

CURRICULUM

OF

**ZOOLOGY
BS/MS**

(Revised 2018)



**HIGHER EDUCATION COMMISSION
ISLAMABAD**

CURRICULUM DIVISION, HEC

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Dr. Muhammad Idrees	Director (Curriculum)
Mr. Hidayatullah Kasi	Deputy Director (Curriculum)
Mr. Rabeel Bhatti	Assistant Director (Curriculum)
Mr. Muhammad Faisal Khan	Assistant Director (Curriculum)

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Composed by: Mr. Zulfiqar Ali, HEC, Islamabad

PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic program are required to undergo to achieve some specific objectives. It includes scheme of studies, objectives & learning outcomes, course contents, teaching methodologies and assessment/ evaluation. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula regularly through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

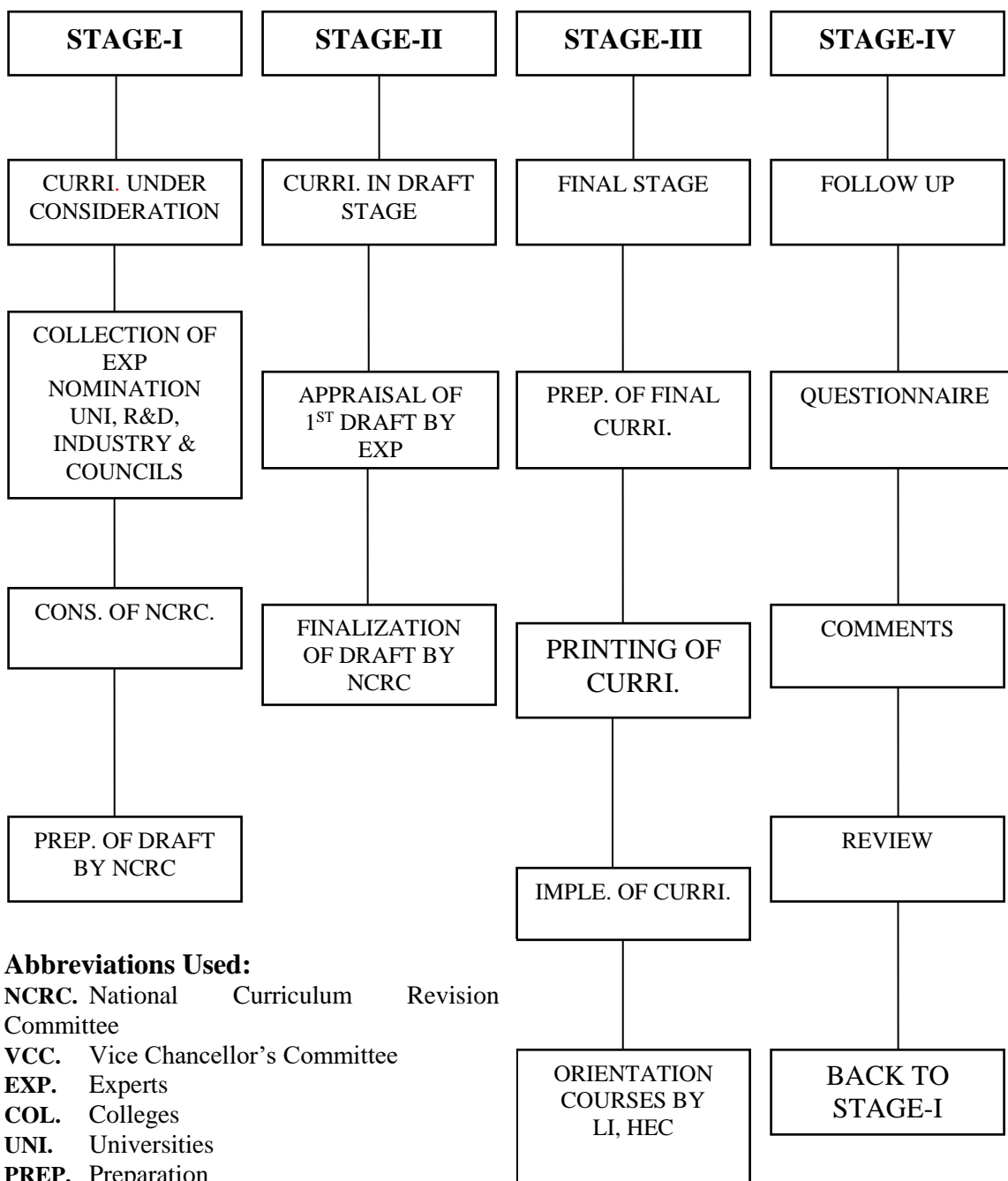
In order to impart quality education which is at par with indigenous needs and international standards, HEC NCRCs have developed unified framework/templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering.

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC

<http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx>

(Muhammad Raza Chohan)
Director General (Academics)

CURRICULUM DEVELOPMENT



Abbreviations Used:

NCRC. National Curriculum Revision Committee

VCC. Vice Chancellor's Committee

EXP. Experts

COL. Colleges

UNI. Universities

PREP. Preparation

REC. Recommendations

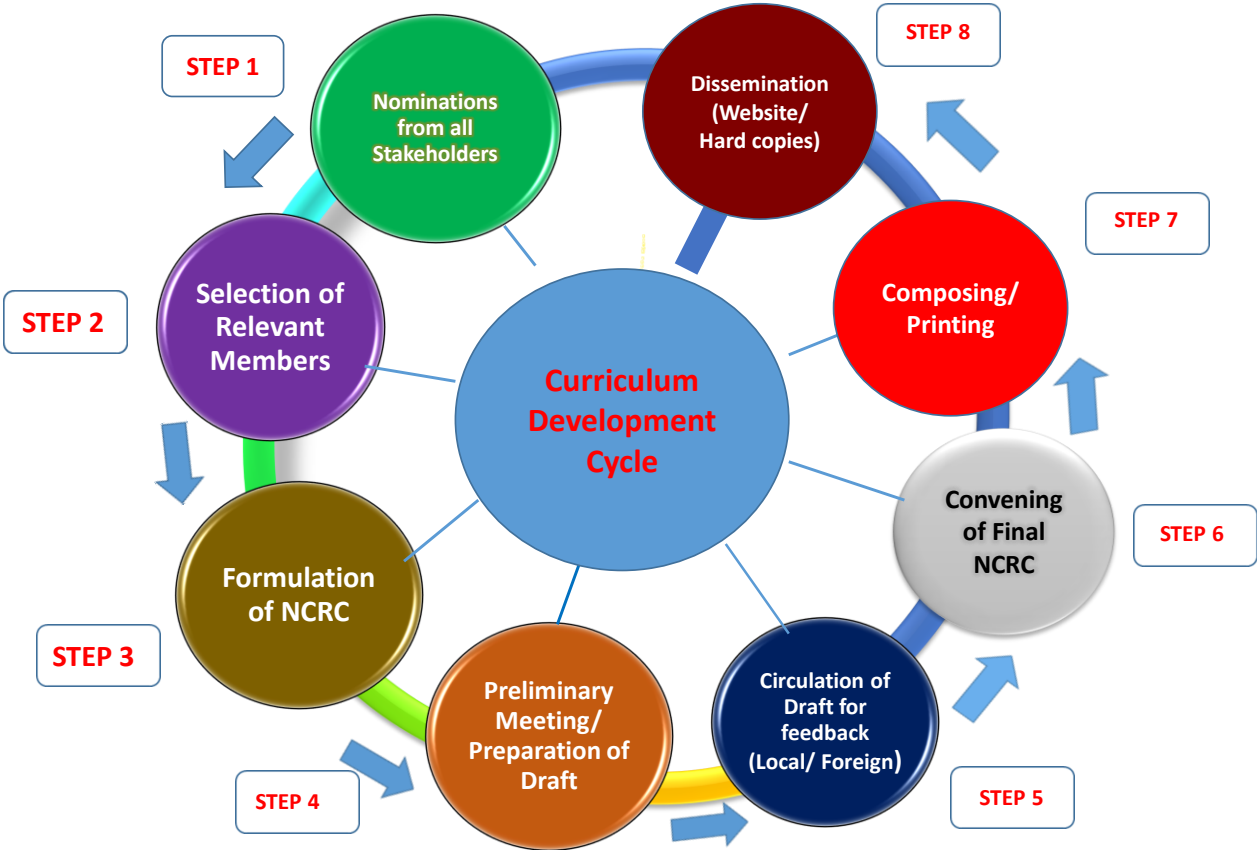
LI Learning Innovation

R&D Research & Development Organization

HEC Higher Education Commission

CONS: Constitution

CURRICULUM DEVELOPMENT CYCLE



Introduction:

The list of the participants who attended the meeting of National Curriculum Revision Committee (NCRC) Meeting for the discipline of Zoology is as below:

1.	Dr. Syed Shahid Ali, Professor / Coordinator, Institute of Molecular Biology & Biotechnology, Department of Zoology, The University of Lahore, Lahore.	Convener
2.	Dr. Muhammad Ramzan Ali, Principal Scientific Officer, Pakistan Agricultural Research Council, Aquaculture & Fisheries Program, NIH, NARC, Park Road, Islamabad.	Secretary
3.	Prof. Dr. Farkhanda Manzoor, Professor / HoD, Department of Zoology, Lahore College for Women University, Lahore.	Member
4.	Prof. Dr. Muhammad Naeem, Professor / Director, Institute of Pure & Applied Biology, Department of Zoology, Bahauddin Zakariya University, Multan.	Member
5.	Prof. Dr. Khawaja Raees Ahmad, Professor, Department of Zoology, University of Sargodha, Sargodha.	Member
6.	Prof. Dr. Hammad Ahmad Khan, Professor, Department of Zoology, Wildlife & Fisheries, Faculty of Sciences, University of Agriculture, Faisalabad.	Member
7.	Prof. Dr. Muhammad Arshad, Professor, Department of Zoology, University of Education, Lahore.	Member
8.	Dr. Rana Hadi, Professor, Department of Zoology Jinnah University for Women, Karachi.	Member
9.	Prof. Dr. Tahira Jabeen Ursani, Professor, Department of Zoology, University of Sindh, Jamshoro.	Member
10.	Prof. Dr. Akram Shah, Professor, Department of Zoology, University of Peshawar, Peshawar.	Member

11.	Prof. Dr. Rubina Mushtaq, Professor, Department of Zoology, Federal Urdu University of Arts Science & Technology, Karachi.	Member
12.	Dr. Muhammad Siddique Awan, Professor, Department of Zoology, City Campus, University of Azad Jammu & Kashmir, Muzaffarabad.	Member
13.	Dr. Nahid Kausar, Professor, Department of Zoology The Women University Multan, Multan.	Member
14.	Dr. Nabeela Tariq, Associate Professor / Chairperson, Department of Zoology, Sardar Bahadur Khan Women University, Quetta.	Member
15.	Dr. Muhammad Mansha, Associate Professor / Director QEC, Department of Zoology, University of Education, Lahore.	Member
16.	Dr. Noor Khan, Associate Professor, Department of Fisheries & Aquaculture, University of Veterinary & Animal Sciences, Lahore.	Member
17.	Dr. Nuzhat Sial, Associate Professor, Department of Life Sciences, BJ Campus, Islamia University, Bahawalpur.	Member
18.	Dr. Shamim Akhtar, Associate Professor, Department of Zoology, Faculty of Sciences, PMAS Arid Agriculture University, Rawalpindi.	Member
19.	Dr. Shagufta Saddozai, Associate Professor, Department of Zoology, Sardar Bahadur Khan Women University, Quetta.	Member
20.	Dr. Wali Muhammad Achakzai, Associate Professor, Department of Zoology, University of Balochistan, Quetta.	Member
21.	Dr. Dil Ara Abbas Bukhari, Associate Professor, Department of Zoology, GC University, Lahore.	Member
22.	Dr. Sumera Afsheen, Associate Professor, Department of Zoology, University of Gujrat, Gujrat.	Member

23.	Dr. Shahid Niaz Khan, Associate Professor / Chairman, Department of Zoology Kohat University of Science & Technology, Kohat.	Member
24.	Dr. Muhammad Zahid, Assistant Professor / HoD, Department of Zoology, Islamia College, Peshawar.	Member
25.	Dr. Akhtar Rasool, Assistant Professor, Centre for Animal Sciences & Fisheries, University of Swat, Kanju, Sector-D Campus, Swat.	Member
26.	Dr. Muhammad Shabaz Chattha, Assistant Professor, Department of Zoology, Women University of Azad Jammu & Kashmir, Bagh.	Member
27.	Dr. Syed Basit Rasheed, Assistant Professor, Department of Zoology, University of Peshawar, Peshawar.	Member
28.	Dr. Maisoor Ahmed Nafees, Assistant Professor, Faculty of Life Science, Department of Biological Sciences, Karakoram International University, Gilgit-Baltistan.	Member
29.	Dr. Rubina Arshad, Principal Scientist, Biological Sciences Division, Nuclear Institute for Agriculture & Biology (NIAB), Faisalabad.	Member
30.	Dr. Shahid Nadeem, Principal Scientist, Animal Sciences Division, Nuclear Institute for Agriculture & Biology (NIAB), Faisalabad.	Member
31.	Dr. Muhammad Idress, Director (Curriculum), Higher Education Commission, Islamabad.	Member
32.	Mr. Rabeel Bhatti, Assistant Director (Curriculum), Higher Education Commission, Islamabad.	Coordinator

RECOMMENDATIONS

After discussions and detailed deliberations, the committee unanimously made following recommendations:

1. Institutions must make arrangements that adequate number of teachers are available to teach core courses and courses from the school of major disciplines for the BS degree course.
2. It is strongly recommended that fresh Ph.Ds. may be appointed in affiliated colleges under Interim Placement Faculty Program (where BS program is introduced) to address the issue of qualified resource persons.
3. The system of online access to the academic resources i.e. journals, books and reports etc. must be provided to all universities, research institutions and affiliated colleges through institutional servers and beyond (preferably on the pattern of “turnitin.com”).
4. Since teacher is the key person in teaching-learning process, it is imperative that he/she should be aware of or have means to be aware of the latest developments in Zoological Sciences. In order to ensure this, it is strongly recommended that all the Universities of Pakistan should hold refresher courses at graduate level.
5. Upgradation of laboratories and libraries is essential to cope with the revised curriculum for effective delivery, assessment and evaluation. Prescribed facilities must be made available for BS (4 Years) Zoology program.
6. Zoology is a field-oriented science; it is essential that institutions make adequate arrangements and provide facilities for fieldwork at all levels.
7. Teaching faculty may be provided with opportunities / resources to visit foreign universities to update their knowledge and skill in accordance with the recent disciplines and research trends.
8. For efficient laboratory management, adequately trained technicians/ engineers may be employed. They should be responsible for processing samples and maintenance of laboratory equipment.
9. All colleges and universities involved in Zoology teaching must submit PC-1 form to HEC/HED to procure funds to run BS (4 Years) Zoology program effectively.
10. Linkage in both teaching and research disciplines be encouraged between the universities, research organizations and industries.
11. HEC may entertain all research institutes/degree awarding institutes (DAI) who apply for funding under National research program for universities (NRPU) and all other projects.
12. Universities must promote Entrepreneurship skills among students to enhance self-employability.
13. Universities must encourage out-reaching and out-sourcing of research facilities in the departments.
14. NCRC members must develop text books comprising course outlines.

BS (4 YEARS) ZOOLOGY PROGRAM

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 Genetics, Physiology, Ecology, Developmental Biology, Microbiology, Parasitology, Entomology, Evolution, Taxonomy, Freshwater Biology, Fisheries and Wildlife etc. This subject has significant role in human resource development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.

Eligibility Criteria:

Eligibility Criteria for BS: F.Sc. Pre medical/ A level (with Biology and Chemistry)

Eligibility Criteria for MS: BS in Zoology/ MSc in Zoology (16 years study)

Objectives and Outcomes:

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

Career Opportunities:

After obtaining the BS degree in Zoology, the graduates will be able to get jobs in wide range of professions including:

Positions in various government and non governmental organizations, teaching and research, administration and management, aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, lab diagnostics, poultry, plant protection, wildlife, livestock and other areas.

Pedagogy (Teaching - Learning Methodologies)

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

Assessment and Evaluation:

Internal evaluation (left to the individual universities)

Mid term test
Seminars and Assignments
Final Examination

SCHEME OF STUDIES FOR BS ZOOLOGY (4 YEAR PROGRAM)

- Total number of Credit hours (Flexible from 133-136)
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 8
- Course Load per Semester 15-18 Cr hr
- Number of courses per semester 5-6

Compulsory Requirements (the student has no choice)		General Courses to be chosen from other departments		Discipline Specific Foundation Courses	
9 courses		7-8 courses		9-10 courses	
Subject	Cr. hr	Subject	Cr. Hr	Subject	Cr. hr
i. English-I: Functional English	3(3+0)	i. Botany-I	3(2+1)	i. Animal Diversity-I (Invertebrates)	4(3+1)
ii. Pakistan Studies	2(2+0)	ii. Chemistry-I	3(2+1)	ii. Animal Diversity-II (Chordates)	4(3+1)
iii. Mathematics-I	3(3+0)	iii. Botany-II	3(2+1)	iii. Cell Biology	3(2+1)
iv. English-II: Communication Skills	3(3+0)	iv. Chemistry-II	3(2+1)	iv. Animal Form & Function-I	4(3+1)
v. Islamic Studies / Ethics	2(2+0)	v. Botany-III	3(2+1)	v. Animal Form & Function-II	4(3+1)
vi. English-III: Technical writing and presentation skills	3(3+0)	vi. Chemistry-III	3(2+1)	vi. Economic Zoology	3(2+1)
vii. Introduction to Computer	3(1+2)	vii. Social Sciences/Univ. Option**	2(2+0)	vii. Biochemistry-I	3(2+1)
viii. English-IV / Univ. Option*	3(3+0)	viii. Psychology/Geography/Etc**.	2(2+0)	viii. Biochemistry -II	3(2+1)
ix. Biostatistics/Univ option	3(2+1)			ix. Evolution	2(2+0)
				x. Principles of Systematics	3(2+1)
	25		22		33

Major courses including research project/ internship		Elective Courses within the major	
11-13 courses		4 courses	
Subject	Cr. hr	Subject	Cr. hr
i. Animal Behavior	3(3+0)	Special PaperA2/Elective-I*****	3(2+1)
ii. Biological Techniques	3(1+2)	Special PaperB2/ Elective –II *****	3(2+1)
iii. Molecular Biology	3(2+1)	Elective –III*****	3(2+1)
iv. Physiology	4(3+1)	Elective –IV*****	3(2+1)
v. Ecology	3(2+1)		
vi. Developmental Biology	4(3+1)		
vii. Genetics	4(3+1)		
viii. Wildlife	3(2+1)		
ix. Zoogeography & Paleontology	3(2+1)		
x. Research Methodology	2(2+0)		
xi. Bioinformatics	3(1+2)		
xii. Special Paper A1***/ Thesis(Univ. Option)****	3(2+1)/ (0+3)		
iii. Special Paper B1/ Thesis(Univ. Option)****	3(2+1) /(0+3)		
	41		12

* University has the option to recommend any other course in lieu of English IV

** Sociology, social work, principles of management, Ethical and moral values in society

*** Aquaculture, Fisheries and fish farming, Mariculture, Apiculture, Taxidermy, Sericulture, Parasitology, Microbiology, Molecular biology, Entomology, Pest Control, Ornithology, Ostrich farming, Quail farming, Immunology, Vaccine production, Environmental Sciences, Endocrinology, etc. (universities may offer any other special paper depending upon the availability of the expertise)

**** Research Thesis will be offered over two semesters and report will be submitted at the end of semester VIII for the evaluation

***** All elective subjects should be selected to support the opted special paper/thesis. Special paper students will take 2 elective papers as special papers and 2 as elective and those opting for research will take 2 courses as elective.

FORMAT/SCHEME OF STUDIES FOR 4-YEAR INTEGRATED CURRICULA FOR BS IN ZOOLOGY

STRUCTURE:

Sr. No.	Categories	No. of Courses	Credit Hours
1.	Compulsory Requirement (No Choice)	09	25
2.	General Courses to be chosen from other departments	08	22
3.	Discipline Specific Foundation Courses	09	33
4.	Major Courses including Research Project / Internship	12	41
5.	Electives within the Major	04	12
	Total	42	133

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

**CURRICULUM BS 4 YEARS (8 SEMESTERS)
PROGRAM IN ZOOLOGY**

Year-1

SEMESTER-I

Course Category	Course Title	Credits
COMPULSORY-I	English-I: Functional English	3(3+0)
COMPULSORY-II	Pakistan Studies	2(2+0)
COMPULSORY-III	Mathematics-I	3(3+0)
GENERAL- I	Botany-I	3(2+1)
GENERAL- II	Chemistry-I	3(2+1)
FOUNDATION-I	Animal Diversity-I (Invertebrates)	4(3+1)
	Total Credits	18

SEMESTER-II

Course Category	Course Title	Credits
COMPULSORY-IV	English-II: Communication Skills	3(3+0)
COMPULSORY-V	Islamic Studies / Ethics	2(2+0)
FOUNDATION-II	Animal Diversity-II (Chordates)	4(3+1)
GENERAL- III	Botany-II	3(2+1)
GENERAL- IV	Chemistry-II	3(2+1)
FOUNDATION-III	Cell Biology	3(2+1)
	Total Credits	18

Year-II

SEMESTER-III

Course Category	Course Title	Credits
COMPULSORY-VI	English-III: Technical writing and presentation skills	3(3+0)
COMPULSORY-VII	Introduction to Computer	3(1+2)
GENERAL- V	Botany-III	3(2+1)
GENERAL- VI	Chemistry-III	3(2+1)
GENERAL- VII	Social Sciences	2(2+0)
FOUNDATION-IV	Animal Form & Function-I	4(3+1)
	Total Credits	18

SEMESTER-IV

Course Category	Course Title	Credits
COMPULSORY-VIII	English-IV / Univ. Option	3(3+0)
MAJOR-I	Animal Behavior	3(3+0)
FOUNDATION-V	Biochemistry-I	3(2+1)
MAJOR-II	Biological Techniques	3(1+2)
FOUNDATION-VI	Animal Form & Function-II	4(3+1)
GENERAL-VIII	Psychology/Geography/Etc.	2(2+0)
	Total Credits	18

YEAR-III

SEMESTER-V

Course Category	Course Title	Credits
FOUNDATION-VII	Economic Zoology	3(2+1)
FOUNDATION-VIII	Biochemistry-II	3(2+1)
MAJOR-III	Physiology	4(3+1)
MAJOR-IV	Ecology	3(2+1)
FOUNDATION IX	Evolution	2(2+0)
	Total Credits	15

SEMESTER-VI

Course Category	Course Title	Credits
MAJOR-V	Research Methodology	2(2+0)
FOUNDATION-X	Principles of Systematics	3(2+1)
MAJOR-VI	Developmental Biology	4(3+1)
MAJOR-VII	Genetics	4(3+1)
MAJOR-VIII	Wildlife	3(2+1)
	Total Credits	16

YEAR-IV

SEMESTER-VII

Course Category	Course Title	Credits
MAJOR-IX	Special Paper A1/ Thesis(Univ. Option)	3(2+1)/ 0+3
COMPULSORY-IX	Biostatistics/Univ option	3(2+1)
ELECTIVE-I	Special Paper A2/ Univ. opt	3(2+1)
ELECTIVE-III	Univ. opt	3(2+1)
MAJOR-X	Molecular Biology	3(2+1)
	Total Credits	15

SEMESTER–VIII

Course Category	Course Title	Credits
MAJOR-XI	Bioinformatics	3(1+2)
MAJOR-XII	Special Paper B1/ Thesis(Univ. Option)	3(2+1)/ 0+3
ELECTIVE-II	Special Paper B2/Univ. opt	3(2+1)
ELECTIVE-IV	Univ. opt	3(2+1)
MAJOR-XIII	Zoogeography & Paleontology	3(2+1)
	Total Credits	15

$$18+ 18+18+18+15+16+15+15=133$$

DETAIL OF COURSES

Year–I SEMESTER–I

Course Category	Course Title	Credits
COMPULSORY-I	English-I: Functional English	3(3+0)
COMPULSORY-II	Pakistan Studies	2(2+0)
COMPULSORY-III	Mathematics-I	3(3+0)
GENERAL- I	Botany-I	3(2+1)
GENERAL- II	Chemistry-I	3(2+1)
FOUNDATION-I	Animal Diversity-I (Invertebrates)	4(3+1)
	Total Credits	18

COMPULSORY–I (ENGLISH-I: FUNCTIONAL ENGLISH) Cr: 3(3+0)

Objectives:

The course aims to:

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

Course Contents:

Basics of Grammar: Parts of speech and use of articles, Sentence structure, Active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verb, Punctuation and spelling.

Comprehension: Answers to questions on a given text

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

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

Translation skills: Urdu to English

Paragraph writing: Topics to be chosen at the discretion of the teacher

Presentation skills: Introduction to presentations and deliberations

Note: Extensive reading is required for vocabulary building

Books Recommended:

1. Thomson, A.J., Martinet, A.V. 1997. Practical English Grammar and Exercises 3rd Ed. Oxford University Press.
2. Boutin, M-C., Brinand, S., Grellet, F. 1993. Writing. Intermediate and Supplementary Skills. Oxford Fourth Impression
3. Tomlinson, B., Ellis, R. 1992. Reading. Upper Intermediate. Oxford Supplementary Skills. Third Impression.

**COMPULSORY– II
(PAKISTAN STUDIES)**

Cr: 2(2+0)

Objectives:

The course aims to:

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

Course Contents:

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

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

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

Books Recommended:

1. Zaidi A.S. 2000. Issue in Pakistan's Economy. Karachi: Oxford University Press.

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

COMPULSORY– III (MATHEMATICS-I)

Cr: 3(3+0)

Objectives:

The course aims to:

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

Course Contents:

Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

Matrices: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression.

Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices. Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Books Recommended:

1. Swokowski, E.W. 1986. Fundamentals of Algebra and Trigonometry. 6th Ed., PWS-Kent Company.
2. Kaufmann, J.E., 1987. College Algebra and Trigonometry. PWS-Kent Company, Boston.
3. Dolciani, M.P., Wooton, W., Beckenback, E.F., Sharron, S. 1978. Algebra 2 and Trigonometry, Houghton & Mifflin.

GENERAL-I

(BOTANY-I/ETC.)

Cr: 3(2+1)

- As per prescribed curriculum of Botany/other

GENERAL- II

(CHEMISTRY-I/ETC.)

Cr: 3(2+1)

- As per prescribed curriculum of Chemistry/other

FOUNDATION-I

ANIMAL DIVERSITY-I (INVERTEBRATES)

Contact Hours:

Theory = 48
Practical = 32
Total = 80

Credit Hours:

Theory = 3.0
Practical = 1.0
Total = 4.0

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 occurred and able to breed animal in the laboratory/field
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.

1. INTRODUCTION

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

2. ANIMAL-LIKE PROTISTS: THE PROTOZOA

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

3. MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

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

Phylum Porifera

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

Phylum Cnidaria (Coelenterate)

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

Phylum Ctenophore;

- a. Characteristics, body organization

4. THE TRIPLOBLASTIC AND WITH ACOELOMATE BODY PLAN

PHYLUM PLATYHELMINTHES

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

Phylum Numerate; Characteristics, body organization

Phylum Gastrotrich; Characteristics, body organization

5. PSEUDOCOELOMATE BODY PLAN

PHYLUM ASCHELMINTHS

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

6. PHYLUM MOLLUSCA

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

7. PHYLUM ANNELIDA

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

8. PHYLUM ARTHROPODA:

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

The Hexapods and Myriapods:

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

10. PHYLUM ECHINODERMS

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

SOME LESSER-KNOWN INVERTEBRATES;

- a. The Lophophorates, Entoprocts, Cyclophores, and Chaetognaths.

Practical:

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

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosome, Paramecium as representative of animal like Protists.
2. Study of prepared slides of sponges, spicules of sponges, and their various body forms. Study of representatives of classes of Phylum Porifera.
3. Study of principal representatives of classes of Phylum Coelenterate.
4. Study of principal representatives of classes of Phylum Platyhelminthes.
5. Study of representatives of phylum Rotifer, Phylum Nematode.
6. 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 Echinodermata.
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

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
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:

2. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
3. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2007. INTEGRATED PRINCIPLES OF ZOOLOGY, 12th& 13th Edition (International). Singapore: McGraw-Hill.
4. Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition, (International), Singapore: McGraw-Hill.
5. Kent, G. C. and Miller, S., 2001. COMPARATIVE ANATOMY OF VERTEBRATES New York: McGraw-Hill.
6. Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin Cummings Publishing Company, Inc.
BOOKS FOR PRACTICAL
7. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), Singapore : McGraw-Hill.
8. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore : McGraw-Hill.

SEMESTER-II

Course Category	Course Title	Credits
COMPULSORY-IV	English-II: Communication Skills	3(3+0)
COMPULSORY-V	Islamic Studies / Ethics	2(2+0)
FOUNDATION-II	Animal Diversity-II (Chordates)	4(3+1)
GENERAL- III	Botany-II	3(2+1)
GENERAL- IV	Chemistry-II	3(2+1)
FOUNDATION-III	Cell Biology	3(2+1)
	Total Credits	18

ENGLISH - II (COMMUNICATION SKILLS)

Course Objectives:

The course aims to:

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

Course Contents:

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

Essay writing: Introduction

CV and job application: Translation skills; Urdu to English

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

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

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

Note: documentaries to be shown for discussion and review

Books Recommended:

1. Boutin, Marie-Christine, Brinandm, S.,Grellet, F. 1993. Writing: Intermediate. Oxford Supplementary Skills.Fourth Impression.
2. Nolasco, R. 1992. Writing: Upper-Intermediate. Oxford Supplementary Skills. Fourth Impression.(particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
3. Tomlinson,B., Ellis, R. 1991. Reading. Advanced.Oxford Supplementary Skills.Third Impression.
4. Thomson, A.J., Martinet, A.V. 1986. Practical English Grammar Exercises 2. 3rd Ed.Oxford University Press.
5. Langan, J. Reading and Study Skills by Riachard York.

ISLAMIC STUDIES

Objectives:

This course aims to:

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

Course Contents:

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

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

Study of Selected Text of Holly Quran: Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.), Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment, Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

Seerat of Holy Prophet (S.A.W) I: Life of Muhammad Bin Abdullah (Before Prophet Hood); Life of Holy Prophet (S.A.W) in Makkah; Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II: Life of Holy Prophet (S.A.W) in Madina: Important Events of Life Holy Prophet in Madina; Important Lessons Derived from the life of Holy Prophet in Madina

Introduction to Sunnah: Basic Concepts of Hadith; History of Hadith; Kinds of Hadith; Uloom –ul-Hadith; Sunnah & Hadith; Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence: Basic Concepts of Islamic Law & Jurisprudence; History & Importance of Islamic Law & Jurisprudence; Sources of Islamic Law & Jurisprudence; Nature of Differences in Islamic Law; Islam and Sectarianism

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

Islam & Science: Basic Concepts of Islam & Science; Contributions of Muslims in the Development of Science; Quranic & Science

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

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

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

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

Books Recommended:

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

GENERAL–III

(BOTANY–II/ETC.)

Cr: 3(2+1)

- As per prescribed curriculum of Botany/other

GENERAL–IV

(CHEMISTRY– II/ETC.)

Cr: 3(2+1)

- As per prescribed curriculum of Chemistry/other

FOUNDATION–II

Animal DiversityII

Contact Hours:

Theory = 48

Practical = 32

Total = 80

Credit Hours:

Theory = **3.0**

Practical= 1

Total = **4.0**

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 protochordates and various classes of chordates.
3. To develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

Course 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**
 - a. Classification of protochordates.
 - b. Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates
 - c. Reproduction; life histories and metamorphosis of protochordates.
 - d. Phylogenetic relationships.
2. **Fishes:**
 - a. Vertebrate Success in Water.
 - b. Phylogenetic relationships of Pisces.
 - c. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli
 - d. Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).
3. **Amphibians:**
 - a. The first terrestrial vertebrates. Characteristics of amphibians
 - b. Phylogenetic relationships.
 - c. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura.
 - d. Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperatureregulation, nervous and sensory functions, excretion and
 - e. Osmoregulation, reproduction, development, and metamorphosis of caudate, anura and Gymnophiona.
4. **Reptiles:**
 - a. The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.
 - b. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia

- c. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development of helonia, squamata, Rhynchocephalia and crocodilian.
- d. Further phylogenetic considerations.

5. Birds:

- a. Classification, Feathers, flight and endothermy.
- b. Phylogenetic relationships; ancient birds and the evolution of flight.
- c. Diversity of modern birds.
- d. Adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development.
- e. Migration and navigation.

6. Mammals:

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

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

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions) 50%
- Assignments 25%
- Quiz 25%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 10%
- Assignments 20%
- Quiz 20%

Text and Reference Books:

1. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
2. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
3. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
4. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.
5. Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.

FOUNDATION-III

CELL BIOLOGY

Contact Hours

Theory = 32
Practical = 32
Total = 64

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

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. **Introduction cell structure and function**
 - a. Cell theory
 - b. Comparison of plant and animal cells
 - c. Comparison of prokaryotic and eukaryotic cells
2. **Cell membranes**
 - a. Structural models

- b. Chemical composition and function
3. **Cell Organelles (structure and function)**
 - a. Endoplasmic reticulum
 - b. Golgi Bodies
 - c. Mitochondria
 - d. Lysosomes
 - e. Peroxisomes
 - f. Ribosome
4. **Nucleus**
 - a. Structure and function
 - b. Nuclear membrane
 - c. Chromatin
5. **Cytoskeleton**
 - a. Structure and types
 - b. Function of cytoskeleton
6. **Cellular transport**
 - a. Diffusion and osmosis
 - b. Facilitated and active transport
 - c. Endocytosis and exocytosis
7. **Cellular reproduction**
 - a. Cell cycle
 - b. Mitosis
 - c. Meiosis

Practical:

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

Teaching Methodology:

- Lecturing
- Written Assignments
- Practical
- Guest speaker

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%

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, 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.

Year-II**SEMESTER- III**

Course Category	Course Title	Credits
COMPULSORY-VI	English-III: Technical writing and presentation skills	3(3+0)
COMPULSORY-VII	Introduction to Computer	3(1+2)
GENERAL- V	Botany-III	3(2+1)
GENERAL- VI	Chemistry-III	3(2+1)
GENERAL- VII	Social Sciences/Univ. Option	2(2+0)
FOUNDATION-IV	Animal Form & Function-I	4(3+1)
	Total Credits	18

COMPULSORY-VII**ENGLISH III (TECHNICAL WRITING AND PRESENTATION SKILLS)****Cr: 3(3+0)****Course Objectives:**

The course aims to:

1. Enhance language skills
2. Develop critical thinking

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

Academic writing: How to write a proposal for research paper/term paper
How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing:

Progress report writing:

Note: Extensive reading is required for vocabulary building

Books Recommended:

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

COMPULSORY–VIII

INTRODUCTION TO COMPUTER Cr: 3(1+2)

- As per prescribed curriculum of Computer Science

GENERAL–V

BOTANY- III/ ETC. Cr: 3(2+1)

- As per prescribed curriculum of Botany/other

GENERAL–VI

CHEMISTRY- III/ ETC. Cr: 3(2+1)

- As per prescribed curriculum of Botany/other

FOUNDATION– IV

ANIMAL FORM AND FUNCTION- I (A COMPARATIVE PERSPECTIVE)

Contact Hours

Theory	=48
Practical	=32
Total	=80

Credit Hours:

Theory	=3.0
Practical	=1.0
Total	=4.0

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:**
 - a. Protection: the integumentary system of invertebrates and vertebrates;

- b. Movement and support: the skeletal system of invertebrates and vertebrates;
 - c. Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates
2. **Communication I:**
- a. Nerves: Neurons: structure and function.
3. **Communication II:**
- a. Senses: Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygrometers, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates
 - b. Lateral line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.
4. **Communication III:**
- a. The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action
 - b. Hormones with principal function each of porifera, cnidarians, platyhelminthes, nemertean, nematodes, 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:**
- a. Internal transport and circulatory systems in invertebrates
 - b. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells
 - c. transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response

Practicals:

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of Labeo (*Labeo rohita*), Frog (*Hoplobatrachus tigerinus*), Varanus (*Varanus bengalensis*), fowl (*Gallus gallus domesticus*) and rabbit (*Oryctolagus cuniculus*).

Note: Exercises of notes on the adaptations of skeletons to their function must be done.

3. Earthworm or leech; cockroach, freshwater mussel, Channa or 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).

Books Recommended:

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

SEMESTER-IV

Course Category	Course Title	Credits
COMPULSORY-VIII	English-IV / Univ. Option	3(3+0)
MAJOR-I	Animal Behavior	3(3+0)
FOUNDATION-V	Biochemistry-I	3(2+1)
MAJOR-II	Biological Techniques	3(1+2)
FOUNDATION-VI	Animal Form & Function-II	4(3+1)
GENERAL-VIII	Psychology/Geography/Etc.	2(2+0)
	Total Credits	18

COMPULSORY-IX (ENGLISH- IV/ UNIV. OPTION)

Cr: 3(3+0)

- As per university decision

GENERAL-VII (BOTANY- IV/ ETC.)

Cr: 3(2+1)

- As per prescribed curriculum of Botany/other

MAJOR-I

ANIMAL BEHAVIOUR

Contact Hours:

Theory =48

Practical = 0

Credit Hours:

Theory = 3.0

Total = 48

Course Objectives:

The objectives of the course are:

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

Course Learning Outcomes:

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

1. OUTLINE the baseline information and knowledge for animal behavior.
2. ASSOCIATE the likely role of external and internal stimuli on various animals during the day, season and year.
3. RELATE daily behavioural rhythms in diurnal and nocturnal periodicities.
4. PREDICT and anticipate variety of animal actions (costs and benefits) as assessed by innate and learned behaviours; displays.
5. INTEGRATE the animal behavior as balanced mechanism to develop animal personality.

Course Outline (Contents)

1. Introduction

- Behaviour and its types
- Proximate and ultimate causes of behaviour.
- Development of behavior and impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses. Physiology of behavior in changed environments.
- Hormones and behavior in animals.
- Innate behavior and innate releasing mechanisms; built in programmed performance by offspring to that of parents. Innate behavior of three spined stickle back fish.
- Learned behavior and its mechanisms; quick learners' vs slow learners. Concept of animal cognition; key to understand and develop multiple behavioural choices. Ecological and genetics to maintain animal behavior. Concept of territoriality and defense in animals.
- Circadian rhythms and concept of bio-rhythmicity in animals. Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities.

- Costs and benefit ratios in behavior; successful foragers and winners of predator-prey relationships. Altruism and parental sacrifice to nurture the young.
- Competition for resources; survival of the most suitable individuals; evolutionary arms races in behavior.
- Social organization in animals and concept of group living; benefits and losses. Aggression, appeasement and selfish individuals. Social organization in insects and mammals.
- Communication in animals: Visual, Bioacoustic, electrical, chemical and tactile.
- Various types of chemical signals in animals' behavior and their importance in ecosystems.

TEXT AND REFERENCE BOOKS:

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

FOUNDATION–IV

BIOCHEMISTRY-1

Contact Hours:

Theory =34
 Practical = 48
 Total = 82

Credit Hours:

Theory =**2.0**
 Practical = 1.0
 Total = **3.0**

Course Objectives:

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

Course 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 problem-based assignments;

Course Contents

1. Introduction to Macromolecules

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

2. Amino acids, peptides & proteins:

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

2.1. Purification Techniques for Proteins

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

2.2. Organization of proteins:

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

3. Enzymes

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

4. Lipids:

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

4.1. 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.

5. Nucleic acids

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

Practical:

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

Teaching Methodology:

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

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
Assignments & Presentation	(15%)

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

2. Biochemistry by Jeremy M. Berg , John L. Tymoczko; Lubert Stryer ,ISBN-10:1429229365,ISBN-13:97814229229364
3. Berg, J. M.,Tymoczko,J. L., Lubert Stryer. 2010. Biochemistry. 7th Ed.
4. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D, Darnell, J. 2012. Molecular Cell Biology.
5. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.
6. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet. D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.
7. Zubay, G., 1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
8. Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York.
9. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan Worth Publishers, New York.
10. McKee, T., McKee, J.R. 2003.Biochemistry:
11. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
12. Lodish, H., Berk, A., Zipursky, S. L., Paul.M., Baltimore D,Darnell, J. 2012. Molecular Cell Biology.
13. McKee, T., McKee, J.R. 2003.Biochemistry:
14. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
15. Molecular cell biology W.H Freeman by Lodish, Berk, Krieger, Scott, Bretscher,Ploegh and Matsudaira 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.

MAJOR-II

BIOLOGICAL TECHNIQUES

Contact Hours:

Theory =16
 Practical = 64
 Total = 80

Credit Hours:

Theory =1.0
 Practical =2.0
 Total =3.0

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 equipments handling/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:

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

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

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

3. Specimen preparation for optical microscopy:

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

4. Separation and purification techniques:

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

5. Chromatography:

- a. Chromatography: Principle, applications, types,
- b. Paper chromatography and thin layer chromatography
- c. Column chromatography
- d. High pressure liquid chromatography.

e. Electrophoresis: Principle, applications and types (Agarose and PAGE).

6. Spectrophotometry:

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

7. Basic principles of Sampling and Preservation:

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

8. DNA sequencing

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

Practical's:

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

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
Assignments & Presentation	(15%)

Books Recommended:

1. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.

2. Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part I. Cambridge University Press, UK.
3. Cheesbrough, M. 1998. District Laboratory Practice in Tropical Countries. Part II. Cambridge University Press, UK.
4. Curos, M. 1997. Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.
5. Curos, M. 1997. Environmental Sampling and Analysis: For Technician. CRC Press LLC. USA.
6. Slingsby, D., Cock, C. 1986. Practical Ecology. McMillan Education Ltd. London.
7. Rob Reed/ David HOLMES, Jonathan Weyers/ Allan Jones Pearson, Practical skill in bio-molecular sciences.
8. Gallagher, S.R. and Wiley E.A. 2008. Current protocols essential laboratory Techniques. John Wiley & Sons Inc, USA.
9. Jones, A. Reed, R and Weyers, J. 1994. Practical skills in Biology. Longman Singapore Publishers (Pte) Ltd.

FOUNDATION-VI

ANIMAL FORM AND FUNCTION-II (A COMPARATIVE PERSPECTIVE)

Contact Hours

Theory	= 48
Practical	= 32
Total	= 80

Credit Hours:

Theory	=3.0
Practical	=1.0
Total	=4.0

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:

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

2. Temperature and Body Fluid Regulation:

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

3. Reproduction:

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

Practicals:

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

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

Books Recommended

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

GENERAL–VIII

(PSYCHOLOGY/GEOGRAPHY/ ETC.)

Cr: 2(2+0)

- As per prescribed curriculum of the subject

YEAR–III

SEMESTER–V

Course Category	Course Title	Credits
FOUNDATION-VII	Economic Zoology	3(2+1)
FOUNDATION-VIII	Biochemistry-II	3(2+1)
MAJOR-III	Physiology	4(3+1)
MAJOR-V	Ecology	3(2+1)
FOUNDATION X	Evolution	2(2+0)
	Total Credits	15

FOUNDATION-VII

ECONOMIC ZOOLOGY

Contact Hours

Theory = 32
Practical = 32
Total = 64

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

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

Course 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, Quail, Turkey, Ostrich and Pigeon).

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.

Teaching Methodology

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Assignments 20%
- Presentation 10%
- Report Writing 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Assignments 20%
- Presentation 10%
- Report Writing 10%

Text and Reference books:

1. *Economic Zoology*. Ravindranathan, K. R. 2003. 1st ed. Dominant Publishers and Distributors. New Delhi. India
2. *Principles of Wildlife Management*. Bailey, J. A. 1986. John Wiley and Sons Inc. USA.
3. *Wildlife ecology and management*. Robinson, W. L. and Bolen, E. G. 1984. McMillan Publishing Company. Cambridge, UK.
4. *A Primer of Conservation of Biology*. Primack R. B. 2000. 2nd ed. Sinauer Associates Inc. USA.
5. *Animal biodiversity of Pakistan*. Mirza, Z. B. 1998. 1st ed: Printopack, Rawalpindi. Pakistan.
6. Ahmad, R. and Muzaffar, N., 1987. Rearing of Silkworm. Misc. Pub. Pak. Agric. Res. Council, pp. 53.
7. Akhtar, M. and Muzaffar, N., 2008. Introduction to Apiculture, Department of Zoology, Punjab University Press, 36 pp.
8. Anon, 1986. The Hive and the Honeybee. Dadant & Sons. Illinois, USA, pp. 740.

9. Anon, 1999. FAO Bulletins on Sericulture Nos. 1 & 2. FAO Office, Rome, Italy.
10. Blackiston, H., 2001. Beekeeping for Dummies. Wiley Publishing, Inc. Indiana, USA, pp. 303.
11. Shukla, G.S. and Upadhayay, V.B., 1997. Economic Zoology, 3rd Ed. Rastogi Publications, Meerut, India, pp. 369.

FOUNDATION–VIII

BIOCHEMISTRY II

Contact Hours:

Theory =32
 Practical = 32
 Total = 64

Credit Hours:

Theory =**2.0**
 Practical =1.0
 Total =**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, self-directed and critical learning.

Course Contents

1. Bioenergetics

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

2. Metabolism

- a. Detailed description of Glycolysis and Catabolism of other Hexoses;
- b. Regulation and Bioenergetics of Glycolysis. Anabolic role of Glycolysis;
- c. Fate of Pyruvate under Aerobic and Anaerobic conditions, Lactate and Alcoholic Fermentation;
- d. Gluconeogenesis, its Regulation and significance in the tissues; Feeder Pathways in Glycolysis; Utilization of other carbohydrates in Glycolysis;
- e. Phosphorolysis of Glycogen and Starch; Regulation of Glycogen metabolism; Utilization of dietary polysaccharides (Starch) and Disaccharides (Sucrose and Galactose). Biosynthesis of Glycogen, Starch and Sucrose;
- f. Pentose phosphate pathway of Glucose oxidation and its major role in the animal tissues.
- g. Citric acid (TCA) cycle: Conversion of Pyruvate to Acetyl CoA, Pyruvate dehydrogenase, a multi-enzyme complex;
- h. Detailed description of citric acid cycle; Bioenergetics and conservation of Energy produced in the cycle. Anabolic or Biosynthetic role of citric acid cycle intermediates; Replenishing or Anaplerotic reactions and their role; Regulation of Citric acid cycle.

