisms relating to the body coordination through cell membran, nerve, muscle excitation and receptor function.

**Course Contents**

 Foundation of excitability at cell membrane level: Membranes, channels and transport. The physical basis of neuronal function: Membrane excitation, resting and action potentials. Communication along and between neurons: Propagation of action potential, synaptic transmission, pre and postsynaptic mechanisms. Neurotransmitters: synthesis, release and their fate. Learning related changes at synapse. Neurochemical basis of behaviour. Organization of sensory receptors. Physiological basis of receptors functions: Mechanoreceptors, photoreceptors, chemoreceptors, Thermoreceptors, Electroreceptors and Nocireceptors.

**Practicals**

 Experiments demonstrating: Nervous organizations in vertebrates (mammals), Potentials particularly the nerve impulse. Nervous regulation of functional system.

**Recommended Books**

1. Aidley, J. David, 1998. The Physiology of excitable cells. Cambridge University Press, Cambridge, U.K.
2. Ganong, W.F., 2000. Review of Medical Physiology. Prentice-Hall International Inc., London.
3. Randall, D., Burggren, W. And French, Kathleen, 1998. W.F. Freeman and Company, New York.

|  |  |  |
| --- | --- | --- |
| **ZOO-6720** | **PRINCIPLES OF FISH PHYSIOLOGY** | 3(2-1) |

**Course Objectives**

The objectives of the course are:-

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

**Learning Outcomes.**

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

1. **Relate** the keyconcepts of fish physiology and breeding techniques.
2. **Describe** the different systems and their coordination.
3. **Assess** problems associated with natural and artificial breeding.
4. **Determine** the fish production with relation to induced breeding.
5. **Judge** the fish behavior and migration patterns**.**
6. **DEMONSTRATE** the various organs by dissecting the fish and also collection of ill fishes for better understanding of various diseases.

**Course Contents:**

1. **Fish nutrition**
	1. Digestive system;
	2. Stomach less fishes;
	3. Stomach fishes;
	4. Digestion and absorption;
	5. Food; Plant origin; Animal origin;
	6. Feeding; Fresh food; Dry concentrates; Pelleted food.
2. **Transportation:**
	1. Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma);
	2. Circulation; Arterial system; Venous system; Capillaries;
	3. Transport of food material.
3. **Respiration:**
	1. Gills;
	2. Lungs;
	3. Skin;
	4. Swimbladder;
	5. Homeostasis.
4. **Excretion:**
	1. Kidneys;
	2. Hypo-osmotic urine;
	3. Hyper-osmotic urine;
	4. Osmoregulation.
5. **Reproduction:**
	1. Gonads; Testes and ovaries;
	2. Maturation;
	3. Reproductive cells (egg and sperm);
	4. Artificial fertilization of sex cells.
6. **Breeding:**
	1. Natural (seasonal); Artificial;
	2. Hormonal induced breeding;
	3. Temperature & photoperiod;
	4. control induced breeding.
7. **Growth:**
	1. Extensive culture (due to the consumption of natural food);
	2. Semi-intensive culture (due to natural & artificial food);
	3. Intensive culture (due to only dry concentrates).
8. **Fish health:**
	1. Water quality;
	2. Hygiene of fish culture facilities;
	3. Hygiene of equipments used in fish culture.
9. **Diseases and their control:**
	1. Viral;
	2. Bacterial;
	3. Fungal;
	4. Parasitic;
	5. Protozoan;
	6. Helminths (trematodes, cestodes, nematodes, acanthocephalons);

Crustaceans (cladocera);

* 1. Annelids (leeches); Arthropods (water ticks, water flea, water mites).
1. **Fish migration:**
	1. To nursery ground;
	2. To maturation grounds;
	3. Freshwater to marine water;
	4. Marine water to freshwater.
2. **Fish behaviour:**
	1. Learning and memory;
	2. Light response for maturation;
	3. Courtship behaviour;
	4. Aquarium fish behavior

**Practicals:**

1. Study of gut contents,
2. Study of feeding modification and adaptation in fish,
3. Study of respiratory adaptation in fish, Study of blood cells and their counts in normal and diseased fish,
4. Study of water quality parameters (DO, NH3, hardness, alkalinity, turbidity, transparency, temperature, salinity),
5. Study of various forms of swimbladder as hydrostatic organ,
6. Study fecundity of various fish species,
7. Study the effects of reproductive hormone (GnRH) on fish maturation,
8. 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, S. C. and Warris, P.D. (Editors). KESTIN FARMED FISH QUALITY, 2002, Blackwell Science, Oxford, UK.
2. Kestin, S. c. and Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.

|  |  |  |
| --- | --- | --- |
| **ZOO-6721** | **PRINCIPLES of Herpetology**  | **3(2-1)** |

**Aims and Objectives**

 The aim of this course is to provide knowledge about the classification, population and distribution of amphibia and reptiles with refernece to their ecological adoptations and interactions.

**Course Contents**

 Classification of amphibians and reptiles. Evolution, geographical distribution, population biology of reptiles and amphibians. Biology, including anatomical, physiological adaptations to their environment, reproduction, foods/feeds, communication (vocal, chemical, behavioural). Mechanism of hibernation in herpeto-fauna (effect of climatic factors). Poisonous species. Sensory mechanisms, predator-prey relationships, chemistry and physiological actions of venoms and patho-physiology and treatment of snake bite.

**Practicals**

1. Visit of PMNH for study of preserved specimens of herpeto-fauna in relation to their taxonomy and ecosystem.
2. Field visits of different habitats for direct/indirect observations of amphibians and reptiles with respect to their ecologies and weather conditions.
3. Visit to Zoos and wildlife parks.

**Recommended Books**

1. Daniel, J.C. 1992. The Book of Indian Reptiles. Bombay Natural History Society, India.
2. Girard, C. 1978. Herpetology. Arno Press.
3. Pough, F. H. 2001. Herpetology. Prentice Hall.
4. Zug, G. R. 1993. Herpetology: An introductory biology of Amphibian and Reptiles. Academic Press.
5. Sharif, M. Herpato-Fauna of Pakistan.

|  |  |  |
| --- | --- | --- |
| **ZOO-6722**  | **Principles of Parasitology**  | **3(2-1)** |

**Course objectives:**

 The objectives of courses are:

1. Describe general concepts of animal parasitology
2. Classify major animal and human parasites.
3. Describe many of the disease conditions that animal parasites cause and to consider measures that may lead to control of these disease agents.
4. Provide knowledge regarding of different modes of transmission of parasites of medical and veterinary importance
5. To study ecology of parasites, host- parasite relationship.
6. To study parasitic zoonoses, their immunity and resistance.
7. To equip students with a fundamental understanding of parasitology science and competence in relevant parasitological techniques.

**Course learning outcomes:**

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

1. Discover the basic knowledge and concepts of animal parasites.
2. Analyze many of the diseases conditions that animal parasite causes.
3. To consider measures that may lead to control of these disease agents.

**Course Outline:**

1. **History and origin of parasitism:**
2. Principles of Parasitology and various concepts of parasitology.
3. Systematics, biology, pathology
4. Ecology of parasites
5. Host- parasite relationship (Symbiosis, commensalism, parasitism, myiasis).
6. Parasitic zoonoses
7. Immunity and resistence
8. Infection and infestation
9. **Evoloutionary aspects related to parasites:**

a: Geographical distribution

b: Epidemiology ( Incidence of occurrence and prevalence)

 c: Classification of hosts: Definitive, intermediate and paratenic hosts.

1. **Classification of parasites:**

a: Brief account and examples of Ectoparasites, endoparasites, temporary,

 Permanent, facultative, accidental, wandering parasites

1. **Host susceptibility and specificity:**

a: Various types of suscepitibility

b: Host- parasitic relationship

c: Morphology and physiology of parasites

d: Adaptations to parasitic mode of life

f:Effects of parasitism on parasites

1. **Effects of parasites on hosts**

a. Influence of parasites on host population

 b. Pathological responses

 c. Immuno-parasitology: immunity and immune response of host

 6: **Diagnosis, prevention, control treatments**

a. Common drugs and anthelmintics

 b. Vector control methods

 **7: Protozology**:

1. Protozoan parasites of man and animals.
2. Classification, life cycle, habitat,morphology, epidemiology and immunopathology of infections: ***Entamoeba spp, Pthogenic amoeba,Giardia spp, trichomonas, Trypanosoma, Leishmania, Plasmodium amd Toxoplasma gondii.***

**8: Helminthology:**

1. Helminth parasites of man and women.

 b, General account , classification, biology,life cycle, pathology and

 symptology and immunology. Platyhelminthes: e.g: **Trematodes**

 (***Fsciola and Schistosoma),* Cestodes: *Taenia ,* Nematodes:**

 ***Trichuris, Strongyloides, Toxocara*** and ***Filiaria*** worm.

 **9: Study of different phylums, orders and claases with examples:**

* 1. Phylum microspra and myxozoa, ciliphora, apicomplexan
	2. Order Amoebida, Schizopyrenida, Opalinida, kinetoplast.
	3. Class Rhomboza, ortthonectida, Litostomitea, Oligohymenophorea

 **10: Medical and Vertinary Entomology:**

1. Biology and classification of arthopods of medical and vertinary

 Importance.

1. Biology and life cycles e.g: ticks, mites, mosquitoes, fleas, flies,

 Bugs etc

1. Arthopods as diseases transmitters\vectors.

**Practicals:**

1. Preparation of temporary and permanent slides.
2. Identification of parasitic protozoans and local helminthic parasites of medically and vertinary importance .
3. Methods of collection, preservation and transporation of parasitic material.
4. Methods of preparation of slides of parasites (available)
5. Study of prepared slides of parasites
6. Qualitative and quantitative faecal examination of helminthic ova.
7. Identification of insects of vertinary and mediccaly importance.
8. Preparation of thick and thin blood smear.
9. Microscopic examination of Plasmodium.
10. Principles and procedure of faecal comcentration techniques.

**Teaching Methodology:**

 . Lecturing

 .Writing Assignments

 . Field visits

 . Report Writing

**Text and Reference Books:**

1. Evolutionary parasitology: The integrated study of infections, immunology, ecology, and genetics. Paul Schmid –Hempel. 2021
2. Human Parasitology. Burton J. Bogitsh, Clint E. Carter, 2012
3. William A. Riley. Medical Entomology. McGraw Hail Book Co. Inc. London.
4. McDonald, GA. The Epidemiology and Control of Malaria, London Oxford Press.
5. Population biology of Vector – borne diseases. John M. Drake, Michael B. Bonsall and Michael R. Strand. 2020
6. Parasitology and Vector Biology. Cherilyn Jose. 2016
7. World Health importance Geneva, WHO, 2018.
8. World health organization. Vector control series. Training and information guide. The House fly.
9. Microbial Control of vector – borne diseases. Brij Kishore Tyagi Dharumadural Dhanasekaran, 2018.
10. Vector biology, Ecology and control, Peter W. Atkinson, 2010
11. Advances in parasitology. David Rollinson, Russell Stothard, 2020.

|  |  |  |
| --- | --- | --- |
| **ZOO-6723** | **REPRODUCTIVE PHYSIOLOGY** | **3(2-1)** |

**Aims and Objectives**

The aim of the subject is to learn about the essential reproductive, histology and physiology of reproductory organs and other relevant organs to integrate this knowledge to study processes that regulate metabolic processes in the body. In addition it includes the study processes of reproduction and examples of bodily dysfunction and disease that illustrate the basic principles of normal physiology through the absence of normal function.

**Course Contents**

**Note**: Theemphasis shall be mainly on human being and poultry.

 Cytological and genetic basis of sex. Female and male reproductive tracts, morphology and histology. Differentiation of sex and role of hormones. Gonadotropins, their chemistry and physiological characteristics. Mammalian ovary. Mammalian female reproductive cycles and its controlling mechanisms. Oogensis and Folliculogenesis. Brief study of avian ovary and its functional mechanisms. Mammalian testis. Spermatogenesis in man and domestic animals. Accessory sex organs in male mammals. Fertilization, early development, embryo transfer and implantation. Hormonal mechanisms in pregnancy, parturition. Mammary Gland development, milk synthesis and lactation. Nutrition and reproductive efficiency. Anti-fertillity mechanisms in human. Sterility causes in domestic animals.

**Practicals**

 Study of male and female reproductive tracts in a mammal and a bird. Histology of different parts of the tract. Study of Spermatogenesis and folliculogenesis. Study of reproductive cycles in a mammal. Experiments on nutrition and reproductive efficiency in mammals and birds.

**Recommended Books**

1. Parkes, D.A. Marshalls, Physiology of Reproduction (Vol. I, II and III).
2. Young, W. C. Sex and Internal Secretion (Vol. I and II), Williams and Wilkins Co. London
3. Cole, H.H. and Cupps, P. T. (1977). Reproduction in Domestic Animals, Academic Press, New York.
4. Bearden H.J. and Fuquay, (1980). Applied Animal Reproduction, Reston Publishing Co. Inc. Reston.
5. Finn, C.A. (1979-81). Oxford. Review of Reproductive Biology (Vol. I, II and III), Clarendon Press, Oxford.
6. Hafez, E.S.E. (1982). Reproduction in Farm Animals, Lea and Febiger.

|  |  |  |
| --- | --- | --- |
| **ZOO-6724**  | **WILDLIFE PARASITOLOGY** | **3(2-1)** |

**Aims and Objectives**

1. To give knowledge to the students about parasites of wild animals and birds fauna as previously this field of study was ignored.
2. To impart tools of parasites survey of wild fauna and methods of parasites collection to students in field study.

**Course Contents**

 Overview of wildlife: A brief out line of wild-life in Pakistan; introduction and classification. Introduction to wildlife parasitology: Host parasite relationship; Occurrence and prevalence of parasites in Wild animals such as Mammals with exception to Carnivora; Birds; and Reptiles excluding Crocodilla; Pathogenesis of parasitic infection; Diagnosis, Prevention and Treatments. Diseases dissemination: Role of wild animals in spreading of parasitic diseases to Domestic Animals and Man; Control of Ecto and Endo-parasites of wild animals and birds; Zoonotic and Epizootic of wild-wide importance.

**Practicals**

1. Collection of literature on parasites of wild animals and birds.
2. Collection of parasites, faces / droppings from wild animals and birds.
3. Processing of parasitic material for examination.
4. Preparation of permanent mounts.
5. Identification of parasites

**Recommended Books**

1. Bush, A. O., Femandez J. C., Esch, G. W. and Seed, J. R. 2001. Parasitism: The diversity and Ecology of animal Parasites. Cambridge University Press, Cambridge, UK.
2. Fowler, M. E. 1999. Zoo and wild animal medicine: Current Theraphy-4 w. b. Saunders Company Philadelphia, USA.
3. Smyth, J. D. 1994. Introduction to animal Parasitology. 3rd Edition Cambridge University Press, Cambridge, UK.
4. Davis, J.W. and Anderson, R. C. 1971. Parasitic diseases of Wild Mammals. The Lowa State University Press, Ames, Lowa, USA.
5. Soluby, E. J. L. 1986. Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Edition Bailliere and Tindal, London.
6. Lavin. N. D. 990. Veterinary Parasitology. The Lowa State University Press. Ames, Lowa,

**LIST AND COURSE CONTENTS OF ELECTIVE/OPTIONAL/SPECIAL COURSES FOR BS-4 YEAR PROGRAM IN ZOOLOGY 8TH SEMESTER**

**YEAR-IV**

**SEMESTER-VIII (Cr. 15)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course code** | **Course title** | **Credits** | **Status** |
|  | Elective-I | 3(2-1) | Elective |
|  | Elective-II | 3(2-1) | Elective |
|  | Elective-III | 3(2-1) | Elective |
|  | Elective-IV | 3(2-1) | Elective |
|  | Elective-V | 3(2-1) | Elective |
| ZOO-6822 | Comprehensive examination | P/F | Compulsory |
| ZOO-6823 | Thesis | 6(0-6) | Elective |
| Note: students who will not opt for thesis, will have to opt 5 elective courses |
|  | **Total Credits** | **15** |  |

**CONTENTS OF ELECTIVE COURSES FOR BS-4 YEAR IN ZOOLOGY 8TH**

**SEMESTER**

|  |  |  |
| --- | --- | --- |
| **ZOO-6801** | **ANIMAL BEHAVIOUR** | **3(2-1)** |

**Aims and Objectives**

To teach students:

1. The concept of physiological mechanism.
2. Functional aspects in animal life
3. The designs of mechanisms in nervous and hormonal coordination, muscle and movements, respiratory gas exchange, excretion and osmoregulation, nutrition and thermal regulation.
4. To correlate these mechanisms at biochemical, molecular and cellular levels to the functions at organ system and organism level.
5. Physiological mechanisms in manifestation of behaviour.