3. Lipid metabolism

- a. Digestion, mobilization and transport of Fats; Biosynthesis of Triacylglycerol;
- b. Utilization of Triacylglycerol; Oxidation of Fatty acids; Activation of Fatty acids and their transportation to mitochondria;
- c. Beta (β)-Oxidation; Bioenergetics of β -oxidation; Omega (ω)-Oxidation pathway;
- d. Biosynthesis of Saturated Fatty acid, Supply of raw material for palmitic acid synthesis; Fatty acid synthetase (FAS) multienzyme complex;
- e. Models of FAS system in Bacteria, Plants, vertebrate tissue and Yeast cell; Biosynthesis of unsaturated Fatty acids, Aerobic and Anaerobic pathways. Ketone bodies and their biosynthesis, utilization and role in the tissues;

4. Cholesterol metabolism

- a. Cholesterol biosynthesis and its Regulation; Steroid hormones, their types and main functions; Prostaglandins, their types, synthesis, inhibition and main functions.

5. Nitrogen metabolism

- a. Metabolic fate of amino acids; Catabolism of amino acids; Deamination and Transamination;
- b. Role of glutamate, glutamine and alanine in transport of ammonia in tissues;
- c. Nitrogen excretion and urea cycle; Regulation of urea cycle;
- d. Pathways of amino acid degradation showing entry points in Citric acid cycle; Decarboxylation of amino acids to biological amines.

- e. Biosynthesis of some amino acids; Incorporation of ammonia in glutamate and glutamine;
- f. Purine and Pyrimidine biosynthesis showing the sources of various atoms in both molecules.

Practical:

1. Preparation of standard curve of proteins using Lowry's technique.
2. Estimation of tissue (liver) proteins using Lowry's technique.
3. Estimation of Free Amino Acids in Biological samples colorimetrically.
4. Separation and identification of various amino acids by paper chromatography.
5. Separation of proteins by Polycrylamide Gel Electrophoresis (PAGE).
6. Preparation of standard curve and estimation of DNA by colorimetric analysis using Diphenylamine method.
7. Preparation of standard curve and estimation of total RNA by colorimetric analysis using Orcinol method.
8. Quantitative analysis of Amylase activity from blood serum or liver.
9. Effect of temperature and pH on enzymatic rate of reaction.

Teaching Methodology:

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

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
Assignments & Presentation	(15%)

Books Recommended:

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

Additional Readings:

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

MAJOR-III

PHYSIOLOGY

Contact Hours:

Theory	=48
Practical	=32
Total	=80

Credit Hours:

Theory	=3.0
Practical	=1.0
Total	=4.0

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.

Cardiovascular Physiology:

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

Respiratory Physiology:

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

Excretory Physiology:

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

Physiology of Nutrition:

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

Practicals:

Respiration and Circulation

1. Study of respiratory pigments in various animals and haemoglobins in various vertebrates.
2. Normal cardiac activity in amphibian model, effect of temperature, effect of drug, heart block, tetanization of heart.
3. Measurement and effects of various factors on blood pressure. Blood pressure alteration in exercise.
4. Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer),

Nerve and Muscle

1. Study of salient features of electromyography
2. Study of excitable and contractile properties of a nerve-muscle preparation.

Nervous System:

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

Hormones System:

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

Text/Reference Books:

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

MAJOR-IV

ECOLOGY

Contact Hours:

Theory =32
Practical =32
Total = 64

Credit Hours:

Theory =2.0
Practical =1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. Understand and apply the basic concepts of Ecology
2. Acquire theoretical knowledge for rehabilitation of destroyed ecosystems and habitats in the environment.
3. Solve the ecological Problems and their management through scientific approach

Course Outline:

1. **Energy**
 - a. Basic Concepts of and Types of Ecology
 - b. Laws of thermodynamics, primary and secondary productions
 - c. Trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.
2. **Biogeochemical cycle:**
 - a. Nitrogen, Phosphorus, Sulphur, Water, Carbon and nutrient.
3. **Limiting factors**
 - a. Basic Concepts, Temperature, Soil, Water and Humidity, Light and Fire.
4. **Global ecosystems:**
 - a. Atmosphere, Hydrosphere, Lithosphere and Ecosphere.
 - b. An overview of Ecosystem with special reference to Ecological Niche, basic concepts and types
 - c. Major ecosystem of world, Forest, Grassland, Desert, Tundra and Agricultural ecosystems.
 - d. Marine, Estuarine, Freshwater and Wetlands
5. **Population ecology**

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

Basic concepts, Community Analysis, Ecotones, Inter-population Interactions
7. **Applied Ecology:** resources and their ecological management;
8. Mineral, Agricultural Desalination, Weather Modification, Forest and Range Management, Landscape and Land use
9. **Pollution:**
10. Definition, Types, Water, Air, Land and Noise, Sources and Management.
11. **Radiation ecology:** Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws).
12. **Exotic and Invasive Species**
 - a. Desertification, Deforestation, exotic and invasive species

Practical:

1. Population Sampling Techniques (Quadrat, Line Transact, Point count, Focal Scan and Capture and Recapture Method).
2. Study of different Ecosystems (Fresh Water, Terrestrial, Marine/Mountain/ Desert).
3. Ecological Notes.
4. Measurements of physical Factors of different Ecosystems.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.

9. Experimental design and approaches in ecological research; writing a research project
10. Development of an ecological management plan of some selected area

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Text and Reference Books:

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

FOUNDATION IX

EVOLUTION

2+0

Course Objectives:

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

Course 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.

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 allopatry, orthogenesis, adaptive radiation.
- Modern concept of Natural Selection: levels of selection, selection patterns, some examples of Natural Selection.
- Impacts of Natural Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry, sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory and recapitulation theory.

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. Preparation of keys for the identification of specimens

Text and Reference Books:

1. Strickberger. M.W. 2012. Evolution. Jones & Barrett Publishers. Gower Street, London, England.

- Ridley, M. 1993. *Evolution*. Blackwell Scientific Publications, New York, USA..
- Moody, P.A. 1989. *Introduction to Evolution*, Harper and Row, Publishers, New York
- Wiley, E. O. and Lieberman, B. S. 2011. *Phylogenetics: Theory and Practical Practice of Phylogenetic systematics*. 2nd Ed. Wiley-Blackwell.
- Mayer, E. *Principles of Systematic Zoology*. 1994. McGraw-Hill, New York.

SEMESTER– VI

Course Category	Course Title	Credits
MAJOR V	Research Methodology	2 (2+0)
FOUNDATION-X	Principles of Systematics	3(2+1)
MAJOR-VI	Developmental Biology	4(3+1)
MAJOR-VII	Genetics	4(3+1)
MAJOR-VIII	Wildlife	3(2+1)
	Total Credits	16

MAJOR-V

RESEARCH METHODOLOGY

Contact Hours:

Theory	=32
Practicals	=0
Total	=32

Credit Hours

Theory	=2.0
Practical	=0.0
Total	=2.0

Course Objectives:

The course is aims to:

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

Course Learning Outcomes:

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

- UNDERSTAND** a general definition of research design.
- IDENTIFY** the overall process of designing a research study from its inception to its report.
- Become **FAMILIAR** with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- KNOW** the primary characteristics of quantitative research and qualitative research.
- IDENTIFY** a research problem stated in a study.

6. Become **FAMILIAR** with how to write a good introduction to an educational research study.
7. To **DISTINGUISH** a purpose statement, a research question or hypothesis, and a research objective.

Course Contents:

1. **Introduction:**
 - a. Objectives of Research, Motivations
2. **Research Process:**
 - a. Research methods vs. research methodology, scientific method
 - b. Types of research, general steps involved in research
 - c. Problems of research in Pakistan
3. **Topic Selection:**
 - a. Problem identification for research, criteria and evaluation
4. **Literature review:**
 - a. Importance and sources
 - b. Referencing and citation and Bibliography
 - c. plagiarism
5. **Research Design:**
 - a. Parts, important features, important concepts in research design
6. **Aims and objectives:**
 - a. Research objectives, qualities of research objectives
7. **Material and methods:**
 - a. Bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources
8. **Data Analysis:**
 - a. Processing, statistics in research, hypothesis testing, t-tests and ANOVA
9. **Scientific Writing:**
 - a. Difference between thesis/report/synopsis/research proposal
 - b. Parts of synopsis/project proposal, parts of thesis/report
10. **Budgeting:** Cost estimates for a research project, funding sources e.g. USAID, HEC, DoST, HED, PMRC, WWF, PSF etc.

Teaching methodology:

Lecturing
Written Assignments
Quizzes

**Assessment:
Midterm (40%)**

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 10%
- Quizzes 10%
- Report Writing 10%

Text and Reference Books:

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

FOUNDATION-X

PRINCIPLES OF SYSTEMATICS

Cr: 3(2+1)

Contact Hours:

Theory =32
Practicals =32
Total =64

Credit Hours

Theory =2.0
Practical =1.0
Total =3.0

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.

(Note: Principles of Systematic Zoology 60% and 40% weightage, respectively).

Course Contents:

1. **Importance and applications 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.

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

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

MAJOR-VI

DEVELOPMENTAL BIOLOGY

Contact Hours:

Theory =48
Practical =32
Total =80

Credit Hours:

Theory =3.0
Practical =1.0
Total =4.0

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

5. **Assess** the set of experiments that will establish whether a planned aspect is both necessary and ample to cause a developmental episode
6. **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

- a. History and Basic Concepts of developmental biology
- b. Principal features of developmental biology and embryology with special emphasis on vertebrate models
- c. Origin of sexual reproduction
- d. Developmental patterns

2. Spermatogenesis

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

3. Primates Menstrual cycle

1. Oogenesis

- a. Mechanism of oogenesis among various classes of vertebrates.
- b. Vitellogenesis
- c. Hormonal control of Vitellogenesis and oogenesis

4. Fertilization

- a. External & Internal Fertilization
- b. Species-specific recognition of sperm and egg
- c. Fusion of male and female gametes
- d. Polyspermy: slow and fast blocks to polyspermy
- e. Activation of egg metabolism

5. *IN VITRO* Fertilization (IVF)

- a. History, Steps and advantages of IVF
- b. Disadvantages and risk factors

6. Cleavage & Blastulation

- a. Patterns of embryonic cleavage and blastulation among different vertebrate classes
- b. Mechanism of cleavage.

7. Gastrulation

- a. Fate maps
- b. Gastrulation in amphibians, birds and mammals

8. Early Vertebrate Development

- a. Neurulation, ectoderm, mesoderm and endoderm formation

9. Placenta and extraembryonic membranes

10. Cellular Basis of Morphogenesis

- a. Differential cell affinity, cell adhesion molecules
- b. Organogenesis
- c. Mechanism of teratogenesis

11. Aging and Regeneration in vertebrates

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speakers
- Hospital Visits
- Report Writing

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%

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. Study of developmental stages of nematodes through microscopic analysis of animal dung
7. Semen analysis
8. Dactylography and its uses in developmental biology

Text and Reference Books:

1. Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill.

3. Scott F. Gilbert and Michael J. F. Barres. 2016. Developmental Biology. Sinauer Associates, Sunderland, MA.
4. Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
5. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
6. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
7. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
8. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

MAJOR-VII

GENETICS

Contact Hours:

Theory =48
 Practical = 32
 Total = 80

Credit Hours:

Theory = **3.0**
 Practical = 1.0
 Total = **4.0**

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

- a. Classical, molecular and population Genetics: Scope and importance of genetics, Forward and reverse genetics. The basic principles of Inheritance (Mendelism): Monohybrid and Dihybrid crosses (Definition - characteristics criss-cross inheritance).
- b. Multiple Alleles: blood groups and coat color in rabbits.
- c. Genetics of Rh factor and Erythroblastosis Foetalis.

2. Chromosomal Basis of Inheritance:

- a. Chromosomal theory of inheritance
- b. Interaction of genes, Epistasis, Lethality and Pleiotropism.

3. Chromosomal Aberrations

- a. Changes in chromosomal number, Euploidy, aneuploidy (Klinefelters syndrome, and Turners syndrome, Down syndrome and Edwards syndrome).
- b. Structural changes, insertion, deletion (Cri du chat syndrome), duplication,
- c. Inversion and translocation

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

Practical:

1. Drosophila culture techniques: preparation and maintenance of culture
2. Identification of male and female fruit fly and isolation of virgin females
3. Study of polytene chromosomes from the salivary glands of Drosophila melanogaster
4. Mutation induction in Drosophila
5. Human karyotyping from photographs prepared slides: paper cut out method

6. Preparation of human metaphase chromosomes from blood lymphocytes
7. Study of mitosis in plants by using onion root tip cells
8. Study of meiosis in the testes of male grasshopper
9. Extraction of genomic DNA from whole blood (lymphocytes)
10. Separation of heterogeneous population of bio-molecules through electrophoresis
11. Study of blood group polymorphisms in local population
12. Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
13. Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc), risk estimation and genetic counselling)
14. Study of quantitative traits in humans: finger prints as model of polygenic traits
15. Study of Barr bodies in human cell nucleus
16. Dermatoglyphics in normal and mentally retarded subjects
17. Probability problems. Tossing of coins. X^2 test
18. Study of transformed bacteria on the basis of antibiotic resistance
19. PCR

Teaching Methodology:

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

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 20%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Books Recommended:

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

MAJOR-VIII

WILDLIFE

Contact Hours:

Theory	= 32
Practicals	= 32
Total	= 64

Credit Hours

Theory	= 2.0
Practical	= 1.0
Total	= 3.0

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

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

2. Philosophy and significance of wildlife conservation

3. Biodiversity and sustainability of wildlife.

4. Wildlife rules and regulations in Pakistan

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

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

- a. National Organisations
- b. International Organisations

6. Protected Areas in Pakistan

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

7. Ramsar convention

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

8. Threatened species of Pakistan.

- a. Vulnerable
- b. Endangered
- c. Critically Endangered

Practicals:

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

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker

- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Miller, A.S. and Harley, J.B., 1999 & 2002. Zoology, Latest Edition (International). Singapore: McGraw-Hill.
2. Ali. S.S. 2005 Wildlife of Pakistan.
3. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
4. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
6. Roberts, T. J., 1991, 1992. The Birds of Pakistan, Vol. I1 and II. Oxford University Press
7. Roberts, T. J., 1997. The Mammals of Pakistan, Oxford University Press
8. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.
9. Wildlife of the Punjab, Punjab Wildlife Department.
10. Khan M. S. 2011, Amphibian and Reptiles of Pakistan
11. Mirza Z.B. 2011 Biodiversity of Pakistan.

YEAR-IV

SEMESTER-VII

Course Category	Course Title	Credits
COMPULSORY-IX	Biostatistics	3(2+1)
MAJOR-IX	Special Paper A1/ Thesis(Univ. Option)	3(2+1)/ 0+3
ELECTIVE-I	Univ. opt	3(2+1)
ELECTIVE-III	Univ. opt	3(2+1)
MAJOR-X	Molecular Biology	3(2+1)
	Total Credits	14

COMPULSORY-IX

BIOSTATISTICS

Contact Hours:

Theory	=32
Practicals	=32
Total	=64

Credit Hours

Theory	=2.0
Practical	=1.0
Total	= 3.0

Course Objectives:

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

Course Outcomes:

Students who successfully complete this course will be able to:

1. **DESCRIBE** the roles biostatistics serves in zoology and biomedical research.
2. **EXPLAIN** general principles of study design and its implications for valid inference.
3. **ASSESS** data sources and data quality for selecting appropriate data for specific research questions.
4. **TRANSLATE** research objectives into clear, testable statistical hypotheses.
5. **DESCRIBE** basic principles and the practical importance of key concepts.
6. **APPLY** numerical, tabular, and graphical descriptive techniques commonly used to characterize and summarize data.

Course Contents:

1. **Introduction:**
 - a. Definition, branches of statistics,
 - b. Scope and importance of statistics
2. **Data:**
 - a. Population and sample, variable, categorical and non-categorical data,
 - b. Scales of measurements, errors of measurements
3. **Presentation of data:**
 - a. Descriptive statistics
 - b. Tabulation of data
 - c. Parts of table and construction of table.
 - d. Diagrams and graphs, pictogram, histogram, line chart, histogram, applications and uses of histogram
 - e. Construction of histogram, comparison of data using histogram,

- f. Bar chart, multiple bar chart, pie chart, gantt chart, timeline, infograph, pedigree chart
4. **Frequency distribution:**
 - a. Empirical FD, relative FD, Cumulative FD, class frequency, class limits, class boundaries, class mark, class interval, midpoints.
5. **Measures of Central Tendency:**
 - a. Types of averages, arithmetic mean for grouped and ungrouped data, harmonic mean for grouped and ungrouped data, geometric mean for grouped and ungrouped data, median, quartiles, deciles, percentiles and mode.
 - b. Advantages and disadvantages of arithmetic mean, harmonic mean, geometric mean, median and mode.
6. **Measures of Dispersion:**
 - a. Range, grouped and ungrouped data, coefficient of range
 - b. Mean deviation of grouped and ungrouped data. Coefficient of mean deviation.
 - c. Standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data.
7. **Probability:**
 - a. Definition, properties, experiment and random experiment, event, outcome, trial, multiplication rule, sample space and sample point, mutually exclusive event, combinations and permutations, probability distribution, binomial experiment
8. **Tests of Significance:**
 - a. Hypothesis testing
 - b. Steps of hypothesis testing
 - c. Z-test
 - d. t-test, types,
 - e. Chi-square
 - f. ANOVA, its uses and LSD
 - g. Correlation
 - h. Regression

Practicals/Tutorials:

1. Data collection, arrangement and frequency table
2. Data presentation in table, graphs (simple bar chart, multiple bar chart, component bar chart)
3. Construction of timeline, pedigree chart, organogram, Gantt chart, infogram
4. Calculating arithmetic mean, harmonic mean and geometric mean, median and mode from ungrouped and grouped data
5. Calculating mean deviation, standard deviation and variance from ungrouped and grouped data

6. Probability distribution
7. z-test
8. T-test
9. ANOVA
10. Correlation
11. Regression

Teaching Methodology:

- Lecturing
- Written Assignments
- Quizzes
- Practicals

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 10%
- Assignments 10%
- Quizzes 10%
- Practical 20%

Text and Reference Books:

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

MAJOR-X

MOLECULAR BIOLOGY

Contact Hours

Theory = 32
Practical = 48
Total = 80

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

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**
 - a. Introduction to nucleic acids
 - b. Chromosome structure, Chromatin,
 - c. DNA forms, structures and packaging
 - d. RNA types and structures
2. **Replication**
 - a. DNA replication in prokaryotes
 - b. DNA replication in eukaryotes
 - c. Enzymology of replication
 - d. DNA damage and repair
3. **Transcription**
 - a. Types of RNA polymerases in prokaryotes and eukaryotes
 - b. Synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved
 - c. RNA processing
 - d. Split genes, concept of ribozymes
 - c. Genetic Code
4. **Translation**
 - a. Role of Ribosomes
 - b. Mechanism of translation in prokaryotes and eukaryotes

- c. Various factors, and posttranslational processing
5. **Mutation**
 - a. Types of Mutations
 - b. Base-Analogue Mutagens
 - c. Chemical Mutagens
6. **Gene expression and control**
 - a. Control of gene expression in Prokaryotes.
 - b. Inducible and repressible operons.
 - c. Control of gene expression in eukaryotes.

Practicals:

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.

Teaching Methodology:

- Lecturing
- Written Assignments/Presentation
- Guest Speaker
- Model making

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

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.

MAJOR–IX

SPECIAL PAPER

Cr: 4(3+1)

Note:University Option: To be selected from the list provided (Annexure-I) as special paper (Major-X). For example, Fisheries/Parasitology/Microbiology/ Entomology/Immunology/Environmental Sciences/Marine Zoology/ Endocrinology etc (Annexure-II). The individual university can add more courses to this list according to the requirement and expertise available.

ELECTIVE–I

Cr: 3(2+1)

Note:University Option: To be selected from the list provided (Annexure-I) to support special paper (Major-X). The individual university can add more electives to this list according to the requirements and expertise available

SEMESTER–VIII

Course Category	Course Title	Credits
MAJOR-XI	Bioinformatics	3(1+2)
MAJOR-XII	Special Paper B/ Thesis(Univ. Option)	3(2+1)/ 0+3
MAJOR-XIII	Zoogeography & Paleontology	3(2+1)
ELECTIVE-II	Univ. opt	3(2+1)
ELECTIVE-IV	Univ, opt	3(2+1)
	Total Credits	15

MAJOR–XII

BIOINFORMATICS

Cr: 3(1+2)

BIOINFORMATICS

Contact Hours:

Theory = 16
Practicals = 96
Total = 112

Credit Hours

Theory = 1.0
Practical = 2.0
Total = 3.0

Course Objectives

The course will provide:

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

Course Outcomes:

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

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

Course Contents:

1. **Introduction:**
 - a. Introduction to Bioinformatics, Scope of bioinformatics, useful websites
 - b. Aims of bioinformatics, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools
 - c. Human genome project
2. **Biological databases**
 - a. Data and types of data, data acquisition
 - b. Major DNA databases around the world, NCBI, BOLD, DDBJ
 - c. Major protein databases in the world, protein sequence databases, protein structure databases
 - d. Specialized databases, genome and organism databases
 - e. Non sequence databases, pubmed, pubmed health, OMIM
3. **Genome mapping**
 - a. Genetic and linkage mapping, physical mapping
4. **Gene family:**
 - a. Introduction, types, protein family, Globin family as an example, globin genes and chains, evolution of globin proteins in human, combination and types of globin proteins in human.
5. **Data Retrieval:**
 - a. Searching sequence databases
 - b. FASTA format
 - c. retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data
6. **Primer Designing:**
 - a. Primer and probe, qualities of primer, general rules for primer designing
 - b. Websites used for primer designing
7. **Sequence Alignment:**
 - a. Importance and significance of alignment, methods for sequence alignment

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

Practicals/Tutorials:

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

Teaching methodology:

- Lecturing
- Written Assignments
- Quizzes
- Practicals

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 10%
- Assignments 10%
- Quizzes 10%
- Practical 20%

Text and Reference Books:

1. Baxevanis, A.D., Ouellette, B.F.F. (2011) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley & sons, Inc.

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

Websites

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

MAJOR–XII

THESIS/RESEARCH PROJECT/INTERNSHIP

Cr: 3(0+4)

MAJOR-XIII

ZOOGEOGRAPHY AND PALEONTOLOGY

Contact Hours:

Theory = 32
 Practical = 32
 Total = 64

Credit Hours:

Theory =2
 Practical = 1
 Total = 3

Course Objectives

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. **DESCRIBE** the zoogeographical distribution of animals and processes involved in the fossilization of animals.
2. **ILLUSTRATE** the association of animals present to their past through fossils record.
3. **DEVELOP** the understanding of speciation, dispersal isolation and extinction process through biogeography and fossils record.
4. **ILLUSTRATE** the ability to locate, characterize and differentiate various biomes and fossils of animals over time.
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 Outline:

1. **Paleo geography**
 - a. Theories of continental drift and plate tectonics
 - b. Pangea
2. **Animal distribution**
 - a. cosmopolitan distribution
 - b. discontinuous distribution
 - c. isolation distribution
 - d. bipolar distribution
 - e. endemic distribution
 - f. barriers and dispersal.
3. **Zoogeographical regions:**
 - a. Zoogeographic Division and Boundaries
 - b. Geographic Ranges, Physical Features
 - c. Climates,
 - d. Faunas And Affinities Of Palaearctic, Nearctic Regions, Oriental, Ethiopian, Australian, And Neotropical Regions
 - e. Insular Fauna
4. **Zoogeography of Pakistan:**
5. **Paleontology:**
The Planet Earth
 - a. History, age, shells of earth
 - b. atmosphere, hydrosphere, biosphere and lithosphere.
6. **Rocks:**
 - a. Types; Igneous rocks, sedimentary rocks and metamorphic rocks.
7. **Fossil and Fossilization**
 - a. Fossil types and uses of fossils, nature of fossils.
 - b. Fossilization

- c. Invertebrates and Vertebrates Fossil
- d. Biostratigraphy
- e. Fossils of Pakistan
- f. Paleontologically important areas of Pakistan.

8. Fossilization:

- a. Geological time scale.
- b. Pre-Cambrian life.
- c. Post Cambrian life,
- d. Paleozoic life
- e. Mesozoic life
- f. Cenozoic life.

9. Paleontological Techniques

- a. Excavation techniques
- b. Excavation tools and techniques
- c. Transportation and processing of fossils.
- d. Presentation of fossils
- e. Pre requisites for paleontological excavation.

10. Geochronometry:

- a. Uranium/Lead dating
- b. radiocarbon dating, methods
- c. index fossils
- d. evolutionary history of man, elephant, horse and camel,
- e. Paleoecology, Paleomagnetism.

Practical:

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

Teaching Methodology

- Lecturing
- Written Assignments
- Practical observations
- Field Visits
- Report Writing

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%

Text and Reference Books:

Zoogeography:

1. Beddard, F. E. 2008. A text book of zoogeography. Bibliobazar, LLC.
2. Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup & Sons. Delhi.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Darlington, P. J. Jr. 1963. Zoogeography, John Wiley and Sons.

Paleontology:

1. Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
2. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Brouwer, A. 1977. General Palaeontology, Oliver and Boyed, London.

ELECTIVE–II

Cr: 3(2+1)

Note: UNIVERSITY OPTION: To be selected from the list provided (Annexure-I) to support special paper (Major-X). The individual university can add more electives to this list according to the requirements and expertise available.

ELECTIVE–III

Cr: 3(2+1)

Note: UNIVERSITY OPTION: To be selected from the list provided (Annexure-I) to support special paper (Major-X). The individual university can add more electives to this list according to the requirements and expertise available.

ELECTIVE–IV

Cr: 3(2+1)

Note: UNIVERSITY OPTION: To be selected from the list provided (Annexure-I) to support special paper (Major-X). The individual university can add more electives to this list according to the requirements and expertise available.

LIST OF ELECTIVE AND SPECIAL COURSES:

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

The individual university can add more Electives & Special courses to this list according to the requirements and expertise available.

- 1 Agricultural Biotechnology
- 2 Analysis of Development
- 3 Animal Adaptations
- 4 Animal Pests and Disease Producing Organisms
- 5 Aquaculture
- 6 Arachnology
- 7 Bacterial genetics
- 8 Basic Human Genetics
- 9 Behavioral Ecology
- 10 Biochemistry of Drug Action
- 11 Biodiversity and Wildlife
- 12 Biodiversity of Inland and Terrestrial Molluscs
- 13 Biological Oceanography
- 14 Biology and Control of Vertebrate Pests
- 15 Biotechnology
- 16 Biotechnology in Aquaculture
- 17 Cancer Biology
- 18 Clinical Biochemistry
- 19 Comparative Developmental Biology
- 20 Conservation Biology
- 21 Ecological Genetics
- 22 Elements of Stratigraphy and Structural Geology
- 23 Endocrinology
- 24 Entomology (Classification of Insects and Pest Management)
- 25 Entomology (Morphology, Physiology and Ecology)
- 26 Environmental Issues
- 27 Environmental Physiology
- 28 Environmental Pollution
- 29 Environmental Toxicology
- 30 Epidemiology and public health
- 31 Epidemiology of parasitic disease
- 32 Evolution and principles of systematic
- 33 Fish Bioenergetics
- 34 Fish Culture
- 35 Fish ecology
- 36 Fish Endocrinology

- 37 Fish Feeding Management
- 38 Fish Health Management
- 39 Fish Physiology and Breeding
- 40 Fundamentals of Microbiology
- 41 General and Comparative Endocrinology
- 42 General Microbiology
- 43 Helminthology And Host-Parasite Relationship
- 44 Hematology
- 45 Histology
- 46 Ichthyology
- 47 Immunology
- 48 Insect Bioacoustics
- 49 Insect Biochemistry and Physiology
- 50 Insect Pathology
- 51 Insects of Veterinary and Medical Importance
- 52 Introduction to Environment
- 53 Invertebrate Paleontology
- 54 Limnology
- 55 Mammalogy
- 56 Microbiology and Biotechnology
- 57 Microbiology of Extreme Environment
- 58 Molecular Genetics
- 59 Neurobiology
- 60 Ornithology
- 61 Parasitology
- 62 Pathological Endocrinology
- 63 Pharmacological Endocrinology
- 64 Physiological Systems and Adaptations
- 65 Physiology of Coordination
- 66 Physiology of Functional Systems
- 67 Planktology
- 68 population Biology
- 69 Principles and Kinetics of Toxicology
- 70 Principles of Fish Biology
- 71 Principles of Ornithology
- 72 Protozoology and immunology
- 72 Quantitative Zoology
- 73 Radiation Biology
- 74 Reproductive Biology
- 75 Restoration Ecology and Sustainable Development
- 76 Taxidermy
- 77 Taxonomy
- 78 Techniques in Fisheries Research
- 79 Teratology

- 80 Vector Biology
- 81 Vertebrate Paleontology
- 82 Veterinary and Wildlife Parasitology
- 83 Wild life Parasitology
- 84 Zoological Techniques

The individual university can add more Elective/Special Courses to this list according to their requirements and expertise available.

COURSE CONTENTS OF SOME ELECTIVE AND SPECIAL COURSES*

1. Agricultural Biotechnology

AGRICULTURE BIOTECHNOLOGY

Contact Hours:		Credit Hours
Theory	= 32	Theory = 2.0
Practicals	= 48	Practical = 1.0
Total	= 80	Total = 3.0

Course Objectives:

1. To train students in modern cellular and molecular biology and genetic engineering.
2. To acquaint students with techniques and skills employed for producing transgenic crops.

Course outcomes:

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

1. **ACQUIRE** the knowledge about the range of approaches to manipulate and improve plants, animals and microorganisms.
2. **DEMONSTRATE** the ability to develop, interpret, and critically evaluate modern approaches to scientific investigation.
3. **UNDERSTAND** the relationship between society and science and the justification for biotechnological manipulation of plants, animals, and microorganisms.

Course Contents:

1. **Agriculture biotechnology**
 - a. Introduction and its applications in crop improvements
2. **Cell and plant tissue culture**
 - a. Introduction, types and methodology
 - b. Improvement of plants via plant cell culture;
3. **Plant molecular biomarkers**
4. **Gene Transformation**
 - a. Direct and indirect methods of plant and animal transformation
 - b. Gene gun method of transformation
 - c. *Agrobacterium* mediated transformation
 - d. chloroplast transformation
 - e. polyethylene glycol (PEG) mediated transformation;

5. **Transgenic crops**
 - a. Transgenic crops with herbicide
 - b. biotic and abiotic stress resistance
 - c. problems related to transgenic plants
6. **Genetically modified organisms (GMOs)**
 - a. Introduction
 - b. Field evaluation and commercialization of GMOs
 - c. Possible effects of releasing GMOs into the environment
7. **Bio-fertilizers**
 - a. Introduction, bio-pesticides and their types
 - b. Non-symbiotic nitrogen fixers
 - c. present and future prospects of biofertilizers.

Practical:

1. Preparation of Murashige and Skoog medium and stocks of macronutrients
2. Micronutrients, and hormones; selection of ex-plant, medium preparation and callus induction
3. Culturing *Agrobacterium* and using it to infect plant callus
4. Selection of transformant's; regeneration of plantlets and acclimatization
5. Plant DNA extraction and PCR for detecting introduction of foreign DNA into plants.

Teaching methodology:

- Lecturing
- Written Assignments
- Quizzes
- Practicals

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 10%
- Assignments 10%
- Quizzes 10%
- Practical 20%

Text and Reference Books:

1. Qaim M, 2010. Agricultural Biotechnology in Developing Countries: Towards Optimizing Benefits for Poor. Springer

2. Kemp Ken F, 2010. Genetic Modification of Plants: Agriculture, Horticulture and Forestry (Biotechnology in Agriculture and Forestry). Springer.
3. Herren RV, 2012. Introduction to Agricultural Biotechnology. 2nd Edition; Delmar Cengage Learning.
4. Slater A, 2008. Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Edition; Oxford University Press, USA
5. Altman A, 2011. Plant Biotechnology and Agriculture: Prospects for the 21st Century. 1st Edition; Academic Press.

2. Analysis of Development

ANALYSIS OF DEVELOPMENT

Contact Hours:

Theory = 40

Practical = 54

Total = 94

Credit Hours:

Theory = 2.0

Practical = 1.0

Total = 3.0

Course Objectives:

1. To provide knowledge of Principal features of development and cellular basis of morphogenesis
2. To impart knowledge of mechanisms of cellular differentiation and concepts of induction in development.
3. To understand the establishment of body axes and mechanism of teratogenesis
4. To provide understanding of the mechanisms of organogenesis and histogenesis related to the mechanisms of development and differentiation.
5. To give understanding of factors controlling growth and oncogenesis.
6. To give concept related to the developmental biology of vertebrate and analysis of development will be practically demonstrated in this course

Course Learning Outcome:

1. Identify the events that lead up to and comprise the process of fertilization.
2. Discuss the critical contributions of sperm and egg to the zygote and how structure informs function.
3. Describe in general terms how vertebrates gastrulate (frog, chick and mammal).
4. Identify embryonic structures in preparations, photographs and diagrams.
5. Indicate the derivatives of embryonic structures.
6. Attain a basic conceptual knowledge of the principal cellular mechanisms of development and identify the genetic and molecular elements that are involved

Course Contents:

1. Introduction:

- a. Historical review of embryology.
- b. Uses of modern molecular techniques in Developmental biology.
- c. Developmental patterns;
- d. Sexual reproduction
- e. Spermatogenesis, Oogenesis and Fertilization

2. Cleavage

- a. Patterns of embryonic cleavage,
- b. Mechanism of cleavage

3. Gastrulation:

- a. Fate maps
- b.** Neurulation, ectoderm, mesoderm and endoderm.

4. Morphogenesis:

- a. Cellular Basis of Morphogenesis:
- b. Differential cell affinity,
- c. Cell adhesion molecules;

5. Mechanism of Cellular Differentiation:

- a. RNA processing,
- b. Translational regulation of developmental process,

6. Cell-fate by progressive determinants,

- a. Autonomous cell specification by cytoplasmic determinants,

7. Axis Development

- a. Establishment of body axes and
- b. Mechanism of teratogenesis;

8. Secondary Induction;

- a. Organogenesis:
- b.** A brief account; Origin and Migration of Germ Cells in Vertebrates;

9. Factors controlling Growth.

- a. Factors controlling Growth and Oncogenesis
- b. Hormones as Mediators of Development;
- c. Regeneration in Vertebrates.

Practical:

1. Preparation and study of serial sections of frog or chick embryos.
2. Application of microsurgical techniques on chick embryos *in vitro*.
3. Preparation and staining of histological slides.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Practical Assignments
- Presentation

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Presentation 20%
- Assignments 20%

Text Book:

1. Gilbert, S. F., 2008. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Scott F. Gilbert. 2000. Developmental Biology, Sinauer Associates Inc., Publishers, Massachusetts.
3. Bruce M. Carlson. 2000. Human Embryology and Developmental Biology, Mosby, London.
4. Oppenheimer. 1989. Introduction to Embryonic Development, S.S. Allen and Bacon.
5. Balinsky, B.I. 1985. An Introduction to Embryology, W.B. Saunders, New York.

Additional Readings:

1. Saunders, J. W., 1982. Development Biology, McMillan.
2. Oppenheimer, S.S., 1984. Introduction to Embryonic Development, Allen and Bacon.
3. Bodemer, C. W., 1968. Modern Embryology. Holt, Rinehart and Winston.
4. Ham, R. G. and Veomett, M. J., 1980. Mechanism of Development. C.V. Mosby Co.
5. Berril, N. J. and Karp, G., 1978. Development. McGraw Hill.

3. Animal Adaptations

N.A

4. Animal Pests and Disease Producing Organisms

N.A

5. Aquaculture

AQUACULTURE

Credit Hours:

Theory = 2.0

Practical = 1.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:.

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

1. **Illustrate** the basic knowledge of fin fish and shell fish, fisheries and aquaculture
2. **IDENTIFY** fish species on the basis of biological characteristics.
3. **SOLVE** problems of appropriate site selection, designing and pond construction; selection of suitable fish species for sustainable aquaculture.
4. **ANALYZE** the problems of fish pond and solve them by using different strategies.
5. **FORMULATE** and prepare aqua feed, induced breeding techniques, diagnosis and control of diseases in commercially important fish species.
6. **DEMONSTRATE** and visit the aquaculture sites and individually the drawings of aquaculture facilities, aquatic resources and integrated aquaculture management.

Course Contents:

1. **Introduction**
 - a. Introduction to fish, fishery and aquaculture,
 - b. History and present status of aquaculture (National and International)
 - c. Introduction and biology of cultivable fin and shell fishes.
 - d. Introduction to aquatic resources of Pakistan (Lentic and lotic environment).
2. **Aquaculture (fin fish culture)**
 - a. Introduction and role of aquaculture, types of culture systems (Ponds, Raceways, cages, pen, raft and line culture).
 - b. Site selection, design and construction of fish ponds
 - c. Pond problems; aquatic vegetation and their control, fish predators, water quality and management, fish disease and their control.

- d. Types of fish feed, characteristics of artificial feed, methods of feeding, types and use of fertilizers,
 - e. Artificial fish breeding techniques
 - f. Integrated aquaculture
- 3. Shell fish culture**
- a. Introduction of shrimp and prawn culture,
 - b. Crabs, molluscs, lobsters and scallops culture etc,

Practicals:

1. Collection and identification of various freshwater fish species
2. Visit and studying of fish pond Components.
3. Visit to fish hatchery and integrated fish farming.
4. Determination of Water quality parameters (Physical, chemical and biological)
5. Fish feed ingredients and formulation of fish feed
6. Artificial Fish breeding
7. Fish market visit
8. Visit to fish feed mill
9. Visit to head works/reservoirs etc.

Books Recommended:

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

5. Arachnology

ARACHNOLOGY

Cr: 3(2+1)

Course Objectives:

The course aims to:

1. Impart in-depth knowledge of Arachnids.
2. Develop concepts about importance of the classification of class Arachnids.
3. Study the history and importance of Arachnids.
4. Demonstrate about identifications of Arachnids.

Course Contents:

1. Importance and applications of Arachnology.
2. Importance and its future perspectives.
3. History of arachnology, Introduction of arachnology according to history
4. Structure of the Arachnids
5. Characters of Arachnids
6. classification position of class Arachnid
7. External and internal anatomy
8. Life history of Arachnids
9. Defense mechanisms.
10. Arachnid with relationship to man.
11. Role of Arachnids as a biological control
12. Arachnids families identification.

Practicals:

1. Systematic. Collection.
2. Preservation.
3. Morphological characters of Arachnid.
4. Anatomy of Arachnid.
5. Writing description of identified (Araneae) Arachnid.
6. Preparation of identified specimen's slide.
7. Identification of specimens up to families with the help of keys.
8. Field survey for the collection of arachnids from different habitats.

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%

Final Term (60%)

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

- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended Books:

1. Foelix, R. 2011. Biology of spiders. OUP USA.
2. Levi, H. W. 1956. The spider genera Neottiura and Anelosimus in America (Araneae: Theridiidae). Transactions of the American Microscopical Society, 75(4), 407-422.
3. Herberstein, M. E. (Ed.). 2011. Spider behaviour: flexibility and
4. Bristowe, W. S. 1958. World of spiders...

6. Bacterial genetics

BACTERIAL GENETICS

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives:

1. To learn the continuity of the life from one generation to other generation
2. To provide knowledge based on the mechanisms involving nucleus, chromosomes and genes etc.

Course Learning Outcomes:

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

1. Acquire the firm knowledge of life stability from one generation to other one.
2. Understand the mechanisms involving nucleus, chromosomes and genes etc.

Course Outline

1. **Nucleic acids**
 - a. Structure and functions
2. **DNA replication**
 - a. Replicon origins
 - b. Events that occur at the replication fork,
 - c. The structure and functions of DNA polymerases
 - d. Replication Strategies
3. **Control of DNA replication**
 - a. Dichotomous replication in prokaryotes
 - b. Control of gene expression in prokaryote
 - c. Polycistrons, transcriptional initiation and termination, the operon, catabolite repression and attenuation control.
4. **Protein synthesis**
 - a. mRNA translation: Genetic code - non universality, codon usage.

- b. Events on ribosomes (c.f. prokaryotes)
 - c. Ribosome structure-function relationships
 - d. Organelle and archaeobacterial systems.
 - e. Plasmids, episomes and transposons.
5. **DNA mutagenesis**
- a. Mutagenic agents
 - b. Repair and mutation suppression
6. **Genetic recombination**
- a. Generalized recombination
 - b. Site specific recombination and Illegitimate recombination.
 - c. Gene transfer mechanisms and their role in evolution
 - d. Transformation, transduction, conjugation and cross-phylogenetic transfer.
 - e. Gene mapping by conjugation and transduction.
 - f. Circular chromosomal maps of bacteria.
 - g. Introduction to genetic rearrangements

Teaching Methodology:

- Lecturing
- Written Assignments

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%

Text and Reference books:

1. Pierca, B. A., 2005. Genetics. A conceptual approach, W. H. Freeman and Company, NY.
2. Griffiths, A. J. F., Wessler, S. R., Lewontin, R. C., Gelbart, W. M., Suzuki, D.T. and Miller, J. H., 2005, Introduction to Genetic Analysis, W. H. Freeman and Company.
3. Hartl, D. L. and Jones, E. W., 2005, Genetics - Analysis of Genes and Genomes, Jones and Bartlett Publishers. Sudbury, U.S.A.
4. Ignacimuthu, S., 2005, Basic Bioinformatics, Narosa Publishing House, India.
5. Lwein, B., 2004, Gene VIII, Pearson Education Int.

6. Primrose, S. B., and Twyman, R. M., 2006. Principles of Gene Manipulation and Genomics. Blackwell Scientific Publications.
7. Wilson, J. and Hunt, T., 2004. Molecular Biology of the cell – the problems book, Garland publishing Inc.
8. Jack, J. P., 2005. An Introduction to Human Molecular Genetics, 2nd edition New Jersey.
9. Ringo, J., 2004. Fundamental Genetics, Cambridge University Press Basic Human Genetics

BASIC HUMAN GENETICS

Contact Hours:

Theory = 34
 Practical = 48
 Total = 82

Credit Hours:

Theory = 2.0
 Practical = 1.0
 Total = 3.0

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

- a. Pedigree construction by using standard symbols.
- b. Mode of Inheritance of genetic disorders
- c. Autosomal dominant and autosomal recessive inheritance
- d. X linked dominant and X linked recessive Inheritance.
- e. Y linked inheritance.

f. Mitochondrial Inheritance

2. Genetic Linkage

- a. Linkage Analysis
- b. Genetic mapping
- c. Physical mapping
- d. Genetic linkage and LOD score calculation

3. Mutations

- a. Missense mutations
- b. Nonsense mutations
- c. Silent mutations
- d. Deletion mutation
- e. Duplication mutations

4. Prenatal Screening

- a. Ultrasonography
- b. amniocentesis
- c. Chorionic villi sampling
- d. Fetoscopy

5 Introduction to human Genome Project

- a. Application and proposed benefits of Human Genome project.
- b. 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

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

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

9. Behavioral Ecology

BEHAVIORAL ECOLOGY

Credit Hours:	=04	Theory =03
Practical	=01	Total = 04

Course Objectives:

The objective of this course is

1. To enable the student to understand not only behavior of animal but combination of behavior and ecology that contribute to reproductive success
2. To understand how animals struggle and survive.
3. To understand difference between survival values on function and those concerned with the casual mechanisms.

Course Learning Outcomes

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

1. Acquire theoretical knowledge of animal behavior, natural selection and evolution.
2. Understand the struggle for survival, their ecological relationships
3. Solve the survival and breeding related problems which are result of anthropogenic activities.
4. Interpretation and synthesis of data and other information about animal behavior, competition and ecological relationships.

Course outline:

1. **Animal behavior and Ecology**
 - a. Introduction
 - b. Gene and Behavior

- c. Natural Selection and Behavior
- d. Ecology and Evolution
- 2. **Hypothesis and Testing**
 - a. Comparative Approach
 - b. Adaptations
 - c. Social Organization and Experimental Studies
 - d. Economic Decisions Made by Individuals
 - e. Marginal Value Theorem and Reproductive Decisions
 - f. Economics of Prey Choice
 - g. Tradeoff and Optimality Models
- 3. **Competition for Resources in Individuals**
 - a. Competition by Exploitation
 - b. Competition by Resource Defense
- 4. **Merits and De-merits of living in Groups**
- 5. **Fighting Among Individuals**
 - a. Role of Resource Values and Fighting Ability
 - b. Fighting for Dominance
- 6. **Altruism**
- 7. **Kin Selection**
- 8. **Repository and Manipulation in Animals**
- 9. **Division of Labor and Specialized Helpers**

Practicals:

1. Visit to Zoo/Aviary/Peasantry/Breeding-center/Recreational Park/Aquarium to study the behavior of animals in different environmental conditions
2. Stimulation of ideal free distribution
3. Arm races in animals
4. Marginal value theorem
5. Tit for tat strategy

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Books Recommended:

1. Krebs, J. R. and Davies, N. B., 2007. Behavioral ecology, an evolutionary approach. Blackwell Scientific publication
2. Dugatkin, L. A., 2001. Model System in Behavioral Ecology. Princeton university press.
3. Ridley, M., 1995. Animal Behavior: An Introduction to Behavioral Mechanisms, Development, and Ecology. Blackwell Scientific publication

10. Biochemistry of Drug Action

N.A

11. Biodiversity and Wildlife

N.A

12. Biodiversity of Inland and Terrestrial Molluscs**Biodiversity of Inland Terrestrial Mollusks****Credit Hours:**

Theory = 1.0

Practical = 2.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To familiarize the students with the mullusc's study and their role in the ecosystem
2. To demonstrate the importance of mollusk culture and economics importance of their by products

Course Learning Outcomes:

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

1. Acquire the basic knowledge about the malacology and role of molluscs
2. Evaluate the threats to the mollusk population and their economic importance
3. Demonstrate the uses of shells and snail's role as intermediate host

Course Outline:**1. Malacology**

- a. A brief introduction to Malacology, Classification, Morphology, Biology and Ecology of common fresh water snails.

- b. Role of mollusks in the transmission of common helminth parasites of livestock and poultry.
- c. Principles of snail control and general control principles of parasites
- 2. **Choncology**
 - a. Description of Choncology, history of shell, parts of shell, diagnostic features of shell and associated structures and modern uses of Shell,
- 3. **Evolutionary perspective**
 - a. Evolutionary perspective; Phylogenetic relationship with other animals; Origin of Coelom
- 4. **Molluscan characteristics:**
 - a. Mechanism of feeding, digestion, gas-exchange, locomotion, reproduction and development in Gastropods and Bivalves
 - b. Slugs Characteristics and classification; Structure and function of Radula; Torsion and Detorsion in gastropods.
- 5. **Pearl culturing**
 - a. Pearl culturing, Economic importance of Molluscs Threats and Conservative strategies.