**Course Contents**

 The Study of Animal Behaviour: Introduction. History of animal behaviour. Approaches and methods. Mechanisms of behaviour: The nervous system and behaviour. Hormones and behaviour Immunology and behaviour. Biological rhythms. Development of behaviour. Learning behaviour. Communication. Finding Food and shelter: Migration, Orientation and navigation. Habitat selection. Foraging behaviour. Social Organization and Mating systems:Conflict. Sexual reproduction and parental care. Mating systems and parental Care. Social systems.

**Practicals**

 Experiments on reflexes, latency, after-discharge, summation, warm up, fatigue, inhibition and feedback. Experiments on habituation, conditioned reflex type I and trial and error learning. Experiments showing hormonal involvement in behavioural responses. Study of social integration in social insects. Study of hibernation and biological rhythms.

**Recommended Books**

1. Drickamer, L. C., Vessey, S. H. and Jacob, E. 2002. Animal behaviour: Mechanism, Ecology Evolution. 5th Edition.
2. Manning, A. and Dawkins, M. S. 1997. An Introduction to Animal Behaviour, 8th edition. Cambridge University Press, Cambridge.
3. Tonap, G. T. 1998. Experimental Entomology an Aid to Laboratory and FieldStudies. C. B. S. Publishers Delhi.

|  |  |  |
| --- | --- | --- |
| **ZOO-6802**  | **ANIMAL PESTS AND DISEASE PRODUCING ORGANISMS**  | **3(2-1)** |

**Aims and Objectives**

The course aims to provide knowled and awareness to students about the different invertebrates and invertebrates animal pests and to aquip the student with suficient knowlege to generate technologies and strategies being used for pest and disease management include testing new pesticides (Chemical and biological) for inclusion in integrated pest management (IPM), to counter this challenge.

**Course Contents**

 Nature and mechanism of damages caused by animals pest injuries to cash crops, vegetables and fruit plants, stored grains and forest plants with brief description of their biology, ecology and control. Role of insects, helminthes, nematodes, protozoans and other pathogens in disease transmission and myiasis. Insects and mites of medical and veterinary importance in Pakistan. Study of mammalian pests of Pakistan.

**Practicals**

 Collection, mounting studying and identification of important animal pests. Endo and ecto-parasite of various animals. Mounting of slides after processing the parasites.

**Recommended Books**

1. Ahmad, M., 1990. Agricultural Entomology of Pakistan. Nalt. Long Auth, Islamabad.
2. Choudhry, G.U. 1970. Survey of insect fauna of forests of Pakistan.
3. Ghani, M.A. and Cheema, M.A. 1973. Biology, ecology and behaviour of principal natural enemies of major insects pests of forests of Pakistan.
4. USDA, 1956. Year Book of Agriculture, Insects.

|  |  |  |
| --- | --- | --- |
| **ZOO-6803**  | **APPLIED MICROBIOLOGY** | **3(2-1)** |

**Aims and Objectives**

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

**Course Learning Outcomes:**

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

* **Attain** the sufficient knowledge about the uses and benefits of microorganisms in different aspects of human life
* **Apprehend** the relevant applied scientific knowledgeand impact of microbiology
* **Elucidate** the problems associated with a particular area of microbiology by using the acquired knowledge and practical skills
* **Explore** the microbial world for applications of microorganisms in biotechnology, medicine and industry

**Course Contents**

 **Control of microorganisms**: Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic agents.

**Microorganisms and diseases:** Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals. **Environmental microbiology**: Fundamentals of microbial ecology. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage.

**Microbiology of food, milk and milk products**.

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

**Microbe-microbe interactions and signaling (quorum sensing): M**icrobial activity measurement in soil, Applications of microbial ecology

**Practicals**

1. Bacteriological examination of water.
2. Isolation and Identification of enteric pathogen.
3. Selective medium for the isolation of pathogenic Staphylococci. The coagulase test for pathogenic *Staphylococcus*, Sucrose plates*.*
4. Normal throat flora and reactions on Blood Agar. Slide Agglutination test.
5. Inhibition and destruction of microorganisms by physical agents (temperature, desiccation, light).
6. Action of disinfectants on bacteria. Bacteriostatic action of certain dyes and drugs.
7. Survey of microorganisms’ activities-based industries

**Recommended Books**

1. Prescott's Microbiology,11th ed. (2019) by [Joanne Willey, Linda Sherwood and Christopher J. Woolverton](https://www.mheducation.com/highered/product/prescott-s-microbiology-willey-sherwood/M1259281590.html#authorbio-tab)
2. Microbiology: An Introduction, 12th ed. (2018) by [Gerard J. Tortora,](https://www.amazon.com/Gerard-J.-Tortora/e/B001H6KK3I/ref%3Ddp_byline_cont_book_1)[BerdellR. Funke,](https://www.amazon.com/Berdell-R.-Funke/e/B00J6W5ERC/ref%3Ddp_byline_cont_book_2)[Christine L. Case.](https://www.amazon.com/Christine-L.-Case/e/B001KHOZNU/ref%3Ddp_byline_cont_book_3)
3. Alcamo's Fundamentals of Microbiology, 9th ed.(2012) by Jeffrey C Pommerville.
4. [Bergey'sManualofSystematicBacteriology(](http://www.springer.com/in/book/9780387950433)2012).
5. Pelczar, Jr., Chan, E.C.S. and kreig, M.R. (1986). Microbiology, McGraw Hill, London.
6. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. Microbiology: A Human Perspective, 2001. McGraw Hill Higher Education.

|  |  |  |
| --- | --- | --- |
| **ZOO-6804**  | **MOLECULAR BIOLOGY** | **3(2-1)** |

**Course Objectives:**

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

**Course Learning Outcomes:**

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

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

**Course Outline:**

1. **Introduction**
	1. Introduction to nucleic acids
	2. Chromosome structure, Chromatin,
	3. DNA forms, structures and packaging
	4. RNA types and structures
2. **Replication**
	1. DNA replication in eukaryotes
	2. Enzymology of replication
	3. DNA damage and repair
3. **Transcription**
	1. Types of RNA polymerases in prokaryotes and eukaryotes
	2. Synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved
	3. RNA processing
	4. Split genes, concept of ribozymes

c. Genetic Code

1. **Translation**
	1. Role of Ribosomes
	2. Mechanism of translation in eukaryotes
	3. Various factors, and posttranslational processing
2. **Gene expression and control.**
	1. Inducible and repressible operons.
	2. Control of gene expression in eukaryotes.

**Practicals:**

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.

**Text and Reference books:**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York.
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016.

Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.

1. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.
2. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
3. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York.

|  |  |  |
| --- | --- | --- |
| **ZOO-6805** | **Bioremediation and Environmental Biotechnology** | **3(2-1)** |

**Aims and Objectives**

Biodegradation of various pollutants and also acts as the microbial metabolism to remove pollutants. The purpose of environmental and bioremediation is used to study harmul substances which are contaminating the environment and discovering and inventing such processes which can be beneficial for the environment.

**Course Contents**

 Concept of bioremediation; Bioremediation of heavy metals, xenobiotic compounds and hazardous wastes; techniques used in bioremediation, bioremediation through consortia of microbes and invertebrates; renewable and non-renewable resources; bioleaching and biomining (low grade and sulfide containing ores processing); domestic solid waste and management. Waste water, sludge and sewage management; biological methods of wastes treatment; sample collection and preservation; bioremediation of crude and petroleum oils. Role of yeast in bioremediation. Biological fuel generation; Bioremediations of industrial effluents.

**Practicals**

 Bioremediation of heavy metals through invertebrates, consortia of microorganism, mycoremediation.

**Recommended Books**

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. Practical Environmental bioremediation the field guide, 1977. R. Barry. King, Gilbert M. Long John K. Sheldon, Lewis Publishers.
3. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
4. Biotechnology, 1996. Smith, J.F., Cambridge University Press.
5. Environmental Biotechnology Principles and Applications, 2000.Pruce, R. Hmana, Parry McCarty, McGraw Hill.
6. Biodegradation and Remediation, 1999. Martin Alexander Academic Press Inc.

|  |  |  |
| --- | --- | --- |
| **Z00-6806**  | **Economic Zoology** | **3(2-1)** |

**Course Objectives:**

The objectives of the course are:-

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

**Course Learning Outcomes:**

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

1. **AcquirE** basic knowledge of Commerce and Economics in relation to Zoology
2. **Understand** the Economic relationship of Animals with Humans
3. **Solve** problems related to animal husbandry and pest management by applying theoretical knowledge with practical efficacy
4. **Analyze** and enhance Animal husbandry techniques by using different Entrepreneurship skills
5. **Evaluate** problems using practical knowledge in Zoology
6. **Demonstrate** the Economy based interactions of Man and Animals

**Course Outline:**

* Basic concepts in Economic Zoology.
* Parasitic protozoans and human disease. Economic importance of protozoa.
* Vectors of human and domestic animals.
* Ecto- and Endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and Arachnida).
* Pests of pulse crops. Pests of oil seed crops. Stored grain pests. Pests of cotton. Pests of vegetables. Pests of fruits. Pests of tea.
* Apiculture, and Sericulture, Lac insect culture and Pearl culture
* Aquaculture and Fisheries (Edible Fresh water, Pond and Marine fish, Prawns, Pearl oysters). Economic importance of fishes.
* Bird farming (Poultry)
* Pharmaceuticals from animals. Bioactive substances from animals.

**Practical:**

1. To study the prepared slides of various types of ecto- and endo-parasites.
2. To observe and study Museum specimens of vertebrate and invertebrate pests of important crops and stored grains in Pakistan.
3. To visit Honey Bee farm. Write a report on their observations.
4. Visit to Sericulture farm in a near by locality and write report on their observations.
5. Study visit to fish Hatchery, Nursery ponds, Stocking ponds, Commercial fish breeding farms and report writing.
6. Identification of important species of Fish and their natural animal.
7. Visit to any bird farm and write a report on their observations.

**Text and Reference books:**

1. *Economic Zoology.*Ravindranathan, K. R. 2003. 1st ed. Dominent Publishers and Distributers. New Delhi. India
2. *A Primer of Conservation of Biology.* Primack R. B. 2000. 2nd ed. Sinauer Associates Inc. USA.
3. *Animal biodiversity of Pakistan.* Mirza, Z. B. 1998. 1st ed: Printopack, Rawalpindi. Pakistan.
4. Ahmad, R. and Muzaffar, N., 1987. Rearing of Silkworm. Misc. Pub. Pak. Agric. Res. Council, pp. 53.
5. Akhtar, M. and Muzaffar, N., 2008. Introduction to Apiculture, Department of Zoology, Punjab University Press, 36 pp.
6. Blackiston, H., 2001. Beekeeping for Dummies. Wiley Publishing, Inc. Indiana, USA, pp. 303.
7. Shukla, G.S. and Upadhayay, V.B., 1997. Economic Zoology, 3rd Ed. Rastogi Publications, Mearut, India, pp. 369.

9. Shukla and Upadhyaya. 2009. Economic Zoology 4th ed. Rastogi Publications.

 10. Mathur S., 2009. Economic Zoology Biostatistics and Animal Behaviour. Rajpal and Sons Publishing.

|  |  |  |
| --- | --- | --- |
| **Z00 6807**  | **Clinical Endocrinology** | **3(2-1)** |

**Course Objectives**

The objectives of the course are: -

1. To understand and introduction base of new knowledge building the character of confidence, maturity and full command in expressing his or her ideas
2. To learn more with various directions, critical thinking, ethical resealing, cognitive development.
3. To provide the information of their body hormonal misbalanced and their control

**Course Learning Outcomes:**

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

1. ACQUIRE: To provide a supportive learning environment, supported by different ideas and presentations.
2. UNDERSTAND: To provide distinctive modules within appropriate areas of endocrinology.
3. SOLVE: To produce graduates well trained in laboratory and research skills and to stand-in the ability to work independently and as part of a group, and to develop presentation skills, both written and oral.
4. ANALYZE: To encourage and develop the student’s motivation, originality of thought and scope of vision.
5. EVALUATE: To provide distinctive modules within appropriate areas of endocrinology, drawing on the expertise and strengths of our academic staff.
6. DEMONSTRATE: To produce graduates well trained in laboratory and research skills in major areas of interest in Endocrinology at both the basic science and clinical levels as well as an understanding of state-ofthe-art technology that is used to further research in the field and ensure that students are familiar with the fundamental principles of endocrine communication.

**Course Outline:**

**INTRODUCTION:**

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

**Functional Pathology in Endocrine Glands:** Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, cortiophin regulation.

 Pituitary Disorders: Prolactinomas, acromegaly, Cushing’s syndrome. Diabetes inspidus, hypo- and hyper-tonic syndromes.

**Thyroid Diseases** of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and testicular functions.

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

**Development and Growth:** Disorders of growth and puberty.

**Practicals**

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

**Textbook:**

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

|  |  |  |
| --- | --- | --- |
| **ZOO-6808** | **Environmental Issues** | **3(2-1)** |

**Aims and Objectives**

 This course is designed to provide students with an appreciation for the complexity of environmental issues and an awareness of the tools that can be applied to understand and solve problems involving the environment.

**Course Contents**

 Life a factor of rapid change in the environment, Population increase of diversified life in an ecosystem, Population system in an ecosystem balance; Mechanisms inter-playing in balance, consequences of imbalance, Endangering and extinction of species, decline of biodiversity, consequences of losing biodiversity. Human population: Main actor in an environment, Human population explosion, Technologies in sustaining population and affluence, addressing population problem, population and development. Poverty; integrated approach to alleviate poverty, Life style: Urban sprawl, consequences of ex-urban migration, Health in life style; Environment and health. Food production (Crops and livestock). Land for cultivation and farming. Food production, its distribution, economics and politics, Hunger, malnutrition and famine, Soil, irrigation, Stalinization, Desertification, Losing soil/ground. Pests and pest controls: Need and approach to pest control. Alternate pest control methods. Socio-economic pressure and pest management, Environmental policy in pest management. Water: Water cycle and water management, Human impact on water resources. Pollution. Bi-products of production systems: Sediments, Nutrients and eutrophication, the process and symptoms of eutrophication, combating eutrophication, long term strategies. Sewage pollution: Sewage hazards and potential, sewage management, recycling and impediment to recycling. Hazardous chemical pollution: Nature and chemical risks, pollution sources and control. Major atmospheric changes: Acid deposition, Global warming/cooling, Green house effect, Ozone depletion. Solid wastes (trash): Landfills, combustion, solutions and management. Energy resources (Fuel of production and development): energy sources and uses, fossil fuel, alternate fossil fuel; Nuclear Power, promises and problems, sustainable energy option, solar and other renewable energy sources. Environmental issues of Pakistan: Ecological issues (Soil erosion, deforestation, issues related to irrigated system, natural hazards), issues related to conservation of habitat and biodiversity (major threats to biodiversity in Pakistan, conservation strategy), pollution and industrial resources (water issues, air issues, soil issues, mineral resources issues, energy issues, food, population issues and socio-economic issues.

**Practicals**

 Review, reports, field trips, discussions on current local, national, regional and global issues. Approaches and strategies, mitigation measures.