Practical:

1. Study of Museum Molluscan Specimens
2. Study of Gastropods and Bivalves shell
3. Classification of Gastropods and Bivalves representatives
4. Study of different parts and dissection of the representatives of Gastropods and Bivalves
5. Field study trips on diversity with emphasis on their adaptation.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Miller, A. S. and Harty, I. B. 2002. Zoology. 4th Edition (International) Singapore McGraw-Hill.
2. Baker, G. 2001. The Biology of Terrestrial Molluscs. 3rd Edition.
3. Rober, T. and Dilton, Jr. 2000. The Ecology of Freshwater Molluscs. Cambridge University Press 1-499.
4. Preston, S. B. 1915. Mollusca (Freshwater Gastropods and Decapods). Fauna of British India including Ceylon and Burma. 244 p. Taylor and Francis Red Lion Court, London.
5. General Parasitology, Cheng T.C. 1986., Second Edition (first published in India, 1999 by Replica Press Pvt. Ltd. Delhi 110-040, India), Academic Press Inc. USA
6. Helminths Arthropods and Protozoa of Domesticated Animals. Soulsby, E.J.L. 1982. Bailliere and Tindall, London, UK.
7. Veterinary Parasitology. Urquhart G.M., Armour J., Duncan J.L. Dunn A.M. and Jennings F.W., 1987 Longman Group UK Ltd., London, UK
8. Veterinary Helminthology, Dunn A.M., 1978. William Heinemann Medical Books LTD. London, UK
9. Malacology, Malek E.A. (1974). Burgess publishing Co. Minneapolis.
10. Introduction to Helminth Parasites of Animals and Birds in Bangladesh Rahman M.H., Ahmed S. and Mondal M.M.H. (1996). Sheba Printing Press, Dhaka, Bangladesh.

13. Biological Oceanography

BIOLOGICAL OCEANOGRAPHY

(Cr.Hrs.2+1)

(A COMPARATIVE PERSPECTIVE)

Course Objectives:

1. To impart concepts about the Biology and Ecology of the sea
2. To incorporate the Physical, Chemical and Geological characteristics of ocean
3. To know about Ocean Resources

Learning Outcomes:

1. **Acquire** basic knowledge about the Oceanography
2. **Understand:** the physical, chemical, geographical, ecological and biological characteristics
3. **Solve:** students confidentially face with full command and expressing ideas about seas
4. **Analyze:** Students will be able to categorize the various aspects about oceans
5. **Evaluate:** To describe the significance of Seas and life present in it
6. **Demonstrate:** To understand the Collection, Preservation, Sorting and identification of marine life with special reference to their habitat and analysis of Plankton samples.

Course Contents:

1. Introduction

- a. Oceanography
- b. Ocean exploration,
- c. Modern oceanography.

2. The Properties of Sea Water

- a. Physical properties of oceans,
- b. Temperature, Pressure, Salinity,
- c. Density, Circulation, Colour, Sound,
- d. Waves, Tides,
- e. Chemical Properties of Oceans
- f. Gases of seawater, Nutrients of seawater,
- g. Major, minor and trace elements of seawater.

3. Marine Ecology

- a. Zonation of marine environment,
- b. Neratic & oceanic province,
- c. Ocean basin floor, Ridges, Rise & trenches,
- d. Coastal habitats,
- e. Estuaries,
- f. Coral reef,
- g. Lagoons, Salt marshes,
- h. Mangrove swamps,
- i. Population of primary biotic division,
- j. Classification of organisms,
- k. Life on sandy shore,
- l. Life on muddy shore
- m. Life on rocky shores.

4. The Plankton

- a. Terminology of plankton,
- b. Methods of collection, Preservation, Analysis and identification,
- c. Phytoplankton-Zooplankton relationship,
- d. Diurnal vertical migration,
- e. Hydrographic indicator species and organic production.

5. The Nekton

- a. Marine reptiles,
- b. Marine birds
- c. Marine mammals.

6. The Ocean Resources

- a. Law of the sea,
- b. Mineral resources, Oil and natural gas, Gas hydrates, Minerals,
- c. Ocean mining
- d. Living resources
- e. Fisheries
- f. Mariculture.

7. The Human Presence in the Ocean

- a. Pollution,

- b. Hydrocarbon in the sea,
- c. Municipal and industrial effluent, Sewage,
- d. Metals, Artificial biocides,
- e. Ocean dredging and mining,
- f. Over-fishing,
- g. The ocean future.

Practicals:

- 1. Study of Specimens of Marine Environment.
- 2. Collection, Preservation, Sorting, Identification & Analysis of Plankton samples.
- 3. Field trips to Rocky, Sandy & Muddy Shores.

Books Recommended:

- 1. Charles B. Miller, Patricia A. Wheeler 2012. Biological Oceanography .John Wiley & Sons 464 pp
- 2. Briggs, J.C. 1974. Marine Zoogeography. McGraw-Hill, New York.
- 3. Castro, P., and Huber, M.E. 2007. Marine Biology, 6th Edition. McGraw-Hills, New York.
- 4. Castro, P., and Huber, M.E. 2005. Marine Biology, 5th Edition. McGraw-Hills, New York, USA-425PP.
- 5. Duxbary, A.B., and Duxbury, A.C. 1996. Fundamentals of Oceanography, 2nd Edition. Wn. C. Brown Publisher-308PP

14. Biology and Control of Vertebrate Pests

N.A

14. Biotechnology

BIOTECHNOLOGY

Contact Hours:

Theory = 32
 Practicals = 48
 Total = 80

Credit Hours

Theory = 2.0
 Practical = 1.0
 Total = 3.0

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:

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

2. Genetics and Biotechnology:

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

3. Biotechnology and Justice:

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

4. Genetic Engineering

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

5. Animal and Insect Biotechnology:

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

6. Bioprocess Technology:

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

7. Biotechnology and Medicine:

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

8. Stem Cell Biotechnology:

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

9. **Public Perception of Biotechnology:**
 - a. Current issues in bioethics (Autopsy, GMOs, Stem Cells, Euthanasia, Organ Transplant, Human Cloning, IVF, Surrogacy and sperm donor, etc)
10. **Bioethics and Islamic Bioethics:**
 - a. Introduction and principles of bioethics,
 - b. Concept of bioethics in different religions, principles of Islamic bioethics

Practicals:

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

Teaching methodology:

- Lecturing
- Written Assignments
- Quizzes
- Practical

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 10%
- Assignments 10%
- Quizzes 10%
- Practical 20%

Text and Reference Books:

1. Clark, D.B., Pazdernik, N.J. (2015) Biotechnology. 2nd Edition. Academic Cell
2. Glick, B., Pasternak, J.J., Patten, C.L. (2009) Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4th Edition. ASM Press.
3. Freeman, S., Quillin, K., Allison, L. (2013) Biological Science. 5th Edition. Pearson.

4. Schmid, R.D., Schmidt-Dannert, C., Hammelehle, R. (2016) *Biotechnology: An Illustrated Primer*. Willey-Blackwell.
5. Dehlinger, C.A. (2014) *Molecular Biotechnology*. Jones & Bartlett Learning
6. Brown, T.A. (2016) *Gene Cloning and DNA Analysis: An Introduction*. 7th Edition. Willey-Blackwell.
7. Butler, J.M. (2009) *Fundamentals of Forensic DNA Typing*. Academic Press.
8. Setlow J. K. (2000). *Genetic Engineering: Principles and Methods*. Kluwer Academic Publishers
9. Krishna.V.S. (2007) *Bioethics and Biosafety in Biotechnology*. New Age International
10. Furr, A.K. (2008) *CRC Handbook of Laboratory Safety*. 5th Edition. Boca Raton, FL, CRC Press
11. Smith, J. E. (2009). *Biotechnology*, 5th Edition, Cambridge University Press

16. Biotechnology in Aquaculture

BIOTECHNOLOGY IN AQUACULTURE

Credit Hours:

Theory = **3.0**

Practical = 1.0

Total = **4.0**

Course Objectives:

The objectives of the course are:-

1. To aware students about the past and present status of biotechnology as well as the need and importance of biotechnology in the current era
2. To provide in-depth knowledge on Gynogenesis, Androgenesis, Cloned Populations and Molecular Markers
3. To provide an overview of the application of biotechnological tools in Genetic Engineering, Selection, Crossbreeding, Strains, Hybrids, feed and other issues.

Course Learning Outcomes:

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

1. Identify and develop insight into the application of biotechnological advances in aquaculture.
2. Conceptualize the principal bases of biotechnology and emerging issues in aquaculture.
3. Elucidate different aspects of genetic biotechnology with reference to food safety.
4. Demonstrate various techniques of molecular nature applied for aquaculture development.

Course Outline:

1. **Introduction**
 - a. History of Biotechnology in Aquaculture

- b. Biotechnological approaches in Aquaculture
2. **Gynogenesis, Androgenesis and Cloned Populations**
 - a. Induction of Gynogenesis and Androgenesis
 - b. Performance of Gynogens and Androgens
 - c. Reproduction
 - d. Monosex Populations
 - e. Cloned Populations.
3. **Biochemical and Molecular Markers**
 - a. Isozymes and Enzymes.
 - b. Restriction Fragment Length Polymorphism.
 - c. Single Nucleotide Polymorphisms.
 - d. Relative Costs of Different Markers
 - e. Relative Effectiveness of Markers
4. **Combining Genetic Enhancement Programmes**
 - a. Sex Reversal and Triploidy
 - b. Genetic Engineering and Crossbreeding
 - c. Genetic Engineering, Selection, Crossbreeding, Strains and Hybrids
5. **Food Safety of Transgenic Aquatic Organisms**
 - a. International Guidelines
 - b. Labelling
6. **Environmental Risk of Aquatic Organisms from Genetic Biotechnology**
 - a. Theoretical Risks
 - b. Environmental Risk Data on Transgenic Fish
 - c. Common Goals of Aquaculture and Genetic Conservation

Practicals:

1. DNA isolation from fish.
2. Electrophoresis, Agarose and polyacrylamide gel electrophoresis.
3. Demonstration of amplification of DNA through PCR.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Lab work

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%

Text and Reference Books:

1. Dunham, R.A., 2011. Aquaculture and Fisheries Biotechnology: Genetic approaches. CABI,UK.
2. Kumar, R., 2010. Biotechnology and Genetics in Fisheries and Aquaculture. Blackwell, USA.
3. Stickney, R.R., 2009. Aquaculture: An introductory Text. CABI Publishing, UK

17. Cancer Biology

N.A

18. Clinical Biochemistry

N.A

19. Comparative Developmental Biology

COMPARATIVE DEVELOPMENTAL BIOLOGY

Contact Hours:

Theory =48
Practical =32
Total =80

Credit Hours:

Theory =3.0
Practical =1.0
Total =4.0

Course Objectives:

The course aims to:

1. To introduce students to the developmental processes that lead to the establishment of the body plan of the vertebrates at the cellular and genetic level.
2. To enable the students to understand and appreciate some of the events and processes which occur during animal growth and development as animal develops from an egg and a sperm into an adult organism.
3. To understand the process of differentiation which leads to different types of cells and tissues to perform various functions in an integrated way as each new organism develops.
4. To understand organogenesis and pathology related mechanisms of development and differentiation.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge to list the types of features that make an organism model for the learning of developmental biology.e.g., the

- mechanisms accountable for the fast and slow blocks to polyspermy through fertilization in sea urchins with mammalian like mechanisms.
2. **UNDERSTAND**a single fertilized egg cell develops gradually into a complex, three-dimensional, multicellular organism composed of highly organized tissues, such as bone, cartilage, skin, muscles, nerves, blood and blood vessels, internal organs or head structures.
 3. **ANALYZE**the fundamental molecular and cellular mechanisms (e.g. differential gene expression, cytoskeletal dynamics or endocytic trafficking), cellular communication (e.g. signalling, adhesion) and developmental concepts (asymmetric cell division, pattern formation, cell migration, branching) contribute during this process.
 4. **EVALUATE**the different mechanisms integrate at the level of whole tissues, organs and organisms, and how they are functionally adapted in distinct developmental contexts.
 5. **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 to development Biology**
 - a. Scope, Science of developmental biology and its applications
 - b. Developmental patterns in metazoan.
2. **Germ Cell**
 - a. Germ cell migration in amphibian, birds and mammals.
 - b. Differentiation of germ cells into sperm or egg.
3. **Spermatogenesis**
 - a. A detailed study of the spermatogenesis in vertebrates and gene expression during sperm development.
4. **Oogenesis**
 - a. Oogenic meiosis
 - b. Maturation of oocyte in amphibian
 - c. Role of estrogen and progesterone in oogenesis
 - d. Gene transcription in oocyte
 - e. Vitellogenesis
5. **Fertilization**
 - a. Contact recognition between sperm and egg
 - b. Acrosomal reaction
 - c. Gametes bindings and fusion (role of egg membranes)
 - d. Egg activation
6. **Creation of multicellularity**
 - a. Cleavage characteristics
 - b. Patterns of cleavage (radial holoblastic, bilateral holoblastic, spiral holoblastic, rotational holoblastic and meroblastic)
 - c. Gastrulation in avian and amphibians (frog and chick)
 - d. Concept of fate maps (chick and frog)

7. **Organizers and induction**
 - a. Primary embryonic induction
 - b. Regional specificity of induction
 - c. Molecular mechanism of primary embryonic induction
8. **Early vertebrate development**
 - a. Neuralation and development of ectoderm
 - b. Organization of mesoderm and endoderm
9. **Differentiation**
 - a. Cell commitment and differentiation
 - b. Chemical basis of differentiation
10. **Organogenesis**
 - a. Development of rudimentary organs in amphibian and mammals
 - b. Cellular interactions during the development of limb, brain, eye, heart and liver
11. **Placenta**
 - a. Development of placenta and its different types
 - b. Placental hormones and their functions/ importance
12. **Multiple ovulation and Embryo transfer technology**
 - a. *In vitro* oocyte maturation
 - b. Cryopreservation
 - c. Embryo transfer technology

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speakers
- Hospital visits
- Report writing

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%

Practicals:

1. Study of gametes structure in some representative cases, *i.e.*, frog, fish, fowl and mammal.

2. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals *i.e.*, frog, chick etc.
3. Study of fertilization, early development of frog through induced spawning under laboratory conditions.
4. Preparation and study of serial sections of frog or chick embryos.
5. Application of microsurgical techniques on chick embryos *in vitro*.
6. 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 and Michael J. F. Barres. 2016. Developmental Biology. Sinauer Associates, Sunderland, MA.
4. Jamie, A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
5. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
6. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
7. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
8. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

7. Conservation Biology

Conservation Biology

Credit Hours:	=2+1	Theory =02
Practical	=01	Total =3

Course Objectives:

The objective of this course is

1. to enable the student to understand and investigate the diversity of living world,
2. to understand the effect of human activities on species, communities and ecosystems; and
3. to develop a practical interdisciplinary approach to protect and restore biological diversity.

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about the phenomena that affect the maintenance, loss, and restoration of biological diversity.
2. UNDERSTAND the ecological and evolutionary principles of biological diversity which influence the conservation of wildlife at spatial and temporal scales in Pakistan as well as abroad.

3. SOLVE the conservation issue by applying the scientific principles and modern technologies.
4. ANALYSE, interpreting and synthesize data and other information about the determinants of the conservation problems.
5. EVALUATE the conservation actions taken by the biologists for solving the conservation problems across biological scales (genes to landscapes) and geographical scales (local to global).
6. DEMONSTRATE sound research skills based on ecological and evolutionary principles in investigating problems in conservation biology.

Course Outline:

1. Introduction to Conservation Biology:

- a. Definition,
- b. History and
- c. Scope.

2. Biodiversity:

- a. Species Diversity; Genetic Diversity; Ecosystem Diversity;
- b. Measurement of Biological Diversity;
- c. An Overview of World's Biodiversity;
- d. The Value of Biodiversity

3. Threats to Biodiversity:

- a. Human Population Growth;
- b. Habitat Destruction; Habitat Fragmentation;
- c. Environmental Degradation and Pollution;
- d. Global Climate Change;
- e. Overexploitation;
- f. Invasive Species

4. Extinctions:

- a. Extinction and Mass Extinctions;
- b. Rates of Extinction; Island Biogeography;
- c. Vulnerability to Extinction;
- d. Problems of Small Populations; Minimum Viable Population (MVP);
- e. Loss of Genetic Diversity; Effective Population Size;
- f. Demographic and Environmental Stochasticity

5. Conserving Populations and Species:

- a. Applied Population Biology; Monitoring populations; Population viability analysis; Metapopulations,
- b. International agreements for conservation of fauna and flora; Role of national and International Laws in Protection of Species;
- c. Ex Situ Conservation Strategies; Zoos; Aquariums; Botanical gardens; Seed banks.
- d. Protected Areas and their Establishment and categories;
- e. Managing Protected Areas; Challenges to Protected Areas Management.
- f. Unprotected Public and Private Lands
- g. Ecosystem Management
- h. Integration of Local Community in Conservation

- i. Restoring Damaged Ecosystems

6. Sustainable Development:

- a. Challenges Involve in Conservation and Sustainable Development at the Local Level
- b. International Approaches to Sustainable Development
- c. Funding for Conservation by the World Bank and international NGOs;
- d. Conservation Education and the Role of Conservation Biologists

Practicals:

1. Conservation issues in protected areas of Pakistan.
2. Study of the role of local community in protected areas of Pakistan.
3. Challenges to sustainable development and their solution in Pakistan.

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Richard B. Primack, 2012. A Primer of Conservation Biology; 5th Edition: Sinauer Associates, Inc. Publishers Sunderland, MA U.S.A.
2. Groom, M.J., G.K. Meffe and C.R. Carroll, 2006, Principles of Conservation Biology, 3rd edition, Sinauer Associates, Sunderland, MA.
3. Malcolm L. Hunter, Jr. 2001. Fundamentals of Conservation Biology, 2nd Edition. Blackwell Science Inc.
4. Mills, L.S. 2007. Conservation of Wildlife Populations: Demography, Genetics and Management. Blackwell Publishing, USA.
5. Richard B. Primack. 2002. Essentials of Conservation Biology. 3rd Edition. Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, U.S.A.

- 21. **Ecological Genetics**
N.A
- 22. **Elements of Stratigraphy and Structural Geology**
N.A
- 23. **Endocrinology**

ENDOCRINOLOGY-I

Contact Hours:

Theory =32
 Practical = 32
 Total = 64

Credit Hours:

Theory = **2.0**
 Practical = 1.0
 Total = **3.0**

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,cyclice and how hormones are transported in the blood and consequences of reversible binding of many hormones by plasma proteins
8. To explain the basis of hormone assays and assessment of biological activity
9. To discuss the metabolism, clearance and excretion of hormones and their metabolic derivatives
10. To define and discuss the physiological actions of hormone relating them whenever possible to human disorders
11. To explain the consequences of under and overproduction of hormones to determine the pathophysiological basis and consequences of specific endocrine disorders.
12. 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 cyclice.
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.
14. Evaluate and assess scientific literature about endocrine function and pathology.

Course Contents:

1. **An overview of general concepts and principles of endocrinology:**
 - a. The endocrine system; Type of hormones; Endocrine and nervous system relationship;
 - b. General principles in function, interaction, nature, synthesis, transport of hormones;
 - c. General concept of feedback, biorhythms, pathology and assessment of endocrine function;
 - d. Evolution of endocrine system. RIA, RIMA, ELISA, bioassay and receptor assay
2. **Hypothalamus and pituitary:**
 - a. Hypothalamic hormones: Origin, chemistry and actions and mechanism of action;
 - b. Anterior pituitary & hormones: Hypothalamic pituitary regulation,
 - c. General chemistry, Physiological action, mechanism of action and metabolism of prolactin-growth hormone family,

- d. glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides;
 - e. posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.
 - f. Causes and effect of over and under production of hypothalamic and pituitary hormones
 - g. Hypothalamic, pituitary and thyroid, adrenocortical, gonadal and other axis.
3. **Thyroid gland:**
- a. Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Function of thyroid hormone,
 - b. Mechanism of action; regulation and factors affecting thyroid function.
 - c. Causes and effect of Hypothyroidism and hyperthyroidism
4. **Calcitropic and Mineral Metabolism Hormones:**
- a. Chemistry, physiological actions, mechanism of action and
 - b. metabolism of parathyroid hormone,
 - c. Causes and effect of over and under production of hormone
 - d. Calcitonin and calciferols; action and mechanism of action
 - e. Homeostasis of calcium, phosphate and magnesium.
5. **Pancreatic Hormones and Regulatory Peptides of the Gut:**
- a. Anatomy and histology for sources of the hormones; Chemistry,
 - b. Physiological roles and mechanism of action of insulin and glucagon;
 - c. Physiological roles of gut peptides.
 - d. Causes and effect of over and under secretion of pancreatic hormones
 - e. Glucose homeostasis
6. **Adrenal Medulla and Catecholamines:**
- a. Chromaffin cell and organization; Structure of adrenal medulla;
 - b. Biosynthesis, storage, release and metabolism;
 - c. Adrenergic receptors and mechanism of action;
 - d. Disorder of Adrenal medulla (pheochromocytoma)
7. **Adrenal Cortex:**
- a. Anatomy and Steroid biochemistry;
 - b. Physiological actions of corticoid hormones and mechanism of action;
 - c. Regulation and metabolism of glucocorticoids,
 - d. Mineralocorticoids and adrenal sex steroids.
 - e. Disorder of adrenal cortex hormones
8. **Testes: Androgenic tissue:**
- a. Anatomy, structure, chemistry, synthesis and transport of hormone,
 - b. Metabolism, action and mechanism of action.
 - c. Testicular disorder
9. **Ovaries:**
- a. Ovarian Anatomy, hormones: Steroid biochemistry and biosynthesis;
 - b. Transport, metabolism, action and mechanism of action.

- c. Cyclic changes, menopause
- d. Ovarian disorder
- 10. **Endocrinology of Pregnancy:**
 - a. Hormones in conception and implantation;
 - b. Hormonal actions and
 - c. Adaptation in pregnancy and parturition.
- 11. **Fetus Endocrinology**
 - a. Endocrinology of developing fetus
- 12. **Endocrinology of Lactation:**
 - a. Hormones in lactation.
- 13. **Endocrinology of development of growth**
 - a. Growth and Puberty
 - b. Disorders of growth and puberty
- 14. **Endocrinology of**
 - a. Heart, Kidney,
 - b. Immune system:
 - c. Growth and pineal gland.
- 15. **Functional diversity of vertebrate hormones**
 - a. Functional diversity of hormones in different vertebrates
- 16. **Overview of Endocrine Mechanisms in Invertebrates**
 - a. Hormones of invertebrates
- 17. **Geriatric Endocrinology**
 - a. Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis

Practical:

- 1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc;
- 2. Histological and ultrastructure features of endocrine glands;
- 3. Experiments to demonstrate physiological roles of hormones of different endocrine glands;
- 4. Experiments to demonstrate regulation of hormones' releases.
- 5. Experiments to demonstrate functional diversity of hormones in different vertebrates.
- 6. Experiments on endocrine mechanism in vertebrates.
- 7. Experiment on recognition and response of receptors
- 8. Studies of disorders of pituitary by observing anatomical and histological features
- 9. Studies of thyroid status in deficient and excess hormone functions
- 10. Studies of type 1 and type 2 diabetes mellitus: Epidemiology of the types in population, studies of management of the type 2;
- 11. Model studies of Ovarian and Testicular disorders;
- 12. Model studies of obesity and anorexia;
- 13. Studies of hormonal status in puberty and aging

Teaching Methodology:

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

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
Assignments & Presentation	(15%)

Text Books:

1. Greenspan, F.S. and Strewler, G.J., 2011. Basic and clinical endocrinology, 9th Edition. Prentice Hall International Inc., London.
2. Bentley, P.J., 1998. Comparative Vertebrate Endocrinology. 3rd Ed. Cambridge University Press, Cambridge.
3. Sam A., Meeran K. Endocrinology and Diabetes. Lecture notes. Wiley-Blackwell (2009) (basic science and clinical context).
4. Laycock J, Meeran K. Integrative Endocrinology. Wiley-Blackwell (2013).
5. Rang H, Dale M and Ritter, J: Pharmacology, 4th ed., (1999). (relevant for drug information) 2nd Edition. The Oxford Textbook of Endocrinology and Diabetes DOI: 10.1093/med/ 9780199235292.003.0134
6. Yen & Jaffe's Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management. Saunders – all editions are excellent (even the older editions)
7. Johnson MH. Essential Reproduction. 7th Ed. Wiley-Blackwell (2013) (relevant for some general background info on reproduction pitched for undergraduate students).
8. Chandra S. Negi, introduction to endocrinology
9. Charles Brook, Nicholas Marshall, essential endocrinology
10. Noris, vertebrate endocrinology

Additional Readings:

1. 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.
2. DeDroot, L.J., Jameson, J.L. *et al.*, 2012 Endocrinology, Vol.I, II & III, th Edition. W.B. Saunders, Philadelphia.
3. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
4. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

24. Entomology (Classification of Insects and Pest Management)

CLASSIFICATION OF INSECTS AND PEST MANAGEMENT

Contact Hours:

Theory = 32
Practical = 32
Total = 64

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To describe the identification characters of insects belonging to different orders.
2. To introduce the insect pests of major crops of Pakistan.
3. To familiarize the students with various control strategies of insects.

Course Learning Outcomes:

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

1. **CLASSIFY** the insects at different hierarchical levels.
2. **RECOGNISE** the insect pests of major crops.
3. **DESIGN** the pest management plan for insect pests of crops.

Course Outline:

1. **Introduction**
 - a. Evolutionary history of insects
 - b. Phylogenetic arrangement of orders and families
2. **Classification of insect orders: General account of apterygota**

Subclass: Apterygota

 - a. Order Collembola
 - b. Order Diplura
 - c. Order Zygentoma
 - d. Order Protura
 - e. Order: Archaeognatha
3. **Subclass: Exopterygota**
 - a. Order Dermaptera
 - b. Order Dictyoptera
 - c. Order Embiidina
 - d. Order Neuroptera
 - e. Order Strepsiptera
 - f. Order Mantophasmatodea
 - g. Order Mecoptera
 - h. Order Orthoptera
 - i. Order Phasmatodea
 - j. Order Phthiraptera
 - k. Order Plecoptera

- l. Order Psocoptera
 - m. Order Siphonaptera
 - n. Order Zoraptera
 - o. Order Megaloptera
 - p. Order Raphidioptera
 - q. Order Ephemeroptera
 - r. Order Odonata
4. **Endopterygota**
- a. Order Megaloptera
 - b. Order Hymenoptera
 - c. Order Coleoptera
 - d. Order Lepidoptera
 - e. Order Trichoptera
 - f. Order Siphonaptera
 - g. Order Diptera
 - h. Order Neuroptera
 - i. Order Mecoptera
 - j. Order Raphidioptera
 - k. Order Strepsiptera
5. **Knowledge of insect pests of**
- a. Rice
 - b. Cotton
 - c. Sugarcane
 - d. Wheat
6. **Brief account of different insect pest management strategies as:**
- a. Cultural Control
 - b. Physical and Mechanical Control
 - c. Host Plant Resistance
 - d. Biological Control
 - e. Chemical Control
 - f. Other approaches

Practical:

1. Field visits for collection of different developmental stages of insects belonging to different orders.
2. Identification and classification of collected specimens.
3. Field visits and report writing of insect fauna of different crops.
4. Field visits for survey of different control strategies being practiced for control of insect pests.
5. Museum visits

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker (If feasible)
- Field Visits

- Museum visits
- Report Writing

Assessment:

Mid Term (40%)

Theory

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10% (Theory only)

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10% (Theory only)

Practical:

1. Written (Long Questions, Short Questions, MCQs, identification etc) 40%
2. Collection of Insects 30%
3. Assignments 20%
4. Report Writing 10%

Text and Reference Books:

1. Atwal, A.S., 2015. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
2. Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
3. Chapman, R. F., 2013. The Insects-Structure and Function. 5th Edition. Cambridge University Press, New York.
4. Gullan, P. J. and Cranstan, P. S., 2014. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
5. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.

25. Entomology (Morphology, Physiology and Ecology)

INTRODUCTION TO ENTOMOLOGY

Contact Hours:

Theory =32
Practical = 32
Total = 64

Credit Hours:

Theory =**2.0**
Practical =1.0
Total =**3.0**

Course Objectives:

The objectives of the course are:-

1. To describe the reasons for evolutionary success of insects.
2. To establish the understanding about body structure of insects.
3. To familiarize the students about different physiological processes of insect.
4. To introduce concepts of insect ecology.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of the body structure of insects.
2. **UNDERSTAND** the role of structures in different life processes of insects.
3. **CLASSIFY** the insects at order level.
4. **ASSOCIATE** the insect structure, physiology and ecological interactions with their abundance and huge diversity.
5. **DIFFERENTIATE** the structural differences between different insects.
6. **ANALYZE** the impact of environmental factors on insect life.

Course Outline:

1. Morphology

- a. **General characteristics of insects.** Relationship with other Arthropods, splitting up into different evolutionary lines, Reasons for success of the insects in diverse environments.
- b. **Hard Parts:** General segmentation, tagmatosis and organization.
- c. **Integument: Cuticle:** Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane, Cuticular outgrowths and appendages sclerotization.
- d. **Colors of Insects.**
- e. **Head:** cephalization, sclerites, modifications.
- f. **Antennae:** Typical Antenna and its types.
- g. **Mouthparts:** Mouthparts and their types. Different modes of ingestion and types of mouthparts.
- h. **Neck:** Sclerites.
- i. **Thorax:** Sclerites: legs, their different modifications and functions.

- j. **Wings:** Origin; Different regions. Development and basal attachments, main veins and their branches (generalized insects), Modifications of wings and wing coupling.
- k. **Flight:** Types of flight.
- l. **Abdomen:** Secondary appendages and external genitalia.

2. Physiology

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

3. Ecology

- a. **Population dynamics:** Density dependent and density independent factors regulating insect population.
- b. Life history and life tables.
- c. Carrying capacity r and k selection.
- d. Food chains.
- e. Predation and competition.
- f. Insect defenses and adaptations.
- g. Diapause.
- h. Insect communication.

Practical:

1. Preparation of permanent slides. All the hard parts (antennae, mouth parts, wings, legs and genitalia).
2. Dissection of insects to study different systems especially digestive, reproductive system of the available representative insects preferably following insects. American Cockroach, Grasshopper.
3. Field visits for collection of different developmental stages of insects belonging to different orders.
4. Field visits and report writing of ecological interactions of different insects.

Teaching Methodology:

- Lecturing
- Written Assignments
- Field Visits
- Report Writing
- Practical observations

Assessment:

Mid Term (40%)

Theory

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Practical

- Written (Long Questions, Short Questions, MCQs Dissections) 50%
- Collection of Insects 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Schowalter, T.D., 2017. *Insect Ecology: An Ecosystem Approach*. Academic Press.
2. Ambrose, D.P., 2015. *The Insects: Structure Functions and Biodiversity*. Kalyani publishers, Ludhiana, India.
3. Atwal, A.S., 2015. *Agricultural Pests of Southeast Asia and their Management*. Kalyani Publishers, Ludhiana.
4. Chapman, R. F., 2013. *The Insects-Structure and Function*. 5th Edition. Cambridge University Press, New York.
5. Gullan, P. J. and Cranstan, P. S., 2014. *The Insects: An Outline of Entomology*. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
6. Miller, S.A., 2002. *General Zoology Laboratory Manual*. 5th Ed. (International), Singapore: McGraw Hill.
7. Pedigo, L.P. and Marlin, E. R. 2009. *Entomology and Pest Management*, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
8. Price, P.W., Denno, R.F., Eubanks, M.D., Finke, D.L., and Kaplan, I., 2011. *Insect Ecology: Behavior, Populations, and Communities*. Cambridge University Press.
9. Richards, O.W. and Davies, R.J. *Imm's General Textbook of Entomology*. 1977. Vol-. Chapman & Hall, London.

26. Environmental Issues

Environmental Issues

Contact Hours:

Credit Hours:

Theory = 2.0

Practical = 1.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To familiarize the students about the learning and solutions of burning environmental issues
2. To enable the students to understand impact and importance environmental issues for the betterment of the environment
3. To check and control all sources that are destroying natural environment in Pakistan

Course Learning Outcomes:

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

1. Acquire the basic knowledge of types of environmental degradation issues
2. Understand the concepts of basic issues related environment of Pakistan
3. Solve the problems using learned tools for tackling the environmental issues

Course Outline:

1. Human population:

- a. Human population explosion, environmental and social impacts of growing population, its affluences and settlement of population problems.
- b. Human impact on water resources, Eutrophication and its control.

2. Hazardous Chemicals:

- a. Nature of chemical risks and sources.
- b. Water and land pollution with micro plastics, biodegradable plastic, oxo-degradable plastic its threats and control

3. Sewage Pollution:

- a. Sprawl and Sewage hazards and sewage managements,

4. Solid waste:

- a. Landfills, incineration, management and solutions

5. Pest and pest control:

- a. Pest and pest control need and approach to pest control and integrated pest management.

6. Major atmospheric Changes:

- a. Acid deposition, global warming/ cooling, greenhouse effect, Ozone depletion. smog and PAN, MTBE & CFCs

7. Environmental Issues in Pakistan:

- a. Ecological issues; soil erosion, deforestation, issues related to irrigation system, natural hazards,
- b. issues related to conservation of habitat and biodiversity
- c. Emerging issues; Lead in paint-chemical products, hazardous electrical, nanotechnology, endocrine-disrupting chemicals, pharmaceutical pollutants and per fluorinated chemicals

8. Energy resources:

- a. Energy sources and uses; issues related to fossil fuel and nuclear power, alternate energy resources.
- b. Nuclear energy, radiation, types, sources, health effects and preventive measures.

9. Major threats to biodiversity

- a. Major threats to biodiversity in Pakistan, Conservation strategies. Global environmental facility (GEF) **biosafety and its importance**

Practical:

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

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments

- Report Writing

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Text and Reference Books:

1. Environmental Science (Earth as a living planet). 2000. 3rd ed. Botkin, D. B. and Keller, E. A. John Wiley and Sons Inc. New York, USA.
2. Environmental Science (The way the world works). 1998. 1st ed. Nebel, B. J. and Wright, R. T. Prentice Hall International Inc. London, UK.
3. The Biosphere. 1998. 2nd ed. Bradbury, I. K. John Wiley and Sons Inc. UK.
4. Environmental Science (Systems and solutions). 1998. McKinney, M. L. and Schoch, R. M. Jones and Bartlett Publications Inc. USA.
5. Pakistan- A Descriptive Atlas (A comprehensive geo-politics course). 2000. 1st ed. Ahmad, R. Z. Ferozsons Pvt. Ltd. Lahore Pakistan.
6. A Geography of Pakistan Environment (Environment, people and economy). 1993. 1st Ed., Khan, F. K. Oxford University Press. New York USA.
7. Daily newspapers for current issues.

WEB SITES

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

27. Environmental Physiology

N.A

28. Environmental Pollution

Environmental Pollution

Contact Hours:

Credit Hours:

Theory = **1.0**

Practical = **2.0**

Total = **3.0**

Course Objectives

The objectives of the course are:-

1. To familiarize the students with the types of environmental pollutants
2. To introduce the students with the ecosystem related pollutant with their origin and mode of action

3. To train the students in tackling the treatments of pollutants

Course Learning Outcomes:

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

1. Acquire the basic knowledge of pollutants nature
2. Understand the concepts of basic techniques and use them efficiently for control of pollutants with their nature
3. Solve the problems of the environment by using different methods

Course outline:

1. Introduction

- a. Pollution, types, water pollution, water pollutants, category and composition of waste water.
- b. Water quality index. Ground water pollution, Aquifers, Hydraulic gradient,
- c. Darcy's Law, contaminants in ground water, waste water remediation technologies for surface and ground water.
- d. Effect of Water pollution on ecosystem and biota

2. Water Quality Control:

- a. Introduction, standard qualities for Drinking Water, Water quality standards for irrigation, industry, fishery and other ventures.
- b. Water treatment systems and waste water treatments technologies
- c. Hazardous waste in Pakistan water bodies, solid wastes, sewerage, sewage disposal and treatment

3. Air Pollution:

- a. Introduction, Pollutant sources, Primary and secondary pollutants and toxic air pollutants.
- b. Air quality standards, motor vehicle emissions and stationary emissions- composition and control.
- c. Formation of aerosol and its effects and indoor air quality standards.
- d. Air pollution assessment technologies and its effect on biota

4. Soil Pollution and Solid Waste:

- a. Introduction, sources of soil pollutants-municipal, agriculture, aquaculture, poultry and industrial sources of soil pollutants.
- b. Classification, characterization of solid waste, hazardous solid waste and biomedical waste.
- c. Leachate of solid waste, transboundary movement of wastes, physical, chemical and biological treatment of waste
- d. Disposal recycling of solid waste, effect of soil pollution on ecosystem and biota.

5. Noise Pollution:

- a. Introduction, Noise and vibration, sources of noise pollution,
- b. Noise, health, permissible levels, sonic boom, impulsive noise

- c. Anechoic chamber reverberating sound, noise topography and regulations for control of noise

6. Thermal and light Pollution:

- a. Introduction, sources of thermal pollution, effect of discharge of heat, effect of thermal pollution and its effect on ecosystem and biota.
- b. Light Pollution, environmental health, effect of light on pollinators and crop yield

7. Status of Environmental Pollutions in Pakistan:

- a. Prevention and control of wastes and National program to control wastes
- b. Reuse and recycle of waste, Acts and regulation to control pollution.

Practical:

1. Estimation of BOD and COD for the given water Sample
2. Acid base reactions in effluent treatment system
3. Collection, classification and segregation of Household waste
4. Analysis of Phosphate and sulphate in waste leachate
5. Recording the noise using noise recorder
6. Construction of models to predict smoke and pollutant dispersal in Air-Box model and Gaussian Plume model
7. Collection, segregation and classification of biomedical waste
7. Isolation, identification of bioindicators of waste water

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing
- **Final Term (60%)**
- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Gilbert M. Masters and Wendall, P. Ela. Introduction to Environmental

- Engineering and Science. PHI learning Pvt. Ltd.
2. Khopkar, S. M. Environmental Pollution- Monitoring and Control. New Age International Publishers, New Delhi.
 3. William W Nazaroff and Lisa A Cohen. Environmental Engineering Science. Wiley Publishers.

29. **ENVIRONMENTAL TOXICOLOGY**

N.A

30. **EPIDEMIOLOGY AND PUBLIC HEALTH**

EPIDEMIOLOGY AND PUBLIC HEALTH

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = **3.0**
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. Describe basic principles of epidemiology, including descriptive/analytical epidemiology
2. Elaborate techniques used to conduct disease outbreak investigations and develop disease prevention programs
3. Describe causal models, distribution/patterns and control of disease or other health-related events in populations

Course Learning Outcomes:

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

1. Discover basic principles of epidemiology, including descriptive/analytical epidemiology
2. Demonstrate techniques used to conduct disease outbreak investigations and develop disease prevention programs
3. Analyze causal models, distribution/patterns and control of disease or other health-related events in populations

Course Outline:

1. **Introduction to epidemiology & public health**
 - a. Disease occurrence
 - b. Mapping
 - c. Causality
2. **Determinants of disease**
 - a. Diagnostic testing
 - b. Transmission and maintenance of infection
 - c. Descriptive epidemiology
 - d. Analytical epidemiology

3. **Case-control studies**
 - a. Cohort studies
4. **Experimental epidemiology**
 - a. Animal disease survey
 - b. Types of sampling
 - c. Surveillance,
 - d. Prevention, Control and eradication,
 - e. Outbreak investigation
5. **National and international disease reporting**
 - a. Trans-boundary disease of veterinary importance
 - b. TAD distribution
 - c. Mapping
 - d. Regulatory implications
 - e. TAD control
 - f. International trade framework

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%

Text and Reference Books:

1. Thrusfield M., 2007. Veterinary Epidemiology. Blackwell Publisher
2. Gordis L., 2008. Epidemiology.4th Edition.Saundeis, Elsevier
3. Bonita, R., R. Beaglehole, T. Kjellstrom, 2006. Basic Epidemiology.2nd Edition. WHO
4. Merrill, R. M., 2013. Introduction to epidemiology, 6th Edition.Jones and Barletta learning LLC.

31. EPIDEMIOLOGY OF PARASITIC DISEASE

EPIDEMIOLOGY OF PARASITIC DISEASE

Contact Hours:

Theory = 30

Total = 30

Credit Hours:

Theory = 3.0

Total = 3.0

Course Objectives:

1. To Describe basic principles of epidemiology, including descriptive/analytical epidemiology
2. To elaborate techniques used to conduct disease outbreak investigations and develop disease prevention programs
3. To describe causal models, distribution/patterns and control of disease or other health-related events in populations.

Course Learning Outcomes:

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

1. Learn basic principles of epidemiology, including descriptive/analytical epidemiology
2. Demonstrate techniques used to conduct disease outbreak investigations and develop disease prevention programs
3. Compute causal models, distribution/patterns and control of disease or other health-related events in populations.

Course Outline:

1. **Introduction of Epidemiology**
 - a. Significance
 - b. Basis terminology
 - c. general concepts
2. **Selection of epidemiological parameters**
 - a. Surveillance study
 - b. Host parasite associations;
3. **Population biology and genetics**
 - a. Genetic variability and parasite transmission.
 - b. Age- intensity and age prevalence profile of parasite infections
4. **Ecological and evolutionary dynamics of parasites**
 - a. Parasite prevalence and seasons
 - b. Epidemiological approaches for the control of parasites
 - c. Application of molecular techniques in Epidemiology of parasitic infections.

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%

Text and Reference Books:

1. Urquhart, G.M.J., Armour, J.L., Duncan and Jennings, F.W., 2000. "Veterinary Parasitology" 3rd Ed. The English Language Book Society/Longman Scientific and Technical UK.
2. Thrusfield, M., 1997. "Veterinary Epidemiology" 2nd Ed., Blackwell Science Publication.
3. Matrin, S.W., MEEK, A.H. and Willeberg, P., 1993. Veterinary Epidemiology.
4. Toft, C.A., Aeschlimann, A. and Bolis, L., 1991. Parasite Host Association. Oxford University press. New York USA.
5. Wayne, S. and Allan, H., 1987. "Veterinary Epidemiology" Principles and Practices S. and H. Allan, H., 1987. "Veterinary Epidemiology" Principles and Practices. Meek and PrebenWilleberg, Iowa State University Press, Ames, Iowa, USA.
6. Rollinson. D.R., Anderson, M., 1984. "Ecology and Genetics of Host-Parasite interactions" Linnean Society Symposium Series No. 11, Academic press, New York. USA.

32. EVOLUTION AND PRINCIPLES OF SYSTEMATIC ZOOLOGY

Credit Hours:

Theory: 3

Practical: 1

Total: 4

Course Objectives:

The objective of the course are

1. To show how natural selection ultimately underpins all biological processes and how evolution has generated biological diversity.
2. To understand relationship between evolution and systematics concepts.

3. To investigate the theoretical basis and methods of modern biological systematics and classification.

Learning Outcomes:

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

1. ACQUIRE an enhanced knowledge and appreciation of evolutionary biology and systematics.
2. UNDERSTAND cogent and critical arguments based on the course material.
3. SOLVE the problems of evolution and taxonomy using different theoretical concepts and methods.
4. ANALYZE and report on experiments and observations in whole-organism biology.
5. EVALUATE the problems by integrating concepts, theories and techniques of the subject.
6. DEMONSTRATE the change in characters of the organisms and their grouping on the basis of these characters from lower to higher categories and phenetic and phylogenetic relationships between organisms.

Course Outline:

Evolution

The causes of micro-evolution; Hardy-Weinberg equilibrium, Mutation, Gene flow, Genetic drift, Nonrandom breeding, and natural selection.

Types of natural selection: directional, disruptive and stabilizing selection.

Causes of polymorphism in populations: Density dependent selection and Heterozygote advantage.

General selection model: one locus and two locus selection model, Genetic load, Cost of selection, Hitch-hiking, Linkage disequilibrium. and shifting balance theory.

Units of selection: allele, cell line, organisms, kin group and group.

Sexual selection: Theories of sexual selection; Darwin, Fisher and Zahavi.

Macroevolution: Evolutionary developmental biology: allometry, heterochrony, Evolutionary innovation and origin of higher taxa.

Rates of evolution; Evolutionary trends and laws, Gradualism and punctuated equilibrium.

Principles of Systematics

- Concepts of taxon, phenon and category.
- Species concepts and its problems: Typological; Nominalistic, Biological, Evolutionary.
- Subspecies, Polytypic species and Superspecies: concept and problems
- Modes of speciation: Allopatric, Sympatric, Parapatric
- Intrapopulation variation: Types and application
- Taxonomic characters: Different kinds of taxonomic characters. Weightage of taxonomic characters. Classification and its types; Phenetic, Cladistic and evolutionary classification.
- Taxonomic collections and the process of identification.
- The rules of zoological nomenclature: interpretation and application of the code (stability, priority, first revisor principle) range of authority of code; concept of availability, type method formation of specific names, synonym, homonym.

Practicals:

1. Calculation of gene and genotype frequency for generations.
2. To calculate deviation of genotype from Hardy Weinberg equilibrium.
3. Simulate to check the effects of natural selection and genetic drift in changing environments. Simulation of assess the role population size in evolution.
4. Discussion on the evidences of evolution, role of biodiversity in evolution.
5. Simulation experiment to show the process of coevolution.
6. The study of a group of organisms while utilizing key.
7. Collection, preservation, labelling and identification of a group of specimen according to expertise available in the institute.
8. Preparation of bracket and indent key.
9. Phylogeny Reconstruction using phenetic (Similarity and dissimilarity matrix and unweighted pair group method) and cladistic (compatibility method) analysis to a group of mock “organisms”.

Teaching Methodology:

- Lecturing
- Field visits
- Assignments
- Report writing

Assessment:

Mid term (40%)

- Written (Objective and Subjective) 50%
- Presentation 30%
- Assignment 10%
- Report writing 10%

Final term (60%)

- Written (Objective and Subjective) 50%
- Presentation 30%
- Assignment 10%
- Report writing 10%

Text and Reference Books:

Textbook

1. Ridley, M. 2004. Evolution, 3rd edition. Blackwell Science.
2. Mayr, E. and Ashlock, P.D., (Latest edition). *Principles of Systematic Zoology*, McGraw-Hill Inc. New York.

Additional Readings

1. Freeman, S. and Herron, J. C. 2004. Evolutionary analysis, 3rd ed. Pearson Prentice Hall.
2. Futuyma, D. J. 1997. Evolutionary Biology, 3rd ed. Sinauer Associates, Inc. Sunderland, Massachusetts.
3. Stearns, S. C. and Hoekstra, R. F. 2000. Evolution, an introduction. Oxford University Press.
4. Strickberger, (3rd or latest edition) Evolution. Jones and Barrett Publishers.
5. Simpson, G.G., (Latest edition). *Principles of Animal Taxonomy*, Columbia University Press, N.Y.
6. Soka, R., and Snaeth P.H.A. (Latest edition). Principles of numerical taxonomy. W.H. Freeman and company, London.
7. Kapoor, V.C. Principles and practices of animal Taxonomy. Science Publishers, 2nd Ed.

33. FISH BIOENERGETICS

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:

1. To elaborate the energetics and energy budget in fishes
2. To describe the fish feed and their nutrition value in fish
3. To impart knowledge regarding fish Metabolism and growth

Course Learning Outcomes:

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

1. **SYNTHESIZE** the scope and components of bioenergetics.
2. **COMPARE** and analyze energy budgets for different fish species.
3. **DESCRIBE** nutrient balances and imbalances and their impacts on fish.
4. **DETERMINE** energy utilization by fish and factors affecting it.
5. **DESCRIBE** how fishes utilize various feed ingredients in feeds.
6. **DESCRIBE** uses of energy in metabolism and food as nutrient sources.

7. **DETERMINE** energy requirements of fish.

Course Outline:

1. **Introduction to Energetics and Energy Budget**
 - a. Energetics
 - b. Energy budget
 - c. Adaptive aspects of energy allocation
2. **Fish feed and their nutrition value**
 - a. Introduction to fish food and nutrition value
 - b. Diet composition and requirement
 - c. Protein, carbohydrate and lipid as an energy source
 - d. Vitamin and minerals requirements of fish
 - e. Dietary sources of vitamins and minerals
3. **Metabolism**
 - a. Carbohydrates metabolism
 - b. Amino acids metabolism
 - c. Lipid metabolism
 - d. Regulation of metabolism by hormones
 - e. Effects of biotic and abiotic factors on metabolism
4. **Growth**
 - a. Regulation of growth by hormones
 - b. Thyroid hormones
 - c. Growth hormone
 - d. Effects of biotic and abiotic factors on growth

Practical:

1. To study energy budget in fishes.
2. Qualitative assessment of fish feed.
3. Oxygen consumption in fish.
4. Visit to fish feed manufacturing industry
5. To study effects of biotic and abiotic factors on growth.

Teaching Methodology:

- Lecturing
- Demonstration
- Written Assignments
- Guest Speaker
- Report Writing

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%

Text and Reference Books:

1. Fish Nutrition in Aquaculture. Sena S. De Silva and Trevor A. Anderson. Chapman & hall Aquaculture series 1 New York- Tokyo. Melbourne. Madras First edition 1995. Reprinted 2009.
2. The Biology of Fish Growth. A.H. weatherley and H.S.Gill. Academic Press Harcourt Brace Jovanovich, Publishers. London, Orlando, San diego, New York, Austin, boston, Sydney, Tokyo, Toronto.Toronto, 1986.
3. Cyprinid fishes. Systematics, Biology and exploitation. Ian J. Winfield and Joseph S. Nelson. Chapman & Hall London, New York. Tokyo, Melbourne. Madras. First edition 1991.
4. Fish Energetics: New Perspectives. Peter Tytler& Peter Calow, Croom Helm London & Sydney. 1985.

34. FISH CULTURE

FISH CULTURE

3(2+1)

Course Objectives:

The objectives of the course are:-

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

Learning Outcomes.

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

1. Acquire basic knowledge of history and aims of fish culture
2. Selection of fish species on the basis of their characteristics.
3. Demonstrate site selection and components of fish ponds.
4. Compute dosage and formulation of feed and fertilizers in fish ponds.
5. Evaluate fish health and product quality

Course Contents:

- a. History of fish culture
- b. Aims of fish culture.
- c. Pond fish culture: Planning and construction of fish pond

- d. Water quality criteria
- e. Culturable fishes of Pakistan.
- f. Pond preparation: Fertilization of fish pond: Organic and inorganic fertilizers, fish seed stocking.
- g. Artificial feeding in fish culture: Fish feeding methods, different components of fish feed, composition of commonly available feed ingredients, preparation and feed storage methods.
- h. Integrated fish farming: Concepts and practices.
- i. Fish enemies. Fish diseases and remedial measures.
- j. Fish hatchery management.
- k. Fishing gears, pre- and post-harvesting care of fish,
- l. Fish handling and transportation,
- m. Fish storage and marketing.
- n. Principles of fish processing and preservation technology.

Practicals:

1. Identification of various fishes
2. Uses of different organic and inorganic fertilizers in fish ponds
3. Determination of water quality criteria
4. Practical demonstration of induced fish breeding
5. Selection of fish feed ingredients and fish feed formulation
6. Practical demonstration of fish catch/netting
7. Visit to fish farm/hatchery etc.

Books Recommended:

1. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture.
2. Agrotech Publishing Academy, Udaipur, New Delhi, India.
3. Hart, P. J. B. and J. D. Reynolds. 2008. Handbook of Fish Biology and
4. Fisheries, Volume 2. Blackwell Science Ltd., New York, USA.
5. Horvath, L., G. Tanes and C. Seagrave. 2002. Carp and Pond Fish Culture Fishing News Book, New York, USA
6. Huet, M. 1998. Text Book of Fish Culture - Breeding and Cultivation of Fish. Fishing News, London, UK.

35. FISH ECOLOGY

FISH ECOLOGY

Contact Hours:

Theory =45
 Practical = 45
 Total = 90

Credit Hours:

Theory = 3.0
 Practical =1.0
 Total = 4.0

Course Objectives:

The objectives of the course are:-

1. To elaborate the interaction of fish and aquatic environment
2. To describe the effects of biotic and abiotic factors on fish

3. To impart knowledge regarding fish population dynamics

Course Learning Outcomes:

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

1. **ACQUIRE** the knowledge of fish population and its interaction with environment
2. **UNDERSTAND** basic knowledge of freshwater and marinewater ecosystems , their relationship to the physical, chemical, and biological factors of environment
3. **SOLVE** the various ecological problems of fishes
4. **DEVELOP** critical thinking, written , oral communication, and professional skills as they relate to ecological theory within the context of fish biology and management

Course Outline:

1. **The Environment, Organisms and Relationships**
 - a. Introduction
 - b. Properties of water
 - c. Diversity of fishes
 - d. Relationship
2. **Effects of Abiotic Environmental Identities on Distribution**
 - a. Introduction
 - b. Effects of abiotic identities
 - c. Abiotic factors and the distribution of fishes in rivers and lakes
 - d. Abiotic factors and the distribution of fishes in estuaries
 - e. Abiotic factors and the distribution of fishes in littoral and sub-littoral marine waters.
 - f. Effect of abiotic factors on the distribution of open-sea species.
 - g. Adaptations of fish to abiotic environmental factors
3. **Biotic Factors and the Structure of Fish Communities**
 - a. Introduction
 - b. Classification of the interactions
 - c. Role of biotic factors and community structure
 - d. Biotic interactions and community structure in rivers and lakes
 - e. Biotic interactions and community structure in the sea
 - f. Competition and predation in freshwater communities
4. **Migration, Territoriality and Shoaling in Fishes**
 - a. Introduction
 - b. Swimming capacity and energy costs
 - c. Patterns and site attachment and social interactions
 - d. Migration and colonization in fishes
 - e. Over-wintering migrations
 - f. Movement of water and modes of fish movements.

- g. Diadromy
- h. Homing
- i. Implications for exploitation

5. **Feeding and Growth**

- a. Introduction
- b. Feeding ecology in freshwater environments
- c. Feeding ecology in estuaries
- d. Ecology of feeding of marine fishes
- e. Detection and selection of food
- f. Ecomorphology of feeding
- g. Trophic categories of fishes
- h. Utilization of food
- i. Rate of food consumption
- j. Growth

6. **Life-Histories and Population Dynamics**

- a. Introduction
- b. Life-history traits and the concept of trade-offs
- c. Breeding pattern of fishes
- d. Population characteristics
- e. Dynamics of fish populations
- f. Production

7. **Applied Ecology of Fishes**

- a. Introduction
- b. A classification of problems in applied ecology
- c. Applied fish ecology of rivers
- d. Applied ecology of lacustrine fishes
- e. Applied fish ecology in the sea

Practical:

- 1. Collection, identification and preservation of fishes
- 2. Water sampling and water preservation techniques for physicochemical and biological analyses
- 3. Estimation of physical characteristics of water viz. temperature, density, light penetration and turbidity
- 4. Estimation of chemical characteristics of water viz. dissolved oxygen, carbon dioxide, pH, total alkalinity, total hardness, bicarbonates, chlorides, calcium, magnesium, salinity
- 5. Collection, preservation and study of fauna and flora of various water Bodies
- 6. Visit to various fish farms and report writing

Teaching Methodology:

- Lecturing
- Demonstration
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Fish Ecology. R.J. Wootton, Blackie Academic & professional an imprint of Chapman & Hall, London, Weinheim. New York- Tokyo. Melbourne. Madras First edition 1992. Reprinted 1996
2. Fisheries Ecology. Tony J. Pitcher, The AVI publishing company inc. Westport, Connecticut 1982.
3. Ecology of Teleost Fishes. Robert J. Wootton. Chapman & Hall London. New York, Tokyo, Melbourne. Madras. First edition 1990, reprinted with revisions 1991.
4. Environmental Biology of Fishes. Malcolm Jobling. Tokyo, Melbourne. Madras. First edition 1995.
5. Ecology and Conservation of Fishes. Harold M. Tyus, CRC Press, Taylor and Francis Group, USA, 2011.

36. FISH ENDOCRINOLOGY

FISH ENDOCRINOLOGY(BS SPECIALIZED COURSE)

Credit Hours:

Theory = **2.0**

Practical = 1.0

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To enhance the understanding of hormones and its significance in the life of fishes.
2. To impart the knowledge of endocrine system of different fishes of Pakistan.
3. To convey the basic knowledge of pheromones and its role in the life of fishes.

Learning outcomes:.

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

1. **ACQUIRE** the knowledge of major neuroendocrine axes that modulate growth, reproduction, and stress.
2. **Understand** the organisms interact with their environments and how environmental conditions modulate physiological regulatory mechanisms.
3. **SOLVE** problems related to unbalancing of the endocrine hormones
4. **ANALYZE** the endocrine hormones of different species of fishes.
5. **FORMULATE** the flow charts of all endocrine hormones for better understanding.
6. **DEMONSTRATE** the induced spawning procedures.

Course Contents:

1. **Fish endocrine system**
 - a. Differentiate between exocrine and endocrine system
 - b. Fish endocrine system and mechanism
 - c. The evolution of fish endocrinology
2. **Pituitary gland**
 - a. Origin
 - b. Functions
 - c. Neurohypophysis and its hormones
 - d. Adenohypophysis and its hormones
3. **Thyroid gland**
 - a. Introduction of thyroid gland
 - b. Functions in fish
4. **Pancreas**
 - a. Introduction to pancreas of fishes
 - b. Types in fish
 - c. Pancreatic glands
 - d. Pancreatic hormones
5. **Gastro-intestinal hormones**
 - a. Introduction

- b. Types
 - c. Function
6. **Adrenal cortex (internal tissue), chromaffin tissues and corpuscles stannous**
- a. Brief introduction
 - b. Important functions in fish
7. **Sex hormones**
- a. Gonadal hormones in fish;
 - b. Testes and Ovaries (androgenic tissue: structure and chemistry; transport, metabolism and mechanism of action. Ovarian hormones: steroid biochemistry and biosynthesis; transport, metabolism and mechanism of action).
8. **Pheromones**
- a. Brief introduction
 - b. Pheromones
 - c. Functions

Practical:

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc
2. Histological and ultra-structure features of endocrine glands
3. Demonstration of physiological roles of hormones of different endocrine glands
4. Demonstration on functional diversity and endocrine mechanism of hormones in different vertebrates.

Recommended Books

1. Melmed, S., Polonsky, K. S., Larsen, P.R. and Kronenberg, H. M., 2016. WILLIAMS textbook of Endocrinology. 13th ed. Elsevier Inc, USA.
2. Norris, D.O. and Carr, J. A., 2013. Vertebrate Endocrinology .5th ed. Elsevier publishing, USA.
3. Papoutsoglou, S.E., 2012. Test book of Fish Endocrinology.Nova Science, USA.
4. Norris, D.O. and Carr, J.A., 2005. Endocrine Disruption. Oxford University Press. USA.
5. Reinecke, M., Zacccone, G., B.G. Kapoor, B.G., 2006. Fish Endocrinology. (2 volume set) 1st ed. CRS Press, USA.
6. Sloman, K.A., Balshine, S. and Wilson, R.W., 2005. Behaviour and Physiology of Fish. Academic Press. UK.

37. FISH HEALTH MANAGEMENT

FISH HEALTH MANAGEMENT

Credit Hours:

Practical =1.0

Theory =2.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To impart knowledge about all aspects of fish health management, prophylactic measures and methods of treatment.
2. To understand various types of infectious and non-infectious fish diseases and control.
3. To learn about various pathogens and their modes of action causing fish disease.

Learning Outcomes:

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

1. Generalize elements of fish health, bio-security and disease management.
2. Identify types of fish diseases, their treatment and mitigation measures.
3. Monitoring and record keeping of infectious and non-infectious fish diseases.
4. Demonstrate conditions and husbandry practices to avoid fish diseases.

Course Contents:

- a. Introduction to fish health management.
- b. Elements of fish health management
- c. General husbandry procedures, feeding, fish handling.
- d. Facility and equipment management: overview of facility, layout plan, management of facility, management of equipment.
- e. Bio-security and mitigation measures: equipment maintenance and disinfection, mitigation disease spread from infected or diseased fish.
- f. Disease emergencies: fish disease outbreaks, fish health emergency procedures, determining the cause of outbreaks.
- g. Monitoring and record keeping: fish health records, feeding, fish monitoring, water quality monitoring, fish production records, treatment records.
- h. Common signs of diseased fish, modern techniques for investigation of disease.
- i. Kinds of diseases: non-infectious diseases, infectious diseases, virus borne diseases, bacterial diseases, fungal diseases, fish vaccination.
- j. Preventive measures, control of fish disease, disease resistance.
- k. Methods of treatments, drug metabolism in fish, routes of drug administration, oral medication, injections.

Practical:

1. Collection and studying of disease fish samples.
2. Fish dissection.
3. Water quality parameters.
4. Dis-infection methods.
5. Fish treatment methods, oral medication, injection, clinical work-up.
6. Fish biopsy techniques.
7. Fish diseases diagnosis.
8. Fish hematology.
9. Blood smears etc.

Assessment:**Mid Term (20%)**

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)**Practical (20%)****Final Term (45%)**

- Written (Long Questions, Short Questions, MCQs)

Books Recommended:

1. DevashishKar. 2015. Epizootic Ulcerative Fish Disease Syndrome, ELSEVIER.
2. Patrick T. K. Woo, David W. Bruno Gregory. 2014. Diseases and Disorders of Finfish in Cage Culture. CABI Publishing.
3. P. T. K. Woo, John F. Leatherland, David W. Bruno. 2011. Fish diseases and Disorders. CABI Publishing.
4. Fish diseases and disorders, 2004. Leatherland, J.F. and Woo, P. T. K. CABI publishing
5. Leatherland, J.F. and Woo, P.T.K. 2004. Fish Diseases and Disorders. Vol.2. Non-Infectious Disorders. CABI Publishing.
6. Woo, P.T.K. and Bruno, D.W. 2003. Fish Disease and Disorders. Vol. 3. Viral, Bacterial and Fungal infections. CABI Publishing.
7. Woo, P.T.K., Bruno, D.W. and Lim, L.H.S. 2002. Diseases and Disorders of Finfish in Cage Culture. CABI Publishing.
8. Roberts, R.J. 2001. *Fish Pathology*. Harcourt Publishers Limited. UK
9. Fish diseases, 1991. Wilhelm Schaperclaus. Oxonian press pvt ltd. New Delhi, India
10. Roberts, R.J. 1989. Fish pathology, Macmillan publishing Co. Inc. New York.
11. Edward J. Noga. Mosby 1996. Fish disease, diagnosis and treatment.

38. FISH FEEDING MANAGEMENT

FISH FEEDING MANAGEMENT

Credit Hours:

Practical =1.0

Theory =2.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To elaborate the significance of fish feeding.
2. To impart the basic principles of artificial feed preparation.
3. To train the students in fish feed formulation procedures and feeding practices.
4. To understand the fate of different nutrients in fish metabolism.

Learning Outcomes:

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

1. Illustrate the importance of artificial fish feed.
2. Formulate feed and rationing for various age groups.
3. Calculate feed conversion ratio, feed efficiency and digestibility.
4. Analyze nutrient concentration in feed and feed ingredients while preparing fish feed.

Course Contents

- a. Need of supplementary/ artificial feeding of fish.
- b. Scope of artificial feeding in fish.
- c. Metabolism of feed nutrients (Protein, Lipid, Carbohydrate) in fish.
- d. Feeding practices, Different types of feeders.
- e. Diet preparation and processing techniques.
- f. Estimation of apparent nutrient digestibility.
- g. FCR and FCE indices.
- h. Feed ration and frequency, judging fish feeding response.
- i. Food acquisition and patterns of estimation of food requirements.
- j. Feed processing and manufacturing: floating and sinking feed.
- k. Feed packaging, transportation and storage problems of feed stuff.

Practical:

1. Collection and identification of fish feed ingredients.
2. Ration calculation for fish feeding based on body weight, body length etc.
3. Proximate analysis of feed and feed ingredients i.e. moisture, dry matter, crude protein, crude lipid, carbohydrates and ash contents.
4. Formulation of fish feed.
5. Feeding methods; introduction and demonstration of demand and belt feeders.

Assessment

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Books Recommended

1. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf, 2015. *Aquaculture Handbook—Fish Farming and Nutrition in Pakistan*.
2. John Halver. 2013. *Fish Nutrition*, ELSEVIER.
3. Tom Lovell. 2013. *Nutrition And Feeding of Fish*, Springer.Ojha, J.S. 2006. *Aquaculture Nutrition and Biochemistry*. GeetaSomaniAgrotech Publishing Academy, Udaipur, India.
4. Lovell, T., 2012. *Nutrition and Feeding of Fish*. 2nd Ed. SpringerScience, USA
5. Pillay T V R, M N Kutty. 2005. *Aquaculture: Principles and Practices*.Balckwell Publishing. UK.
6. Reddy, M.S. and Sambasiva K.R.S. 1999. *A Textbook of Aquaculture*.Discovery Publishing House, N. Delhi.
7. Pillay, T.V.R. 1999. *Aquaculture: Principals and Practices*. FishingNews Books, London.

39. FISH PHYSIOLOGY AND BREEDING

FISH PHYSIOLOGY AND BREEDING(BS SPECIALIZED COURSE)

Credit Hours:

Practical = 1.0

Theory = **2.0**

Total = **3.0**

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 key concepts 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**
 - a. Digestive system;
 - b. Stomach less fishes;
 - c. Stomach fishes;
 - d. Digestion and absorption;
 - e. Food; Plant origin; Animal origin;
 - f. Feeding; Fresh food; Dry concentrates; Pelleted food.
2. **Transportation:**
 - a. Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma);
 - b. Circulation; Arterial system; Venous system; Capillaries;
 - c. Transport of food material.
3. **Respiration:**
 - a. Gills;
 - b. Lungs;
 - c. Skin;
 - d. Swimbladder;
 - e. Homeostasis.
4. **Excretion:**
 - a. Kidneys;
 - b. Hypo-osmotic urine;
 - c. Hyper-osmotic urine;
 - d. Osmoregulation.
5. **Reproduction:**
 - a. Gonads; Testes and ovaries;
 - b. Maturation;
 - c. Reproductive cells (egg and sperm);
 - d. Artificial fertilization of sex cells.
6. **Breeding:**
 - a. Natural (seasonal); Artificial;
 - b. Hormonal induced breeding;
 - c. Temperature & photoperiod;
 - d. control induced breeding.
7. **Growth:**
 - a. Extensive culture (due to the consumption of natural food);
 - b. Semi-intensive culture (due to natural & artificial food);
 - c. Intensive culture (due to only dry concentrates).

8. **Fish health:**
 - a. Water quality;
 - b. Hygiene of fish culture facilities;
 - c. Hygiene of equipments used in fish culture.
9. **Diseases and their control:**
 - a. Viral;
 - b. Bacterial;
 - c. Fungal;
 - d. Parasitic;
 - e. Protozoan;
 - f. Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera);
 - g. Annelids (leeches); Arthropods (water ticks, water flea, water mites).
10. **Fish migration:**
 - a. To nursery ground;
 - b. To maturation grounds;
 - c. Freshwater to marine water;
 - d. Marine water to freshwater.
11. **Fish behaviour:**
 - a. Learning and memory;
 - b. Light response for maturation;
 - c. Courtship behaviour;
 - d. 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. Saksena, D.N. ICHTHYOLOGY: RECENT RESEARCH ADVANCES. 1999. **Oscar Publications. India.**
3. Woo, P.T.K FISH DISEASES AND DISORDER. Vol 1. PROTOZOAN AND METAZOAN INFECTIONS. 1995. CABI Publisher.
4. Brenabe, G. AQUACULTURE, Vol. I. 1992. Blackwell Publishing, Oxford. UK.

5. Maseke C. FISH AQUACULTURE. 1987. Pergamon Press, Oxford. UK.
6. Huet M. TEXT BOOK OF FISH CULTURE: BREEDING AND CULTIVATION. 1973. Blackwell Publishing Company
7. Hoars, W.S. FISH PHYSIOLOGY. 1971. Academic Press. UK.
8. Hoars, W.S. FISH REPRODUCTION. 1969. Academic Press. UK.
9. Matty, A.J. FISH ENDOCRINOLOGY. 1985. Timber Press, UK.
- 10 Gorbman, A. COMPARATIVE ENDOCRINOLOGY. 1st Edition. 1983. John Wiley & Sons. UK

40. **FUNDAMENTALS OF MICROBIOLOGY**

FUNDAMENTALS OF MICROBIOLOGY

Contact Hours:

Theory = 48

Practical = 48

Total = 96

Credit Hours:

Theory =3.0

Practical =1.0

Total = 4.0

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. **ATTAIN** the basic knowledge of microorganisms
2. **FAMILIARIZE** with the concepts of basic microbiological techniques
3. **ELUCIDATE** the role of microbes with reference to food, health and environment in general
4. **EXPLORE** the plant-microbial interaction
5. **INVESTIGATE** the potential of pathogenic microorganisms
6. **APPLY** the appropriate microbiological techniques, methodologies and equipment in accordance with Lab safety protocol

Course Outline:

1. **Introduction**
 - a. History of microbiology
 - b. Microbes influencing our lives
 - c. Characterization and identification of microorganisms
2. **Virology**
 - a. Structure of virus, Characteristics of virus, Virus-host cell interaction

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

- c. Microbiology of sea, lakes and ponds, rivers and streams, Microbes of domestic water, Microbes of sewage water.

Practical:

1. Sterilization Techniques (Dry/Wet)
2. Media Preparation
3. Isolation of microorganisms from air, water, soil and plants
4. Microbial Characterization
5. Gram Staining
6. Endospore, flagellar and capsular staining
7. Microbial Count

Teaching Methodology:

- Lecturing
- Written Assignments
- Lab/Field Activity
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Presentation 20%
- Assignments 10%
- Quiz 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Microbiology: An Introduction, 12th ed. (2018) by Gerard J. Tortora, Berdell R. Funke, Christine L. Case.
2. Prescott's Microbiology, 10th ed. (2017) by Joanne Willey, Linda Sherwood and Christopher J. Woolverton.
3. Environmental Microbiology: Fundamentals and Applications: Microbial Ecology (2015) by Jean-Claude Bertrand, Robert Matheron, Pierre Caumette, Philippe Lebaron, Télesphore Sime-Ngando.
4. Jawetz, Melnick & Adelberg's Medical Microbiology (2015) by Barbara Detrick, James H. McKerrrow, Jeffery A. Hobden, Judy A. Sakanari, Karen C. Carroll, Stephen A. Morse, Steve Miller, Thomas G. Mitchell and Timothy A. Mietzner.
5. Laboratory Experiments in Microbiology, 11th ed. (2015) by Ted R. Johnson and Christine L. Case.

6. Brock Biology of Microorganisms, 14th ed. (2014) by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock.
7. Alcamo's Fundamentals of Microbiology, 9th Ed., (2012) by Jeffrey C Pommerville.
8. Bergey's Manual of Systematic Bacteriology(2012).
9. Microbiology Principles and Explorations (2001) by Jacquelyn, G.G.

41. **GENERAL AND COMPARATIVE ENDOCRINOLOGY**

GENERAL AND COMPARATIVE ENDOCRINOLOGY

Contact Hours:

Theory =32

Practical = 48

Total = 80

Credit Hours:

Theory = **2.0**

Practical = 1.0

Total = **3.0**

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,cyclic and how hormones are transported in the blood and consequences of reversible binding of many hormones by plasma proteins
8. To explain the basis of hormone assays and assessment of biological activity
9. To discuss the metabolism, clearance and excretion of hormones and their metabolic derivatives
10. To define and discuss the physiological actions of hormone relating them whenever possible to human disorders
11. To explain the consequences of under and overproduction of hormones to determine the pathophysiological basis and consequences of specific endocrine disorders.
12. 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 cyclical.
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.
14. Evaluate and assess scientific literature about endocrine function and pathology.

Course Contents:

- a. **An overview of general concepts and principles of endocrinology:**
The endocrine system; Type of hormones; Endocrine and nervous system relationship;
General principles in function, interaction, nature, synthesis, transport of hormones;
General concept of feedback, biorhythms, pathology and assessment of endocrine function;
Evolution of endocrine system.
- b. **Hypothalamus and pituitary:**
Hypothalamic hormones: Origin, chemistry and actions; Anterior pituitary & hormones: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.

- c. **Thyroid gland:**
Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.
- d. **Calcitropic and mineral metabolism hormones:**
Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.
- e. **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.
- f. **Adrenal medulla and catecholamines:**
Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors.
- g. **Adrenal cortex:**
Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.
- h. **Hypothalamic-Hypophyseal-Gonadal axis in Reproduction:**
Hormonal and neuronal factors and their interactions in ovarian, testicular and other reproductive targets functions.
- i. **Testes:**
Androgenic tissue: Structure and chemistry; Transport, metabolism and mechanism of action.
- j. **Ovaries:**
Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action. The interactions in developments in estrous and menstrual cycles.
- k. **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.
- l. **Endocrinology of lactation:**
Hormones in lactation.
- m. **Endocrinology of heart, kidney, immune system:**

Growth and pineal gland.

- n. **Functional diversity of hormones in vertebrates.**
- o. **Overview of endocrine mechanisms in invertebrates.**
Study of hormones of invertebrates in concepts of growth, metamorphosis, reproduction and pheromones.

Title: Lab. General and Comparative Endocrinology

Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections etc. Histological and ultrastructure features of endocrine glands; Experiments to demonstrate physiological roles of hormones of different endocrine glands; Experiments to demonstrate regulation of hormones' releases. Experiments to demonstrate functional diversity of hormones in different vertebrates. Experiments on endocrine mechanism in vertebrates. Through flow chart to demonstrate the feedback mechanism of hormonal homeostasis.

Teaching Methodology:

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

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
Assignments & Presentation	(15%)

Text Books:

1. Greenspan, F.S. and Strewler, G.J., 2011. Basic and clinical endocrinology, 9th Edition. Prentice Hall International Inc., London.
2. Bentley, P.J., 1998. Comparative Vertebrate Endocrinology. 3rd Ed. Cambridge University Press, Cambridge.
3. Sam A., Meeran K. Endocrinology and Diabetes. Lecture notes. Wiley-Blackwell (2009) (basic science and clinical context).
4. Laycock J, Meeran K. Integrative Endocrinology. Wiley-Blackwell (2013).
5. Rang H, Dale M and Ritter, J: Pharmacology, 4th ed., (1999). (relevant for drug information) 2nd Edition. The Oxford Textbook of Endocrinology and Diabetes DOI: 10.1093/med/ 9780199235292.003.0134
6. Yen & Jaffe's Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management. Saunders – all editions are excellent (even the older editions)
7. Johnson MH. Essential Reproduction. 7th Ed. Wiley-Blackwell (2013)

(relevant for some general background info on reproduction pitched for undergraduate students).

8. Chandra S. Negi, introduction to endocrinology
9. Charles Brook, Nicholas Marshall, essential endocrinology
10. Noris, vertebrate endocrinology

Additional Readings:

1. 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.
2. DeDroot, L.J., Jameson, J.L. *et al.*, 2012 Endocrinology, Vol.I, II & III, th Edition. W.B. Saunders, Philadelphia.
3. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
4. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.
5. Knobil, E. and Neill, J.D., *et al.*, 1995. The Physiology of Reproduction, Vol.1&2; 2nd Edition, Raven Press, New York.
6. Evert, B.J. and Johnson, M.H., 2000. Essential Reproduction, 5th Edition. Blackwell Science Inc., Oxford.

42. **GENERAL MICROBIOLOGY**

GENERAL MICROBIOLOGY

Contact Hours:

Theory = 48
Practical = 48
Total = 96

Credit Hours:

Theory =**3.0**
Practical =1.0
Total =**4.0**

Course Objectives:

The objectives of the course are:-

1. Toenable the students to work with microorganisms
2. Tounderstand the basic techniques of sterilization, culturing and isolation
3. Todetermine different characteristics of the microorganisms

Course Learning Outcomes:

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

1. **ATTAIN**the fundamental knowledge regardingmicroorganisms
2. **COMPREHEND** the basic concepts of microbial diversity
3. **GRASP**the microbiological techniques and use them efficiently
4. **EXPLORE**the microbial diversity androle of microorganisms
5. **VALIDATE**practical skills in the design and execution of experiments
6. **APPLY** the scientific method of investigation and hypothesis testing

Course Outline:

1. The beginnings of Microbiology

- a. Discovery of the microbial world
- b. Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods
- c. The scope of microbiology
- d. Microbial evolution, systematics and taxonomy
- e. Characterization and identification of microorganisms
- f. Nomenclature and Bergey's manual

2. Viruses

- a. Bacteriophages and phages of other protists
- b. Replication of bacteriophages
- c. Viruses of animals and plants
- d. History, structure and composition
- e. Classification and cultivation of animal viruses
- f. Effects of virus infection on cells
- g. Cancer and viruses

3. Morphology and fine structure of bacteria

- a. Size, shape and arrangement of bacterial cells
- b. Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks
- c. Structure and chemical composition of cell wall
- d. Cytoplasmic membrane
- e. Protoplasts, spheroplasts, the cytoplasm, nuclear material

4. Cultivation of bacteria

- a. Nutritional requirements and nutritional types of bacteria
- b. Physical conditions required for growth
- c. Bacteriological media
- d. Choice of media and conditions of incubation

5. Reproduction and growth of bacteria

- a. Modes of cell division
- b. New cell formation, Normal growth cycle of bacteria, synchronous growth, Continuous culture
- c. Quantitative measurement of bacterial growth, Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method
- d. Determination of nitrogen content and dry weight of cells
- e. The selection of a procedure to measure growth and importance of measurement of growth

6. Pure cultures and cultural characteristics

- a. Natural microbial populations, Selective methods, Chemical methods, Physical methods, Biological methods, Selection in nature

- b. Pure cultures, Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collections
 - c. Cultural characteristics; Colony characteristics, Characteristics of broth cultures
- 7. Eukaryotic microorganisms**
- a. Algae: Biological and economic importance of algae
 - b. Characteristics of algae; Lichens. Fungi: Importance of fungi
 - c. Morphology; Physiology and reproduction, Cultivation of fungi
 - d. Economic importance of protozoa
- 8. Prokaryotic diversity**
- a. Purple and green bacteria, cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria
 - b. Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonous and chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria
 - c. Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes
 - d. Archaea, Extremely Halophilic archaea, Methane producing archaea, Methanogens, Hyperthermophilic archaea, Thermoplasma

Practical:

1. Preparation of culture media
2. Pure culturing and cultivation of microbes
3. Simple, Gram, endospore, capsular, flagellar and acid fast staining of different genera of bacteria/Vital staining and microscopic observations of protozoa
4. Isolation of bacteriophages

Teaching Methodology:

- Lecturing
- Written Assignments
- Lab/Field Activity
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Presentation 20%
- Assignments 10%

- Quiz 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Microbiology: An Introduction, 12th ed. (2018) by Gerard J. Tortora, Berdell R. Funke, Christine L. Case.
2. Prescott's Microbiology, 10th ed. (2017) by Joanne Willey, Linda Sherwood and Christopher J. Woolverton.
3. Laboratory Experiments in Microbiology, 11th ed. (2015) by Ted R. Johnson and Christine L. Case.
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's Manual of Systematic Bacteriology (2012).
7. Microbiology Principles and Explorations (2001) by Jacquelyn, G.G.

43. HELMINTHOLOGY AND HOST-PARASITE RELATIONSHIP*

HELMINTHOLOGY AND HOST-PARASITE RELATIONSHIP

Contact Hours:

Theory =48
 Practical = 16
 Total = **64**

Credit Hours:

Theory =3.0
 Practical =1.0
 Total =**4.0**

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. **Attain** the basic knowledge of helminthes and principles of host-parasite interaction

2. **Comprehend** the concepts of etiology, biology and pathogenesis of helminthes and their relationship with hosts
3. **Explain** the complications related to the pathogenesis of the helminthes and successfully treating these infections.
4. **Diagnose** the helminthic infections by applications of basic and modern techniques
5. **Assess** the problems associated with helminthes infections on the basis of signs and symptoms.
6. **Demonstrate** helminthic infection affecting livestock, its morphology, life cycle, epidemiology, pathogenesis, treatment and control strategies.

Course Outline:

HELMINTHOLOGY

1. **Introduction**
 - a. Taxonomy, etiology and biology of helminthes parasites.
2. **Class Cestoda (Tapeworms)**
 - a. Etiology, Pathology and pathogenesis, diagnosis, treatment and control of the following Cestodes;
 - b. *Diphyllobothrium latum*
 - c. Sparganosis
 - d. *Taenia saginata* & *T. solium*
 - e. *Echinococcus granulosus* & *E. multilocularis*
 - f. *Hymenolepis nana*
 - g. *Dipylidium caninum*
3. **Class Trematoda (Flukes)**
 - a. Etiology, Pathology and pathogenesis, diagnosis, treatment and control of the following Trematodes;
 - b. *Schistosoma mansoni*, *S. japonicum*, *S. haematobium*
Fasciola hepatica
 - c. *Fasciolopsis buski*
 - d. *Dicrocoelium dendriticum*
 - e. *Paragonimus westermani*
 - f. *Colonorchis sinensis*
 - g. *Heterophyes heterophyes*
4. **Monogenetic Trematodes:**
 - a. *Dactylogyruv vastator*
 - b. *Gyrodactylus*
 - c. *Diplozoon paradoxum*
5. **Class Nematoda**
 - a. Etiology, Pathology and pathogenesis, diagnosis, treatment and control of the following Nematodes;

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

6. Host-Parasite Relationship

- a. Host parasite relationship: as associative organization between two organisms
- b. Structural aspects of the association interface
- c. Nutrient exchanges in associations
- d. Physiological and regulatory interactions: between associates
- e. Behavioural Aspects of organism associations
- f. Ecology and evolution of intimate associations
- g. Biology of Arthropods (Vector born) causing disease or those responsible for transmission of disease

Practicals:

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

Teaching Methodology

- Lecturing
- Written Assignments
- Practical work
- Presentations

Assessment

Mid semester (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Practical 10%

Final semester (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Practical 10%

Text and Reference Books:

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

44. HEMATOLOGY

HAEMATOTOLOGY

Contact Hours:

Theory =48
Total =48

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives

The objectives of the course are:-

1. To impart knowledge about hemopoiesis, blood clotting, anemias, allergy, hypersensitivity and immune complexes.
2. To develop critical thinking about the mechanisms of autoimmune disorders and changes in hematological parameters in allergy and hypersensitivity reactions.
3. To develop analytical approach about the clinical investigations of anemia, allergy and hypersensitivity.

Course Learning Outcomes:

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

1. **ACQUIRE** the knowledge about hemopoiesis, anemias and changes in blood profile in altered immune response.
2. **UNDERSTAND** the concept of duality of immune response.
3. **ANALYZE** the clinical investigations in allergy and hypersensitivity cases.

4. **DEMONSTRATE** individually hemopoiesis and changes in blood profile in anemias, allergy and autoimmune disorders.

Course Outline:

1. Introduction

- a. Introduction to Hematology and techniques of hematology.
- b. Anticoagulants EDTA , heparin, balanced oxalate, calcium citrate and low molecular weight heparin
- c. Phelbotomy tray and phlebotomy procedure.

2. Hemopoiesis

- a. Normocytic erythropoiesis.
- b. Megalocytic erythropoiesis and substances required for erythropoiesis.
- c. Life span of RBC, Structure of RBC and composition of hemoglobin.
- d. Synthesis of hemoglobin.
- e. Leukopoiesis, maturation of neutrophils.
- f. Maturation of basophils and maturation of eosinophils.
- g. Maturation of lymphocytes AND maturation of monocytes.
- h. Maturation of plasmacytes and their proliferation.
- i. kinship between neutrophils and monocytes.
- j. Maturation of thrombocytes and thrombocytopenia.
- k. Erythrocyte indices and CBC.

3. Anemias

- a. Hypoproliferative anemia and bone marrow damage.
- b. Spur cell anemia and Sickle cell anemia.
- c. Hemolytic anemia and mechanism involved in hemolysis of RBC.
- d. Sideroblastic and nonsideroblastic anemia.
- e. Macrocytic anemia.
- f. Coagulation factors.

4. Immunity

- a. Phagocytosis, microphages, macrophages ,mast cells and grades of immunity.
- b. Measurement of immunity.
- c. Antigens and immune tolerance.
- d. Major histocompatibility complex I and II.
- e. Characteristics of antigens.Acquired immunity. Passive acquired immunity.
- f. Consequences of antigen and antibody binding.
- g. Humoral immunity and cell mediated immunity.

5. Allergy and hypersensitivity

- a. Atopic allergy and anaphylactic hypersensitivity.
- b. Immune complex dependent hypersensitivity and hypersensitive response.

- c. Sensitization of cells.Adaptive immunity.
- d. Immediate hypersensitivity. Delayed hypersensitivity
- e. .Adjuvants and their types.Complement system and hypersensitivity reactions.
- f. Cellular basis of cell mediated hypersensitivity.
- g. Complement.Antibodies.
- h. Synthesis of antibodies and stimulatory hypersensitivity.
- i. Interferones and serum sickness.
- j. Autoimmune disorders

Teaching Methodology:

- Lecturing
- Written Assignments
- Seminar
- Discussion
- Case study

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions) 50%
- Assignments 25%
- Quiz 25%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 10%
- Assignments 20%
- Quiz 20%

Text and Reference Books:

1. Bain, B., Bates, I., Laffan, M. and Lewis, M., 2012: Decie and Lewis Practical Hematology. 11th Ed. Churchill livingstone
2. Montanaro, A., 2015. Primary immunodeficiency Disorders. 1st Ed. Elsevier
3. O'Hehir, R.E., Holgate, S. T. and Sheikh, A., 2016: Middleton's Allergy Essentials. 2nd Ed. Elsevier
4. Richard, A. Goldsby, Thomas and Barbra,A. Kuby IMMUNOLOGY 20076th edition. W.H Freeman and company Newyark

Additional Reading:

1. Roitt, I.,1990. Essential Immunology.2nd ed. Black well Scientific Publication. Oxford,UK
2. Abbas,L., and Pober,A., 1994.Cellular and molecular immunology:1994 .2nd edition. W.B Saunders company London.

45. **HISTOLOGY**

N.A

46. **ICHTHYOLOGY**

ICHTHYOLOGY(BS SPECIALIZED COURSE)

Credit Hours:

Theory = **2.0**

Practical = 1.0

Total = **3.0**

Course Objectives:

1. To improve the skill of understanding of fish identification and classification.
2. To provide the concrete knowledge about anatomy of the fish.
3. To explain the morphology and physiology of most important commercial fishes.

Course Learning Outcomes:

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

1. **Classify** the most important commercial fish species.
2. **UNDERSTAND** the concepts of basic internal and external morphology and physiology.
3. **SOLVE** the challenges in field of fish taxonomy and providing them concept of latest keys of identification.
4. **ANALYZE** the morphological and taxonomical features of various species.
5. **EVALUATE** the problems in identification of fishes.
6. **DEMONSTRATE** Fishes should be dissected to show all the key features in identifying the fishes and also show all the external and internal organs for better understanding.

Course Contents:

1. **Classification and distribution of freshwater fishes**
 - a. Systematic position of fish in animal kingdom
 - b. Distribution of various commercial and noncommercial fishes of Pakistan
2. **Morphology of fishes**
 - a. External features of fishes
3. **Coordination of fishes**
 - a. Fish muscular system, locomotion and energetics of swimming.
 - b. Physiology of respiration and air breathing among fishes.
 - c. Cardiovascular system,
 - d. blood and its circulation and hydromineral balance: Osmoregulation, ionic regulation, stress responses, freezing resistance and acid-base balance.

- e. Digestion and control of gastro-intestinal motility in fish. Physiology of gas bladder: Use of gas by the fish as a source of static lift.
- f. Gas in the gas bladder: Loss, retention and secretion of gas.
- g. Process of aestivation in fish.
- h. Control of kidney function in fish. Sensory system and communication in fish: Acoustico-lateralis system, sound reception and production.

Practical:

1. Collection and identification of some freshwater and marine water fishes.
2. Dissection of fishes for studying anatomical features (Reproductive, Digestive, Respiratory and circulatory systems).

Books Recommended:

1. Lagler, K.F., J.E. Baradach and R.R. Miller. 2009. Ichthyology. John Wiley and Sons, Inc., New York, USA.
2. Moyle, P.B. and J.J. Cech. 2008. Fishes: An Introduction to Ichthyology. 6th Ed. Prentice Hall, New Jersey, USA.
3. David, H. 2003. The Physiology of Fishes 3rd Ed. CRC Press, UK.
4. Smith, L.S. 2002. Introduction to Fish Physiology. 2nd Ed. Argent Labs. Washington DC, USA.

47. **IMMUNOLOGY**

IMMUNOLOGY

Contact Hours:

Theory = 36
 Practical = 48
 Total = 84

Credit Hours:

Theory = **3.0**
 Practical = 1.0
 Total = **4.0**

Course Objectives:

The objectives of the course are:-

1. To be able to clearly state the role of the immune system and a foundation in immunological processes
2. To provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology
3. The students will be able to describe immunological response and how it is triggered and regulated.

Course Learning Outcomes:

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

1. **Explore** the basic knowledge of immune system
2. **Describe** the concepts of how the immune system works.
3. **Interpret** the problems using immunological techniques for diagnosis of immune disorders.
4. **Identify** the problems using immunological diagnostic tools.
5. **Detect** the problems using the same techniques for other disorders.

6. **DEMONSTRATE** individually the ELISA and other Assays/Tests.

Course Outline:

1. **Introduction**
 - a. Introduction to immunity.
 - b. Immune response
 - c. Infectious agents
2. **Innate Immunity and Inflammation**
 - a. Sentinel cells and circulating leukocytes
 - b. Inflammatory events and signaling
 - c. The formation of pus
3. **Microbial Recognition and Responses in Innate Immunity**
 - a. Pattern recognition receptors
 - b. Innate immune signaling
 - c. The complement system
4. **Antibodies**
 - a. B lymphocytes
 - b. Antibody structure and function
5. **Lymphocyte Development and Diversity**
 - a. Lymphocyte development
 - b. Clonal selection and expansion
 - c. Differences between B and T lymphocytes
 - d. The generation of lymphocyte receptor diversity
6. **T Cell Activation by Antigens**
 - a. The role of dendritic cells
 - b. The lymphatic system and delivery of antigen to lymph nodes
 - c. Adaptive immune activation in secondary lymphoid tissues
 - d. Antigen presentation
7. **T Cell-Dependent B Cell Responses**
 - a. T Cell activation of B cells
 - b. Isotype switching and affinity maturation
8. **Helper T Cells**
 - a. Helper T cell functions
 - b. The role of helper T cells in disease
9. **Cytotoxic T Cells**
 - a. Cytotoxic T cell functions
 - b. Selection and expansion of cytotoxic T cells
 - c. Therapies that target cytotoxic T cell functions
10. **Failures of the Immune System**
 - a. Immunodeficiencies
 - b. Autoimmune diseases

c. Allergic diseases

11. Immunology-Based Therapy of Diseases

a. Transplantation and transfusion

Practical:

1. Antibody Purification and Conjugation
2. Immunofluorescence
3. Gel Techniques
4. ELISA
5. SDS PAGE/Western blots.

Teaching Methodology

- Lecturing
- Written Assignments
- Lab work
- Analysis/interpretation of diagnostic Tests results

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Sessional tests 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Sessional tests 10%

Text and Reference Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell (5th ed. 2008, Garland)
2. Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby: Immunology (2003, Freeman).
3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt: Roitt's Essential Immunology (12th ed. 2012, Blackwell)
4. Abul Abbas , Andrew H. Lichtman, Shiv Pillai. Cellular and Molecular Immunology , 9th edition, 2017. Elsevier Pub Co.
5. Gerd R. Burmester, Antonio Pezzutto Color Atlas of Immunology, 2006. Thieme Stuttgart, New York.

- 48. **Insect Bioacoustics**
N.A
- 49. **Insect Biochemistry and Physiology**
N.A
- 50. **Insect Pathology**
N.A
- 51. **Insects of Veterinary and Medical Importance* drsumara**

INSECTS OF MEDICAL AND VETERINARY IMPORTANCE

Contact Hours:

Theory = 30

Total = 30

Credit Hours:

Theory = 3.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide knowledge about insect vectors, disease borne pests of veterinary and human importance
2. To impart knowledge about their control
3. To Understand their life cycles as they carry viruses and other organisms during transmission of diseases

Course Learning Outcomes:

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

1. Acquire the firm knowledge of important insect vectors and disease borne pests of veterinary and human importance.
2. Understand their life cycles during transmission of diseases for control.
3. Analyze about their control

Course Outline:

1. **Introduction**
 - a. General introduction to medical and veterinary entomology
2. **Phylum arthropoda**
 - a. Salient features of insects
 - b. Classification
 - c. General morphology and physiology of insects
 - d. Modifications in mouthparts and appendages of insects
 - e. Metamorphosis and its types
3. **Insects of medical and veterinary importance**
 - a. Mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks
 - b. Life cycles
 - c. Diseases and their control

4. **Insect venoms**

- a. Bees, wasps, ants.
- b. Insect toxins
- c. Arthropod allergens

5. **Insect pest management**

- a. Definition
- b. Principles and methods of insects control
- c. Components of pest management
- d. Techniques
- e. General measures to control insects
- f. Economics of pest management

Teaching Methodology:

- Lecturing
- Written Assignments

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%

Text and Reference Books:

1. Roy, D. N. and Brown, A.W.A .2004. Entomology.Biotech .Books, New Delhi.
2. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
3. Rozendael, J. A. 1999. Vector ConIJ19l.A I. T. B. S. publishers, New Delhi.
4. Service, M.W. 1996. Medical Entomology. Chapman and Hall, USA
5. Pedigo, L. P. 2003. Entomology and Pest Management.4th ed. Pearson Education, Singapore, Pvt. Ltd.