**Recommended Books**

1. Botkin, D.B. and Keller, E.A. 2008. Environmental science (Earth as a living planet). 3rd Ed. John Wiley and Sons Inc. N.Y, USA.
2. Ahmad, R.Z. 2000. Pakistan-A-descriptive Atlas (A comprehensive geopolitics Course). 1st Ed. Ferozsons Pvt. Ltd. Lahore Pakistan.
3. Nebel, B.J. and Wright, R.t. 1998. Environmental Sciences (the way the world works). 1st Ed. Prentice Hall International Inc. London, UK.
4. Gaston, K.J. and Spicer, J.I. 1998. ‘Biodiversity (An Introduction), 1st Ed. Blackwell Science Ltd. UK.
5. Brandbury, I.K. 1998. The Biosphere. 2nd Ed. John Wiley and Sons Inc. UK.
6. Mckinny, M.L. and Schoch, R.M 1998. Environmental Science (systems and solutions). Jones and Artlett Publications Inc. USA.
7. Emiliani, C. 1997. Planet Earth (Cosmology, geology and the evolution of life and environment). 3rd Ed. Cambridge. University Press, UK.
8. Khan, F.K. Geography of Pakistan Environment (Environment, People and economy). 1993. Oxford University Press, NY, USA.
9. Hussain, S.S. 1992. Pakistan Manual of Plant Ecology (A text book of plant ecology for degree students). National Book Foundation, Islamabad, Pakistan.
10. Daily news papers for current issues.

|  |  |  |
| --- | --- | --- |
| **Z00-6809** | **Fish Biology**  | **3(2-1)** |

### **Course Objectives:**

The objectives of the course are:

1. To enable students in obtaining complete understanding aboutfreshwater as well as marine fishes in general and freshwaterculturable fishes in particular.
2. To impart knowledge of morphology, anatomy, classification andunderstanding of various feeding groups found in different waterbodies.

**Course Learning Outcomes:**

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

1. Classify fishes on the basis of morphological and anatomical characters of freshwater and marine water fish species.
2. Differentiatevarious groups of fishes on the basis of their feeding habits.
3. Outline various aquatic habitats of fishes on the basis of water quality and characteristics

**Course Contents:**

1. **Systematic:** Identification of fishes up to; Families; Order; Genus; Species.
2. **Fish morphology:** Head (size, shape, and orientation); Scales (types,arrangements, coloration, scale less fishes); Operculum; Fins, fin rays andfin spine (dorsal, pectoral, caudal, anal); Barbel (upper lip barbels, lower lipbarbels).
3. **Anatomy:** Skeleton (skull, backbone, spines); Brain and spinalcord; Gills (Number, size, arrangements);Vital organs (heart, liver, kidney);Viscera and mesenteries (swim bladder, stomach, spleen, pancreas,intestine, gonads).
4. **Feeding groups of fishes**; Herbivore; Plankton eater; Larvivore; Carnivore;Voracious.
5. **Ecology of fishes:** Freshwater; Brackish water; Marine water.

**Practicals:**

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 museums.
4. Studying quality of various water bodies.

**Recommended Books**

* 1. Kestin Farmed Fish Quality (2001).
	2. Woo. Fish diseases and Disorder: *Protozoan and Metazoan infections* (1995)
	3. Brenabe Aquaculture Vol. IandII (1992) Fishing News Books Ltd. England
	4. Maseke C. Aquaculture, IandII (1992) Pergamon Press, Oxford.
	5. Huet M. Text Book of Fish Culture: *Breeding and cultivation* Fishing News Book Ltd. England.
	6. Kestin, S. C. and Warris, P.D. (Edition). Kestin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.

|  |  |  |
| --- | --- | --- |
| **ZOO-6810** | **HUMAN GENETICS** | **3(2-1)** |

**Course Objectives:**

The objectives of the course are:-

1. To understand the extension to basic genetic laws.
2. To develop understanding of structure of human karyotype and chromosomal disorders
3. To equip the students with skills of genetic counseling and risk calculation of genetic disorders.

**Course Learning Outcomes:**

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

1. **Illustrate** the key features of human karyotyping and role of certain genes in cancer
2. **Understand** the basic mechanism involved in certain metabolic disorders.
3. **Interpret** certain pedigrees and assess risk calculation and reoccurrence risk of certain genetic disorders**.**
4. **Identify** certain treatment strategies of inherited disorders.

**Course Outline:**

1. **Exceptions/Extensions to Mendel’s laws**
	1. Phenocopy
	2. Lethal Alleles
	3. Genetic heterogeneity
	4. Multiple alleles
	5. Sex limited and sex influenced traits
	6. Incomplete and co dominance
	7. Polygenic inheritance
	8. Penetrance and expressivity
2. **Human Karyotyping**
	1. Staining
	2. Chromosomal banding
	3. Chromosomal Abnormalities
3. **Pedigree analysis**

a. Autosomal recessive

* 1. Autosomal dominant
	2. X-linked recessive
	3. X-linked dominant
	4. Y-linked
	5. Mitochondrial
1. **Oncogenes and Cancer**
	1. Proto-oncogenes
	2. Activation of Oncogenes
	3. Classification of Oncogenes
	4. Telomer, telomerase and cancer
2. **In born Errors of Metabolism**
	1. Disorder of carbohydrate metabolism
	2. Disorder of amino acid metabolism
	3. Disorder of Urea cycle
3. **Twin Studies**
	1. Monozygotic Twins
	2. Dizygotic Twins
	3. Concordance
4. **Prenatal Diagnosis**
	1. Methods of Prenatal Diagnosis
	2. Genetic counselling for Prenatal diagnosis
5. **Population Genetics**
	1. Hardy Weinberg equilibrium
	2. Heterozygote advantage and gene frequency in population
	3. Genetics in Medicine

**Practicals**

* Pedigree analysis.
* Ability to test PTC.
* Human chromosomes (slides).
* Study of inheritance of some human characteristic- hair color, eye color and tongue rolling.
* Genetic Counseling problems.
* Demonstration of various Cytogenetic techniques, Karyotyping and Banding, DNA extraction and sequencing.

**Text and Reference Books:**

1. Alberts, B., A. Johnson, J. Lewis, M. Raff, K .Roberts, and P. Walter. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc.New York.2002.
2. Watson, J,D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick.
3. Molecular biology of the gene.Pearson Education. 2004.
4. Snyder, L. and W. Chapness. Molecular Genetics of bacteria. ASM, Press, 2003.
5. Human genetics: concepts and applications, 11th Ed. McGraw-Hill education. 2014
6. Jocelyn E, Elliot S. Goldstein, Stephin T. Lewin’s Gene-XII. Jones and Bartlett learning 2018.
7. Nussbaum, Mclnnes and Willard. Thompson and Thompson Genetics In Medicine 7th Edition 2009.
8. Willam S. Klug, Michael R. Cummings and Charlotte Spencer (2006). Concepts of genetics. Pearson education, Inc

\

|  |  |  |
| --- | --- | --- |
| **ZOO-6811**  | **ICHTHYOLOGY (FISH MORPHOLOGY)** | **3(2-1)** |

**Aims and Objectives**

The purpose ofthis course is to provide students with a thorough introduction to fundamental ichthyology with emphasis on aspects of fish anatomy, biology and form and function.

**Course Contents**

 Basic Morphology, Systematic, Zoogeography of fin fishes, shell fishes and crustaceans with special references to Pakistan. Brief survey of world fisheries and non-fish resources. Fishing Technology, fish preservation, Shelf life of fisheries of various types.

**Practicals**

 Collection and identification of local fishes (fin fishes and shell fishes) and study of anatomy of selected fishes.

**Recommended Books**

1. Lagler, K.F. (1977). Ichthylogy.
2. Norman, J.R. and Green wood, P.H. (1975). A history of fishes.
3. Kestin, S. C. and Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.
4. Huet M. Text Book of Fish Culture: Breeding And Cultivation. 1973. Blackwell Publishing Company.

|  |  |  |
| --- | --- | --- |
| **ZOO-6812** | **LIMNOLOGY-B** | **3(2-1)** |

**Aims and Objectives**

Limnology is the study of inland waters – lakes (both freshwater and saline), reservoirs, rivers, streams, wetlands, and groundwater – as ecological systems interacting with their drainage basins and the atmosphere. The limnological discipline integrates the functional relationships of growth, adaptation, nutrient cycles, and biological productivity with species composition, and describes and evaluates how physical, chemical, and biological environments regulate these relationships.

**Course Contents**

 Dynamics of lotic and lentic series, Organisms in lotic and lentic environments, Influence of physical and chemical conditions on biota and their adaptations to physical and chemical conditions, Bacteria and other fungi, Nektons, Biological productivity.

**Practicals**

 Collection, preservation and study of fauna and flora of various approachable water bodies; preparation of slides of microfauna and flora, identification, study of adaptive characteristics of animals and plants.