52. Introduction to Environment

INTRODUCTION TO ENVIRONMENT

Contact Hours:

Theory = 30

Total = 30

Credit Hours:

Theory = 3.0

Total = 3.0

Course Objectives:

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 matter, energy, birth of Universe, solar system and origin of earth.
3. To provide knowledge about environmental geology and environment and 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 interrelationship between various components of the environment.
2. Interpret basic concepts of matter, energy, birth of Universe, solar system and origin of earth.
3. Assess environmental geology and environment and life and human activity for understanding of environment and its trans disciplinary integration.

Course Outline:

1. **Environment**
 - a. Introduction and definitions.
 - b. Environmental systems; Atmosphere, Lithosphere, Hydrosphere, Biosphere, Origin and their interrelationships
2. **Environmental factors**
 - a. Physical, chemical and biological factors.
3. **Variety of life and environment (brief account).**
4. **Environment and human interactions.**
 - a. Environmental pollution; types, sources, causes and effects (brief overview).
5. **Environmental issues and challenges**
 - a. Deforestation, water logging

- b. Salinity, drought and desertification
- c. Loss of natural habitat, Depletion of resources
- d. Population and genetic diversity

6. Environment and sustainable development

7. Issues of social environment

- a. Population growth, urbanization
- b. Migration and poverty
- c. Lifestyle and environment.

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%

Text and Reference Books:

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

53. Invertebrate Paleontology

Invertebrate Paleontology

Contact Hours:

Theory =32
Practical = 32
Total = 64

Credit Hours:

Theory =2.0
Practical =1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide the information regarding the distribution of invertebrates in the past eras and rationalize their relationship in the present time.
2. To observe morphology and evolutionary history of invertebrate animals commonly found as fossils.
3. To understand the biological requirements and limitations of common fossil organisms and use this information to interpret the depositional history and paleoenvironment of the surrounding rock.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge to recognize fossils from Siwaliks and their type of preservation.
2. **UNDERSTAND** the trends in diversity and evolution of invertebrates through geological time.
3. **CLASSIFY** fossils based on different morphological characteristics and assign them to their proper phylum, classes, orders or even genera.
4. **ASSOCIATE** fossils as a key indicator of the depositional environment with associated processes like paleoecology.
5. **DIFFERENTIATE** between extinct and extant invertebrates including major origination and extinction events and their probable causes.
6. **ANALYZE** the role of taphonomy in the evolutionary history of a taxonomic group.

Course Outline:

1. **Introduction**
 - a. **Introduction** to Invertebrate Paleontology
 - b. **Types of Fossils:** altered and unaltered body fossils, trace fossils.
 - c. **Process of Fossilization:** mineralization, replacement and carbonization.
 - d. **Taphonomy** (pre- and post-burial conditions for fossil preservation)
 - e. **Geological Time Scale:** pre-Cambrian life, Paleozoic life, Mesozoic life, Cenozoic life.
 - f. **Rocks: igneous, sedimentary and metamorphic rocks.**

2. **Siwalik Hills**
 - a. **Siwalik Hills:** A brief account of the Siwalik Hills.
 - b. **Division of Siwalik Group:** Upper Siwaliks, Middle Siwaliks and Lower Siwaliks.
 - c. **Formations of Siwalik Group:** Kamliyal, Chinji Nagri, Dhok Pathan and Soan.

3. **Siwaliks Invertebrate fauna**
 - a. A detailed classification of invertebrate microfossils and macrofossils.
 - b. **Study of the structure, affinities, distribution of the Protozoa, Coelenterata, Bryozoa, Brachiopoda, Mollusca, Arthropoda and Echinodermata.**
 - c. **Biostratigraphical importance and lithostratigraphic correlations of the Invertebrate fossils.**
 - d. **Morphological trends, phylogenetic characteristics and evolutionary trends in the major invertebrate phyla.**
 - e. Paleocology & Paleoclimatology of Siwaliks invertebrates.

Practical:

1. Field visits for collection of fossil invertebrates from Siwalik Hills of Pakistan.
2. Preparation, identification and study of collected specimens.
3. A general survey and report writing of the fossil invertebrates in various museums of Pakistan.

Teaching Methodology:

- Lecturing
- Written Assignments
- Field Visits
- Practical observations
- Report writing

Assessment:

Mid Term (40%)

Theory

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Practical:

1. Written (Long Questions, Short Questions, MCQs) 50%
2. Collection of fossils 20%
3. Assignments 20%
4. Report Writing 10%

Text and Reference Books:

1. Clarkson, E.N.K., 2018. Invertebrate Paleontology and Evolution. 5th Ed. Blackwell, New York, USA.
2. Sepkoski, D., 2012. Rereading the Fossil Record: The Growth of Paleobiology as an Evolutionary Discipline. University of Chicago Press.
3. Michael, J.B., David, A, and Haper, T., 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
4. Foote, M. and Millar, A.I., 2007. Principles of paleontology. 3rdEd. W.H. Freeman & Co. USA.
5. Armstrong, H. A. and Brasier, M.D., 2005. Microfossils. Blackwell Publishing.
6. Prothero, D.R., 2004. Bringing fossils to life: An introduction to paleobiology. 2nd Ed. McGraw Hill, New York.
7. Doyle, P., 1996. Understanding Fossils. An Introduction to Invertebrate Paleontology. John Wiley & Sons. Chichester.
8. Boardman, R.S., Cheetham, A.H. and Rowell, A.J., 1987. Fossil Invertebrates. Blackwell Scientific, Boston, USA.
9. Shrock, R.R. and Twenhofel, W.H., 1953. Principles of Invertebrate Paleontology. McGraw-Hill Book Company, Inc., New York.
10. Moore, R.C., *Lalicker*, C.G. and Fischer, A.G., 1952. Invertebrate Fossils. McGraw Hill, New York.

54. Limnology***LIMNOLOGY****Credit Hours:**

Theory = 2.0

Practical = 1.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To enhance the concept of Limnological parameters and 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 of physico-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

- a. Introduction, History and scope
- b. Structure of aquatic ecosystems
- c. Origin of lotic and lentic waters, and estuaries
- d. Zonation
- e. Thermal stratification
- f. Eutrophication

2. Properties of freshwater

- a. Physical properties of water (temperature, light, color, turbidity, conductivity); chemical properties of water (pH, oxygen, CO₂, salinity, dissolved solids, trace elements, nitrogen, phosphorous and sulphur cycles)
- b. Biological properties, plankton (phytoplankton, zooplankton)
- c. Methodology for collection
- d. Preservation and identification;
- e. Planktonic adaptations and diurnal migration;
- f. Factors affecting planktonic productivity

3. Lake formation

- a. Lake formation and basin morphometry
- b. Processes of Lake Eutrophication
- c. Sedimentation and acidification
- d. Biological productivity in lakes
- e. Lakes of Pakistan
- f. 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.
3. 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.
3. Agarwal, S.C. 1999. Limnology. A.P.H. Public New Delhi.
4. Boyd, C.E. 2000. Water Quality in Ponds for Aquaculture. Auburn University, Alabama, USA.
5. Boyd, C.E. and Tucker, C.S. 2000. Water Quality and Pond Soil Analyses for Aquaculture. Auburn University, Alabama, USA.
6. Lamert.1997.. Limnology. Oxford. University, UK.Mishra, R. 2002.Fresh Water Environment. Anmol Publication Pvt. Ltd., New Delhi.
7. Kestin,S.C. and Warris, P.D. 2001.Farmed fish quality. Fishing News Books, Blackwell Science Ltd.
8. Kumar, A .2003. Aquatic Ecosystems. A.P.H. Publishing Corporation, New Delhi.

55. **Mammalogy**

MAMMALOGY

Cr: 2+ (1)

Course Objectives:

Followings will be the objectives of this course to:

1. Assess ecological and evolutionary processes which led to the diversification and diversity of mammals.
2. Identify factors for mammalian adaptations for survival in a variety of conditions.
3. Study mammalian classification up to orders and determine the distribution and abundance of the mammalian species with structure communities for various ecosystems.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of the mammals in diversified ecosystems.
2. **UNDERSTAND** the behavior of the mammals and their relationships to the natural habitats.

3. **SOLVE** the problems in the mammalian study using scientific approaches and methods.
4. **ANALYZE** the impacts of mammals on the ecosystem and likely impacts on economy.
5. **UNDERSTANDING** the role played by mammalogists in the conservation and management of mammals.

Course Outlines:

- a. **Introduction and history** of mammalogy; basic characteristics of mammals; diversified habitats for mammals in Pakistan and various continents.
- b. **Mammalian phylogeny**; dentition and dental formulae, cranial characteristics, evolution of mammals. Concepts of viviparity and ovoviviparity.
- c. **Concept of biogeography**; mammalian radiations, biogeography of mammals of Pakistan, occurrence, habits and varied habitats, importance to ecosystems and negative values.
- d. **Food and feeding strategies; preferred food sources** of mammals, foraging habits, diurnal and
- e. nocturnal feeding regimes of mammals; ecological constraints and mammalian adaptations. Concepts
- f. of stenophagy and euryphagy.
- g. **Population dynamics of mammals; rates of natality, mortality, immigration and emigration**
- h. **Population modeling concepts** in mammals; mammalian crowding and scuffles with respect to various environments.
- i. **Communication and social organization**; chemical signaling in mammals, types and causes of occurrence, communication skills and emergence of mammalian call notes.
- j. **Mammalian Adaptations**; concept of torpor formation, aestivation, hibernation, acoustic lateralis systems in mammals. Concept of molecular basis of mammalian adaptations.
- k. **Behavior of mammals**; home range, territoriality, predation pressure, evolutionary arms races and competition for resources.

Practical:

1. General survey of mammalian species (Visits to zoological museums and zoos and field study)
2. Study of techniques for the collection of mammals, their identification and systematic relationships
3. Comparative study of mammalian skeleton
4. Dissection of a rabbit or rat to expose its different systems

Text and Reference Books:

1. Vaghuwan, T. A., J. M. Ryan and N. J. Czaplewski. 2010. Mammalogy. 5th Ed. The John Hopkins University Press, New York, USA.

2. Feldhamer, G. A., L. C. Drickamer, S. H. Vessey, J. F. Merritt and C. Krajewski. 2007. *Mammalogy: Adaptation, Diversity, Ecology*. 3rd Ed. The John Hopkins University Press, New York, USA.
3. Genoways, H.H., 2000. *Current Mammalogy*. Plennium Press, New Yor

56. **Microbiology and Biotechnology**

MICROBIAL BIOTECHNOLOGY

Contact Hours:

Theory = 48
 Practical = -
 Total = 48

Credit Hours:

Theory =3.0
 Practical = -
 Total =3.0

Course Objectives:

The objectives of the course are:-

1. To enable the students to understand what biotechnology is;
2. To comprehend the basic role of microorganisms for life
3. To highlight the dynamic role of microbes in the entire ecosystem

Course Learning Outcomes:

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

1. **ATTAIN** the primary knowledge about microorganisms regarding biotechnology
2. **RECOGNIZE** the vital role of microbes in relation to diversity
3. **EXPLORE** the vibrant talent of microbes for metabolite production
4. **ENDORSE** the realistic connection of microbes with technology
5. **APPLY** the systematic information in a precise manner

Course Outline:

1. **Microbial Biotechnology**
 - a. History and scope
 - b. Techniques and examples (e.g. biofertilizers, Bio-pesticides, Bio-herbicides, bacterial and fungal Bioinsecticides, Virus-based bioinsecticides)
2. **Microbial Diversity**
 - a. Microbial classification (Morphological classification, Nutritional classification, Biochemical classification, Serological/ antigenic classification, Staining reaction)
 - b. Morphological diversity
 - c. Metabolic diversity
 - d. Structural diversity
 - e. Genetic diversity
 - f. Ecosystem and *Biomes*

3. **Biomass:**
 - a. Major components of plant biomass (Cellulose, Hemicelluloses, Lignin)
 - b. Architecture and composition of the wood cell wall
 - c. Biomass degradation
4. **Production of Proteins in Bacteria and Yeast**
 - a. Production of proteins in bacteria
 - b. Production of proteins in yeast
5. **Plant–Microbe Interactions**
 - a. Use of symbionts
 - b. Use of nitrogen-fixing bacteria to improve crop yields
 - c. Production of transgenic plants
 - d. Insect-resistant plants
6. **Recombinant and Synthetic Vaccines**
 - a. Problems with traditional vaccines
 - b. Impact of biotechnology on vaccine development
 - c. Mechanisms for producing immunity
 - d. DNA vaccines
7. **Primary Metabolites: Organic Acids and Amino Acids**
 - a. Citric Acid
 - b. Microbial production of Amino Acids (Lysine, Glutamic acid)
 - c. Enzymatic production of amino acids
8. **Secondary Metabolites**
 - a. Antibiotics
 - b. Other biologically active microbial metabolites;
9. **Ethanol:**
 - a. **Stage I** - from feedstock to fermentable sugars
 - b. **Stage II** - from sugars to alcohol
10. **Environmental Applications**
 - a. Degradative capabilities of microorganisms
 - b. Origins of organic compounds
 - c. Microbiological degradation of xenobiotics
 - d. Microorganisms in mineral recovery
 - e. Microorganisms in the removal of heavy metals from aqueous effluent

Use of Microbes for Production of Enzymes in Food and other Industries.

Teaching Methodology:

- Lecturing
- Written Assignments
- Quiz
- Presentations

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs)

Final Term (50%)

- Written (Long Questions, Short Questions, MCQs)

Sessional (20%)

- Presentation 10%
- Assignments 5%
- Report Writing 5%

Text and Reference Books:

1. Microbiology: An Introduction, 12th Ed. by Gerard J. Tortora, Berdell R. Funke, Christine L. Case.
2. Prescott's Microbiology, 10th Ed. by Joanne Willey, Linda Sherwood and Christopher J. Woolverton.
3. Modern Biotechnology: Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals by NS Mosier and MR Ladisch.
4. Microbial Biotechnology: Fundamentals of Applied Microbiology, 2nd Edition, by AN Glazer and H Nikaido.
5. Microbial Biotechnology: Principles and Applications, 2nd edition, by Kun, LY.
6. Microbial Fundamentals of Biotechnology by B. Volkmar and G.Friedrich.

57 **Microbiology of Extreme Environment**

N.A

58. **Molecular Genetics**

MOLECULAR GENETICS

Contact Hours:

Theory =34

Practical = 48

Total = 82

Credit Hours:

Theory = **2.0**

Practical = 1.0

Total = **3.0**

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of genome of various organisms
2. **UNDERSTAND** the key features involved DN damage and Repair
3. **SOLVE** the problem by using advance molecular biology Techniques.
4. **ANALYZE** the problem various available techniques.

Course Outline:

1. **Introduction**
 - a. Genome organization of various organisms
 - b. DNA and RNA viruses.
 - c. Transposable Elements.
2. **Gene Regulation**
 - a. Gene regulation in Prokaryotes
 - b. Gene regulation in Eukaryotes
3. **Post Transcriptional Modifications**
 - a. Capping and Poly A tail addition
 - b. RNA splicing
 - c. RNA editing.
4. **DNA Damage**
 - a. Single strand break
 - b. Double strand breal
 - c. Oxidative damage
 - d. Pyrimdine dimer formation

5. **DNA Repair Mechanism**
 - a. BER
 - b. NER
 - c. Photoreactivation
6. **Study of Molecular Techniques**
 - a. Southern blotting
 - b. Western blotting
 - c. Northern blotting
 - d. RFLP
 - e. RAPDS
 - f. Microsatellite DNA

Practical:

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

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

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. Lewin, B. Gene-VIII. Oxford University Press, Oxford, UK. 2004.

59. Neurobiology

NEUROBIOLOGY

Contact Hours:

Theory =48
 Practical = 48
 Total = 96

Credit Hours:

Theory =**3.0**
 Practical =1.0
 Total = **4.0**

Course Objectives:

1. To Provide the knowledge about the structure and function of cells that comprise the nervous system.
2. To impart understanding of chemical and electrical signaling in the nervous system.
3. To provide knowledge of sensory and motor systems.
4. To understand the brain development and complex brain functions.
5. To provide knowledge how to develop a hypothesis from a set of observations and then suggest experiments to test the hypothesis.

Course Learning Outcome

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

1. Define the molecular, cellular, and tissue-level organization of the central and peripheral nervous system
2. Understand the properties of cells that make up the nervous system including the propagation of electrical signals used for cellular communication
3. Relate the properties of individual cells to their function in organized neural circuits and systems
4. Understand how the interaction of cells and neural circuits leads to higher level activities such as cognition and behavior
5. Generate testable scientific hypotheses and develop research plans to test these hypotheses
6. Evaluate and discuss primary research literature and evaluate the validity of hypotheses generated by others
7. Work on research projects independently and in small group settings.
8. Communicate effectively orally and in writing

Course Outline:

1. **Organization of the nervous system**
 - a. The organization of the nervous system; neurons, types of neurons, nerves
2. **Electrical signals of nerve cells**
 - a. Membrane permeability; Channels and transporters; Nerve Impulse

3. **Synaptic Transmission;**
 - a. Neurotransmitters; their receptors and effects; Intracellular signal transduction;
4. **Sensory somatic system:**
 - a. The somatic sensory system; Pain;
5. **Vision**
 - a. Vision; molecular basis of photoreception, central visual pathways; Neural basis of visual perception, types of eyes, photoreceptor and phototransduction, retinal circuits, visual cortex.
6. **Hearing**
 - a. Nature of Sound, The auditory system; the vestibular system; Lateral line organs and electroreceptor, The mammalian ear, the auditory nerve fibers. Brainstem auditory pathways, Auditory cortex.
7. **The chemical senses;**
 - a. Taste system, Olfactory system
8. **Motor Neurons/system**
 - a. Lower motor neuron circuits and motor control;
 - b. Upper motor neuron control of the brainstem and spinal cord;
 - c. Modulation of movement by the basal ganglia and the cerebellum;
 - d. Eye movements and sensory motor integration; the visceral motor system;
9. **Brain development**
 - a. brain development; construction of neural circuits;modification of brain circuits as result of experience;plasticity of mature synapses and circuits;
10. **Association Cortices**
 - a. The association cortices; Language and lateralization; sleep and wakefulness; emotions; sex, sexuality and brain;human memory.

Practical:

1. Demonstration of nervous system organization
2. Study of Sensory organs
3. Culture of embryonic neurons
4. Histology of neuronal tissue
5. Immunohistochemistry
6. Ionic basis of resting potential.
7. Sciatic nerve compound action potential.
8. Introduction to intracellular recording.
9. Recording of action potentials on oscilloscope
10. Study of Synaptic physiology and Synaptic activity with neuromuscular preparations.
11. Experiments on characteristics of skeletal muscle contractions
12. Responses of intestinal muscles

Assessment:

Mid Term	(20%)
Final Term	(45%)
Lab	(20%)
Assignments & Presentation	(15%)

Books Recommended:

1. Neurobiology by Gordon M. Shepherd 3rd ed. ISBN-13: 978-0195088434, ISBN-10: 0195088433
2. The Neuroscience of Intelligence (Cambridge Fundamentals of Neuroscience in Psychology) Paperback – December 28, 2016 by Richard J. Haier
3. Brain & Behavior: An Introduction to Behavioral Neuroscience 5th Edition by Bob Garrett (Author), Gerald Hough 5th edition, ISBN-13: 978-1506349206, ISBN-10: 150634920X
4. Neuroscience ABCs: Human Brain Physiology Guide [Print Replica] Kindle Edition
5. by Robert Lavine (Author), Publications Staff National Institute of Mental Health (Author)
6. Beatty, J. (2001). The human brain. Sage Publications, Inc.
7. Conn, P. M. (1995). Neuroscience in medicine. J. B. Lippincott Co.
8. Haines, D, E. (1997). Fundamental Neuroscience. Churchill Livingstone. Inc.
9. FitzGerald, M.J.T and Jean Folan- Curran (2002). Clinical neuroanatomy and related neuroscience. Harcourt Publishers Limited.
10. Levitan, I. B. and Kaczmarek, L. K. (1997). The neuron: cell and molecular biology. Oxford University Press. Inc.
11. Matthews, G. G. (1998). Neurobiology. Blackwell Science.
12. Purves, D., Augustine, G. J., Fitzpatrick, D., Katz, L. C., LaManta, A-S., McNamara, J. O., Williams, S. M. (2001). Neuroscience. Sinauer Associates, Inc.
13. Shepherd, G. M. (1994). Neurobiology. Oxford University Press, Inc.
14. Revest, P. and Longstaff. (1998). Molecular neurosciences. BIOS Scientific Publishers. Ltd.
15. Rafael Yuste and Arthur Konnerth (2005). Imaging in neuroscience and development a laboratory manual. Cold spring Laboratory press.

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:

6. **ACQUIRE** the basic knowledge of the birds in the diversified habitats.
7. **UNDERSTAND** their behavior and possible their relationships to the natural habitats.
8. **SOLVE** the issues to detect minute morphological variations by using different high power spotting scopes in the field study for various habitats.
9. **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):

- a. **Introduction** to ornithology; basic ecology and themes of study.
- b. **Classification and taxonomy** of birds up to orders and species
- c. **Evolution** of birds; evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis.
- d. **Biology of fossil birds**; study of the representative birds viz. *Archaeopteryx*, *Archaeornithes* and *Neoornithes*. Comparison with the present existing birds.
- e. **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; brood parasitism and importance.
- f. **Predator-Prey** relationships, mobbing impacts; foraging and territoriality scuffles; predator avoidance.
- g. **Physiology of birds**: types of food; mastication; digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds.

- h. **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

Text and Reference Books:

1. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
2. A.J.Urfi (2009). Birds of India: A Literary Companion, OUP.
3. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.
4. Kaiser, G. W. (2008). The Inner Bird: Anatomy and Evolution. Amazon Co.
5. *Handbook of Bird Biology* (2014). Cornell Lab. Ornithology. Princeton University Press. New Jersey, USA.

61. **Parasitology**

PARASITOLOGY

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = **3.0**
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. Describe general principles and concepts of animal parasitology
2. Classify major animal parasites of animals and humans.
3. Describe many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents

Course Learning Outcomes:

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

1. Assess general principles and concepts of animal parasitology
2. Analyze many of the disease conditions that animal parasite cause and to consider measures that may lead to control of these disease agents

Course Outline:

1. **History and Origin of parasitism**
 - a. Classification of relationships between two individuals
 - b. Symbiosis, commensalisms, parasitism, myiasis, zoonosis
 - c. Infection and infestation.

2. **Evolutionary aspects related to parasites**
 - a. Geographical distribution
 - b. Epidemiology: Incidences of occurrence and prevalence.
3. **Classification of parasites**
 - a. Ectoparasites, endoparasite, temporary parasites, permanent parasites, facultative parasites, accidental parasites, wandering parasites (brief account and examples)
 - b. Classification of hosts: Definitive, intermediate and paratenic hosts.
4. **Host susceptibility and specificity**
 - a. Various types of susceptibilities
 - b. Host-parasite relationships
 - c. Morphology and physiology of parasites
 - d. Adaptations to parasitic mode of life
 - e. Effects of parasitism on parasites.
5. **Effects of parasites on hosts**
 - a. Influence of parasites on host populations.
 - b. Pathological responses
 - c. Immunoparasitology: immunity and immune responses of host.
6. **Diagnosis, prevention, control treatment**
 - a. Common drugs and anthelmintics
 - b. Vector control methods.
7. **Protozoology**
 - a. Protozoan parasites of man and other animals
 - b. Classification, life cycle, habitat, morphology, epidemiology and immunopathology of infections e.g., *Entamoeba spp.* *Pathogenic amoeba*, *Giardia spp.* *Trichomonas*, *Trypanosoma*, *Leshmania*, *Plasmodium* and *Toxoplasma gondii*.
8. **Helminthology**
 - a. Helminth parasites of man and other animals
 - b. General account, classification, biology, life cycle, pathology and symptomatology and immunology. Platyhelminthes: e.g. Trematodes (*Fisccciola* and *Schistosoma*) Cestodes: *Taenia*. Nematodes: *Trichuris*, *Strongyloides*, *Toxocara* and *Filaria* worms.
9. **Medical and Veterinary Entomology**
 - a. Biology and classification of arthropods of veterinary and medical importance.
 - b. Biology and life cycles e.g. lice, Ticks, mites, mosquitoes, fleas, flies, bugs etc.
 - c. Arthropods as disease transmitters/vectors.

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%

Text and Reference Books:

1. Foundation of Parasitology, 2000, 6th ed. Roberts, L.S. and Janovy, J. McGraw-Hill Book Co
2. Protozoology, 1996, 2nd ed. Hausman, K. and hulsman, N. Thieme medical publishers, Inc. New York
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine.Vol.I. University Press Cambridge
4. Roberts, L.S. and Janovy, J. Jr., 2005. Foundations of Parasitology, 7th Edition. W.M. Brown Publishers, Chicago, London, Tokyo, Toronto
5. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W. Veterinary Parasitology. 2000. Longman Scientific and Technical publications, Longman Group, UK

- Pharmacological Endocrinology (Dr. Tahira Jabeen)

Pharmacological Endocrinology Cr: 4(3+1)

(A COMPARATIVE PERSPECTIVE)

Course Objectives:

- The objective to study pharmacological Endocrinology is to develop and study drugs used to combat human diseases. It is an applied discipline based on physiology, to a large extent, but also on other biomedical disciplines. This is a course of choice for special group of endocrinology students interested in biomedicine.
- This course is optional for a Master's degree in Zoology. It is included in the master program as major in Endocrinology. The pharmacological Endocrinology course will be a very valuable basis for further postgraduate studies or for future work within the fields of biomedicine and pharmaceutical sciences.
- To obtain maximal benefit from the course, you are recommended to take it towards the end of your master studies.

Course Learning Outcomes:

1. **Acquire** basic knowledge of medicine about the physiological disturbance of hormones such as pituitary gland, thyroid gland, parathyroid gland, pancreas (Islets of Langerhans), adrenal gland.
2. **Understand:** the physiological changes, recognized with body system.
3. **Solve:** with the help of hormone test students able to solve problems related drugs.
4. **Analyze:** Students will be able to assess test of blood serum.
5. **Evaluate:** To identify the basic mode of action of medicines.
6. **Demonstrate:** An understanding of physiological changes on their related hormones which are responsible for body transformation.

Course Outlines:

- a. **Anti thyroid Agents:** hypothyroidism and hyperthyroidism
- b. **Oral ant diabetic agents:** IDDM (Insulin dependent diabetic mellitus), NIDDM (non-insulin diabetic mellitus)
- c. **Anti fertility agents:** mode of actions
- d. **Immunology:**
- e. **Prostaglandins:** discovery, biochemistry, anatomy, and mode of actions
- f. **Renin angiotensin system:** history, anatomy, biochemistry, physiological action

Practicals:

Books Recommended:

1. Goodman Gilman, Hardman, Limbird (Eds). The Pharmacological Basis of Therapeutics, 13th Edition, 2011 U.S.A. McGraw Hill Publications.
2. Bertram G. Katzung, 'Basic and Clinical Pharmacology', Lange Medical Book, 14th Edition, McGraw Hill Publications, 2017
3. Rang H.P., Dale M.M., Ritter J.M., et al., 'Pharmacology', 8th Edition, Churchill Livingstone, Edinburgh London 2015.
4. Therapeutic Drugs, Vol 1 and Vol. 2, 2nd Edition, Colin Dollery (Eds), Churchill Livingstone, Edinburgh London 1999
5. Vogel, G.H., Vogel W.H. (Eds), 'Drug Discovery and Evaluation', Pharmacological Assays, Springer-Verlag Berlin Heidelberg Publications, 1997
6. Martindale 'The Extra Pharmacopoeia', 30th Edition, James E.F. Reynolds

63. Pathological Endocrinology

PATHOLOGICAL ENDOCRINOLOGY

Contact Hours:

Theory =32
Practical =48
Total =80

Credit Hours:

Theory =2.0
Practical =1.0
Total =3.0

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 world class research.
2. UNDERSTAND: To provide distinctive modules within appropriate areas of endocrinology, drawing on the expertise and strengths of our academic staff.
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-of-the-art technology that is used to further research in the field and ensure that students are familiar with the fundamental principles of endocrine communication within the body, the underlying molecular events which support these processes, the pathological states that emerge when these processes malfunction and opportunities for the development of novel therapeutic targets More over Students demonstrate their learning by cross questioning, by drawing diagrams, by participating in presentations and participation in extracurricular activities.

Course Outline:

INTRODUCTION:

The Endocrine system provides a critical means of communication within the body and maintains a constant internal environment in the face of an ever-changing external environment. It is thus essential for survival and adaptation throughout life and plays a key role in the balance between health and disease. Endocrine study is obtain transferable skills essential for academic success and future careers: these include writing good science; searching, storing and understanding the literature; data interpretation and critical analysis will develop these skills in the context of basic and clinical science relating to endocrinology: this focuses on the essential elements of the hypothalamic-pituitary-endocrine axes and communication pathways between the brain and periphery which underpin basic endocrine concepts and their clinical significance.

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

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

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

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

Development and Growth: Disorders of growth and puberty.

Endocrine Hypertension.

Polyendocrine Syndromes.

Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy.

Geriatric Endocrinology: Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis. Overview of the clinical states in endocrine gland and molecular aspects in their diseases with details of model studies in thyroid diseases, diabetes, obesity and lipid metabolism. Endocrine-Responsive Cancer. Humoral Manifestations of Malignancy.

Lab. Clinical and Pathological Endocrinology

Credit Hour: 1

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

Textbook:

1. Greenspan, F.S. and Strewler, G.J., 2002. Basic and clinical endocrinology, 5th Edition. Prentice Hall International Inc., London.

Additional Readings:

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

64. Physiological Systems and Adaptations*

N.A

65. Physiology of Coordination*

N.A

66. Physiology of Functional Systems

N.A

67. Planktology

PLANKTOLOGY

(Cr.Hrs.2+1)

Course Objectives:

1. To impart the knowledge about Plankton
2. To provide the information about the economic importance of Plankton
3. To know about the collection and preservation of Plankton

Course Learning Outcomes:

- a. **Acquire** basic knowledge about Planktonic organisms and Larval stages of different organisms as plankton
- b. **Understand:** the basic techniques of collection, preservation and identification of Plankton
3. **Solve:** students have full command on handling and identifying the Plankton.
 - **Analyze:** Students will able to analyze the Meroplankton and Holoplankton.
 - **Evaluate:** To describe the types of Planktonic organisms, its sizes and migratory behavior, relationship between Phytoplankton and Zooplankton, economic importance of Plankton
 - **Demonstrate:** to describe the collection ,preservation and identification of Plankton

Course Outlines:

Introduction

- a. Methods of collection and Preservations,
- b. Types of plankton on the basis of the size,
- c. Distribution, food and life cycle.
- d. Meroplankton, Holoplankton: “ R” selected species and “ K” selected species.

Planktonic organisms and Larval stages

- a. Bacterioplankton, Protists, Porifera
- b. Cnidarians, Ctenophora,
- c. Helminthes, Polycheata,
- d. Crustacea, Mollusca
- e. Echinodermata, Chaetognatha,
- f. Protochordates and Pisces.

Diel Bathymetric migration

- a. Diurnal vertical migration, Theories and factors.
- b. Factors that influence the distribution of Zooplankton:
- c. Predation, Reproduction, Community interactions,
- d. PH, heavy metals, Calcium and Aluminum,
- e. Hydrographic indicator species,

- f. Plankton spectrography,
- g. Organic production mass mortality and behavior,
- h. Bioluminescence,
- i. Economic importance of Plankton, Phytoplankton and Zooplankton relationship, Adaptation factors of Zooplankton.

Communities of Zooplankton

- a. Biomass and abundance of zooplankton communities,
- b. Nutrients like nitrogen and Phosphorus affect on the prey of Zooplankton: Algae, Protozoa, Bacteria;
- c. Mortality ,
- d. Physical and Biological controls: Competition, , food, supply, availability of places, seasonal variation.

Practicals:

1. Nets and Gears.
2. Collection of Plankton.
3. Preservatives of Planktonic samples.
4. Sorting and Plankton.
5. Identification and analysis of plankton samples taken at regular intervals from the coastal Areas of Arabian Sea.
6. Permanently stained slide preparation and staining techniques.

Books Recommended:

1. Iain M. Suthers ,2009 Plankton: A Guide to Their Ecology and Monitoring for Water Quality 256 pages
2. Christian Sardet, 2015 Plankton: Wonders of the Drifting World 219 pp
3. A.C. Pierrot. Bults, S. Van Der Spoel. 1981 Zoogeography and Diversity of Plankton.
4. Cristopher D. Todd, M, S. Laverack , Geoff Boxshall, 1996. Coastal Marine Zooplankton A practical manual for students.
5. De Boyd. L. Smith and Kevin B. Johnson , 2003. A guide to Marine coastal Plankton and Marine Invertebrates larvae.
6. Fincham, A.A. 1984. Basic marine Biology. British Museum (Natural History) Cambridge University Press.
7. Hardy, Sir. A. 1971. The open sea: Its natural history. The World of plankton: 335 Collins (New Naturalist).
8. John. E.G. Raymont, 1983. Plankton and productivity in the Oceans.
9. Zooplankton. Vol.2.
10. John Wickstead, 1976. Marine Zooplankton.
11. Makoto Omori, 1991. Methods in Marine Zooplankton Ecology.
12. Newell, G.E. and R.C; 1977. Marine plankton. A practical guide: 244. Hutchinson.
13. Roger Harris, 2000. ICESS: Zooplankton Methodology Manual.
14. Sverdrup, H.U.M.W. Johnson and R.H. Fleming 1961. The Oceans.
15. UNESCO; 1976. Zooplankton fixation and preservation Monographs on Oceanography Methodology, No.4.

68. **Population Biology:**

Population Biology

Contact Hours:

Credit Hours:

Theory = **1.0**

Practical = **2.0**

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To familiarize the students with the basic concepts of population diversity & ecology
2. To educate the students with the methods of population samplings
3. To educate the students with the population dynamics in an ecosystem and their biotic & abiotic factors

Course Learning Outcomes:

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

1. Acquire the basic knowledge of biological population and their evolutionary processes
2. Understand the concepts of basic methods of population samplings
3. Evaluate the population dynamics of biotic and abiotic factors of ecosystem

Course Outline:

1. **Population**
 - a. Population, basic population characters, population dynamics, exponential, logistic,
 - b. Forms of population growth, density dependent and independent growth
 - c. Animal behavior, ecology and evolution, Structural population, population genetics, adaptation and speciation
2. **Population ecology**
 - a. Basic concepts, Population ecology of plants, population simulation,
 - b. Community ecology, community analysis, succession, ecotones, predator-prey systems, competition, mutualism, commensalism and carrying capacity
 - c. Population estimation methods, relative and absolute measures, age and sex composition
3. **Life history**
 - a. Demographic and life history parameters, evolution of life history parameters: R and K selection
 - b. Allometry, aging and sexing, life tables, age and stage structures models
 - c. Methods of estimation of life history parameters

4. **Population sampling**

- a. Preparation of sampling designs for population estimation
- b. Analysis of census data, Studies of various population parameters and use of census techniques

Practical:

1. Population studies mark and recapture method and statistical analysis of collected data
2. Community analysis through different sampling techniques (Quadrat and Line transect).
3. Adaptive features of animals in relation to food and environment.
4. Food chain studies through analysis of gut contents and fecal materials.
5. Analysis of polluted and fresh water for biotic and abiotic variations.
6. Field visits for study of selected habitat and writing notes.
7. Study of different ecosystems: pond, agricultural, grassland and forest.
8. Development of an ecological management plan of some selected area.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Townsend, C. 2007. Essentials of Ecology. 3rd Ed. Publishing & Co. London, UK.
2. Odum, E.P., 1994. Fundamentals of Ecology. W.B. Saunders.
3. Moles, M.C., 2002. Ecology: Concepts and Applications..McGraw-Hill, Boston.
4. Dodson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne,
5. Kitchell, R.L., J.F., Langston, N.E. and Turner, M.G., 1998. Ecology. Oxford Univ. Press, Oxford.

6. Singby, D. and Cork, D., 1986. Practical Ecology. McMillan Education Ltd., London.
7. Chapman, J.L. and Reiss, M.J., 1997. Ecology. Principles and Application. Cambridge Univ. Press, Cambridge.
8. Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.
9. Southwick, C.H., 1976. Ecology and Quality of our Environment. D. Van Nostrand Co, New York.
10. Boyd, C.E. 1981. Water quality in warm water fish ponds. Craft Master Printers Incorporation, Alabama.

69. Principles and Kinetics of Toxicology

Principles and Kinetics of Toxicology

Contact Hours:

Theory = 30

Total = 30

Credit Hours:

Theory = 3.0

Total = 3.0

Course Objectives:

The course objectives are:

1. To provide knowledge about the nature and mode of action of different categories of toxicants
2. To provide knowledge about the procedural protocols used in toxicological studies

Course Learning Outcomes:

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

1. Examine the differential effects of variety of toxicants on different cellular sites
2. Discover the nature and mode of action of different categories of toxicants

Course Outline

b. Measuring toxicity and assessing risk

- a. Introduction
- b. chemistry of toxicants; toxicity testing methods; routes of exposure; determining the
- c. responses to varying doses of substances
- d. time of exposure; the LD50 experiments
- e. Toxicity, hazards and risks.

c. Toxicokinetics

- a. Introduction; pharmacokinetics and toxicokinetics
- b. absorption: the oral, respiratory and dermal route of exposure, distribution,
- c. elimination, toxicokinetic models: mathematical models of elimination;

- d. Absorption and bioavailability; contrasting kinetics of lipophilic substances.

d. Biotransformation

- a. Introduction
- b. Primary biotransformation (phase I reaction) Hydrolysis, oxidation, reduction,
- c. Secondary metabolism (phase II reaction) Glucuridination, Glutathione conjugation, acetylation and other
- d. Phase II reactions, factors influencing metabolism.

e. Cellular sites of action

- a. Introduction, interaction of toxicants with proteins
- b. Effect of toxicants on enzymes
- c. Receptors and ion channels, voltage activated ion channels and transport proteins
- d. Effects of toxicants on lipids and nucleic acids,
- e. Mechanism of cell death; apoptosis, necrosis, stress, repair and recovery.

Teaching Methodology:

- Lecturing
- Written Assignments

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%

Text and Reference Books:

1. Principles of Toxicology, Karen E. Stine and Thomas M. Brown, CRC press, Taylor and Francis Group.
2. Toxicology, Hans Marquardt, Siegfried, G. Schafer, Roger McClellan, Frank welsch, 1999,2004, Academic press, San Diego. 118
3. Principles of toxicology testing, Frank A. Barile, CRC Press Taylor and Francis Group.
- f. M. Lois Murphy, C. P Dagg and David A. Karnofsky, Comparison of teratogenic chemicals in the rat and chick embryos. *Pediatrics*,19:701-714

70. Principles of Fish Biology

Principles of Fish Biology

Credit Hours:

Theory	=2.0
Practical	=1.0
Total	=3.0

Course Objectives:

The objectives of the course are:

1. To enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular.
2. To impart knowledge of morphology, anatomy, classification and understanding 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. Differentiate various 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 and fin spine (dorsal, pectoral, caudal, anal); Barbel (upper lip barbels, lower lip barbels).
3. **Anatomy:** Skeleton (skull, backbone, spines); Brain and spinal cord; Gills (Number, size, arrangements); Vital organs (heart, liver, kidney); Viscera and mesenteries (swim bladder, stomach, spleen, pancreas, intestine, gonads).
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.

Assessment:
Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Books Recommended:

1. Kestin, S. C. and Warris, P.D. (Editors). 2002. Kestin Farmed Fish Quality Blackwell Science, Oxford, UK.
2. Woo, P.T.K 1995. Fish diseases and disorder. Vol 1. Protozoan and metazoan infections. CABI Publisher.
3. Brenabe, G. Aquaculture, 1992. Vol. I. Blackwell Publishing, Oxford. UK.
4. Huet M. 1973. Text book of fish culture: breeding and cultivation. Blackwell Publishing Company.

71. **Principles of Ornithology**

N.A

72. **Protozoology and Immunology**

PROTOZOLOGY AND IMMUNOLOGY

Contact Hours:

Theory =48
Practical =16
Total = **64**

Credit Hours:

Theory =3.0
Practical =1.0
Total = **4.0**

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes

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

1. **Attain** the basic acquaintance of Protozoans and philosophy of host-parasite interface
2. **Understand** the perception of parasitism and other animal associations; clarify the concept of damage; understand the basic features and characteristics of hosts
3. **Elucidate** the impediments related to the pathogenesis of the protozoan and effectively treating these infections.
4. **Diagnose** the protozoan infections by presentations of elementary and current techniques
5. **Evaluate** the difficulties linked with protozoan infections on the basis of signs and symptoms.
6. **Articulate** protozoan parasite infections affecting livestock, its morphology, life cycle, epidemiology, pathogenesis, treatment and control approaches.

COURSE GOALS:

The goals of the course are to train students with a fundamental understanding of parasitology science and capability in relevant recent parasitological techniques.

Course Outline:

PROTOZOOLOGY

1. Introduction
 - a. Meet and Greet
 - b. Introduction to Parasitology, Some elementary definitions, Introduction to animal associations; concept of harm; parasite hosts.
 - c. Association to other sciences, Parasitology and human well-being.
 - d. Carriers in Parasitology
2. Parasitic Protozoa
 - a. Classification
3. Morphological features, Life cycles, host-parasite interactions, geographical distribution, reservoir hosts, methods of transmission and control, pathology, immunological aspects, diagnosis and treatment of the following protozoan parasites;
 - a. *Giardia species*
 - b. *Trichomonas species*
 - c. *Entamoeba species*
 - d. *Naegleria species*
 - e. *Trypanosoma species*
 - f. *Leishmania species*
 - g. *Plasmodium species*
 - h. *Babesia species*
 - i. *Anaplasma species*

- j. *Cryptosporidium species*
 - k. *Toxoplasma species*
 - l. *Histomonas meleagridis*
4. Parasitic Zoonosis and Risk Perception of Zoonotic infections in Pakistan

IMMUNOLOGY

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

Practicals:

1. Study of prepared slides for Protozoa of medical and veterinary importance
2. Preparation of permanent slides and mounts of parasitic Protozoa.
3. Analysis of human faeces and domesticated animals for the presence of protozoans by using standard laboratory techniques.
4. Preparation of blood/exudates smears and diagnosis of blood parasites by light microscopy and rapid diagnostic tests (RDTs).

Teaching Methodology:

- Lecturing
- Written Assignments
- Practical work
- Presentations

Assessment:

Mid semester (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Practical 10%

Final semester (60%)

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

- Presentation 20%
- Assignments 20%
- Practical 10%

Text and Reference Books:

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

73. Quantitative Zoology

QUANTITATIVE ZOOLOGY

Contact Hours:

Theory	=48
Practicals	=0
Total	=48

Credit Hours

Theory	= 3.0
Practical	= 0.0
Total	=3.0

Course Objectives

1. The course will provide knowledge about the importance and use of quantitative data in zoology.
2. To help the students to understand the methods to analyse data pertaining to their research work and to assess the significance of their experimental designs.

Course Learning Outcomes

Students who successfully complete this course will be able to:

- **DESCRIBE** the roles quantitative data serves in Zoology and biomedical research.
- **EXPLAIN** general principles of study design and its implications for valid inference.

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

Course Outlines:

1. Introduction:

- a. Types and properties of numerical data
- b. Population and sample, variable, categorical and non-categorical data,
- c. Scales of measurements, errors of measurements
- d. Mensuration studies of animals

2. Measure of central tendency

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

3. Frequencies distributions and grouping

- a. Empirical FD, relative FD, Cumulative FD, class frequency, class limits, class boundaries, class mark, class interval, midpoints.
- b. Range, grouped and ungrouped data, coefficient of range
- c. Mean deviation of grouped and ungrouped data. Coefficient of mean deviation.
- d. Standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data

4. Population and sampling

- a. Inference in finite and infinite populations.
- b. Inference based on sampling design.
- c. Simple random sampling with and without replacement.

5. Probability and probability distribution

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

- e. binomial experiment
- 6. Confidence interval**
- 7. Correlation and regression**
- 8. The analysis of variance and Tests of frequencies**
 - a. ANOVA, its uses and LSD
 - b. Hypothesis testing
 - c. Steps of hypothesis testing
 - d. Z-test
 - e. t-test, types,
 - f. Chi-square

Teaching methodology:

- Lecturing
- Written Assignments
- Quizzes

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 10%
- Quizzes 10%
- Report Writing 10%

Text and Reference Books

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

74. **Radiation Biology**

N.A

75. **Reproductive Biology**

REPRODUCTIVE BIOLOGY

Contact Hours:

Theory =16
Practical = 96
Total = 112

Credit Hours:

Theory = **1.0**
Practical = 2.0
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To introduce the field of Reproductive Biology, its history and significance
2. To impart knowledge about anatomy and physiology of reproduction
3. To demonstrate the socio-economic issues of reproductive biology.

Course Learning Outcomes:

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

1. **UNDERSTAND** the fundamental anatomy of male and female reproductive systems in various mammalian species
2. **ACQUIRE** knowledge about histology and physiology of the male and female reproductive systems
3. **COMPREHEND** the basic patterns and periodicity of reproductive processes in mammals
8. **ELABORATE** the socio-economic problems related to reproductive biology

Course Outline:

a. Introduction

a. Reproductive Biology Around Us – Overview

b. Anatomy of female reproductive system

c. Anatomy of male reproductive system

d. Reproductive Endocrinology

e. Pituitary and hypothalamus

6. Reproductive cycles

a. Puberty and seasonality of breeding

b. Estrous cycle and menstrual cycle

• **Disorders of sexual development**

• **Folliculogenesis**

• **Spermatogenesis**

• **Fertilization and early embryonic development**

• **Implantation and placentation**

- Parturition & Post-Partum recovery
- Obesity & Reproduction
- Regulation of Fertility in Humans
- Reproductive Aging
- Lactation
- Addictions & Reproduction
- Endocrinology of Stress in Reproduction
- Course wrap up

Practical:

7. Demonstration of male reproductive organs in vertebrates.
8. Demonstration of female reproductive organs in vertebrates.
9. Histological studies of ovaries
10. Histological studies of testes
11. Histological studies of endocrine gland

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Report Writing

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%

Text and Reference Books:

1. Pathways to Pregnancy and Parturition by P. L. Senger. 3rd edition (2012). Published by Current Conceptions Incorporated USA.
2. Andrology by E. Nieschlag, H. M. Behre and S. Nieschlag. 3rd edition (2010). Published by Springer, USA.
3. Knobil & Neill's Physiology of Reproduction by *T. M. Plant and A. J. Zeleznik*. 4th edition (2014). Published by Springer, USA.
4. Endocrinology: Adult and Pediatric (Vol II) by J. L. Jameson and L. J. De Groot. 7th edition (2015). Published by Elsevier - Health Sciences Division.