**Recommended Books**

1. Agrawal, S.C. 1999. Limnology. A.P.H. Publishing Corporation, N. Dehli.
2. Goldman, C.R. and Home, A.J. 1983. Limnology, McGraw Hill, International Book.
3. Welch, P.S. 1968. Limnology 8th Edition, McGraw Hill Book Co.l Inc., New York.
4. Singh, H.R. Advances in Limnology. Narendra. Publishing House, N. Delhi.
5. Allen S.E. 1990. Chemical Analysis of Ecological Materials. Scientific Publishers, London.

|  |  |  |
| --- | --- | --- |
| **ZOO-6813** | **MAMMALOGY** | **3(2-1)** |

**Aims and Objectives**

The purpose of this course is to acquaint students with the origin, evolution, identification, characteristics, systematics, life history, and adaptive strategies of the Mammalia and to expose them to field techniques used in their study.

**Course Contents**

 Classification of mammals (including Mesozoic mammals: Triconodonts, Symmetrodonts, Multituberculates, Docodonts and pantotheres); Mammalian characteristics; The Monotremes, Marsupials and Placental mammals; Specialization of Mammalian teeth; Mammalian molar and its origin (Trituberular Theory); Distribution, Dispersal; Territory and Territoriality; Classification of mammals according to their diet; Food and food storage in mammals; Hibernation and Aestivation; Defense and Protection; Movement in mammals (running, leaping, fossorial, swimming, arboreal, flying and gliding mammals); Origin and evolution of mammals.

**Practicals**

1. General survey and classification up to species of important mammals
2. Skeleton of Mongoose or Cat, Hedgehog and Rabbit.

**Recommended Books**

1. Terry, A. Vaughan, J.M. Ryan and N.J. Czaplewski, 2009. Mammalogy 5th Ed. Jones and Bartlett Publishers.
2. F. Harvey, Pough, Christine, M. Janis, John, B. Heiser. Vertebrate Life. 2003. Pearson Education.
3. Hickman, Roberts, and Larsen, 2005, Integrated principles of Zoology (13th Edition). McGraw Hill, New York.
4. David, D., 1963. Principles of Mammalogy.
5. Davis. Principles of Mammalogy.
6. Gelder, Biology of Mammals.
7. Miller and Harley, 1999. Zoology (8th Edition).
8. Hickman, Roberts, and Larsen, 2001. Integrated Principles of Zoology (11th Edition).

|  |  |  |
| --- | --- | --- |
| **ZOO-6814** | **MEDICAL MICROBIOLOGY**  | **3(2-1)** |

**Aims and Objectives**

* Aims of this course are to let the students know about the science of microbiology,

To work with microorganisms, their pathogenicity, and various diseases and problems caused by microorganisms.

* The course may also initiate their interest in agricultural, industrial and/or environmental microbiology.

**Course Learning Outcomes:**

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

* Attain the sufficient knowledge about the microorganisms in different aspects of human life
* Identify specific areas in practical life where the science of microbiology is being applied.
* They can seek different job in various organizations such as clinical, industrial and environmental microbiology sections.

**Course Contents**

**Microbiology and Medicine:** antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of the infections in the community. Immunological principles, antigen, antibodies and antigen-antibody reactions.

**Bacterial pathogens and associated diseases**. *Staphylococcu*s, skin and wound infections. *Streptococcus*, sore throat, scarlet fever, glomeruonephritis. *Pneumococcus*, respiratory infections*. Corynebacteriumdiphtheriae, Mycobacterium tuberculosis*: Pulmonary and other tuberculosis infections.*Salmonella, Shigella, Escherichia coli, Klebsiella proteus, Bacillus anthracis. Clostridium tetnai*.

**Viruses**: Pox viruses, Herpes viruses. Herpes simplex. Cytomegalovirus infections. Adenoviruses. Influenza viruses. Hepatitis viruses. Arbovirsus

**PahtogenicFungi and Protozoa.**

**Practicals**

1. Basic techniques. ( Staining of microorganisms: Simple stains, positive staining; negative staining. Culturing of microorganisms: Preparation and sterilization of culture media, agar slope, agar slab, streak plates, pour plates method
2. Laboratory diagnosis and control of infections: Streptococcus, Corynebacterium, Listeria, Mycobacterium, Salmonella, Escherichia
3. Widal test
4. Blood tests: TLC, DLC, RBC.

**Recommended Books**

1. [Kenneth Ryan](http://www.mhprofessional.com/contributor.php?id=47543), [C. George Ray](http://www.mhprofessional.com/contributor.php?id=49896), [Nafees Ahmad](http://www.mhprofessional.com/contributor.php?id=37479), [W. Lawrence Drew](http://www.mhprofessional.com/contributor.php?id=42933), [James Plorde](http://www.mhprofessional.com/contributor.php?id=47661). (2021). Ryan and Sherris Medical Microbiology, 8th Edition. McGraw Hill Publishers, Washington DC
2. Patrick R. Murry, Ken S. Rosenthal, Michael A. Pfaller: [Medical Microbiology](http://www.intl.elsevierhealth.com/catalogue/title.cfm?ISBN=0323033032)**,** 9th edition, Philadelphia: Elsevier/Mosby, 2020.
3. Prescott's Microbiology,11th ed. (2019) by [Joanne Willey, Linda Sherwood and Christopher J. Woolverton](https://www.mheducation.com/highered/product/prescott-s-microbiology-willey-sherwood/M1259281590.html#authorbio-tab)
4. Microbiology: An Introduction, 12th ed. (2018) by [Gerard J. Tortora,](https://www.amazon.com/Gerard-J.-Tortora/e/B001H6KK3I/ref%3Ddp_byline_cont_book_1)[BerdellR. Funke,](https://www.amazon.com/Berdell-R.-Funke/e/B00J6W5ERC/ref%3Ddp_byline_cont_book_2)[Christine L. Case.](https://www.amazon.com/Christine-L.-Case/e/B001KHOZNU/ref%3Ddp_byline_cont_book_3)
5. Microbial Applications (Complete Version) Laboratory Manual In General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.
6. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.

|  |  |  |
| --- | --- | --- |
| **ZOO-6815** | **MEDICAL PARASITOLOGY** | **3(2-1)** |

**Aims and Objectives:**

To provide an overview of the major parasitic diseases of man and their vectors prevalent in Pakistan. By the end of these course students should be able to:

1. Demonstrate understanding of the biology and the life cycles of the major parasites and of their vectors or intermediate hosts
2. Identify the major parasites, vectors and intermediate hosts
3. Demonstrate understanding of the pathogenesis and pathology of the major parasitic diseases and the immune responses to these parasites
4. Appreciate the epidemiology of the major parasitic infections
5. Appreciate methods available for chemotherapy and control

**Course Learning Outcomes:**

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

1. Identify important parasites of medical importance.

2. Comprehend how each parasite become involved in the transmission of causative agents of human diseases.

3. Develop methods to control of parasitic diseases based on knowledge of vector biology.

**Course Contents:**

Introduction to Medical Parasitology (Terminologies used in Medical Parasitology, Medically important parasites in Animal Kingdom, Importance and Scope of Medical Parasitology), Parasitic Adaptations (Morphological and Physiological), Cryptobiosis

* Amoebiasis
* Giardiasis
* Trypanosomiasis
* Leishmaniasis
* Ascariasis
* Echinococcosis
* Schistosomiasis
* Fascioliasis

Study of abovemedically important diseases of Human with following headings

* Introduction about disease (History, parasite and disease name)
* Biology (Life Cycle of Parasite)
* Epidemiology
* Signs and Symptoms
* Diagnosis
* Prevention and Control
* Treatment

**Practical:**

* Methods of collection of parasites
* Preservation of parasites
* Transportation of parasitic material
* Isolation of these parasites from different sources
* Identification of parasites (Different techniques used for diagnosis of above parasitic diseases)
	+ Microscopic Examination of Parasite
	+ Staining of parasites
	+ ELISA
	+ PCR Identification
* Identification of Insects of medical importance

**Teaching Methodology:**

• Lecturing

• Written Assignments

• Report Writing

• Practical observations

**Assessment:**

Mid Term (40%)

Theory

• Written (Long Questions, Short Questions, MCQs) 50%

• Presentation 20%

• Assignments 20%

• Quizzes10% Final Term (60%)

• Written (Long Questions, Short Questions, MCQs) 50%

• Presentation 20%

• Assignments 20%

• Quizzes10%

**Recommended Books:**

1. Noble and Noble, 1982. Parasitology. The Biology of Animal Parasites. 5th edition. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical Parasitology. 3rd edition. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M. 1987. Medical Laboratory Manual for Tropical Medicine. Vol. I. University Press Cambridge.
4. Smith, J.D., 1998. Introduction to Animal Parsitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J.Jr., 2001. Foundations of Parasitology. 5th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitology Long man Scientific and Technical publications, Longman Group, U.K.

|  |  |  |
| --- | --- | --- |
| **ZOO-6816** | **MOLECULAR PHYSIOLOGY** | **3(2-1)** |

 **Course Objectives:**

**Knowledge**

At the end of the course the student will be able to:

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

**Skills:**

At the end of the course the student will be able to:

1. Perform experiments designed either primarily for the study of physiological phenomena or for assessment of function.
2. Analyze and interpret experimental/investigative data critically in performance of functions in changed conditions.
3. Distinguish between normal and failure of the function in abnormal conditions even through results of experiments/data collections also by the students in laboratory and fields.