76. **Restoration Ecology and Sustainable Development**

RESTORATION ECOLOGY AND SUSTAINABLE DEVELOPMENT

Credit Hours: 2+1

Theory =02

Practical=1

TOTAL=03

Course Objectives:

1. To review major ecological concepts and principles to be involved in ecological restoration and sustainable development
2. To understand different social and ecological issues associated with ecological restoration of the local natural ecosystems and sustainable development practices
3. To gain experience for reviewing fundamental concepts, current literature, and contemporary topics regarding the ecological restoration in natural ecosystems
4. To practically involve the students in the process of ecological restoration through applied case studies on restoration feasibility analysis etc.

Course Learning Outcomes:

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

1. Understand the underlying principles and theories, current practices and different social/ ecological issues in restoration ecology and sustainable development.
2. Recognize the composition of local ecosystems, and describe the theoretical aspects of restoring different terrestrial and aquatic ecosystems.
3. Develop oral and written communication skills needed by professionals in the field.
4. Apply the gained knowledge to practically develop and write restoration plans and strategies for implementation by integrating the local communities and other stakeholders.

Course Outline:

1. Introduction to ecological restoration

- a. What is Ecological Restoration
- b. Role of restoration ecology in conservation
- c. Ecological disturbance and impairment
- d. Challenges to ecological restoration

2. Practices in Restoration of different environments

- a. Steps in designing and implementing ecological restorations
- b. Restoration of damaged ecosystems (marine, wetlands and

- terrestrial) and endangered populations
- c. Management of species invasions
- d. Local, national and international legislations that drive restoration practices.
- e. Animal Reintroduction
- 3. **Protected Areas Management:**
 - a. Existing protected areas and their effectiveness
 - b. Designing protected Areas: minimizing edge and fragmentation effects, habitat corridors, landscape ecology.
 - c. Managing protected areas: Habitat and species management, management of people.
 - d. Managing biodiversity outside protected areas.
- 4. **Conservation and Sustainable Development:**
 - a. What is Sustainable Development?
 - b. Traditional societies and sustainable development;
 - c. Conservation ethics of traditional societies,
 - d. Biological diversity and cultural diversity,
 - e. Conservation efforts involving traditional societies.
 - f. International approaches to conservation and sustainable development:
 - g. Ecotourism for sustainable development

Practicals:

1. Visits to the national parks of Pakistan and report writing.
2. To study and review the threats to regional biodiversity.
3. To study the effectiveness of different In-situ and Ex *situ* conservation strategies for the ecological restoration in Pakistan.

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Text and Reference Books

1. Galatowitsch, 2012. Ecological Restoration, Sinauer Associates, Sunderland, MA.
2. Howell et al. 2012. Introduction to Restoration Ecology. Island Press, Washington.
3. Van Andel, J. and J. Aronson. 2006. Restoration ecology. Blackwell Science Publishing, Oxford, UK.
4. Groom, M.J., G.K. Meffe and C.R. Carroll, 2006, Principles of Conservation Biology, 3rd edition, Sinauer Associates, Sunderland, MA.
5. Falk, D. A., M. A. Palmer, and J. B. Zedler. 2006. Foundations of restoration ecology. Island Press, Washington, USA.
6. Jordan, W. R., M. E. Giplin, and H. J. D. Aber, editors. 1987. Restoration ecology: a synthetic approach to ecological research. Cambridge University Press. Cambridge, UK.

77. Taxidermy

TAXIDERMY

Contact Hours:

Theory =32
Practical = 16
Total = 48

Credit Hours:

Theory = **2.0**
Practical =1.0
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. Introducing students to the ethics, regulations, materials, wildlife identification and basic techniques appropriate for preparing natural specimens.
2. Giving the students a basic introduction of what a person must know to start in taxidermy.

Course Learning Outcomes:

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

1. Practice basic taxidermy techniques.
2. Produce taxidermy mounts using a variety of taxidermy techniques.
3. Review state and federal taxidermy laws.
4. Compare different taxidermy techniques in order to recommend appropriate techniques for preserving specimens.

Course Outline:

1. Introduction

- a. Definition
- b. scope and importance; daily life, hobby, zoos, wildlife, sport hunting and science (natural history museums)

2. **Materials and equipment**
 - a. Chemicals and solutions
 - b. Skinning and mounting tools

3. **Techniques**
 - a. Skinning
 - b. Dehydration
 - c. Tanning
 - d. preparing and mounting of reptiles, birds and mammals
 - e. mounting of heads of mammals (deer, markhoretc)
 - f. mounting of skeletons
 - g. resin embedding
 - h. preparation of head casts.

4. **Transportation and status**
 - a. Laws of transportation of skins across the continents
 - b. Status of taxidermy in the modern time today
 - c. Alternatives of taxidermy.

5. **Wet preservation**
 - a. Materials and methods
 - b. Pinning
 - c. Curation of stuffing
 - d. Mountings
 - e. Wet materials preservatives for different specimens.

Practicals:

1. Complete mounting of a small mammal specimen (domestic or wild, as is convenient)
2. Complete mounting of a bird
3. Practical demonstration of resin embedding (videos may be shown in support)
4. Wet preservation demonstration through different invertebrate and vertebrate specimens
5. Study trip to a place taxidermy is done by skilled professionals (Pakistan Museum of Natural History Islamabad or as is convenient)

Books Recommended:

1. Pray, L.L. (1943). Taxidermy. The Macmillan Company.
2. Simpkins, J. (1974). Techniques of biological preparations. Blackie and Sons Limited, Bishopbrigs, Glasgow G64 2NZ.
3. British Museum (Natural History), Instructions for Collectors No 1 Mammala and No 2 Birds.
4. Wagstaffe, R. and Fidler, J.H. (1968). The preservation of natural history specimens Volume Vertebrates. Witherby. Video presentations from youtube can be helpful.

78. Taxonomy

TAXONOMY

Cr: 4(3+1)

Course Objectives:

The objectives of the course are:-

5. Acquire the basic knowledge of contribution of taxonomy in biology
6. Provide in-depth knowledge of taxonomy in animal sciences
7. Develop concepts about importance of the taxonomy.
8. Study the history of taxonomy with basic rules
9. Demonstrate about identifications and naming of the organisms according to international code of zoological nomenclature

Course Outlines:

- a. Introduction of the taxonomy in biology.
- b. History of taxonomy (downward classification, upward classification)
- c. Impact of origin of species, population systematics and current trends.
- d. Micro taxonomy, phenon, taxon, taxonomic categories.
- e. Typological concept, nominalistic concept, biological concepts, evolutionary concepts.
- f. Non dimensional species concept, multi-dimensional concept species.
- g. Difficulties of the species concept, polytypic species, subspecies, super species, sibling species.
- h. Variations within a single population, macro taxonomy, kinds of taxonomy characters.
- i. Taxonomic collections and identification.
- j. Description of synonyms of homonym, keys.
- k. Theory of nomenclature, interpretation of application of codes (stability, priority).
- l. Concept of availability, type method, formation of specific names.
- m. Brief concept of cladistics.

Practical:

1. Study of preserved invertebrate species and their classification upto class level.
2. Collection, preservation and identification of common species with the help of keys.
3. Preparation of keys for the identification of specimens.
4. Methods of statistical analysis of sampled data.
5. Preparation of keys for the identification of specimens.

Assessment:

Mid Term (40%)

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

- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Books Recommended:

1. Kapoor, V.C. 2005. Theory and Practice of Animal Taxonomy. (5th ed.) Oxford and IBH Publishing Co. Pvt. Ltd.
2. Thompson, J.N., 1994. The Evolutionary Process. Univ. Chicago Press, Chicago.
3. Harvey, P.H. and Pagel, M.D. 1991. The Comparative Methods in Evolutionary Biology. Oxford Univ. Press, UK.
4. Mayer, E. and Asblock, P.D., 1991. Principles of Systematic Zoology. McGraw Hill, N.York.

79. Techniques in Fisheries Research

TECHNIQUES IN FISHERIES RESEARCH

Credit Hours:

Theory =1.0

Practical= 2.0

Total =3.0

Course Objectives:

The course aims to;

1. Equip students with basic and advanced techniques used in fisheries & aquaculture research.
2. Develop critical thinking, technical expertise and work habits.
3. Expose students to the equipment, field situations, collecting techniques, laboratory procedures, data analyses, writing styles, research expectations, and frustrations of fishery science..
4. Reproductive capacity and success, recruitment, food habits, migrations, population estimates, and other aspects of fishery science and management.

Course Learning Outcomes:

After completing this course students will be able to;

1. Understand basic and advanced techniques used in fisheries research.
2. Solved problems by using technical expertise to design and devise strategies.
3. Practically using equipment and software to formulate, analyze and elaborate results.
4. Demonstrate advanced equipment and techniques used for analysis.

Course Outlines:

Identification and growth indices:

Fish sampling, Fish morphometric measurements, stock assessment, age and growth studies, length weight relationship, Condition factor; Daily Growth Coefficient, Hatchery operations and fish breeding techniques.

Feed formulation and Proximate Analysis: Definition, Categories: Moisture, Ash, Crude protein, Crude lipid, Crude fibre, Nitrogen-free extracts (digestible carbohydrates). Genetic and hormonal manipulation for increased fish production. Food Conversion Efficiency, Fish Health & Safety.

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

Extraction techniques: Centrifugation, Ultracentrifugation, Distillation, Use of Soxhlet and Rotary evaporator for extraction. Gene isolation; Probes; Recombinant DNA technology. Transgenic fish and Gene transfer technology, Molecular and immunological techniques – PCR; immunoblotting; ELISA; Restriction fragment length polymorphism.

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

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

Basic principles of Sampling and Preservation: Sampling soil organisms, Invertebrates, Aquatic animals, Mammals, Preservation of dry and wet specimens.

Practical:

1. Key to identification of fish species by studying morphometric and meristic counts.
2. Age determination by studying scales and operculum bone, otolith bone.
3. Gel Electrophoresis
4. ELISA.
5. DNA sequence analysis and comparison.
6. Induced fish breeding techniques.
7. Cryopreservation of gametes.
8. Estimation of total nitrogen and crude protein of fish tissue.
9. Extraction and estimation of total lipids in fish tissue.
10. Determination of oil texture and water parameters analysis.
11. Histopathology of normal and diseases fish and shellfish.

12. Techniques in disease diagnosis: Microbiological, haematological. Histopathological, immunological, molecular techniques and Biochemical tests.
13. Liquid handling: proper use of pipettes and micropipettes
14. Histological preparations: skeletal muscle, intestine liver and testes
15. Handling of centrifuge machines
16. Thin layer chromatography of amino acids
17. Spectrophotometric estimation of glucose.

Books Recommended:

1. William R. Persons, David L. Ward, and Luke A. 2015. Standardized Methods for Grand Canyon Fisheries Research, By Avery U.S. Geological Survey, Reston, Virginia/ First Release: 2013 Revised: January 2015 (ver. 1.1).
2. Nielsen, L. A., and D. L. *Fisheries Techniques*. American Fisheries Society, Bethesda, Maryland. Pp. xi + 428.
3. J. E. Halver and R.W. Hardy 2002. *Fish Nutrition*, third edition. editors. Academic Press, New York.
4. *Nutrient Requirements and Feeding of Finfish for Aquaculture*. 2002. C. Lim and C.Webster, editors. CAB International Publishers, U.K.
5. Laboratory Manual on Analytical Methods and Procedures for Fish and Fish Products, 1992. Marine Fisheries Research Department, Southeast Asian Fisheries Development Center in collaboration with Japan International Cooperation Agency.
6. *Fish Nutrition in Aquaculture*. 1995. S. S. De Silva and T.A. Anderson. Chapman & Hall, London.
7. *Nutrient Requirements of Fish*. 1993. National Research Council. National Academy Press, Washington, D.C., USA.

80. **Teratology**

TERATOLOGY

Contact Hours:

Theory =48
Total = 48

Credit Hours:

Theory =3.0
Total =3.0

Course Objectives

The course aims to:

4. **Provide information on** understanding the basis of possible drugs, infections and environmental effects on the developing human embryo and fetus
5. Impart detailed knowledge about cellular basis of teratogenesis
6. Provide understanding of the mechanisms of dysmorphogenesis

Course Learning Outcomes:

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

1. **Gain** familiarity with the study of anomalous fetal development
2. **Apprehend** the contributions of teratology infections during pregnancy.
3. **Elucidate** the problems associated with cell differentiation with teratogens.
4. **Arrange and investigate teratology** principles and possible common exposures during pregnancy.
5. **Assess** features that provide a teratology update for prescription and non-prescription drugs
6. **Demonstrate** the ability to label practitioners with a summary of information regarding teratology risks for drug, chemical, and infection exposures during pregnancy.

Course Outline:

1. **Introduction to teratology**
 - a. Teratology: an overview
 - b. Impact of Planned and Unplanned Pregnancy on teratological development
 - c. Mechanism of teratogenesis
2. **Effect of ionizing radiations**
 - a. Atomic bomb survivors in Japan
 - b. Impact of radiation before or immediately after implantation of the embryo into the uterine wall
 - c. Higher doses of radiation during all stages of intrauterine development
3. **Hypoxia, hyperthermia and industrial exposure**
 - a. Activation of stress protein
 - b. *Hypoxic exposure* impact on during chorio-vitalline membrane development
4. **Teratogenic effects of substances of abuse**
 - a. Ethanol
 - b. Heroin
 - c. Cocaine and heavy smoking
5. **Effects of maternal infections in pregnancy**
 - a. Zika virus
 - b. Rubella
 - c. Toxoplasmosis
6. **Effects of maternal diabetes on the developing embryo and fetus**
7. **Effects of systemic lupus erythematosus (SLE) and other autoimmune diseases and effects of anemia during pregnancy**
8. **Impact of various medications on development**
 - a. Antiepileptic drugs
 - b. Anticancer drugs
 - c. Antithyroid medicines
 - d. Psychoactive medication

Teaching Methodology:

- Lecturing

- Written Assignments
- Guest Speakers
- Hospital Visits
- Report Writing

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%

Text and Reference Books:

1. Berry, C.L and Poswillo, D.E. (2014). Teratology: Trends and Applications. Springer Verlag, New York, Heidelberg
2. Ronan R. O'Rahilly_and Fabiola Müller. (2001). Human Embryology & Teratology, Wiley-Liss Publishers 3rd Edition ISBN-13: 978-0471382256
3. Naira R. Matevosyan. (2017). Lectures in Teratology. CreateSpace Independent Publishing Company New York: ISBN-13: 978-1548510381
4. Scott F. Gilbert and Michael J. F. Barres. (2016). Developmental Biology. Sinauer Associates, Sunderland, MA.
5. Rogers, J.M., Kavlock, R.J. (1996). "Developmental toxicology". In C.D. Klaassen (ed.): *Casarett&Doull's Toxicology*, (5th ed.). p.301-331. New York: McGraw-Hill. ISBN 0-07-105476-6.
6. ThallBastow, B.D, Holmes, J.L. (2016). "Teratology and drug use during pregnancy". *Medscape*. WebMD. Retrieved 24 February 2016

80. **Vector Biology**

VECTOR BIOLOGY

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide in-depth appreciation of diseases transmitted by invertebrate vectors
2. To impart knowledge about control of vector-borne disease

Course Learning Outcomes:

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

1. Discover the basic knowledge of vector biology
2. Illustrate the concepts of disease transmission by invertebrate vectors.
3. Analyze knowledge for control of vector-borne disease

Course Outline:

1. **Vector Biology and Control**
 - a. Key aspects of vector taxonomy
 - b. Evolution
 - c. Biology and Behavior.
2. **An introduction to the life-cycles of vectors**
 - a. Ecology
 - b. Role in transmission of various diseases
3. **Major groups of arthropod-borne pathogens and vectors**
 - a. Basic components of arthropod-borne disease cycles
 - b. Principles of pathogen transmission dynamics
4. **Emergent pathogens**
 - a. Vector genetics
 - b. Vaccines for vector-borne disease
 - c. Traditional and modern disease control strategies
 - d. Venomous Arthropods.
5. **Biology and Ecology of some vectors of medical importance (order Diptera)**
 - a. Mosquitoes (*Anopheles culicine*), Black flies and 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.

Teaching Methodology:

- Lecturing
- Written Assignments
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Handler, A. M. James, A.A. (Eds.). 2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.
2. Hoy, M.A.2000. Insect Transgenesis: Methods and Application. CRC Press.
3. Pedigo, L. P. 2003. Entomology and Pest Management. 4th ed. Pearson Education, Singapore, Pvt. Ltd.
4. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi.
5. Peter, W. Atkinson., 2010. Vector Biology, Ecology and Control.Springer Dordrecht Heidelberg, London, New York.
6. William, H. Marquardt, *et al.*, 2004. Biology of Disease Vectors.2nd Edition.
7. William Charles Marquardt, Richard S. Demaree, Jr., Robert Burton Grieve., 2000. Parasitology & Vector Biology.2nd Edition.

81. Vertebrate Paleontology

VERTEBRATE PALEONTOLOGY

Credit Hours

Theory = 3.0

Practical =1.0

Total= 4.0

Course Objectives:

The objectives of this course are

1. **To discuss the history and evolution of the vertebrates.**
2. **The phylogenetic relationships and evolutionary patterns of the major groups.**
3. **The laboratory component focuses on comparative vertebrate osteology and fossil representation of major groups.**

Course Learning Outcomes:

On completion of the course, the students will be able to;

1. **Acquire** theoretical knowledge about prehistoric life form of fishes, amphibians, reptiles, birds and mammals at different stages of Geological Time Scale.
2. **Compare** different oestology of vertebrate groups.
3. **Collect** the fossils from field

4. **Evaluate** the palaeocology and palaeoenvironment associated with different faunal elements.

Course Outline:

1. Introduction to vertebrate Palaeontology and vertebrate origins.
2. Fishes
 - a. Early Fishes and Acquiring Jaws
 - b. Post-Devonian Fish Evolution:
 - c. Sharks, rays, and bony fishes
 - d. Sarcopterygii and the oldest tetrapods (fishes with legs)
3. Carboniferous Tetrapods and amphibians
4. Reptiles
 - a. Origin of Amniotes and early Amniotes
 - b. Synapsids of the Permian
 - c. Basal Archosaurs and Origin of Crocodiles
 - d. Early Crocodylians, Testudines, and Lepidosauurs
 - e. Mesozoic Marine Reptiles
 - f. Origin of Dinosaurs
 - i. Saurischia
 - ii. Ornithischia
 - iii. Pterosaurs
5. Birds and Feathered Dinosaurs
6. Cretaceous–Tertiary Boundary Extinction
7. Origin of Mammals; Mesozoic Mammals
8. Dawn of the Age of Mammals; Early Cenozoic Mammals
9. Major Groups of Cenozoic Placentals

Practicals:

1. Osteology of the fishes Skull.
2. Osteology of the amphibian Skull.
3. Osteology of the reptilian Skull.
4. Osteology of the mammalian Skull.
5. Topography of vertebrate teeth.
6. Diversity of mammals.
7. Field visits for collection of vertebrate fossils.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest speaker
- Field visits
- Report writing

Assessment:**Midterms (40%)**

- Written (MCQs, Short Questions; Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final term (60%)

- Written (MCQs, Short Questions; Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Text and Reference Books:

1. Vertebrate Palaeontology 3rd Edition (2005), by Michael J. Benton
2. Vertebrate Paleontology and Evolution, by Robert L. Carroll (1988), published by W. H. Freeman and Company.
3. Mammals from the Age of Dinosaurs, by Z. Kielan-Jaworowska, R. Cifelli, and Z. Luo (2004), published by Columbia University Press.
4. Gaining Ground: The Origin and Evolution of Tetrapods, by Jennifer A. Clack (2002), published by Indiana University Press.
5. The Beginning of the Age of Mammals, by Ken D. Rose (2006), published by The Johns Hopkins University Press.
6. The Rise of Placental Mammals, edited by Ken D. Rose and J. David Archibald (2005), The Johns Hopkins University Press.

82. Veterinary and Wildlife Parasitology**N.A****83. Wild life Parasitology****WILDLIFE PARASITOLOGY****Contact Hours:**

Theory = 30

Total = 30

Credit Hours:

Theory = 3.0

Total = 3.0

Course Objectives:

1. Provide knowledge regarding different modes of transmission of wildlife parasites along with their pathology, life cycles and host parasite relationship
2. Impart advance knowledge on various important wildlife parasites
3. Give understanding about host parasite relationship and control measure

Course Learning Outcomes:

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

1. Acquire knowledge regarding different modes of transmission of wildlife parasites along with their pathology, life cycles and host parasite relationship
2. Examine about host parasite relationship and control measure

Course Outline:

1. An overview of Wildlife in Pakistan
2. Parasites of wild animals and birds
3. Role of wild animals and birds in dissemination of parasitic disease of domestic animals and man
4. Pathogenesis
5. Diagnosis and control of ecto and endo-parasites of wild animals and birds.

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%

Text and Reference Books:

1. Fowler, M.E., 1990. Zoo and Wild Animal Medicine Current Therapy Saunders, W.B. Company, Philadelphia, USA.
2. Levine, N.D., 1990. Veterinary Protozoology. The Iowa State University press. Ames, Iowa, USA.
3. Soulsby, E.J.L., 1986 Helminths. Arthropods. And Protozoa of Domesticated Animals. 7th Ed. Bailliere and Tindall, London.
4. Davis, J.W. and R.C. Anderson. 1971. Parasitic Disease of wild Mammals, The Iowa State University Press, Ames, USA.

84.. **Zoological Techniques**

N.A

MODEL SCHEME OF STUDIES FOR MS ZOOLOGY (2 YEAR)

Semester-I

Course Title	Credits
Core Course-I (Advanced Biological Techniques)	3/4
Course (Univ. Option)	3/4
Course (Univ. Option)	3/4
Course (Univ. Option)	3
	12

Semester-II

Course Title	Credits
Core Course-II (Applied Biostatistics)	3/4
Course (Univ. Option)	3/4
Course (Univ. Option)	3/4
Course (Univ. Option)	3
	12

Semester-III & IV

Course Title	Credits
Research and thesis	6*/10**
Seminar	2**
	8*/12**
TOTAL CREDITS 30*(Flexible from 30-36**)	30*/36**

Course work = 24 credits (compulsory) Core and Special (as per university options)

Research & Thesis = Minimum 6 credits (Compulsory)

- **Semester 1=** There can be 3 courses of 4credits or 4 courses of 3 credits (total=12 credits)
- **Semester 2=** There can be 3 courses of 4credits or 4 courses of 3 credits (total=12 credits)
- a) **Semester 3 & 4=** Research and thesis (minimum 6 credits*)
OR
As per university (Total credits for MS degree 30-36)**
In case of 36 credits= Sem-1 (12 credits), Sem-2 (12 credits)
Sem- 3 & 4 (2 credits Seminar + 10 credits Research & thesis)

COURSES FORMS PROGRAM IN ZOOLOGY

(Courses may be added as per specialization)

MS Compulsory Courses:

1. Advanced Biological Techniques*
2. Applied Biostatistics
3. Seminar

Core Course-I

ADVANCED BIOLOGICAL TECHNIQUES

Course Objectives:

The course aims to:

1. Familiarize the students with advance biological equipments and technique
2. Develop basic understanding of the equipment handling in reserch.
3. Develop scientific and technical expertise, culture and work habits.

Course Learning Outcomes:

After studying this course students must be able to:

1. Understand advanced biological techniques
2. Apply practical and research skills
3. Operate and use the lab equipement efficiently.

Course Outlines:

UV Spectroscopy/Separations, Flame Atomic Absorption Spectroscopy, Spectrofluorimetry, Thin Layer Chromatography (TLC), Gas Chromatography, High Performance Liquid Chromatography (HPLC), Amino acid sequening, Blotting techniques, Centrifugation techniques, PCR, DNA Sequencing, Electrophoresis, Isoelectric Focusing Apparatus, Lyophilizer, Microarray Technology, Microscopy, Microtomy, Nuclear Magnetic Resonance Instrument, principles and application, Geographic Information Systems and Remote sensing, ELISA, Cell culture.

Books Recommended:

1. Chemical Analysis: Modern instrumentation, methods and techniques, Francis Rouessac and Annick Rouessac, John Wiley & Sons, 2000, ISBN 0-471-97261-4.
2. Principles of Instrumental Analysis (5th ed), Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Brooks Cole, 1997, ISBN 0-03-002078-6.
3. Spectrometrische analysetechnieken, M.T.C. de Loos - Vollebregt, Heron reeks - Bohn Stafleu Van Loghum, 2004, ISBN 90-313-4142-8.

MS Specialized Courses

1. Advance insect ecology
2. Advance Mammaalogy
3. Advanced Biochemistry
4. Advanced Cancer biology
5. Advanced Enzymology
6. Advanced Herpetology
7. Advanced insect ecology
8. Advanced instrumental techniques
9. Advanced Molecular Biology
10. Advanced molecular genetic
11. Advanced ornithology
12. Advanced physiology
13. Advances in Aquaculture
14. Advances in Biochemistary
15. Advances in bioinformetic
16. Advances in Cell Biology
17. Advances in Ecology
18. Advances In Forensic Biology
19. Advances in Helminthology
20. advances in Immunology
21. Advances in Protozoology
22. Advances in Research Methodology
23. Advances In Wildlife*
24. Aerosol and environmental health
25. Air Pollution Monitoring
26. Animal physiology
27. Applied entomology
28. Applied Genetics
29. Appllied Microbiology
30. Appllied Parasitology
31. Applied Reproductive Physiology
32. Apiculture
33. Aquaculture
34. Aquaculture and Fisheries
35. AquaCulture Biotechnology
36. Biological Toxicology
37. Biology of Birds and Mammals In Pakistan
38. Biology of ornamental fish and aquaria management
39. Cancer Genetics
40. Cell and tissue culture
41. Cellular and Molecular Physiology
42. **Chemical Oceanography**
43. Classification of Insects and Pest Management
44. Climate Change, Ecosystem Resilience And Stability
45. Clinical Endocrinology
46. Clinical Immunology

47. Clinical Teratology
48. Conservation Biology
49. Conservation Biology of Wildlife
50. Dersert Zoology
51. Ecosystem Engineering
52. Ecotourium Planning and management
53. Endocrine Toxicology
54. Environmental Biotechnology
55. Environmental health policy and law
56. Environmental Toxicology
57. Fish and Aquatic Toxicology
58. Fish Breeding and hatchery management
59. Fish Nutrition and Health
60. Fish parasitology
61. Fish Processing and value addition
62. Fish Requirements
63. Fisheires extension education
64. Fishing Gear Technology
65. Forensic entomology
66. Freshwater Biology
67. Gene therapy
68. Genomics and proteomics
69. Herpetology
70. Human Genetics
71. Insect toxicology
72. Industrial biotechnology
73. Lab and Biosafety*
74. Lac Insects
75. Mangroove ecology
76. Medical and Veterinary Parasitology
77. Medical Biotechnology*
78. Medical Entomology
79. Medical Virology
80. Mericulture technology
81. Molecular Endocrinology
82. Molecular Evolution
83. Molecular immunology
84. Natural Photograph
85. Ornamental fish aquaria management
86. Physical Oceanography
87. Principles of aquaculture
88. Principles of Wildlife Management*
89. Recombinant DNA Technology
90. Reproductive Physiology
91. Research Methods in Entomology
92. Sea Food Processsing
93. Sericulture

- 94. Toxicology
- 95. Vaccinology
- 96. Wetlands Management
- 97. Wildlife Conservation and Management
- 98. Wildlife of Pakistan
- 99. Wildlife Techniques and Data Analysis

DETAIL OF COURSES

1. Advance insect ecology

ADVANCED INSECT ECOLOGY

Contact Hours:

Theory =48

Practical = 32

Total = 80

Credit Hours:

Theory =3.0

Practical =1.0

Total = 4.0

Course Objectives:

The objectives of the course are:-

1. To provide a synthesis of ecological principles with an applied interpretation.
2. To explore the roles of insects in delivery of ecosystem services and applications to pest management and conservation.
3. To demonstrate the intra and inter specific interactions of insects thus highlighting their ecological niche.

Course Learning Outcomes:

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

1. **UNDERSTAND** how insects engineer our global ecosystem as well as how they respond to environmental changes.
2. **DESCRIBE** the reasons of insect abundance and diversity in any ecosystem.
3. **APPRAISE** the principles of ecology at four levels of integration i.e. populations, communities, ecosystems, and landscapes.
4. **EXPLORE AND ESTABLISH** the links between different levels of integration.

Course Outline:

Scope of Insect ecology.

- a. Introduction to insect ecology: Insects in ecosystems, Adaptations of Insects, Life history strategies.
- b. Responses to abiotic conditions.
- c. Resource acquisition.
- d. Insects and Landscape: affects of landscape modification on insects.
- e. Insects and Climate: affects of climate change on insect species, Insect invasions & climate change.

- f. Biodiversity: Insect conservation, Insect extinctions.
- g. Insect populations: Population Dynamics, Population sampling methods.
- h. Insect communities: Community Interactions: (1) Insect-plant interactions, Plant defenses and insect counter-defenses, Insect herbivores, Natural Enemies of insect herbivores with emphasis on Ichneuomonidae and Braconidae, Insect defenses against enemies (2) Predator-prey interactions (3) host-parasite interactions (4) Mutualisms (5) Pollinators-plant interactions: co-evolution of plants & pollinators (6) Insect and pathogens (7) Ecology based Insect pest management.
- i. Behavioral ecology: Social organization in insects, Insect communication, Insect societies (with emphasis on societies of ants, termites and bees).

Practical:

1. Sampling methods
2. Diversity Indices
3. Density estimates
4. Field surveys

Teaching Methodology:

- Lecturing
- Case Studies
- Written Assignments
- Field Visits
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Text and Reference Books:

1. Schowalter, T.D., 2017. Insect Ecology: An Ecosystem Approach. Academic Press.633pp.
2. Price, P.W., Denno, R.F., Eubanks, M.D., Finke, D.L., and Kaplan, I., 2011. Insect Ecology: Behavior, Populations, and Communities. Cambridge University Press.
3. Speight, M.R., Hunter, M.D., & Watt, A.D. (2008). Ecology of Insects: Concepts and Applications. Wiley-Blackwell.

4. Denno, R. F. and Eubanks, M. D. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press, New York, USA.
5. Gullan, P. J. and Cranston, P. S., 2014. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
6. Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
7. Rockwood, L.L. 2006. Introduction to Population Ecology. Wiley, John and Sons.
8. Bourtzis, K. and Miller, T. 2003. Insects Symbiosis. CRC Press.
9. Vandermeer, J.H. and Goldberg, D.E. 2003. Population Ecology: First Principles, Princeton University Press.
10. Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. 3rd Ed. Blackwell Science.
11. Grimaldi, D. and Engel, M.S. 2005. Evolution of Insects. Cambridge University Press.

2. Advance Mammalogy

ADVANCE MAMMALOGY

Credit Hours =03
Practical= 01

Theory =02
Total =03

Course Objectives:

The objective of this course is

1. To enable the student to understand basic characteristics, behavior and significance of mammalian species.
2. To develop an understanding for evolution, mammalian distribution and their adaptations.
3. To understand how National and International agencies involved in mammal conservation.

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 mammals
2. UNDERSTAND the adaptations for mammals, selection, migration and conservation.
3. SOLVE the threats to wildlife by applying the scientific principles and modern technologies.
4. ANALYSE, interpreting and synthesize data and other information about mammalian population.
5. EVALUATE the conservation management by government department, National and International organizations for mammals conservation

6. DEMONSTRATE the ecological assessment and importance of wildlife to certain area.

Course Outline :

a. Mammals of Pakistan

- a. Introduction
- b. Important Definitions
- c. Descriptions
- d. Identification
- e. Characteristics
- f. Origin and Classification
- g. Distribution
- h. Status

b. Mammalian Behavior and Ecology.

c. Evolution and dental characteristics

d. Mammalian structure and function

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

e. Mammalian reproductive physiology: Adaptive responses to changing environments.

- a. Introduction
- b. Environmental constraints on Mammalian Reproduction
- c. Mammalian responses to Environmental Information

f. Environmental adaptations for mammals

g. Selection and Survival

h. Habitat selection and Migration

i. Mammalian conservation

Practicals:

1. Methods for studying mammals
2. Trapping and marking
3. Observational methods
4. Laboratory and museum methods
5. Systematic methods

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%

- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Books Recommended:

1. Feldhammer, G.A., Drickamer, L.C., Vessey, S.H., Merritt, J.F. and Krajewski 2007. Mammalogy, Adaptation, Diversity, Ecology 3rd ed. The Johns Hopkins University Press, Baltimore.
2. Vaughan, T. A., Ryan, J. M. and Czaplewski, N.J. 2000. Mammalogy 4th ed. Brooks/cole Thomson learning, USA.
3. Davis, David 1963. Principles of Mammalogy
4. Gelder, 1969 Biology of Mammals. Reinhold Publishers Corporation, New York.
5. Miller and Harly, 1999. Zoology (4th Edition). McGraw Hill, New York.
6. Hickman, Roberts, and Larsen, 2001, Integrated principles of Zoology (11th Edition). McGraw-Hill, New York.
7. Genoways, H. H., 1987. Current Mammalogy. Springer Science+Business Media, LLC

3. Advanced Biochemistry

N.A

4. Advanced Cancer biology

ADVANCES IN CANCER BIOLOGY

Contact Hours:

Theory =32
 Practical = 48
 Total =80

Credit Hours:

Theory =2.0
 Practical =1.0
 Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To enhance the knowledge in the area of Cancer Biology.
2. To provide core concepts involved in the transformation of normal cell in to cancer cell.
3. To introduce the major signaling circuitry programs contributing towards cancer.

Course Learning Outcomes:

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

1. **ACQUIRE** the advanced knowledge of Cancer Biology.

2. **UNDERSTAND** the concepts of transformation of normal cell in to tumor cell.
3. **ANALYZE** the signaling pathways contributing towards Cancer.
4. **EVALUATE** the problems related to genetic mutations and tumor suppressor genes, etc.

Course Outline:

1. Introduction

- a. Introduction of Cancer
- b. General features and types of cancers,
- c. The nature of Cancer,
- d. Arise of Cancer from normal and specialized cells.
- e. Monoclonal growth of tumor cells.
- f. Physical and chemical carcinogens
- g. Mutagens causing cancers.

2. Tumor Viruses

- a. RNA viruses
- b. DNA Viruses causing cancer.
- c. Transformation of cells by tumor viruses.

3. Cellular oncogenes:

- a. Oncogenes in the cell
- b. Proto-oncogenes,
- c. Activation of proto-oncogenes,
- d. myc oncogene

4. Growth factors, Receptors, and Cancer

- a. Receptors and their ligands,
- b. Growth factor genes,
- c. EGF receptor,
- d. TGF

5. Signaling Circuitry programs

- a. Introduction to signaling pathway,
- b. The Ras protein
- c. Tyrosine phosphorylation
- d. Cascade of kinases.

6. Cell Cycle

- a. Cell cycle,
- b. Cell cycle regulation,
- c. Tumor suppressor genes,
- d. Apoptosis.
- e. Significance of apoptosis
- f. Extrinsic and Intrinsic apoptosis.

Practical:

1. Study of prepared slides of cancer cells,
2. Slides showing conversion of epithelia in to metaplastic/hyperplastic/dysplastic conditions.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Report Writing

Assessment:**Mid Term (40%)**

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Zhang, W., & Fuller, G. N. (Eds.). (2004). Genomic and Molecular Neuro-Oncology. Jones & Bartlett Learning.
2. Cooper, G. M. (1995). Oncogenes. Jones & Bartlett Learning.
3. Hicky, R., Clark, R. L., & Cumbley, R. W. (1986). Year book of cancer. Chicago: Year book.
4. Weinberg, R. (2013). The biology of cancer. Garland science.
5. Hejmadi, M. (2009). Introduction to cancer biology. Bookboon.

5. Advanced Enzymology**ADVANCED ENZYMOLOGY****Contact Hours:**

Theory = 64

Total = 64

Credit Hours:

Theory =4.0

Total =4.0

Course Objectives :

The course aims to:

1. To Introduce students to various theoretical and practical aspects of enzymology

2. To stimulate students interest in learning the structure, function and kinetics of enzymes and their role as catalyst and regulator of cell metabolism.
3. To understand the mechanism of enzymes action and important components of the enzyme molecules.
4. To evaluate the basics of enzyme kinetics, pathways, mechanisms of their control and the importance of the parameters describing the kinetics.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of the major classes of enzymes and their functions in the cell; role of co-factor in enzyme catalyzed reaction.
2. **UNDERSTAND** between equilibrium and steady state kinetics and analyzed simple kinetic data and estimate important parameter (K_m , V_{max} , K_{cat} etc).
3. **ANALYZE** the structure/function relationships in bio-catalyzed reactions
4. **EVALUATE** the different possible catalytic mechanisms of given reaction types
5. **DEMONSTRATE** the strategies for the analysis of kinetic mechanisms of catalyzed reactions

Course Outline:

1. **Introduction and History of Enzymes**
 - a. Historical aspects
 - b. Discovery and chemistry of enzymes
 - c. Function and importance
 - d. Enzymes in Biotechnology
2. **Characteristics and Properties**
 - a. Catalytic power and specificity
 - b. Enzyme-substrate interactions
 - c. Lock and key model
 - d. Induce fit model
 - e. Transition state model
 - f. Quantum tunnelling model
 - g. Enzymes as proteins
 - h. Non-protein cofactors-metal ions
 - i. Organic cofactors
3. **Multi-substrates Reactions and Substrate Binding Analysis**
 - a. Multi-substrates reactions
 - b. Ordered and random mechanisms
 - c. Sequential and Non-sequential mechanisms
 - d. Substrate binding analysis
4. **Determination of Enzyme-Substrate Dissociation Constants**
 - a. Equilibrium dialysis
 - b. Equilibrium gel filtration

- c. Ultracentrifugation
- d. Spectroscopic methods
- 5. Experimental analysis of catalytic and kinetic mechanisms**
 - a. Spectrometry, X-ray crystallography, stopped flow, isotope effects, structure/reactivity relationships).
 - b. Mathematical data analysis (regression analysis, model discrimination).
 - c. Modelling of enzymatic reactions. Stereo chemistry (mechanisms). Structure/function relationships (protein folding, mutagenesis, enzyme inhibition).
 - d. Catalytic mechanism, catalytic antibodies, catalytic nucleic acids ribozymes, catalytic DNA.
- 6. Enzyme Purification and Assay**
 - a. Enzyme units of activity
 - b. Turnover number and properties
 - c. Purification and assessment
 - d. Methods for measurements
- 7. Enzyme Engineering and Design**
 - a. Substitution
 - b. Insertion
 - c. Hybrid proteins
 - d. Genes for novel enzymes
 - e. Engineering more stable enzymes
 - f. Incorporation of non-natural amino acids into enzymes
 - g. Protein engineering by combinatorial methods
 - h. DNA shuffling

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speakers
- Visits to pharmaceutical companies and industries
- Report writing

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%

Text and Reference Books:

1. Bisswange, H., 2011. Practical Enzymology. Wiley-VCH. Publishers.
2. Bowden, A.C., 2012. Fundamentals of Enzyme Kinetics 4th Edition. Wiley-Blackwell.
3. Okotore, R.O., 2015. Essentials of Enzymology. Publisher XLIBRIS.
4. Sauro, M.H., 2012. Enzyme Kinetics for Systems Biology Ambrosius Publishing
5. Voet, D., Voet, J. G. and Pratt, C. W., 2002. Fundamentals of Biochemistry; John Willey and Sons. Inc., New York
6. Mckee, T. and Mckee, J. R. 2011. Biochemistry, the Molecular Basis of Life. 5th edition, Oxford University Press, New York.

6. Advanced Herpetology

7. Advanced Insect Ecology

Advanced Insect Ecology

Contact Hours:

Theory =48
Practical = 32
Total = 80

Credit Hours:

Theory =**3.0**
Practical =1.0
Total =**4.0**

Course Objectives:

The objectives of the course are:-

1. To provide a synthesis of ecological principles with an applied interpretation.
2. To explore the roles of insects in delivery of ecosystem services and applications to pest management and conservation.
3. To demonstrate the intra and inter specific interactions of insects thus highlighting their ecological niche.

Course Learning Outcomes:

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

1. **UNDERSTAND** how insects engineer our global ecosystem as well as how they respond to environmental changes.
2. **DESCRIBE** the reasons of insect abundance and diversity in any ecosystem.
3. **APPRAISE** the principles of ecology at four levels of integration i.e. populations, communities, ecosystems, and landscapes.
4. **EXPLORE AND ESTABLISH** the links between different levels of integration.

Course Outline:

1. Scope of Insect ecology.

2. Introduction to insect ecology: Insects in ecosystems, Adaptations of Insects, Life history strategies.
3. Responses to abiotic conditions.
4. Resource acquisition.
5. Insects and Landscape: affects of landscape modification on insects.
6. Insects and Climate: affects of climate change on insect species, Insect invasions & climate change.
7. Biodiversity: Insect conservation, Insect extinctions.
8. Insect populations: Population Dynamics, Population sampling methods.
9. Insect communities: Community Interactions: (1) Insect-plant interactions, Plant defenses and insect counter-defenses, Insect herbivores, Natural Enemies of insect herbivores with emphasis on Ichneuomonidae and Braconidae, Insect defenses against enemies (2) Predator-prey interactions (3) host-parasite interactions (4) Mutualisms (5) Pollinators-plant interactions: co-evolution of plants & pollinators (6) Insect and pathogens (7) Ecology based Insect pest management.
10. Behavioral ecology: Social organization in insects, Insect communication, Insect societies (with emphasis on societies of ants, termites and bees).

Practical:

1. Sampling methods
2. Diversity Indices
3. Density estimates
4. Field surveys

Teaching Methodology:

- Lecturing
- Case Studies
- Written Assignments
- Field Visits
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Text and Reference Books:

1. Schowalter, T. D., 2017. Insect Ecology: An Ecosystem Approach. Academic Press.633pp.
2. Price, P.W., Denno, R.F., Eubanks, M.D., Finke, D.L., and Kaplan, I., 2011. Insect Ecology: Behavior, Populations, and Communities. Cambridge University Press.
3. Speight, M. R., Hunter, M.D., & Watt, A.D. (2008). Ecology of Insects: Concepts and Applications. Wiley-Blackwell.
4. Denno, R. F. and Eubanks, M. D. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press, New York.USA.
5. Gullan, P. J. and Cranstan, P. S., 2014. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
6. Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
7. Rockwood, L.L. 2006. Introduction to Population Ecology. Wiley, John and Sons.
8. Bourtzis, K. and Miller, T. 2003. Insects Symbiosis. CRC Press.
9. Vandermeer, J.H. and Goldberg, D.E. 2003. Population Ecology: First Principles, Princeton University Press.
10. Southwood, T.R.E. and Henderson, P.A. 2000. Ecological Methods. 3rd Ed. Blackwell Science.
11. Grimaldi, D. and Engel, M.S. 2005. Evolution of Insects. Cambridge University Press.

8. Advanced Instrumental Techniques

ADVANCED INSTRUMENTAL TECHNIQUES

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = **3.0**
Total = **3.0**

Course Objectives:

The course objectives are:

1. To provide knowledge and skill to select appropriate spectrophotometric, chromatographic and electrochemical instrumentation for chemical analysis.

Course Learning Outcomes:

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

1. Use appropriate spectrophotometric, chromatographic and electrochemical instrumentation for chemical analysis.

Course Outline:

- a. Spectroscopy
- b. Chromatography
- c. Electrophoresis
- d. Immunological techniques
- e. Radioisotope techniques
- f. Biosensors

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%

Text and Reference Books:

1. *Principles of laboratory techniques and methods*. Meena Shrivastava and Rajesh Singh Yadav.
2. *Chemical analysis: Modern instrumentation, methods and techniques*, Francis Rouessac and Annick Rou Fessac, John Wiley & Sons, 2000, ISBN 0-471-97261-4.
3. *Principles of instrumental analysis* (5thed), Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Brooks Cole, 1997, ISBN 0-03-002078-6.
4. *Spectrometrische analysetechnieken*, M.T.C. de Loos- Vollebregt, Heron reeks- Bohn Stafleu Van Loghum, 2004, ISBN 90-313-4142-8.

9. Advanced Molecular Biology

N.A

10. Advanced Molecular Genetic

ADVANCED MOLECULAR GENETICS

Contact Hours:

Theory =48
Practical =0
Total = 48

Credit Hours:

Theory = **3.0**
Practical = 0
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To understand the organization of human nuclear genome and mitochondrial genome.
2. To develop understanding of different types gene families and superfamilies'
3. To equip the student with different modern molecular Techniques.

Course Learning Outcomes:

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

1. **Acquire** the basic knowledge of human nuclear genome and mitochondrial genome.
2. **Illustrate** the key features of human genome and certain gene families.
3. **Discover** the role of certain RNA coding genes along with protein coding genes.
4. **Investigate** certain molecular problems with the help of modern molecular techniques.

Course Outline:

1. **Genome structure**
 - a. Human mitochondrial genome
 - b. Human Nuclear genome
 - c. Protein Coding gene
 - d. RNA genes
2. **Gene Families**
 - a. Solitary gene and gene family
 - b. Gene superfamily.
 - c. Pseudogenes
 - d. Retrogenes
 - e. Cluster gene families
 - f. Interspersed gene families
3. **Transposable Genetic Elements**
 - a. LINES
 - b. SINES
 - c. Fossil Transposons

2. Repeat Instability and Genetic Disorders

- a. TRED1
- b. TRED2
- c. Fragile X- Syndroem
- d. Mytonic Dystrophy

3. DNA Methylation and Cancer

- a. Differential methylation and cancer
- b. Imprinting
- c. Epigenetics and its implications in the genome
- d. ,Telomere and Telomerase and their role in cancer and aging
- e. RNA interference
- f. RNAi mediated pathways in nucleus

4. Study of Molecular Techniques

- a. Southern blotting
- b. Western blotting
- c. Northern blotting
- d. RFLP
- e. RAPDS
- f. Microsatellite DNA

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

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. Lewin, B. Gene-VIII. Oxford University Press, Oxford, UK. 2004.

11. **Advanced ornithology**

ADVANCED ORNITHOLOGY

Cr 3 (+1)

Course Objectives::

Students will learn that:

1. To know about various aspects of bird life in relation to various environments.
2. To assess the different ecological factors to either inhibit or facilitate avian species in their roosts and nests.
3. To monitor the ongoing climatic changes on various birds in rural and urban habitats.

Course Learning Outcomes:

1. **Acquire:** robust knowledge on how to design and conduct a scientific, ornithological study, including data recording and report writing.
2. **Understand:** professional skills in sourcing information about birds from a variable ecosystems and incorporate required changes for better output.
3. **Solve:** issues related to bird capture, handling and measuring techniques for various field studies.
4. **Analyze:** important role played by birds in ecosystems, outdoor croplands urban gardens and parks as pestiferous agents and also as pet farming.
5. **Understanding:** advanced knowledge in how to estimate bird diversity, abundance and population size; and measure reproductive success, survival rates, dispersal, migration, and distribution in a scientific manner.