**Course Learning Outcomes:**

Following the completion of this course, each student should have:

1. An understanding of critical concepts, processes, and factual information in the performance of functions and changing conditions.
2. A knowledge of resources for finding the solution for strategies to sustain diverse forms of animal life kept and in wild in normal and abnormal conditions.
3. The ability to utilize knowledge of animal physiology in critical study and for making intelligent decisions in professional life.

***Theory:***

**Concept of Physiology**

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

**Membrane Physiology:**

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

**Nerve and Muscle Physiology:**

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

**Endocrine Physiology**:

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

**Respiratory Physiology**:

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

**Excretory Physiology**:

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

**Physiology of Nutrition**:

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

**Practicals:**

**Nerve and Muscle**

1. Study of post synaptic receptor mechanisms in neuromuscular preparation of frogs.
2. Study of excitable and contractile properties of a nerve-muscle preparation.
3. Ultrastructure study of muscle structure for muscle contraction.

**Respiration andcirculation**

1. Respiratory function and oxygen consumption in acidosis and alkalosis in mouse.

**Hormones System:**

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

**Text/Reference Books:**

1. [**PrinciplesofAnimalPhysiologyT**](https://www.abebooks.com/servlet/BookDetailsPL?bi=17255082788)**hird Edition**

Moyes, Christopher D.^Schulte, Patricia M. **Publisher:** Pearson; 3 edition, 2015.

1. **Eckert Animal Physiology Fifth Edition**

David Randall, Warren Burggren, Kathleen French W. H. Freeman; 2001.

1. **Animal Physiology: From Genes to Organisms 2nd Edition**Lauralee Sherwood, HillarKlandorf, Paul Yancey Brooks Cole; 2012.
2. **Animal Physiology 4th Edition**

Richard W. Hill, Gordon A. Wyse, Margaret Anderson Sinauer Associates, Oxford University Press, 2016

|  |  |  |
| --- | --- | --- |
| **ZOO-6817** | **PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS** | **3(2-1)** |

**Aims and Objectives**

The course aims to understand the basic physiological mechanisms relating to different body organs and systems and their relationhip with the surrounding environment.

**Course Contents**

 **Cardiovascular System:** Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; cerebral, fetal. **Respiratory System:** Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbon dioxide; Regulation of ventilation; Respiratory responses in extreme conditions. **Renal System:** Elements of renal function; tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostasis; Role of kidney in acid-base balance. **Gastrointestinal System:** Gastrointestinal secretions and their control: salivary, gastric, pancreatic and hepatic; Digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments. **Osmoregulation:** Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments. **Environmental Challenges:** Temperature and animal energetics; Temperature relation of ectotherms, Heterotherms and endotherms; Dormancy: Special metabolic state; body rhythms and energetic; Energy, environment and evolution.

**Practicals**

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

**Recommended Books**

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

|  |  |  |
| --- | --- | --- |
| **ZOO-6818** | **PRINCIPLES OF ORNITHOLOGY** | **3(2-1)** |

#### **Course objectives:**

Objectives of the proposed course are aimed to:

1. Impart knowledge to identify birds and understand their behavior and relationships in their natural habitat.
2. Provide vision to understand the factors that cause bird populations to change, and to assess certain bird habitats in relation to climate changes.
3. Address both the theoretical and practical knowledge regarding widespread bird diversity in the diversified environments.

**Course Learning Outcomes:**

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

1. **ACQUIRE** the basic knowledge of the birds in the diversified habitats.
2. **UNDERSTAND** theirbehavior and possible their relationships to the natural habitats.
3. **SOLVE**the issues to detect minute morphological variations by using different high power spotting scopes in the field study for various habitats.
4. **ANALYZE** the likely impacts of changing climatic conditions on variety of birds in different ecosystems to sift in roosting, nesting and behavioural mechanisms.

**Course Outlines (contents):**

1. **Introduction** to ornithology; basic ecology and themes of study.
2. **Classification and taxonomy** of birds up to orders and species
3. **Evolution** of birds; evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis.
4. **Biology of fossil birds**; study of the representative birds viz. *Archaeopteryx, Archaeornithes* and *Neoornithes*. Comparison with the present existing birds.
5. **Behavioural studies of birds**: song and sound dialects in birds; types of songs; preferred season and time for bird pleasure calls; distress calls. Courtship behavior in birds, bird foraging, nesting and roosting activities. Learned and imprinting mechanisms in birds; Birds as pests
6. **Predator**-Prey relationships, mobbing impacts; foraging and territoriality scuffles; predator avoidance.
7. **Physiology of birds**: types of food; mastication; digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds.
8. **Bird conservation strategies**; sanctuaries and importance of urban zoos in bird life.

**Practical:**

1. Identification characteristics and taxonomy of birds to orders and families.
2. Dissection of sparrow, pigeon or common myna.
3. Study of gut contents of birds to assess their feeding habits.
4. Bird watching and preparation of ethograms

5. Visit of PMNH for study of preserved specimens of different groups of birds in relation to their taxonomy and ecosystem etc.

 6. Field visits for bird watching (population estimation, nesting, vocal calls, feeding and other behaviours etc.) in different ecologies.

**Text and Reference Books:**

1. Gill, F. B, and Prum, R.O. 2019. Ornithology, 4th Ed. Macmillan.

2. Lovette, I. J and Fitzpatrick, J. W. 2016. Handbook of Bird Biology, 3rd Ed. Wiley.

3. Birkhead, T., Wimpenny, J., and Montgomerie, B. 2014. Ten thousand Birds: Ornithology since Darwin. Princeton University Press. Princeton, NJ.

4. Birkhead, T. 2013. Bird Sense: What it’s like to be a bird? Bloomsbury, NY.

 5. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.

 6. A.J.Urfi (2009). Birds of India: A Literary Companion, OUP.

 7. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008).Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.

 8. Kaiser, G. W. (2008). [The Inner Bird: Anatomy and Evolution.](http://www.amazon.com/Inner-Bird-Anatomy-Evolution/dp/077481344X/ref%3Dsr_1_1?s=books&ie=UTF8&qid=1286452496&sr=1-1) Amazon Co.

 *9. Handbook of Bird Biology* (2014). Cornell Lab. Ornithology. Princeton University Press. New Jersey, USA.

|  |  |  |
| --- | --- | --- |
| **ZOO-6819**  | **Vector Biology**  | **3(2-1)** |

**Course objectives:**

 The objectives of courses are:

1. To provide in depth appreciation of diseases transmitted by invertebrate vectors.
2. To impart knowledge aboutvector- parasite interactions relevant to vector epidemiology and control of vector-borne diseases.
3. To provide students with a broad understanding of the key aspects of insect behavior, vector ecology.

**Course learning outcomes:**

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

1. Discover the basic knowledge of vector biology.
2. IIustrate the conceptsof disease transmission by invertebrate vectors.
3. Analyze knowledge for control of vector – borne diseases

**Course Outline:**

1. Basic Concepts of vector biology
2. What are vectors and vector biology
3. Detailed studies of systematics
4. Vector biology and Control
5. Key aspects of Vector Taxonomy
6. Evolution
7. Biology and Behaviour
8. an introduction to the life cycles of vectors
9. Ecology:

 Role in transmission of various diseases

1. Major groups of arthrop-borne pathogens and vectors

a: Basic components of arthopathogen disease cycles

b: Principle of pathogen transmission dynamics

1. Emergent pathogens:

a: Vector genetics

b: Vaccines for vector borne diseases

c: Traditional and modern disease control strategies

d: Venomous Arthopods

1. Biology and Ecology of some vectors of medical importance (order diptera)
2. Anopheles mosquito, culicine mosquitoes, black flies, sand flies, biting

Midges. Horse flies, deer flies and clegs, tsetse flies. House flies, myiasis producing flies, (blow flies,blue bottles, green bottles, flesh flies, warble flies and bot flies)

 b. Morphology, anatomy, distribution, breeding habits, life-cycle and

 Seasonal prevalence of the species

 c. Brief account of diseases spread by these vectors

 d. Methods of control

 e. Modern trends in their biological and chemical control.