Course Outlines (contents):

- a. **Systematics:** classification and phylogeny, species concept, taxonomic characters and cladistics, convergent evolution in birds and molecular phylogenetic techniques.
- b. **Bird structure and function:** feather structure and growth, types, as ornaments, tail shape and length with function, tracts, maintenance, moults and plumages in birds.
- c. **Avian brain;** importance, intelligence, eye anatomy and vision senses, hearing and echolocation with taste and smell mechanisms.

- d. **Details of bird physiology:** energetics and bio-energetics, circulation, flight adaptations, physiological requirements of flight, nutrition and metabolic pathways.
- e. **Breeding behavior:** avian mating systems, effects of environmental constraints on mating; predation pressure and egg-laying and incubation. Concept of brood parasitism and economic consequences.
- f. **Altruism:** parental care; sacrifice on fledglings, energy costs and mortality by parents to nurture the young. Cooperative breeding birds and inbreeding in avian species.
- g. **Growth and development: developing mechanisms of birds, solitary birds and colonial birds, concept of social structure in birds.** Sexual selection, courtship and various displays in birds impacted by environment.
- h. **Communal studies:** avian community structures, habitats selection, foraging success, migration (temporary and permanent); use of microsatellites to determine their parentage relatedness with kins based on evolutionary history.

Practical::

1. Weekly visits to bird habitats in the selected study sites to assess the various bird species population index.
2. Incorporation of sampling methods viz. quadrat, transect, line transect, survey within short landscape using point method.
3. Randomized complete block design method, precision method and estimation of roosts and nests with their characteristics.

Text and Reference Books:

1. Fitter, J., D. Merton. 2017. Birds of New Zealand. Prentice Hall Press, England
2. Lovett, I.J., J.W. Fitzpatrick. 2015. Handbook of Ornithology. 3rd Edition, W.B. Saunders Inc., USA.
3. Birkhead, T. 2011. The Wisdom of Birds. McMillan & Co., Inc., USA.
4. Proctor, N. 2015. Manual of Ornithology. Cambridge Univ. Press, Cambridge, UK.
5. Scott, G. 2010. Essentials of Ornithology, Oxford Univ. Press, London, England.

12. Advanced physiology

ADVANCED PHYSIOLOGY

Contact Hours:

Theory = 48
Total = 48

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To impart knowledge about permeation machinery of membrane channels and channel blockers.
2. To develop critical thinking about the mechanisms of integration in the different functional systems of the animals.
3. To develop analytical approach about the mechanism of membrane potentials and synaptic transmission.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of membrane channels, membrane potentials and physiological changes by diminished receptor and hormonal activity.
2. **UNDERSTAND** the concepts of basic mechanism of action potential and its propagation.
3. **ANALYZE** the physiological changes due to stress, loss of synapses, hormonal problem, respiratory arrest and cardiovascular problems.
4. **DEMONSTRATE** individually permeation machinery of membrane channels and synaptic transmission and factors responsible for physiological stress.

Course Outline:

6. Membrane Potentials

- a. Membrane channels and their permeation machinery.
- b. Channel blockers
- c. Mechanisms in resting membrane potentials. Local circuit current flow
- d. Electrogenic ion pump and ionic mechanism in action potentials.
- e. Diffusional potentials. Nernst equation, Donnan equilibrium
- f. Ionic mechanisms in action potentials
- g. Properties of action potential.
- h. Propagation of action potential in neurons.

7. Synaptic transmission

- a. Structure and function of electrical synapse structure and function of chemical synapse,
- b. Mechanism of Docking, priming and fusion of synaptic vesicles, snare complex
- c. Role of MUNC-18 and MUNC-13 in synaptic transmission and limitations of electrical synapses.
- d. Non synaptic Chemical transmission through varicosities.
- e. Neurotransmitters (Biogenic amines, neuropeptides and opiates) Synaptic receptors; excitatory
- f. Postsynaptic potentials.
- g. Inhibitory postsynaptic potentials.
- h. Presynaptic inhibitions, afferent collateral inhibition,
- i. Recurrent inhibition,

- j. Integration at synapses.
 - k. Facilitation, Posttetanic Potentiation.
- 8. Receptor Physiology**
- a. Spinothalamic tract, ascending and descending neural tracts.
 - b. Mechanoreception and hair cell mechanism.
 - c. pain receptors and ascending and descending pathways for pain signal.
 - d. Ultra structure of photo receptors, photochemistry, color vision.
 - e. Structure and physiology of taste receptors and olfactory receptors
 - f. Physiological stress due to diminished receptor activity.
- 9. Hormones**
- a. Mechanism of hormone action.
 - b. Steroid hormones and their action.
 - c. Non steroid hormones and their action.
 - d. Role of insect hormones in molting.
 - e. Negative feedback mechanism of hormonal control (Insulin, Glucagon, regulation of blood calcium level)
 - f. Mechanisms of hormonal stress.
 - g. Cyclic AMP as secondary messenger.
- 10. Respiration**
- a. Neural and chemical control of respiration. Role of nucleus of tractus solitaries and other nuclei of brain stem in the regulation of respiration.
 - b. Bohr's effect and Haldane effect
 - c. Oxygen –hemoglobin dissociation curve and factors affecting this curve
 - d. Respiratory responses in extreme conditions as hypoxia.
 - e. Hypercapnia in air breathing divers.
 - f. Anaesthesia and periodic breathing, Shunt pathways and effect of anesthesia on hemodynamics.
- 11. Osmoregulation and Excretion**
- a. Osmoregulation in aquatic and terrestrial environment.
 - b. Vertebrate nephron as osmoregulatory organ.
 - c. Physiological anatomy of excretory system.
 - d. Glomerular filtration, Tubular absorption and secretion.
 - e. Nitrogenous waste products.
 - f. Patterns of nitrogenous excretion and their phylogenetic development.
 - g. Renal lesions and glomerular nephritis.
 - h. Role of kidneys in long term regulation of blood pressure.
 - i. Hypertension and renal lesions.
- 12. Muscle contraction**
- a. Structural basis of muscle contraction of skeletal, smooth and cardiac muscle fiber
 - b. Molecular structures of contractile components and their interaction.
 - c. Sarcoplasmic reticulum and voltage sensors in T-tubule.
 - d. Cross bridge chemistry, sliding filament model and walk long theory.

13. Temperature relations

- a. Stages of sleep and mechanism of sleep induction
- b. Physiology of torpor and stress level during torpor and hibernation and arousal problems.

14. Rhythmicity of heart

- a. Excitatory and conductive system of heart.
- b. Control of blood flow and blood pressure.
- c. Sick sinus syndrome.
- d. ECG , vectoral analysis of ECG and ecography.
- e. Balloon angioplasty and bypass surgery.
- f. MAHA

15. Physiology of Digestion

- a. Movements in GIT.
- b. Absorption of water and nutrients in GIT. Malabsorption syndrome, Tropical sprue
- c. Regulation of digestive secretions.
- d. Neural control of GIT potential

Teaching Methodology:

- Lecturing
- Written Assignments
- Seminar
- Discussion
- Case study

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions) 50%
- Assignments 25%
- Quiz 25%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 10%
- Assignments 20%
- Quiz 20%

Text and Reference Books:

1. Guyton, A.C. and Hall, J.E. 2010: Text book of Medical Physiology, 11th Edition. W.B. Saunders Company, Philadelphia
2. Hill, R.W., Wyse, G.A. and Anderson, M., 2016: Animal Physiology. 4th Ed. Sinauer Associates, Inc. New York
3. John E. Hall., 2015: Guyton and Hall textbook of Medical Physiology. 13th Ed. Elsevier
4. Moyes, C.D. and Schulte, P.M. 2015: Principles of Animal Physiology. 3rd Ed. Pearson New York
5. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert. 2002: Animal

- Physiology. 5th Edition. W.H. Freeman and Company, New York
6. Widmaier, E., Raff, H. and Strang, K. 2013: Vander's Human Physiology: The Mechanisms of Body Function. 13th Ed. McGraw-Hill Education
 7. Withers, P.C. 1992: Comparative Animal Physiology. Saunders College Publishing, Philadelphia.

13. **Advances in Aquaculture**

ADVANCED AQUACULTURE

Credit Hours:

Theory = 2.0

Practical = 1.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To train the students about the advancement in the aquaculture practices
2. To impart knowledge about the risk associated factors to the aquaculture and their handling for sustainable aquaculture
3. To impart knowledge shell fish culture and its impact on the society.

Course Learning Outcomes:

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

1. **Explain** the integrated fish culture and fish diseases and also describe the control of diseases.
2. **IDENTIFY** the problems related to integrated and shell fish culture.
3. **SOLVE** problems related to aquaculture management and breeding techniques.
4. **ANALYZE** the problems of aquaculture and solve them by using different strategies.
5. **FORMULATE** integrated breeding techniques, diagnosis and control of diseases in commercially important fish species.
6. **DEMONSTRATE** and visit the aquaculture sites (Lakes and rivers) and also highlight aquatic resources and integrated aquaculture management.

Course Contents:

1. Introduction

- a. Aquaculture basics
- b. History;
- c. Principles
- d. Future prospects

2. Management of aquaculture

- a. Management levels in cultural practices
- b. Criteria for selection of aquatic plants and animal species

- c. Management of aquaculture systems (ponds, cages, raceways)
- 3. Shell fish culture**
 - a. Major cultivated species of shrimps and prawn
 - b. Shrimp culture system
 - c. Reproduction of shrimps
 - d. Oyster culture
 - e. Cray fish and crabs culture
- 4. Integrated aquaculture**
 - a. Integrated aquaculture definitions
 - b. Scope
 - c. Principles and practices of different integrated aquaculture systems
 - d. Economic importance of integrated fish farming
 - e. Aquaculture economics and marketing
 - f. Sustainability and development
 - g. Environment and aquaculture interaction
- 5. Aquaculture sustainability**
 - a. Aquaculture sustainability and food security,
 - b. Sustainable use of living resources (marine & inland);
 - c. Effects of aquaculture wastes on ecological systems,
 - d. Environment and health issues,
 - e. Impact of aquaculture and risks posed by escape of exotic invasive species.
- 6. Fish breeding and diseases**
 - a. Fish breeding techniques
 - b. Fish diseases

Practicals:

1. Study of important aquatic plants
2. Different aquaculture systems and fish feed ingredients
3. Visit to fish farm and installations
4. Identifications of important shell fishes (shrimp, prawn, crab, oyster, mussels etc) and their aquaculture systems.
5. Field tours
6. Field trials (waste viz vegetables/ visits of different integrated fish farms in Pakistan
7. Preparation of feasibility reports of different integration.

Text Books:

1. Ali, S.S. 1999. Fresh Water Fisher Biology. Naseem Book Depot, Hyderabad
2. Pillay, T.V.R. 2002. Aquaculture: Principles and Practices. Blackwell Science Ltd.
3. Arrignon, J. 1999. Management of freshwater fisheries. Oxford and I.B.H Pub.
4. Kumar, H.D. 2003. Sustainability and Management of Aquaculture and Fisheries Daya Publishing House, New Delhi. Qasim, S. Z. and DinabundhuSahro.

Reference Books

1. Bhatti, M.N. and Mirza, M.R.1995. Jadeed Fish Culture. Feroz Sons, Lahore.
2. Huet, M. and Timmermans, J. Text book of Fish Culture. Blakwell Science Ltd.
3. Shammi, Q.J. and Bhatnagar, S. 2002. Applied Fisheries, Agrobios, India.
4. NIIR 2003. Hand Book on Fisheries & Aquaculture Technology. Asia Pacific Business Press Inc., Delhi.
5. Sedgwick, S.D.1990. Trout Farming Hand Book. Blackwell Science Ltd.
6. Hussain, S.M. 2002. Encyclopedia of Fish Culture, Vol I& II. A.P.H. Publishing Corporation, New Delhi.
7. Hameed, M.S. and Boopendranath, M .R. 2000. Modern Fishing Gear Technology. Daya Publishing House, Delhi.
8. Parker, R. 2002. Aquaculture Science. Delmar Thomson Learning. USA.
9. Sahoo, D. and Qasim. S.Z. 2002. Sustainable Aquaculture. A.P.H. Publishing Corporation, New Delhi.
10. Sustainable Aquaculture. A. P. H. Publishing Corporation, Darya Gang, New Delhi.
11. Calder, I. 2000. The Blue Revolution: Land Use and Integrated Water Resource Management. Earthscan, Publications.
12. Davenport, J. 2003. Aquaculture: The Ecological Issues. Blackwell Publishing.
13. Midlen, A., Redding, T. and Reading, T. A., 1998. Environmental Management for Aquaculture. Chapman & Hall, UK
14. **Advances in Biochemistary**
N.A
15. **Advances in bioinformetic**

ADVANCES IN BIOINFORMATICS

Contact Hours:

Theory	= 32
Practicals	= 48
Total	= 80

Credit Hours

Theory	= 2.0
Practical	= 1.0
Total	= 3.0

Course Objectives:

The course will provide:

4. An introduction to advances in bioinformatics.
5. To develop awareness about fundamental and advanced bioinformatics databases.
6. Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

Course Outcomes:

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

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

Course Outlines:

1. **Introduction:**
 - a. Introduction to Bioinformatics, Scope of bioinformatics, useful websites
2. **Biological databases**
 - a. Data and information, databases, data acquisition
3. **Genome mapping**
 - a. Genetic and linkage mapping, physical mapping, QTL mapping, Association mapping
7. **Gene family:**
 - a. Introduction, types, protein family, Globin family as an example, globin genes and chains, evolution of globin proteins in human, combination and types of globin proteins in human
8. **Data Retrieval:**
 - a. Searching sequence databases, FASTA format, retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data
9. **Primer Designing:**
 - a. Primer and probe, qualities of primer, general rules for primer designing
 - b. Websites used for primer designing
10. **Synthetic gene designing:**
 - a. Sequence retrieval, codon code optimization, primer designing
11. **Sequence Alignment:**
 - a. Importance and significance of alignment, methods for sequence alignment
 - b. Local and global alignment, pair-wise local alignment, uses of local alignment
12. **BLAST:** Introduction, types, uses, algorithm, BLAST Scores
13. **Amino Acid Matrices:**
 - a. Amino acids and their symbols, amino acid scoring matrices
 - b. PAM and BLOSUM, comparison of PAM and BLOSUM
14. **Multiple Sequence Alignment:**
 - a. Introduction, tools for MSA, uses and importance
15. **Phylogenetic analysis:**
 - a. Introduction, interpretation, rooted and unrooted tree,
 - b. phylogenetic methods, tree terminology, comparison of methods, software

16. Protein Structure Prediction:

- a. Homology modelling, threading, *ab initio* modelling,
- b. Motivation to acquire structure
- c. Protein 3D structure, software/databases

17. Molecular Docking:

- a. Introduction, steps, importance and uses

18. Microarrays:

- a. Gene expression, differential expression,
- b. DNA chips, principle of microarray, types, steps of a microarray experiment, qualitative interpretation of results, applications of microarray, advantages and disadvantages of microarray

19. Next Generation Sequences data analysis

20. Real time PCR data analysis

Practicals:

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

Teaching methodology:

- Lecturing
- Written Assignments
- Quizzes
- Practicals

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 10%
- Assignments 10%
- Quizzes 10%

- Practical 20%

Text and Reference Books

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

Websites

5. <http://www.ncbi.nlm.nih.gov>
6. <http://www.ebi.ac.uk>
7. <http://www.rcsb.org>
8. <http://www.ensemble.org>

16. Advances in Cell Biology

ADVANCES IN CELL BIOLOGY

Contact Hours

Theory =80
Total =80

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To develop an advanced understanding of cell biology.
2. Focusing on the major processes within cells, including: cell signaling, regulation of cell shape, cell division, apoptosis and the functions of the endomembrane system.
3. To learning about how all living organisms develop, survive, evolve and work.

Course Learning Outcomes:

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

1. Explain the main processes that occur within a eukaryotic cell.
2. Develop an ability to summarize, integrate and organize information.
3. Describe the tools with which cells are studied.
4. Describe research problems in other disciplines such as genetics, oncology and in terms of molecular biology.

Course Outline:

1. Introduction to Growth Control and Cell Cycle:

- a. Mitotic spindle formation and centrosome biology Contractile ring formation and ingression (actin polymerization and/or myosin activation).
- b. Prokaryotic division (i.e. ftsZ ring formation, mreB in sculpting cell shape).
- c. Mitotic exit network Plant cell division Cell migration and its regulation.
- d. Epigenetic mechanisms.
- e. Cellular polarity (e.g. mechanisms of planar cell polarity, epithelial organization).
- f. Organelle division (mitochondria or lysosomes).
- g. Organelle fragmenting during division (ER or golgi).
- h. Membrane remodeling (changes in curvature during cell rounding/division, secretory 3 events to add new membrane or changes in phospholipid composition).
- i. Cell Differentiation and development.
- j. Apoptosis.

2. Nucleic Acid and Protein Structure and Function:

- a. Chromatin structure Chromatin modifications (changes upon during M phase).
- b. Regulation of cellular functions by ubiquitination. Selected examples of regulation of cellular function by protein phosphorylation or other post-translational modifications.
- c. Signal transduction.
- d. DNA replication/repair.

3. Cell Membranes and Cytoskeleton:

- a. Cytoskeleton, cell signaling.
- b. Compartments and protein sorting.
- c. Regulation of cell shape and migration.
- d. Cell division, apoptosis and autophagy.
- e. Cell-cell interactions, the secretory pathway.
- f. Phagocytosis, nuclear import and export.

4. Structure and Function of the Eukaryote Cell Nucleus:

- a. Regulation of the gene expression to the changes in chromatin associated with the activation and silencing of genes.
- b. Three-dimensional organization of the nucleus.
- c. Signal transduction through reversible phosphorylation.

5. **Introduction to Cancer Cell Biology:**
 - a. Regulation of the cell cycles in normal and cancer cells.
 - b. Control of angiogenesis in cancer.
 - c. Autophagy.
6. **Biological Transport Mechanisms:**
 - a. The role of ion canals and Ca²⁺ signaling in synapse.
 - b. Sensory neurons and the regulation of contraction.
 - c. Exocytosis; lipid second messengers.
 - d. Analysis of structure-function relationships of canals.
 - e. Molecular biology of the beta cells of the pancreas.
 - f. Protein Sorting and transport.
 - g. Cell Adhesion and motility.
7. **Laws of Thermodynamics:**
 - a. How cells manipulate them to regulate their volume.
 - b. High-resolution imaging techniques in cell biology.

Teaching Methodology:

- Lecturing
- Written Assignments
- Practical
- Guest speaker

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%

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, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.
3. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York.

4. E. Edward Bittar and Michael Pusch. 2006. Advances in Molecular and Cell Biology. Volume 38
5. K.R. Miller 1987. Advances in Cell Biology, 1st Edition. Elsevier Science.

17. **Advances in Ecology**

ADVANCES IN ECOLOGY

Cr 3(+1)

Course Objectives:

Studying the proposed course, students should be able to:

1. Understand the conceptual mechanisms of ecology
2. Utilize the subject tools qualitatively and quantitatively in relation to environment.
3. Able to conduct independent research in diverse disciplines of ecology.

Course Learning Outcomes:

1. **Acquire** knowledge and apply advanced methods for studying ecosystem patterns and processes.
2. **Understand** the integrated understanding of the different concepts and theories for the community assembly and how they impact ecosystem functions.
3. **Solve** some basic and critical ecological issues related to present day ecology and community structures of animals.
4. **Analyze** sophisticated ecological ecological issues and explain their role for environmental sustainability and fluctuations.
5. **Understanding** the complex interactions for the nutritional fluxes in ecosystems and predicted environmental disturbances to faunal distribution.

Course Outlines (contents):

- a. **Basic themes of ecology;** types of ecology, ecosystem classification, terrestrial, freshwater, desert and marine. Organismal ecology including the protists and invertebrates with their classification and characteristics.
- b. **Aquatic Environment:** water cycle and its properties, role of light in aquatic environments; water as solvent; dissolved oxygen contents, acidity and water movements and water balance.
- c. **Terrestrial ecosystems:** biogeo-chemical cycles in environment, role of forest plantations, types of forests; tropical, tropical-rain forests and coniferous forests to house animals fauna.
- d. **Animal adaptations:**Animal adaptations to the environment role of temperature in maintenance of animals, life history patterns, nutritional constraints and animal development.
- e. **Climate changes:** global wind circulation, precipitation, ocean currents, regional climates, microclimates and their effects on animals. Animal survival values and adaptations to climate changes in various environments.

- f. **Population trends:** animals surviving in various environments, factors affecting growth rates, causes of mortality, natality and logistic equations to explain their sustainability. Concepts of animal tussles; intra and inter-specific competitions.
- g. **Community Dynamics:** primary and secondary succession; landscape ecology and its importance. Ecosystem energetics and concept of bioenergetics in ecology.
- h. **Habitat Loss;** fragmentation ecology, biodiversity values and loss, conservation strategies in environments in response to restoration ecology.

Practical:

1. Field visits for assessment of animal communities in variable habitats.
2. Ecological techniques to learn sampling methods for animals' viz. mark-recapture methods, landscape analysis.
3. Forecasting methods in landscape ecology
4. Importance of radio-telemetry techniques to determine animal community populations.

Text And Reference Books:

1. Molles, M.M. 2015. Ecology; Concepts and Applications. McGraw-Hill Books; Inc., New Mexico, USA.
2. Bonan, G. 2015. Ecological Climatology. Cambridge Univ. Press, Cambridge, UK.
3. Dodds, W.K., M.R. Whiles. 2010. Freshwater Ecology. Acad. Press, Netherlands.
4. Nordell, S., T. Valone. 2017. Animal Behaviour. Freeman Press, New York, USA.
5. Speight, M.R., M.D. Hunter, A.D. Watt. 2008. Ecology of Insects. Wiley-Blackwell Co., USA.

18. Advances In Forensic Biology

ADVANCES IN FORENSIC BIOLOGY

Contact Hours:

Theory =16
 Practical = 48
 Total = 64

Credit Hours:

Theory = **1.0**
 Practical = 2.0
 Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To give the students basic understanding of forensic Science with reference to biology.
2. To equip the students for biological sample collection, handling and storing from crime scene.

3. To elaborate certain types of test which are involved in forensic biology.

Course Learning Outcomes:

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

1. **Acquire** the basic knowledge of forensic science and forensic biology.
2. **Understand** the key steps in forensic biology from examination of crime scene to sample collection processing and final interpretation.
3. **Solve** the problems like sexual and physical assault, paternity cases and murder cases.
4. **Analyze** certain types of sample with serology testing, DNA quantification and PCR analysis.
5. **Justify** certain cases with the help of available evidences.

Course Outline:

1. Biological material – collection, characterization and storage

- a. Sources of biological evidence
- b. Collection and handling of material at the crime scene
- c. Identification and characterization of biological evidence
- d. Evidence collection
- e. Sexual and physical assault
- f. Presumptive testing
- g. Storage of biological material

2. Serology Testing

- a. Identification of Semen
- b. Acid Phosphatase Screening
- c. Alternate Light Source or Ultraviolet (UV) Light
- d. Microscopic Identification of Spermatozoa
- e. Protein Confirmation of Semen

3. Identification of Blood

- a. Presumptive Testing for Blood
- b. Species Testing of Blood.
- c. ABO Blood Typing
- d. Blood Spatter Interpretation

4. DNA Testing

- a. DNA Extraction
- b. Differential DNA Extraction
- c. DNA Quantification
- d. Restriction Fragment Length Polymorphism (RFLP)
- e. Early PCR-Based Methods
- f. Tandem Repeat (STR) Analysis
- g. Mitochondrial DNA (mtDNA) Sequencing
- h. Y-Chromosome STR Analysis
- i. Single-Nucleotide Polymorphism (SNP) Analysis

Practical:

1. DNA Extraction
2. DNA Quantification
3. The polymerase chain reaction.
4. Presumptive Testing for Blood
5. Species Testing of Blood
6. ABO Blood Typing
7. Low Copy Number (LCN) DNA Testing

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference books:

1. Goodwin W, Linacre A, Hadi S. An introduction to forensic genetics. John Wiley & Sons; 2011.
2. Mozayani, A. and Noziglia, The forensic laboratory handbook procedures and practice. Springer Science. 2010.
3. Siegel, J.A. and Mirakovits, K. Forensic science: the basics. CRC Press. 2015.
4. Saferstein, R., *Criminalistics*. Pearson Education. 2013.

19. Advances in Helminthology

ADVANCE HELMINTHOLOGY

Contact Hours:

Theory = 45
Practical = 45
Total = 90

Credit Hours:

Theory = 3.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To impart knowledge on various Helminthic infection affecting livestock, its morphology, life cycle, transmission, pathogenesis, clinical signs, diagnosis, treatment and control.
2. To understand basic aspects of various trematodes, cestodes and nematodes affecting man and animals.
3. To familiarize students with morphologic criteria to differentiate the most common helminthes.
4. To improve their understanding regards recent advances in the development of vaccine and other international regulations for use of novel control measures.

Course Learning Outcomes:

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

1. **Acquire** the basic knowledge of various helminthes including trematodes, cestodes and nematodes.
2. **Understand** the concepts of helminthic infection affecting livestock, its morphology, life cycle, transmission, pathogenesis, clinical signs, diagnosis, treatment and control.
3. **Solve** the complications related to the pathogenesis of the helminthes and successfully treating these infections.
4. **Diagnose** the helminthic infections by applications of recent techniques
5. **Evaluate** the problems associated with helminthes infections on the basis of signs and symptoms.
6. **Demonstrate** helminthic infection affecting livestock, its morphology, life cycle, epidemiology, pathogenesis, treatment and recent control strategies.

Course Outline:

- a. Introduction to the phylum Platyhelminthes. Trematoda, Aspidohotria
- b. Digenians
- c. Digenians strigeiformes; *Schistosoma haematobium*, *S. japonicum*, *S. mansoni* (Schistosomiasis)

- d. **Digeneans Echinostomiformes:** *Fasciola hepatica*, *F. gigantica*, *Paramphistomum cervi*, *Megalodiscus temperatus*.
- e. **Digeneans, Plagiorchiformes and opisthorchiformes:** *Paragonimus westermani*, *Clonorchis sinensis*, *Heterophyesheterophyes*, *Prosthogonimus macrochis*.
- f. **Monogenea**
- g. **Polystomum integraruum.** Form, function, classification, life cycle
- h. **Cestoidea**, form function, life cycle and classification of the tapeworms
- i. **Cyclophyllidae:** *Taenia solium*, *Taeniarhynchus saginata*, *T. pissiformis* (Taeniasis), *Taenia multiceps*, *Echinococcus granulosus*, *E. multilocularis*, *E. vogeli*, *Hymenolepis nana*, *H. diminuta*, *Raillietina* species, *Diphylidium caninum*, *Moniezia* species, *Mesocestoides* species
- j. **Phylum Nematoda, Form, Function and Classification**
- k. **Trichurida and Dioctophymatida;** enoplean parasites (*Trichuris trichiura*), *Capillaria hepatica*, *Anatrichosoma ocularis*,
- l. **Rhabditida;** *Strongyloides stercoralis*, *Strongylida*, *bursate rhabditidians*, *Bunostomum*, *Necator americanus*, *Ancylostoma duodenale*, *Synagamus trachea*, *Haemonchus contortus*, *Trichostrongylus* species, *Ostertagia* species, *Prostrongylus rufescens*
- m. **Ascaridida, intestinal large round worms;** *Ascaris lumbricoides*, *Toxocara canis*, *Lagochilasascaris minor*, *Heterakis gallinarum*, *Ascaridia galli*.
- n. **Oxyurida, the pinworms;** *Enterobius vermicularis*. Nematodes, Spirurida, a potpoorri, *Gnathostoma doloresi*.
- o. **Filaroidea; the filarial worms,** *Wuchereria bancrofti*, *Brugia malayi*, *Loa loa*, *Mansonella perstans*, *M. ozzardi*, *Onchocerca volvulus*, *Dirofilaria immitis*
- p. **Camallanina, the Guinea worms and others;** *Dracunculus mediensis*. Phylum Acanthocephala, Thorny headed worms. Forms, function and classifications; *Macrocanthorhynchus hirudinaceus*.
- q. **Helminth Zoonoses** (Trematode, Cestodes and nematode zoonoses).

Practicals:

1. Methods for collection, transportation, fixation and preservation of flukes, tapeworms and round worms.
2. Methods for collection and examination of faeces, urine and sputum for the presence of eggs/larvae of various helminthes.
3. Methods for examination and staining of blood film for helminthes.
4. Identification of important members of class Trematoda, Cestoda, Nematoda and Acanthocephala. Practical demonstration of helminthes at slaughter houses.

Teaching Methodology:

- Lecturing
- Written Assignments

- Practical work
- Presentations

Assessment:

Mid semester (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Practical 10%

Final semester (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Practical 10%

Text and Reference Books:

1. K.D. Chatterjee. (2015). Parasitology: Protozoology and Helminthology 13th Edition.
2. Robberts, L. Sand Janovy John Jr. 2015. Foundation of Parasitology 9th edition. McGraw-Hill, Boston.
3. Schmidt, G. D. and Robbert, T. S. (2001). Foundation of Parasitology. The C.V. Mosby Company, Saint Louise.
4. Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London.
5. Wright, D. Bowman. 2009. WB Saunders Company Georgis' Parasitology For Veterinarians, WB Saunders Company, 9th edition.

20. **Advances in Immunology**

ADVANCES IN IMMUNOLOGY

Contact Hours:

Theory = 72
Total = 72

Credit Hours:

Theory = 4.0
Total = 4.0

Course Objectives:

The objectives of the course are:-

1. To provide the knowledge about the components and role of the immune system.
2. To provide students with knowledge of different mechanisms of the immune system.
3. The students will be able to describe immunological response and how it is triggered and regulated.
4. To describe the roles of the immune system in both maintaining health and contributing to diseases.

Course learning outcomes:

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

1. **Explore** the basic knowledge of the mechanisms of immune system
2. **Describe** the concepts about the role of immune system.
3. **Interpret** the problems using immunological techniques for diagnosis of immune disorders.
4. **Identify** the problems using immunological diagnostic tools.
5. **Detect** the problems using the same techniques for other disorders.
6. **DEMONSTRATE** individually the ELISA and other Assays/Tests.

Course Outline:

1. **Introduction**
 - a. Components of the immune system
 - b. Antigens and Pathogens
2. **Innate Immunity and Inflammation**
 - a. Different types of leukocytes
 - b. Inflammation and Fever
3. **Recognition and Responses to foreign antigens**
 - a. Pattern recognition receptors
 - b. Innate immune signaling
 - c. The complement system
 - d. Complement activation pathways
4. **Antibodies**
 - a. B lymphocytes
 - b. Antibody structure and function
 - c. Monoclonal and polyclonal antibodies
 - d. Hybridoma technology
5. **Lymphocyte Development and Diversity**
 - e. Lymphocyte development
 - f. Clonal selection and expansion
 - g. Differences between B and T lymphocytes
 - h. The generation of lymphocyte receptor diversity
6. **T Cell Activation by Antigens**
 - a. Antigen presentation
 - b. The role of dendritic cells
 - c. The lymphatic system and delivery of antigen to lymph nodes
 - d. Adaptive immune activation in secondary lymphoid tissues
7. **T Cell-Dependent B Cell Responses**
 - a. T Cell activation of B cells
 - b. Isotype switching and affinity maturation
 - c. Helper T cell functions
 - d. The role of helper T cells in disease
 - e. Cytotoxic T cell functions
 - f. Selection and expansion of cytotoxic T cells
 - g. Therapies that target cytotoxic T cell functions

8. **Hematological Diseases**
 - a. Acute Leukemias
 - b. Overview of Lymphoma Classification
 - c. Hodgkin's disease
 - d. T-Cell Lymphomas
 - e. B-Cell Lymphomas
 - f. Plasma Cell Dyscrasias
 - g. Multiple Myeloma
 - h. Cryoglobulinemia
 - i. Amyloidosis
9. **Tumor Immunology**
 - a. Detection and identification of Tumor Antigens
 - b. Immune Escape Mechanisms of Tumor Antigens
 - c. Immunotherapeutic Strategies (I)
 - d. Immunotherapeutic Strategies (II)
10. **Transplantation of Autologous**
 - a. Bone Marrow/Hematopoietic Stem Cells
 - b. Transplantation of Allogenic bone Marrow/Hematopoietic Stem Cells
 - c. Clinical Aspects of Organ Transplantation

Teaching Methodology:

- Lecturing
- Written Assignments
- Lab work
- Analysis/interpretation of diagnostic Tests results

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Sessional tests 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Sessional tests 10%

Text and Reference Books:

- c. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell (5th ed. 2008, Garland)
- d. Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby: Immunology (2003, Freeman).
- e. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt: Roitt's Essential Immunology (12th ed. 2012, Blackwell)

- f. Abul Abbas , Andrew H. Lichtman, Shiv Pillai. Cellular and Molecular Immunology , 9th edition, 2017. Elsevier Pub Co.
- g. Gerd R. Burmester, Antonio Pezzutto Color Atlas of Immunology, 2006. Thieme Stuttgart, New York.

JOURNALS RECOMMENDED:

- Annual Review Of Immunology, Journal Of Immunology
- European Journal Of Immunology, Immunology Today, Advances In Immunology
- CRC Critical Reviews in Immunology and Human Gene Therapy

21. **Advances in Protozoology**

N.A

22. **Advances in Research Methodology**

ADVANCES IN RESEARCH METHODOLOGY

Contact Hours:

Theory = 48
 Practicals = 0
 Total = 48

Credit Hours

Theory = 3.0
 Practical = 0.0
 Total = 3.0

Course Objectives:

The course aims to:

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

Course Outcomes:

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

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

Course Contents:

1. **Introduction:**
 - b. Objectives of Research, Motivations
2. **Research Process:**
 - a. Research methods vs. research methodology, scientific method
 - b. Types of research, general steps involved in research
 - c. Problems of research in Pakistan
3. **Topic Selection:**
 - a. Problem identification for research, criteria and evaluation
4. **Literature Review:**
 - a. Importance and sources
 - b. Referencing and citation and bibliography
 - c. Plagiarism
5. **Research Design:**
 - b. Parts, important features, important concepts in research design,
6. **Aims and Objectives:**
 - a. Research objectives, qualities of research objectives
7. **Material and Methods:**
 - a. Bioethics, sampling, sampling designs, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources
8. **Data Analysis:**
 - a. Processing, statistics in research, hypothesis testing, t-tests and ANOVA
9. **Statistical Software**
 - a. SPSS, SAS, SATA, Python and R etc.
10. **Data Presentation**
 - a. Tabulation, graphical presentation
 - b. Presentation software
11. **Scientific Writing:**
 - a. Difference between thesis/report/synopsis/research proposal
 - b. Parts of synopsis/project proposal, parts of thesis/report
12. **Reference management software**
 - a. Endnote, Reference Manager, Mendeley etc.
13. **Budgeting:**
 - a. Cost estimates for a research project, funding sources e.g. USAID, HEC, MOST, HED, PMRC, WWF, PSF etc.

Teaching methodology:

- Lecturing
- Written Assignments
- Quizzes

Assessment:

Midterm (40%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Final Term (60%)

- Written (MCQs, Short Questions, Long Questions) 50%
- Presentation 20%
- Assignments 10%
- Quizzes 10%
- Report Writing 10%

Text and Reference Books:

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

23. **Advances in Wildlife***

N.A

24. **Aerosol and environmental health**

AEROSOL AND ENVIRONMENTAL HEALTH

Credit Hours: 04

Practical= 01

Theory =03

Total = 04

Course Objectives:

The objective of this course is

1. To enable the student to understand relationship between air pollution and individual health, monitoring and causes.

2. To understand how aerosols, bio-aerosols are affecting individuals along with possible measures to reduce the cause and impact.

Course Learning Outcomes:

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

1. Acquire theoretical knowledge of aerosol, bio-aerosols and relationship between indoor and outdoor air pollution.
2. Understand the sources and impact of air pollution.
3. Solve the problems related to individuals' health and air pollution.
4. Interpretation and syntheses of data and other information about aerosols and environmental health.
5. Evaluate the mitigation measures for reducing air pollution.
6. Demonstrate the impact health assessment.

Course Outline:

1. **Introduction to air pollution**
 - a. General Introduction
 - b. Important Definitions
 - c. Aerosols and Bio-aerosol
 - d. Indoor and outdoor Air quality
 - e. Pollutants and their Sources
2. **Instrumentation and Analysis**
 - a. Instrumentation for sampling and monitoring Aerosols
 - b. Levels and limits of pollutants in air
 - c. Bio-aerosol sampling and analysis
3. **Relationship between indoor and outdoor air quality**
4. **Global warming and its implications on humans**
5. **Other pollutants**
 - a. Introduction
 - b. Properties
 - c. Sources
6. **Measures to reduce the sources and impact of Air pollution**
 - a. Involvement of National and international organizations
 - b. Public awareness
 - c. Role of government institutions

Practicals:

1. Measurement of PM_{10} , $PM_{2.5}$ and PM_1 in indoor and outdoor environment.
2. Assessment of other pollutants in the air

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits

- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Books Recommended:

1. Ali. Z. Colbeck, I, and Nasir, Z. A. 2010. Basics of air pollution monitoring, HEC-BC Link publication.
2. Welburn, A. 2007. Air pollution and climate change: 2nd edition; Longman Scientific and Technical
3. Colbeck, I. 1998. Physical and Chemical Properties of Aerosols, Blackie Academic & Professional
4. Hinds, W. C. 1999. Aerosol Technology (2nd edition), John Wiley & Sons
5. Ruzer L.S. And Harley, N. H. 2005. Aerosols Handbook, CRC Press
6. Vincent, J. H. 2007. Aerosol Sampling: Science, Standards, Instrumentation and Applications, John Wiley
7. Gurjar, B. R., Molina, C. T. and Ojha, C. S.P. 2010. Air Pollution, CRC-Press
8. Tarlo, S. M., Cullinan, P. and Nancy, B. 2010. Occupational and Environmental Lung Disease, Wiley-Blackwell.

25. Air Pollution Monitoring

AIR POLLUTION MONITORING

Credit Hours: 03

Theory =02

Practical= 01

Total = 03

Course Objectives:

The objective of this course is

1. To enable the student to understand Air Pollution
2. To understand how to monitor different air pollutants
3. To understand how global warming and green house effects by greenhouses gases

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about air pollution, air quality, climate change and air pollution monitoring techniques

2. UNDERSTAND the reasons, consequences, associated diseases of air pollution.
3. SOLVE the problem by using national and International mitigation measures.
4. ANALYSE, Ecological and health Impacts of air pollution and climate change.
5. EVALUATE the health risk and sustainable strategies to reduce impact
6. DEMONSTRATE the impact health assessment.

Course Outline:

1. **Air Pollution**
 - a. Introduction
 - b. Important Definitions
 - c. Indoor and Outdoor air pollution
 - d. Air pollutants
 - e. Types
 - f. Properties
 - g. Sources
2. **Particulate matter and Aerosol**
3. **Aerosol fundamentals and instrumentation**
 - a. Definition and Classification of Aerosol
 - b. Tropospheric aerosol
 - c. Air pollution monitoring techniques
4. **Aerosol types, sources and effects**
5. **Bio-aerosols**
 - a. Introduction
 - b. Types
 - c. Sources
6. **Air borne diseases, testing and remediation**
7. **Air pollution and climate change**
 - a. Introduction
 - b. Causes
 - c. Mitigation measures
8. **Bio indicators, Thresholds and Injury**
9. **Genetic Adaptations**
10. **Industrial melanism, sensitivity and tolerance**
11. **Instrumentation and Impacts**
 - a. The nitrogen cycle
 - b. Global Warming
 - c. Greenhouse effect
 - d. Plant effects
11. **Human implications**

Practicals:

1. Study and analysis of PM 10 of ambient air
2. Study and analysis of PM 10 of indoor air

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Books Recommended:

1. Ali. Z. Colbeck, I, and Nasir, Z. A. 2010. Basics of air pollution monitoring, HEC-BC Link publication.
2. Welburn, A. 2007. Air pollution and climate change: 2nd edition; Longman Scientific and Technical
3. Write.T.R. 2007. Environmental Science, towards a sustainable future. Pearson Prentice Hall.
4. Purohit, S.S. and Ranjan, R. 2003. Ecology, Environment and Pollution, Agrobios.
5. Colbeck, I. 1998. Physical and Chemical Properties of Aerosols, Blackie Academic & Professional
6. Ruzer L.S. And Harley, N. H. 2005. Aerosols Handbook, CRC Press
8. Vincent, J. H. 2007. Aerosol Sampling: Science, Standards, Instrumentation and Applications, John Wiley

26. APPLIED ENTOMOLOGY

APPLIED ENTOMOLOGY

Contact Hours:

Theory = 96
Practical = 16
Total = 112

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. Acquire knowledge of insect pests of crops, vegetables, fruits, stored grains and household pests.
2. Identification of insect pests, their control methods and pesticide application equipments.

3. Introduction with entomological cottage industries.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge about pest of economic importance.
2. **UNDERSTAND** the relationship of various crops and pest population.
3. **SOLVE** the problems using integrated pest management.
4. **ANALYZE** the problems of pesticides resistance mechanism.
5. **EVALUATE** the problems using practical knowledge in Entomology.
6. **DEMONSTRATE** methods to enhance the productivity of agricultural crops through insect pest management.

Course Outline:

Introduction; causes of success and economic importance of insects; principles and methods of insect control i.e. cultural, biological, physical, mechanical, reproductive, legislative, chemical and bio-technological control; introduction to IPM; insecticides, their classification, formulations and application equipments; identification, life histories, mode of damage and control of important insect pests of various crops, fruits, vegetables, stored grains, household, termites and locust; introduction to entomological industries: apiculture, sericulture and lac-culture.

Practical:

1. Collection, identification and mode of damage of insect pests of various crops,
 Fruits
 Vegetables,
 Stored grains and household
2. Insecticide formulations, their dilutions and safe handling;
3. Use of application equipments, instructions for apiculture, sericulture and lac-culture.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs) 20%
- Presentation 05%
- Assignments 05%

Final Term (70%)

- Written (Long Questions, Short Questions, MCQs) 55%
- Practical 10%
- Attendance 05%

Text and Reference Books:

1. Atwal, A.S. 2005. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
2. Awastheir, V.B. 2009. Introduction to General and Applied Entomology. Scientific Publisher, Jodhpur, India. 13
3. Duncton, P.A. 2007. The Insect: Beneficial and Harmful Aspects. Kalyani Publishers Ludhiana.
4. Gullan, P. J. and Cranstan, P. S. 2010. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
5. Lohar, M. K. 2001. Applied Entomology, 2nd Ed. Department of Entomology, Sindh Agriculture University Tandojam Sindh, Pakistan.
6. Mathews, G.A. 2004. Pesticide Application Methods, 3 rd. Ed. John Wiley & Sons, Inc. N.Y. 7. Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6 th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.
7. Pfadt, E.R. 1985. Fundamentals of Applied Entomology, 4 th Ed. The McMillan Co., N. Y.
8. Robinson, D.H. 2006. Entomology Principles and Practices. Agro-bios.
9. Shah, H.A. and Saleem, M.A. 2002, Applied Entomology, 3rd Ed. Izhar Sons Printers, Lahore.
10. Srivastava, K.P. 2005. Text Book of Applied Entomology. Kalyani Publishers, New Delhi. 12. Romoser, W. S. and Stoffolano, J. G. 1998, The Science of Entomology, WCB McGraw-Hill.

27. Animal Physiology

ANIMAL PHYSIOLOGY

Contact Hours:

Theory = 48
Total = 48

Credit Hours:

Theory = **3.0**
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To impart knowledge about membrane irritability and generation of nerve impulse.
2. To develop critical thinking about the mechanisms of integration in the different functional systems of the animals.
3. To develop analytical approach about the physiology of neural and hormonal control systems.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of membrane irritability, physiology of receptors and membrane potentials.

2. **UNDERSTAND** the concepts of basic mechanism of action potential and its propagation.
3. **ANALYZE** the physiological changes due to stress, hormonal problem, respiratory arrest and cardiovascular problems.
4. **DEMONSTRATE** individually ECG and various cardiovascular problems.

Course Outline:

1. **Membrane Potentials**
 - a. Membrane channels
 - b. Mechanisms in resting membrane potentials
 - c. Electrogenic ion pump.
 - d. Diffusional potentials. Nernst equation
 - e. Ionic mechanisms in action potentials
 - f. Properties of action potential.
 - g. Propagation of action potential in neurons.
2. **Synaptic transmission**
 - a. Structure and function of electrical synapse structure and function of chemical synapse .
 - b. Non synaptic Chemical transmission.
 - c. Neurotransmitters; Synaptic receptors; excitatory postsynaptic potentials.
 - d. Inhibitory postsynaptic potentials.
 - e. Presynaptic inhibitions; Integration at synapses.
 - f. Facilitation, Posttetanic Potentiation.
3. **Receptor Physiology**
 - a. Mechanoreception and hair cell mechanism.
 - b. Pain receptors and ascending and descending pathways for pain signal.
 - c. Ultra structure of photo receptors, photochemistry, color vision.
Structure and physiology of taste receptors and olfactory receptors
4. **Hormones**
 - a. Mechanism of hormone action.
 - b. Steroid hormones and their action.
 - c. Non steroid hormones and their action
 - d. Negative feedback mechanism of hormonal control (Insulin, Glucagon, regulation of blood calcium level)
 - e. Insect hormones.
 - f. Cyclic AMP as secondary messenger.
5. **Respiration**
 - a. Neural and chemical control of respiration.
 - b. Bohr's effect and Haldane effect
 - c. Oxygen –hemoglobin dissociation curve and factors affecting this curve
 - d. Respiratory responses in extreme conditions as hypoxia.
 - e. Hypercapnia in air breathing divers.
 - f. Anaesthesia and periodic breathing. Shunt pathways

6. **Osmoregulation and Excretion**
 - a. Osmoregulation in aquatic and terrestrial environment.
 - b. Vertebrate nephron as osmoregulatory organ.
 - c. Physiological anatomy.
 - d. Glomerular filtration, Tubular absorption and secretion.
 - e. Nitrogenous waste products.
 - f. Patterns of nitrogenous excretion and their phylogenetic development.
 - g. Renal lesions
7. **Muscle contraction**
 - a. Structural basis of muscle contraction.
 - b. Molecular structures of contractile components and their interaction.
 - c. Sarcoplasmic reticulum
 - d. Cross bridge chemistry and sliding filament model
8. **Temperature relations**
 - a. Temperature relations of ectotherms
 - b. Temperature relations of endotherms
 - c. Stages of sleep
 - d. Torpor, hibernation and winter sleep
9. **Rhythmicity of heart**
 - a. Excitatory and conductive system of heart.
 - b. Control of blood flow and blood pressure.
 - c. Sick sinus syndrome.
 - d. ECG and hemodynamics.
10. **Physiology of Digestion**
 - a. Movements in GIT.
 - b. Absorption of water and nutrients in GIT.
 - c. Regulation of digestive secretions.
 - d. Neural control of GIT potential

Teaching Methodology:

- Lecturing
- Written Assignments
- Seminar
- Discussion

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions) 50%
- Assignments 25%
- Quiz 25%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 10%
- Assignments 20%
- Quiz 20%

Text and Reference Books:

1. Guyton, A.C. and Hall, J.E. 2010: Text book of Medical Physiology, 11th Edition. W.B. Saunders Company, Philadelphia
2. Hill, R.W., Wyse, G.A. and Anderson, M., 2016: Animal Physiology. 4th Ed. Sinauer Associates, Inc. New York
3. John E. Hall., 2015: Guyton and Hall textbook of Medical Physiology. 13th Ed. Elsevier
4. Moyes, C.D. and Schulte, P.M. 2015: Principles of Animal Physiology. 3rd Ed. Pearson New York
5. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert. 2002: Animal Physiology. 5th Edition. W.H. Freeman and Company, New York
6. Widmaier, E., Raff, H. and Strang, K. 2013: Vander's Human Physiology: The Mechanisms of Body Function. 13th Ed. McGraw-Hill Education
7. Withers, P.C. 1992: Comparative Animal Physiology. Saunders College Publishing, Philadelphia.