**Practicals:**

1. Demonstration on identification methods.
2. Demonstration of dissection methods.
3. Dissestion of selected vectors like mosquitoes, house flies ,blue bottles, green bottles and bot flies.
4. Methods of preparation of slides of parasites (available)
5. Study of prepared slides of parasites
6. Epidemiological studies of vector-borne diseases like malaria as well as studies of control methods and parasitic evaluation.

**Teaching Methodology:**

 . Lecturing

 .Writing Assignments

 . Field visits

 . Report Writing

**Text and Reference Books:**

1. Vector biology, Ecology and control, Peter W. Atkinson, 2010
2. William A. Riley. Medical Entomology. McGraw Hail Book Co. Inc. London.
3. McDonald, GA. The Epidemiology and Control of Malaria, London Oxford Press.
4. Population biology of Vector – borne diseases. John M. Drake, Michael B. Bonsall and Michael R. Strand. 2020
5. Parasitology and Vector Biology. Cherilyn Jose. 2016
6. World Health importance Geneva, WHO, 2018.
7. World health organization. Vector control series. Training and information guide. The House fly.
8. Microbial Control of vector – borne diseases. Brij Kishore Tyagi Dharumadural Dhanasekaran, 2018.

|  |  |  |
| --- | --- | --- |
| **ZOO-6820**  | **VERTEBRATA** | **3(2-1)** |

**Course Objectives**

The objectives of the course are: -

1. To enable them to understand the Taxonomic characteristics of protochordates and chordates.
2. To impart knowledge about the classification of protochordates and various classes of chordates.
3. To enable them to compare embryological development of different classes of chordates.
4. To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions in chordates.

**Course Learning Outcomes:**

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

1. **ACQUIRE** the basic knowledge of Taxonomic characteristics of chordates and the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **UNDERSTAND**that diverse forms adapted to perform the same functions are because of the different past and present conditions in Pisces, amphibians, reptiles and mammals.
3. **ANALYZE** the comparative anatomy and physiology within chordates.
4. **DEMONSTRATE** individually physiological adaptations of chordates.

**Course Outline:**

1. **Protochordates**
	1. Classification of protochordates (up to orders).
	2. Structure, anatomy and organ systems of Acorn worms, Urochodates and Cephalochodates
	3. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in protochordates
	4. Reproduction; life histories and metamorphosis of protochodates.
2. **Fishes**:
	1. Classification of Chondrichthyes, Osteichthyes, Dipnoi and
	2. Holocephalli (up to orders).
	3. Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (Scoliodon) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).
	4. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in fishes.
3. **Amphibians**:
	1. The first terrestrial vertebrates. Characteristics of amphibians.
	2. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura.
	3. Structure and locomotory adaptations,nutrition and the digestive system, circulation, gas exchange, temperatureregulation, nervous and sensory functions, excretion and
	4. Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.
	5. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in amphibians.
4. **Reptiles**:
	1. The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.
	2. Characteristics of OrderTestudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia
	3. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous andsensory functions, excretion and osmoregulation, reproduction and development of helonia, squamata, Rhynchocephalia and crocodilian.
	4. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in reptiles.
5. **Birds**:
	1. Classification of birds (up to orders).
	2. Feathers, flight and endothermy.
	3. Ancientbirds and the evolution of flight.
	4. 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.
	5. Migrationand navigation.
	6. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in birds.
6. **Mammals**:
	1. Classification (up to orders).
	2. Specialized teeth, endothermy, hair and viviparity.
	3. Adaptations in external structure and locomotion, nutrition andthe digestive system, circulation, gas exchange, and temperature regulation,nervous and sensory functions, excretion and osmoregulation, behaviour,reproduction and development.
	4. Morphogenesis: Egg type, Cleavage, Blastula, Gastrulation in mammals.

**Practicals:**

1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
2. Visit to PMNH for the study of diversity of chordates.
3. whole mount of Amphioxus sp. T.S. Amphioxus through different regions. Pharynx of an ascidians. Sections of skin of fish, frog and rabbit. Section of mammalian liver, kidney, spleen, thyroid gland, testes, ovary, heart muscle, pancreas, nerve card, lungs and Intestine etc. Whole mounts and histological sections of different developmental stages of chick.

**Teaching Methodology:**

* Lecturing
* Written Assignments
* Practical
* Discussion

**Text and Reference Books:**

1. Pandey, B. N., & Mathur, V. (2018). Biology of chordates. PHI Learning Pvt. Ltd.
2. Salazar, A. (2018). Advanced Chordate Zoology. Scientific e-Resources.
3. Verma, P. S. (2013). Chordate zoology. S. Chand Publishing**.**
4. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
5. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
6. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed.

(International), Singapore: McGraw Hill.

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principlesof Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.
2. Verma, P. S., & Agarwal, V. K. (2006). *Chordate Embryology*. S. Chand Publishing.

|  |  |  |
| --- | --- | --- |
| **ZOO-6821** | **WILDLIFE** | **3(2-1)** |

**Course Objectives:**

The objective of this course is

1. to enable the student to understand philosophy and significance of wildlife conservation
2. to understand the wildlife management rules and regulations in Pakistan
3. to understand how National and International agencies are involved in conservation and management of wildlife

**Course Learning Outcomes:**

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

1. ACQUIRE theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
2. UNDERSTAND the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks)
3. SOLVE the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).
4. ANALYSE,interpret and synthesize data and other information about the population of wildlife
5. EVALUATE the conservation management by government department, National and International organisations
6. DEMONSTRATE the ecological assessment and importance of wildlife to certain area.

**Course Outline**

1. **Wildlife of Pakistan**
2. Introduction to wildlife
3. Existing wildlife of Pakistan,
4. Identification, classification, distribution, and conservation status of important wildlife species of Pakistan
5. Introduction to major wildlife habitats in Pakistan/AJK.
6. **Philosophy and significance of wildlife conservation**
7. Philosophy and significance of wildlife conservation.
8. Conservation of wildlife- insito and exsito conservation approaches
9. Conservation and Management of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan
10. Biodiversity and sustainability of wildlife.
11. Human-wildlife conflict and its mitigation
12. **Wildlife rules and regulations in Pakistan**
13. Wildlife management in Pakistan/AJK.
14. Wildlife rules and regulations in Pakistan/AJK.
15. **National and International agencies involved in conservation and management of wildlife**
	1. National Organizations
	2. International Organizations
16. **Protected Areas in Pakistan**

Protected areas (Sanctuaries, Game Reserves and National Parks) in Pakistan/ AJK.

**6.Introduction to some modern techniques used in wildlife conservation**

1. Radio telemetry,
2. remote camera,
3. TIR,
4. GPS,
5. GIS,
6. RS,
7. molecular analysis

**Practicals:**

1. Study of museum specimens and their classification (Birds and Mammals)
2. Demonstration of distribution of avian and mammalian fauna of Pakistan. (Blank maps may be provided).
3. Study of Birds and mammals census techniques.
4. Use of GPS in field studies.
5. Visit of Zoos, museums and protected areas

**Text and Reference Books:**

1. Miller, A.S. and Harley, J.B., 1999 & 2002. Zoology, Latest Edition (International). Singapore: McGraw-Hill.
2. Ali. S.S. 2005 Wildlife of Pakistan.
3. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
4. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
5. Roberts, T. J., 1991, 1992. The Birds of Pakistan, Vol. I1 and II. Oxford University Press
6. Roberts, T. J., 1997. The Mammals of Pakistan, Oxford University Press
7. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management.

McMillan, Cambridge.

1. Wildlife of the Punjab, Punjab Wildlife Department.
2. Khan M. S. 2011, Amphibian and Reptiles of Pakistan

Mirza Z.B. 2011 Biodiversity of Pakistan.