28. **Applied Genetics**

APPLIED GENETICS

Contact Hours:

Theory =48
Practical = 0
Total = 48

Credit Hours:

Theory =3.0
Practical =0
Total =3.0

Course Objectives:

The objectives of the course are:-

1. To give basic understanding of genetic transformation processes.
2. To develop understanding of Transposable elements and their mechanism of Transposition
3. To enable the students to understand the genetic factors influencing human development and behavior.

Course Learning Outcomes:

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

1. **Describe** the phenomenon involved in transformation of genetic material.
2. **Understand** the Transposable elements and bacterial transposition.
3. **Interpret** the regulation of gene expression in prokaryotes and eukaryotes.
4. **Outline** the roles of various genes and genetic factors in development and human behavior.

Course Outline:

1. **Nucleic acids.**
 - a. Plant and animal viruses
 - b. Tumor viruses
 - c. Retroviruses

2. **Genetic Transformation**
 - a. Conjugation
 - b. Transformation
 - c. Transduction
 - d. Integration of viral DNA
3. **Transposition**
 - a. Transposable Elements
 - b. Detection of Transposition In Bacteria
 - c. Types of Bacterial Transposons
 - d. Modes of Transposition In Bacteria
4. **Gene expression**
 - a. Regulation of Gene expression in Prokaryotes
 - b. Regulation of gene expression in Eukaryotes
5. **Quantitative Genetics of Human Behavior**
 - a. Intelligence
 - b. Personality
6. **A genetic perspective on development**
 - a. Maternal effect genes
 - b. Determination of dorsal-ventral and anterior posterior axis
 - c. Body segmentation
 - d. Organ formation

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

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. Lewin, B. Gene-VIII. Oxford University Press, Oxford, UK. 2004.

29. **Applied Microbiology**

APPLIED MICROBIOLOGY

Contact Hours:

Theory = 32
Practical = 48
Total = 80

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide knowledge to the students about the application of microbes in different fields of life
2. To develop an understanding of relevant applied scientific knowledge with the ability to use microbes in a wide range of professional disciplines
3. To enhance the ability to employ appropriate laboratory and other materials and equipment in a safe and responsible manner and follow standard operating procedures
4. To apply microbiological principles and methods to identify and solve problems associated with a particular area of professional expertise

Course Learning Outcomes:

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

1. **ATTAIN** the sufficient knowledge about the uses and benefits of microorganisms in different aspects of human life
2. **APPREHEND** the relevant applied scientific knowledge and impact of microbiology
3. **ELUCIDATE** the problems associated with a particular area of microbiology by using the acquired knowledge and practical skills
4. **EXPLORE** the microbial world for applications of microorganisms in biotechnology, medicine and industry
5. **EVALUATE** critically the principles and mechanisms underlying the different fields of microbiology
6. **DETERMINE** the potential of microorganisms to make a great impact on the development of basic and applied research

Course Outline:

1. Control of microorganisms

- a. Fundamentals of microbial control by physical and chemical agents
- b. Antibiotics and other chemotherapeutic agents
- c. Microorganisms and diseases:
 - i. Host-microbe interactions
 - ii. Resistance and immunity
 - iii. Air, food and water-borne human infections
 - iv. Human contact diseases
 - v. Infectious diseases of animals
- d. Environmental microbiology:
- e. Microbiology of air, water and soil
- f. Microbiology of domestic water and sewage
- g. Microbiology of food, milk and milk products

2. Industrial Microbiology

- a. Introduction: Scope and characteristics of industrial microbiology
- b. Microorganisms commonly used in microbial industry and biotechnology
- c. Overproduction of metabolites of industrial microorganisms
- d. Production of fermented foods
- e. Production of microbial insecticides
- f. Production of *Rhizobium* inoculants
- g. Production of organic acids and industrial alcohol
- h. Production of amino acids by fermentation
- i. Production of vaccines, antibiotics and therapeutic agents
- j. Biocatalysts: Immobilized enzymes and immobilized cells
- k. Mining Microbiology: Ore leaching (Bioleaching) by microorganisms
- l. Bioremediation and treatment of industrial wastes
- m. Biotechnology and its role in modern human comforts

3. Microbial Ecology

- a. Microbial diversity, populations, communities and ecosystems
- b. Microbes in natural habitats; air, water, deep-sea hydrothermal vents, soil and symbionts
- c. Animal and plant microbiomes
- d. Rumen microbial ecosystem
- e. Microbial leaching, organic matter decomposition and heterotrophy
- f. Biodegradation of Xenobiotics
- g. Biogeochemical cycles- microbial engines of the Earth system

4. Microbe-microbe interactions and signaling (quorum sensing)

- a. Microbial activity measurement in soil
- b. Applications of microbial ecology

Practical:

1. Bacteriological examination of water
2. Isolation and identification of coliform bacteria and enteric pathogens; Isolation of pathogenic *Staphylococci*

3. Normal throat flora and reaction on blood agar; Enumeration and identification of microorganisms in urinary tract infections
4. Isolation and identification of microorganisms from the diseased ear
5. Inhibition and destruction of microorganisms by physical agents
6. Action of disinfectants on bacteria; Bacteriostatic action of certain dyes and drugs; Bacterial sensitivity tests (some contemporary antibiotics)
7. Bacterial examination of food, raw milk
8. Quantitative and qualitative methods: Fluorescent microscopy and molecular techniques (PCR)
9. Survey of microorganisms' activities based industries

Teaching Methodology:

- Lecturing
- Written Assignments
- Lab/Field Activity
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 60%
- Presentation 20%
- Assignments 10%
- Quiz 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Microbiology: An Introduction, 12th ed. (2018) by Gerard J. Tortora, Berdell R. Funke, Christine L. Case.
2. Prescott's Microbiology, 10th ed. (2017) by Joanne Willey, Linda Sherwood and Christopher J. Woolverton.
3. Laboratory Experiments in Microbiology, 11th ed. (2015) by Ted R. Johnson and Christine L. Case.
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. Processes in Microbial Ecology (2012) by David L. Kirchman, Publisher: Oxford University Press.
6. Microbes and Evolution: The World that Darwin Never Saw (2012) Edited by R. Kolter and S. Maloy.
7. Processes in Microbial Ecology, 1st ed.(2012) by David L. Kirchman.

8. Modern Industrial Microbiology and Biotechnology (2007) by Nduka Okafor, Department of Biological Sciences Clemson University, Clemson South Carolina USA Science Publishers, United States of America.
9. Microbiological Applications : Laboratory Manual in General Microbiology, Short Version, 8th ed. (2002) by Benson, Harold J., McGraw-Hill, Boston, MA.

30. **Applied Parasitology**

APPLIED PARASITOLOGY

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = **3.0**
Total = **3.0**

Course Objectives:

The course objectives are:

1. To enable students get familiarized with the most important parasites of humans and domestic animals
2. Their transmission patterns, diagnosis, treatment, prevention, control
3. Their economic and medical importance.

Course Learning Outcomes:

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

1. Discover the most important parasites of humans and domestic animals
2. Examine transmission patterns, diagnosis, treatment, prevention, control, their economic and medical importance

Course Outline:

1. **Chemicals and reagents used in preservation of parasitic materials**
 - a. Collection, processing and identification of parasites
 - b. Recovery of parasite eggs, oocysts and larvae from faecal specimens
 - c. Determination of parasite resistance to pesticidal chemicals and chemotherapeutic drugs.
2. **Control and Vaccine Development Against Parasitic Infections.**
3. **Chemotherapeutic agents used against parasitic infections**
 - a. eg. anthelmintics, insecticides etc.
 - b. The mode of action of chemotherapeutic agents.
 - c. The mechanisms of parasite resistance to drugs.
4. **Methods of Vaccine Development**
 - a. Various approaches will be discussed for example: Helminths use of 3 types of antigens viz: Irradiation-attenuated live helminths,
 - b. Somatic extracts of helminthes
 - c. Metabolic or excretory/secretory (E/S) antigens produced by the in vitro culture of helminths.

- d. Genetic engineering. the application of genetically engineered vaccines will be discussed. Cultivation of Parasites tissue culture techniques, cryopreservation

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%

Text and Reference Books:

1. William Charles Marquardt, Richard S. Demaree, Jr., Robert Burton Grieve., 2000. Parasitology & Vector Biology. 2nd Edition.
2. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
3. Handler, A. M. James, A.A. (Eds.). 2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.
4. Erlich, H. 1992. PCR Technology: Principles and Applications for Amplification. W.H. Freeman & Company, New York.

31. Applied Reproductive Physiology

APPLIED REPRODUCTIVE PHYSIOLOGY

Contact Hours:

Theory =16
Practical = 96
Total =112

Credit Hours:

Theory = 1.0
Practical =2.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To introduce modern reproductive biotechnologies applied in the field of animal agriculture, medicine and conservation
2. To demonstrate various reproductive problems of medical and veterinary significance
3. To impart knowledge about practical application of reproductive physiology using recent published reports

Course Learning Outcomes:

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

1. **IDENTIFY** and **EXPLAIN** both normal and pathological processes of the male and female reproductive system
2. **APPLY** their knowledge and understanding of reproductive physiology for genetic improvement of farm animals
3. **DEVELOP** reproductive biotechnologies for conservation of threatened wild species.
4. **UPDATE** themselves with current research in the field of reproductive biotechnologies

Course Outline:

1. **Assisted Reproductive techniques: an overview**
2. **Semen Collection & Evaluation**
 - a. Semen collection methods
 - b. Initial assessment : Appearance, volume & concentration
 - c. Sperm motility: Computer Aided Sperm Analysis
 - d. Sperm Morphology
 - e. Acrosome status
 - f. Chromatin integrity
3. **Semen cryopreservation**
 - a. Properties of Semen Extenders
 - b. The cryopreservation technique
 - c. Application in farm animals & endangered species and humans
4. **Artificial insemination**
 - a. Introduction and history of Artificial insemination
 - b. Artificial insemination procedures
5. **Estrus synchronization**
6. **In vitro fertilization (IVF)and in vitro embryo production (IVEP)**
 - a. IVEP & Transfer for genetic improvement of farm animals
 - b. IVF and ICSI for treatment of infertility in human
7. **Superovulation and Embryos transfer**
8. **Assisted Reproductive techniques for conservation of endangered species**
 - a. Sperm cryobanking
 - b. Embryo freezing
9. **Causes of sterility in domestic animals.**

10. **Infertility in Male**
11. **Infertility in female**
12. **Sperm sexing for sex pre-selection.**
13. **Contraception**
14. **Student's presentation: recent research paper/ review article in the field**
15. **Student presentation: recent research paper/ review article in the field**
16. **Student presentation: recent research paper/ review article in the field**

Practical:

1. Morphological & morphometric studies of sperm in buffalo/cattle.
2. Morphological & morphometric studies of ova in buffalo/cattle.
3. Collection and cryopreservation of sperm in farm animals.
4. Artificial insemination in buffalo/cattle.
5. Motility assessment of sperm.
6. Staining of live and dead sperm.
7. Acrosomal analysis of sperm.
8. Aspiration and in vitro maturation of oocytes

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Andrology by E. Nieschlag, H. M. Behre and S. Nieschlag. 3rd edition (2010). Published by Springer, USA.
2. Knobil & Neill's Physiology of Reproduction by *T. M. Plant and A. J. Zeleznik*. 4th edition (2014). Published by Springer, USA.
3. Reproduction in Farm Animals by E. S. E. Hafez and B. Hafez. 7th edition (2013). Published by Wiley-Blackwell, NY. USA.

4. Applied Animal Reproduction by H. J. Bearden, J. W. Fuquay and S. T. Willard. 6th edition (2004). Published by Pearson Prentice Hall, USA.

32. Apiculture

APICULTURE

Contact Hours:

Theory = 96
Practical = 16
Total = 112

Credit Hours:

Theory = **2.0**
Practical = **1.0**
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To provide the concepts of different species of bees.
2. To provide awareness about bee keeping their behavior.
3. To provide knowledge about diseases of bees and their management.

Course Learning Outcomes:

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

1. **ACQUIRE** basic knowledge of apiculture economics in relation to Zoology.
2. **UNDERSTAND** the concepts of the maintenance of honey bee colonies.
3. **SOLVE** the problems related to bee production by applying theoretical knowledge with practical efficiency.
4. **ANALYZE** bee products of the hive including beeswax, propolis, pollen, and royal jelly.
5. **EVALUATE** the growing market potential for honey and its products.
6. **DEMONSTRATE** practical information on various aspects of apiculture.

Course Outline:

Introduction, importance, scope of apiculture industry, bee species and their biology, morphology, behavior and products, bee flora their distribution and flowering time; beekeeping equipments, seasonal management, uniting, dividing and preparation for shifting colonies; bee stings, queen rearing and swarming; pest and diseases of bees and their management; honey extraction; factors affecting honey yield; importance of bees in pollination; honey, its properties and uses; granulation, fermentation and storage of honey, uses of other bee products; beekeeping as an enterprise.

Practical:

1. Demonstration of bee colonies.
2. Observation of colonies and different casts.
3. Beekeeping equipment.
4. Preparation of frames and comb foundation for their hives.

5. Colony inspection; visit to apiaries.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs) 20%
- Presentation 05%
- Assignments 05%

Final Term (70%)

- Written (Long Questions, Short Questions, MCQs) 55%
- Practical 10%
- Attendance 05%

Text and Reference Books:

1. Ahmad, R. 1979. A Guide to Bee Keeping in Pakistan. Extension Book.
2. Devillers, J., Phame, M. and Delegue, M. 2002. Honey Bees.
3. Goodwin, R.N. and Van Eaton, C. 1999. Elimination of American Foulbrood without the use of Drugs. A Practical Manual for Bee Keepers. National Bee Keepers Association of New Zealand, Napier, New Zealand.
4. Hooper, T. 1991. Guide to Bees and Honey. BAS Printers Ltd. Hampshir, U.K

33. Aquaculture

AQUACULTURE

Credit Hours:

Practical =1.0

Theory =2.0

Total =3.0

Course Objectives:

The objectives of the course are:-

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

Learning Outcomes:

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

1. Illustrate the basic knowledge of fin fish and shell fish, fisheries and aquaculture
2. Identify fish species on the basis of biological characteristics.

3. Solve problems of appropriate site selection, designing and pond construction; selection of suitable fish species for sustainable aquaculture.
4. Recognize the problems of fish pond and solve them by using different strategies.
5. Formulate and prepare aqua feed, induced breeding techniques, diagnosis and control of diseases in commercially important fish species.
6. Demonstrate aquaculture sites individually and drawings of aquaculture facilities, aquatic resources and integrated aquaculture management.

Course Contents:

1. Introduction

- a. Introduction to fish, fishery and aquaculture.
- b. History and present status of aquaculture (National and International).
- c. Introduction and biology of cultivable fin and shell fishes.
- d. Introduction to aquatic resources of Pakistan (Lentic and lotic environment).

2. Aquaculture (fin fish culture)

- a. Introduction and role of aquaculture, types of culture systems (Ponds, Raceways, cages, pen, raft and line culture).
- b. Site selection, design and construction of fish ponds.
- c. Pond problems; aquatic vegetation and their control, fish predators, water quality and management, fish disease and their control.
- d. Types of fish feed, characteristics of artificial feed, methods of feeding, types and use of fertilizers.
- e. Artificial fish breeding techniques
- f. Integrated aquaculture

3. Shell fish culture

- a. Introduction of shrimp and prawn culture, crabs, lobsters and scallops culture etc.
- b. Mari-culture: Substrate system, sea water ponds. Aquaculture in fresh and brackish waters.
- c. Aquaculture in practice: Culture of algae, seaweeds.

Practical:

1. Collection and identification of various freshwater fish species
2. Visit and studying of fish pond Components.
3. Visit to fish hatchery and integrated fish farming.
4. Determination of Water quality parameters (Physical, chemical and biological)
5. Fish feed ingredients and formulation of fish feed
6. Artificial Fish breeding
7. Fish market visit
8. Visit to fish feed mill

9. Visit to head works/reservoirs etc.

Assessment:

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Books Recommended:

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. Metha, V. 2009. Fisheries and Aquaculture Biotechnology. 2nd Ed. Campus Books International, New Delhi, India.
4. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India.
5. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
6. Ali, S.S. and Narejo, N.T., 2009. Fundamentals of Ichthyology. Sindh University Press, Jamshoro.
7. Pandey, B. N., S. Deshpande and P. N. Pandey. 2007. Aquaculture. APH Publishing Corporation, New Delhi, India.
8. Pillay, T. V. R. 2005. Aquaculture: Principles and Practices. 2nd Ed. Blackwell Sciences Limited. UK.
9. Parker, R. O. 2004. Aquaculture Science 4th Ed. Delmar Learning, London, UK.
10. NIIR 2003. Hand Book on Fisheries & Aquaculture Technology. Asia Pacific Business Press Inc., Delhi.
11. Huet, M. and Timmermans, J. (2002). Text book of Fish Culture. Blackwell Science Ltd. UK.
12. Shammi, Q.J. and Bhatnagar, S. 2002. Applied Fisheries, Agro bios, India.
13. Ali, S.S. 1999. Fresh Water Fisher Biology. Naseem Book Depot, Hyderabad.

34. Aquaculture and Fisheries

AQUACULTURE AND FISHERIES

Credit Hours:

Practical = 1.0

Theory = 2.0

Total = 3.0

Course Objectives:

The course aims to-

1. Impart knowledge about history, needs and importance of fisheries and Aquaculture.
2. Describe the cultureable fish species and their biology.
3. Elaborate the basics of fish culture and aquaculture facilities.
4. Provide knowledge about fishing gears and post-harvest techniques.

Course Learning Outcomes:

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

1. Acquire knowledge about history, needs and importance of fisheries and aquaculture.
2. Discuss various fish species characteristics and understand their culture requirements.
3. Understand basics of pond fish culture and other advanced culture practices.
4. Define various types of fishing gears, capturing methods and post-harvest technology.

Course Outlines:

- a. Introduction to fisheries and aquaculture, national and international trends. Fish morphology and diversity in size and shape. Distribution of fishes in Pakistan, commercial fishes, marine and freshwater.
- b. Types of ponds, planning construction and pond preparation. Pond fertilization, dosage and methods of application.
- c. Food and feeding habits of fishes, feed types, artificial and natural fish feeds, feeding strategies of artificial fish feeds.
- d. Aquatic habitats, ecology and extant of distribution, Water quality parameters (abiotic: temperature, light, salinity, pH, turbidity etc.) and their effects on fish health and production.
- e. Biotic parameters (plankton, insects, aquatic vegetation etc.) of ponds, lakes, rivers, and impacts on fish growth.
- f. Induced breeding techniques.
- g. Fish diseases and their control.
- h. Fishing gears, fishing techniques, fishing communities.
- i. Fisheries co-management.
- j. Fish preservation, processing, transportation and marketing.

Practical:

1. Morphological characters of a typical fish
2. Identification of commercially important fish species, meristic counts, fin formula, scale formula etc.
3. Dissection of common fish to study its various systems.
4. Practical demonstration of induced fish breeding.
5. Introduction to artificial feed ingredients.
6. Fish disease diagnosis and identification.
7. Demonstration of fishing gears and methods of fish capture.

Assessment

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Books Recommended:

1. Stickney R.R. 2016. Aquaculture an introductory text, CABI. Publishing, London, UK.
2. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf, 2015. *Aquaculture Handbook—Fish Farming and Nutrition in Pakistan*.
3. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India.
4. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
5. Pillay, T.V.R. and M.N. Kutty 2005. Aquaculture: Principles and Practices. Blackwell Science Limited. New York.
6. Ali, S.S. 1999. An Introduction to Freshwater Fishery Biology. University Grants Commission, H-9 Islamabad.

35. AquaCulture Biotechnology

AQUACULTURE BIOTECHNOLOGY

Credit Hours:

Practical = 1.0

Theory = **3.0**

Total = **4.0**

Course Objectives:

The objectives of the course are:-

1. To aware students about the past and present status of biotechnology as well as the need and importance of biotechnology in the current era
2. To provide indepth knowledge on Gynogenesis, Androgenesis, Cloned Populations and Molecular Markers

3. To provide an overview of the application of biotechnological tools in cloning, feed and other issues.
4. Elucidate different aspects of genetic biotechnology and fish genomics

Course Learning Outcomes:

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

1. Identify and develop insight into the application of biotechnological advances in aquaculture.
2. Conceptualize the principal bases of biotechnology and emerging issues in aquaculture.
3. Elucidate different aspects of genetic biotechnology with reference to food safety.
4. Demonstrate various techniques of molecular nature applied for aquaculture development.

Course Learning Outcomes:

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

1. **RECOGNISE** the basic knowledge of biotechnology in relation to fisheries and Aquaculture.
2. **DISCRIMINATE** the skill into the application of biotechnological advances.
3. **ILLUSTRATE** the food safety of different transgenic aquatic organism.
4. **ANALYZE** various commercial application of fish biotechnology.
5. **EVALUATE** the risks associated with gene therapy.
6. **DEMONSTRATE** the sequence of genes by using gene sequences of fishes.

Course Outline:

1. **Introduction**
 - a. History of Biotechnology in Aquaculture
 - b. Biotechnological approaches in Aquaculture
2. **Gynogenesis, Androgenesis and Cloned Populations**
 - a. Induction of Gynogenesis and Androgenesis
 - b. Performance of Gynogens and Androgens
 - c. Reproduction
 - d. Monosex Populations
 - e. Cloned Populations.
3. **Biochemical and Molecular Markers**
 - a. Isozymes and Enzymes.
 - b. Restriction Fragment Length Polymorphism.
 - c. Single Nucleotide Polymorphisms.
 - d. Relative Costs of Different Markers
 - e. Relative Effectiveness of Markers
4. **Gene-transfer Technique in Fish**
 - a. Promoters
 - b. Integration
 - c. Transmission of Transgenes

- d. Transgene Expression of Growth-hormone and Reporter Genes
- e. Performance of Transgenic Fish
- f. Disease resistance
- 5. **Commercial Application of Fish Biotechnology**
 - a. 876 Polyploidy
 - b. Sex Reversal and Breeding
 - c. Genetic Engineering
- 6. **Combining Genetic Enhancement Programmes**
 - a. Sex Reversal and Triploidy
 - b. Genetic Engineering and Crossbreeding
 - c. Genetic Engineering, Selection, Crossbreeding, Strains and Hybrids
- 7. **Food Safety of Transgenic Aquatic Organisms**
 - a. International Guidelines
 - b. Labelling
- 8. **Environmental Risk of Aquatic Organisms from Genetic Biotechnology**
 - a. Theoretical Risks
 - b. Environmental Risk Data on Transgenic Fish
 - c. Common Goals of Aquaculture and Genetic Conservation

Practicals:

1. DNA isolation from fish.
2. Electrophoresis, Agarose and polyacrylamide gel electrophoresis.
3. Demonstration of amplification of DNA through PCR.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Midterm exam 20%
- Assignments 20%
- Presentation 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Final term exam 20%
- Assignments 20%
- Presentation 10%

Text and Reference Books:

1. Dunham, R., 2011. Aquaculture and Fisheries Biotechnology. 2nd ed. CABI, UK.
2. Beaumont, A., Boudry, P. and Hoare, K., 2010. Biotechnology and Genetics in Fisheries and Aquaculture. Blackwell, USA.
3. Liu, Z. J., 2007. Aquaculture Genome Technologies. Blackwell, USA.
4. Montet, D. and Ray, R. C., 2009. Aquaculture Microbiology and Biotechnology. Science Publishers, USA.
5. Overturf, K., 2009. Molecular Research in Aquaculture. Blackwell, USA.
6. Pandian, T.J., Strüssmann, C.A. and Marian, M.P., 2005. Fish Genetics and Aquaculture Biotechnology. CRC Press, USA.

36. **Biological Toxicology**

BIOLOGICAL TOXICOLOGY

Credit Hours:

Practical = 1.0

Theory = **2.0**

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. The course provides knowledge and understanding about the different carcinogenic, mutagenic and teratogenic agents and their mode of action on cell life.
2. To familiarize the students with deleterious effects of different chemicals on living cell.
3. They will also learn about the role and mode of action of different toxicants on different organ systems.

Course Learning Outcomes:

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

1. Classify various toxic agents and their mode of action.
2. Indicate various chemicals deleterious to living cells.
3. Describe the role and mode of action of various toxicants on different organ systems.

Course Outlines:

1. **Reproductive toxicology and teratology:** Effects of toxicants on male and female reproductive system; protective mechanisms, interference with cell division, cytotoxicity and infertility, interference with hormonal control. Effects of toxicants on development; teratogens and teratogenesis, effects of dose exposure level and timing of exposure, examples and mechanism of teratogenity.
2. **Respiratory Toxicology:** General principles for the effects of toxicants on the system, defense mechanism, measuring the exposure levels, deposition of gases and particulates. Immediate response to respiratory toxicants; free radical induced damage, the irritant response,

involvement of immune response. Immediate response; upper and lower airways. Delayed and cumulative response to toxicants; asthma and immune-related chronic condition, COPD; bronchitis and emphysema; fibrosis and pneumoconiosis, lung cancer.

3. **Cardiovascular Toxicology:** Effects of toxicants on heart; arrhythmias, cardiomyopathies and other effects, myocardial infarction. Effects of toxicants on the vascular system; Atherosclerosis, vascular spasm and blood pressure. Effects of toxicants on blood; anemias, hemolysis and related disorders and effects on hemoglobin.
4. **Neurotoxicology:** General principles of effects of toxicants, BBB. Effects on electrical conduction, synaptic function (acetylcholine, Biogenic amines, amino acid neurotransmitters and neuroactive peptides), axonopathies (axon transport, proximal and distal axonopathies), myelinopathies, direct effects on neurons; excitotoxicity, other neurotoxicants.
5. **Hepatic Toxicology:** Types of toxicant induced injury; fatty liver, necrosis and apoptosis, cirrhosis and miscellaneous effects. Response to liver injury.
6. **Renal Toxicology:** General principles of effects on the system; damage to glomerulus, proximal and remainder of the tubule. Measurement of kidney function *in vivo* and *in vitro*.
7. **Immunotoxicology:** Effects of toxicants on immune system; toxic-induced allergies, autoimmunity and immunosuppression. AIDS and antiviral drugs.

Practical:

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

Assessment

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Book Recommended:

1. Karen E. Stine and Thomas M. Brown, 2015. Principles of Toxicology, CRC press, Taylor and Francis Group.
2. Frank A. Barile, 2007. Principles of toxicology testing, CRC Press Taylor and Francis Group.

3. Hans Marquardt, Siegfried, G. Schafer, Roger McClellan, Frank Welsch, 1999, 2004, Toxicology, Academic press, San Diego.
4. M. Lois Murphy, C. P Dagg and David A. Karnofsky, Comparison of teratogenic chemicals in the rat and chick embryos. *Pediatrics*, 19:701-714.

37. **Biology of Birds and Mammals In Pakistan**

N.A

38. **Biology of ornamental fish and aquaria management**

**BIOLOGY OF ORNAMENTAL FISHES AND AQUARIA
MANAGEMENT**

Credit Hours:

Practical = 1.0

Theory = **2.0**

Total = **3.0**

Course Objectives:

The objectives of the course are to:-

1. Enhance knowledge about biology of ornamental fish species.
2. Impart knowledge about ornamental fish species.
3. Develop skills of aquaria making and management.

Course Learning Outcomes:

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

1. Explain the biology (feed and feeding habit, reproduction) of various ornamental fish species.
2. Acquire knowledge about husbandry and requirements of indigenous and exotic ornamental fishes.
3. Develop and design setting of aquarium,
4. Manage water quality, feeding and diseases of aquarium fish species.

Course Outlines:

1. Introduction to ornamental fish culture.
2. Commercially important ornamental fishes: Exotic and indigenous.
3. Food and feeding habits.
4. Food and feeding management.
5. Culture of live food organisms.
6. Preparation of artificial feed for ornamental fish species.
7. Breeding of live bearer, breeding of egg laying species.
8. Selection of spawning tanks.
9. Diseases of ornamental fishes and prophylactic measures.
10. Techniques in genetic improvement of ornamental fishes.
11. Species used for genetic improvement.
12. Important consideration and management practices in ornamental fishes.
13. Transportation of ornamental fishes.

14. Ornamental fishes trades.
15. Trade regulation and wildlife Act.
16. Fabrication of aquarium, material required for construction of aquarium.
17. Methods for construction of aquarium.
18. Setting up of aquarium.
19. Aquarium accessories and equipment on small and large scale units.
20. Aeration in aquarium, filtration.
21. Water quality management.
22. Aquarium plants.

Practical:

1. Identification of commercially important live bearer ornamental fishes.
2. Identification of commercially important egg laying ornamental fishes.
3. Identification of commercially important common ornamental fishes.
4. Identification of commercially important common ornamental aquatic plants.
5. Fabrication of glass tanks, setting of glass aquarium, aquarium accessories and equipment.
6. Preparation of ornamental fish feed
7. Setting of aerators, filters and heater.
8. Disease of ornamental fishes and prophylactic measures
9. Breeding setup for live bearer ornamental fishes
10. Breeding setup for egg laying ornamental fishes
11. Visit to ornamental fish farms.

Assessment:

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Recommended Books /Readings

1. Hargreaves, V. 2007. The Complete Book of the Freshwater Aquarium: A Comprehensive Reference Guide to More Than 600 Freshwater Fish and Plants.
2. Sexana, A. 2003. Aquarium Management. Daya Publishing House, Delhi
3. Petrovicky, I.1998. Aquarium Fishes of the World. Arch Cape Press. New York
4. Tekriwal, K.L., Rao, A.A and Dawes, J.1999. Ornamental Aquarium Fishes of India. TFH Publication
5. Penzes, C.P and Tolg, I.1985. Goldfish and Ornamental. Barron Educational Series
6. Sandford, G. 2000. Aquarium Owner Guide.DK Publishing
7. Schliewen, U. 1988. Aquarium Fishes: How to care for them. Barron Juveniles

8. Robert, H.E.2009. Fundamental of Ornamental Fish Health. Published by Wiley Blackwell
9. Robert, H.E.2009. Ornamental Fish. Published by Wiley Blackwell
10. Dholakia, A.D.2010. Ornamental Fish culture and Aquarium Management. Amazon Publisher
11. Wildgoose, W.H. 2001. BASAVA Manual of Ornamental Fish. Published by Wiley Blackwell.
12. Mahapatra, B.K., S.Datta, GhPhailan and S. Dasgupta. 2015. Ornamental Fish Breeding, Culture and Trade. Published by Director, KAR-CIFE Mumbai.

39. **Cancer Genetics**

CANCER GENETICS

Contact Hours:

Theory =48
 Practical = 0.0
 Total =48

Credit Hours:

Theory =**3.0**
 Practical =0.0
 Total =**3.0**

Course Objectives:

The objectives of the course are:-

1. To enhance the knowledge in the area of Cancer Genetics.
2. To provide core concepts involved in the activation of proto-oncogenes.
3. To introduce the major genes involved in signaling circuitry programs contributing towards cancer.

Course Learning Outcomes:

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

1. **ACQUIRE** the basicknowledge of Cancer Genetics.
2. **UNDERSTAND** the concepts of genes involvedin signaling circuitry programs of tumor cell.
3. **ANALYZE** the activation of proto-oncogenes in to oncogenes.
4. **EVALUATE** the problems related to genetic mutations and tumor suppressor genes, etc.,

Course Outline:

1. **Introduction**
 - a. Genetic basis of cancer.
 - b. Oncogenes,
 - c. Proto-oncogenes
 - d. Tumor Suppressor Genes.
2. **Cell Cycle Control Genes**
 - a. Types of Cyclins
 - b. CDKs,
 - c. pRb,
 - d. E2F transcription factor,

- e. Myconcoprotein
- 3. **DNA Repair Pathways**
 - a. Genes involved in Repair pathways.
 - b. p53
 - c. Mdm2
 - d. ARF
- 4. **Oncogenes and cancer metastasis:**

How faulty genes lead to cancer.

 - a. Proto-oncogenes.
 - b. Tumor suppressor genes.
 - c. DNA repair genes.
 - d. Metastasis suppressor genes.
 - e. Genetic instability and cancer.
- 5. **Apoptosis:**
 - a. Introduction to apoptosis,
 - b. Proapoptotic genes,
 - c. Antiapoptotic genes,
 - d. How cell maintains balance between pro and antiapoptotic genes
- 6. **Genetic Screening for Cancer.**
 - a. SNP and Cancer.
 - b. Case Studies:
 - c. P53
 - d. BRCA1
 - e. RRCA2

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., & Walter, P. (2013). Essential cell biology. Garland Sciencebiology. Garland Science

2. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002). Biochemistry, W. H. Lewin, (Latest Edition). Genes VIII.
3. Krebs, J. E., Lewin, B., Goldstein, E. S., & Kilpatrick, S. T. (2014). Lewin's genes XI. Jones & Bartlett Publishers.
4. Articles Published in Nature Review Cell & Molecular Biology. (Latest Edition).
5. Articles Published in Nature Review Immunology. (Latest Edition).

40. **Cell and tissue culture**

CELL AND TISSUE CULTURE

Ch. Hr: 3(2+1)

Course Objectives:

The objective of the course is:-

1. To provide students with a thorough understanding of the importance of cell, tissue and organ culture and its application in life sciences.

Course Learning Outcomes:

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

1. **EXPLAIN** the various components of cell and tissue culture media, e.g. minerals, growth factors, hormones and what governs the choice of components
2. **UNDERSTAND** how to initiate, grow and harvest eukaryotic cells and their uses.

Course Outline:

7. **The cell culture laboratory**
 - a. Introduction
 - b. sterile techniques
 - c. media preparation and handling
 - d. growth environment
 - e. Cell counting and analysis
 - f. Cryopreservation
 - g. Cell banking and subculture (variety of different systems)
8. **Microscopy of living cell**
9. **Plant tissue and cell culture**
 - a. Introduction to in vitro culture
 - b. requirements for in vitro cultures
 - c. culture facilities
 - d. Protoplast culture
 - e. haploid cultures
 - f. Organ Culture
 - g. meristem culture for virus elimination
10. **Animal Cell Culture**
 - a. Introduction to Mammalian Cell Culture

- b. Insect Culture
- c. Qualitative characteristics of cell cultures
- d. Animal cells for bioassays and bioproducts
- e. Design and operation of animal cell culture bioreactors for therapeutic protein production
- f. Cell adhesion, cell proliferation, differentiation and evolution of cell line.
- g. Tissue culture in genetic engineering and biotechnology

Practicals:

1. Preparation of stock and working solutions
2. preparation of culture media (liquid) semi-liquid and semi-solid)
3. callus culture and organogenesis
4. Preparation and fusion of protoplasts.

Teaching Methodology:

- Lecturing
- Written Assignments/Presentation
- Guest Speaker
- Model making

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Freshney RI, 2011. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications
2. Nicholl DST, 2010. An Introduction to Genetic Engineering.; Cambridge University Press.
3. Setlow JK, 2002. Genetic Engineering: Principles and Methods. Kluwer Academic Publishers.
4. Razdan MK, 2003. Introduction to Plant Tissue Culture. 2nd Edition; Intercept, New York, USA.
5. Lanza et al., 2000. Principles of Tissue Engineering. 2nd Edition; Academic Press, California.
6. Punia MS, 1999. Plant Biotechnology and Molecular Biology: A Laboratory Manual. Scientific Publishers.

41. **Cellular and Molecular Physiology**

N.A

42. **Chemical Oceanography**

CHEMICAL OCEANOGRAPHY

(Cr.Hrs.2+1)

Course Objectives:

1. To impart concepts about the chemistry of the seas and oceans
2. To incorporate the Chemical characteristics of ocean
3. To know about Marine Geochemistry

Course Learning Outcomes:

1. **Acquire** basic knowledge about the Chemical Oceanography
2. **Understand:** the chemical characteristics of dissolved gases, distribution of nutrient and trace elements, Geochemical cycles and organic sedimentation of oceans
3. **Solve:** students confidently face with full command and expressing ideas about the chemistry of the oceans
4. **Analyze:** Students will be able to categorize the various chemical aspects about the sea water
5. **Evaluate:** To describe the significance of chemical properties of sea water
6. **Demonstrate:** Hand on knowledge about analysis of water parameters, Heavy metals, organic sediments.

Course Outlines:

5. **Introduction**

- a. History of Chemical oceanography.
- b. Chemical composition of sea water; major constituents,
- c. Law of constancy of major ion ratios
- d. Oxidation state and Redox reactions,
- e. Redox and PH diagrams, alkalinity and PH. Ion speciation,
- f. Geochemical reservoirs and transport of material to the oceans.
- g. Air-sea exchange.

6. **Dissolved gases and nutrients**

- a. Dissolved gases in sea water,
- b. Geochemical cycles: nitrogen, sulfur, phosphorus, silicon and carbon cycle.
- c. Distribution of nutrients in sea water.

7. **Trace elements in Oceans**

- a. Oceanic residence time; Distribution of trace elements in sea water;
- b. Oceanic water mass tracers, Radio-isotopic tracers; Stable isotopic tracers.

4. **Estuarine chemistry**

- a. Estuaries: Classification and mixing processes.

- b. Biological modeling of estuaries.
- 11. **Marine geochemistry**
 - a. Formation of deep sea sediments. Sedimentation rates.
 - b. Classification of marine sediments.
 - c. Distribution of organic matter and its role in ocean chemistry.

Practicals:

1. Introduction to instruments used in chemical analysis.
2. Analysis of water parameter: Dissolved oxygen and nutrients (NH₄, NO₂ and PO₄) in different samples of sea waters.
3. Analysis of heavy metal in metal in marine sediments/ marine animals.
4. Grain size analysis of marine sediments.
5. Detection of moisture contents and organic matter in marine sediments.
6. Estimation of organic load in sea water by filtration techniques.
7. Field visit for collection of marine sediments and sea water from different localities.

Books Recommended:

1. Frank J. Miller 2016 Chemical Oceanography, 4th Edition, CRC press 591pp.
2. Michael E. Q. Pilson 2013 An Introduction to the Chemistry of the Sea 2nd Edition. Cambridge university press 516pp
3. Jorge L. Sarmiento 2006 Ocean Biogeochemical Dynamics. Princeton University press 495 pp
4. Chester, R.1990. Marine Geochemistry, Unwin Hyman , London,
5. Garrison, T. 2005. Oceanography: An invitation to Marine Science. 5th edition. Thomson Learning, Incorporation.
6. Millero, F.1996. Chemical Oceanography, CRC Press, Boca Raton, Fla.
7. Pilon, M.E.Q.1998. An introduction to the Chemistry of the sea, Prentice Hall, Upper Saddle River, N.J ;431.
8. Riley, J. P. and G. Skirrow, Ed.1974. Chemical Oceanography. New York, Academic Press.

43. **Classification of Insects and Pest Management**

N.A

44. **Climate Change, Ecosystem Resilience And Stability**

CLIMATE CHANGE, ECOSYSTEM RESILIENCE AND STABILITY

Credit Hours: 03

Practical= 01

Theory =02

Total = 03

Course Objectives:

The objective of this course is

1. To enable the student to understand ecosystem, climate change, Stability and Ecological constraints.

2. To understand the Regime shift, Assembly rules, Theories and biogeography.
3. To understand how National and International agencies involved in controlling constraints and increasing biotic and Abiotic resistance.

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about Climate change, causes, impacts and mitigation measures.
2. UNDERSTAND the species compatibility, Ecosystem Threshold and Restoration to Constrain Invasion.
3. SOLVE the problems of climate change and Ecological constraints.
4. ANALYSE, interpreting and synthesize data and other information about Ecosystem Resilience, climatic alterations and Restoration
5. EVALUATE the sustainable management by government department, National and International organizations
6. DEMONSTRATE the Ecological constraints, Restoration of Alternative stable states and Fire management.

Course Outline:

1. **The Earth System**
 - a. Introduction
 - b. Climate change
 - c. Ecosystem Resilience
 - d. Resistance
 - e. Stability
 - f. Ecological Constraints
2. **Alternative Stable States**
 - a. Regime shift
 - b. Restoring Alternative Stable States
 - c. Assembly Rules
3. **Sequence Introduction**
4. **Species Compatibility**
5. **Ecosystem Thresholds and Ecosystem filters**
6. **Unified Neutral Theory of Biodiversity and Biogeography**
7. **Invasive species**
 - a. Process of Invasion
 - b. Effects of Invasion on Ecosystem
 - c. Methods of control
 - d. Eradication
 - e. Containment
8. **Chemical and Biological Control**
9. **Restoration to Constrain Invasion**
 - a. Niche Preemption
 - b. Fire Management
 - c. Increasing Biotic and abiotic Resistance

Practicals:

1. Study of climate change (weatherdata),
2. Resilience and Ecosystem Restoration
3. PHRIA's Metdology.

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Text Books:

1. Laird, S. A. 2006. Biodiversity and traditional Knowledge, Viva Books Private Limited.
2. Greipsson, S. 2011, Restoration Ecology, Biology and Physics Department, Kennesaw State University, Kennesaw, Georgia
3. Kumar, H. D. 2006. Global Climate Change, Insight, Impacts and concerns, Vitasta Publishing Pvt. Ltd.
4. Plummer, R., Lundholm, C. And Krasny, M. 2011. Resilience in Social-Ecological Systems, The Role of Learning and Education, Routledge – 224 pages
5. Baumgartner, R. and Hogger, R. (2004). In search of sustainable livelihood systems: Management Resources and change. Sage publications New Delhi Thousand Oaks London.Pp.380.

45. Clinical Endocrinology

N.A

46. Clinical Immunology

CLINICAL IMMUNOLOGY

Contact Hours:

Theory = 64
Practical = 0
Total = 64

Credit Hours:

Theory = 4.0
Practical = 0
Total = 4.0

Course Objectives:

1. To familiarize the students about importance of healthy immune system.
2. To enable students to understand various immunological abnormalities.
3. To acquaint the students about the clinical basis of the abnormalities.
4. To understand mechanism of immunological diseases

Course Learning Outcomes:

1. Acquire the basic knowledge of clinically important immunological abnormalities.
2. Analyze the mechanism of various immunological diseases.
3. Demonstrate differences between healthy and abnormal immune system

Course Outline:

1. **Musculoskeletal Diseases**
 - a. Clinical features of Rheumatoid Arthritis
 - b. Synovial Changes in Rheumatoid Arthritis
 - c. Pathogenesis of Rheumatoid Arthritis
 - d. Juvenile Chronic Arthritis
 - e. Clinical Features of Spondylarthritis
 - f. Gout, Polychondritis and Bechet,s Syndrome
2. **Skin Diseases**
 - a. Urticaria
 - b. Contact Allergies
 - c. Atopic Dermatitis
 - d. Leukocytoclastic Vasculitis
 - e. Psoriasis
 - f. Bullous Skin Disease
3. **Gastrointestinal Diseases**
 - a. Atrophic Gastritis
 - b. Whipple,s Disease and Sprue
 - c. Chronic Inflammatory Bowl,s Disease
4. **Respiratory Diseases**
 - a. Bronchial Asthma and Allergic Rhinitis
 - b. Sarcoidosis
 - c. Idiopathic Pulmonary Fibrosis
 - d. Extrinsic Allergy

- e. Alveolitis and Tuberculosis
- 5. **Renal Diseases**
 - a. Immunological Mechanisms of
 - Glomerulonephritis (I)
 - Glomerulonephritis (II)
 - b. Interstitial Nephritis
- 6. **Metabolic Diseases**
 - a. Autoimmune Thyroid Disease
 - b. Diabetic Mellitus type I
 - c. Diabetic Mellitus type II
 - d. Autoimmune Polyglandular Syndrome
- 7. **Heart Disease**
 - a. Rheumatoid fever
 - b. Myocarditis
 - c. Post-infection Syndrome
- 8. **Neurological Diseases**
 - a. Multiple Sclerosis
 - b. Autoantibody Mediated Diseases
 - c. Myasthenia Gravis
 - d. Lambert-Eton Syndrome
- 9. **Ophthalmic Diseases**
 - a. Anatomy and Pathology
 - b. Extraocular Inflammations
 - c. Uveitis (I)
 - d. Uveitis (II)
 - e. Ocular Manifestation of Systemic Disease
- 10. **Reproductive Immunology**
 - a. Immunological basis of reproductive disorders
 - b. Immunological tolerance and reproductive immunology
- 11. **Gene Therapy**
 - a. Modern Approaches and Tools for Gene Therapy
 - b. Applications of gene therapy in Immunology

Teaching Methodology:

- Lecturing
- Written Assignments
- Discussion

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions) 50%
- Assignments 25%
- Quiz 25%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 10%

- Assignments 20%
- Quiz 20%

Text and Reference Books:

1. Richard, A., Goldsby, Thomas, J., Kindt and Barbara, A., Osborn. 2009. Kuby's Immunology, 7th Ed. W.H. Freeman & Company, New York.
2. Murphy, K and Weaver, C. 2016. Immunobiology by Janeway, 9th Ed. Garland Science Taylor and Francis Group, New York and London
3. Annual Reviews of Immunology and Journal of Immunology. The editions available in Pakistan

47. Clinical Teratology

CLINICAL TERATOLOGY

Course Objectives:

1. To introduce the basic concepts of developmental errors and birth defects
2. To impart knowledge about the environmental, infectious, genetic and physiological causes of congenital abnormalities
3. To develop understanding on the biological mechanisms of teratogenesis and their possible solutions in biomedical sciences

Course Learning Outcomes

1. The students will be acquainted with the emerging threats of birth defects imposed by various infectious agents, radiation, heavy metals, medicines, drugs, and environmental chemicals (pesticides) in the developing embryos.
2. The basic understandings will help the students to suggest possible precautionary measures and the biomedical and surgical solutions to the parents during the course of pregnancy
3. Further exploration will help the students to excel this knowledge in reproductive and developmental counseling.

Course Outlines:

1. Teratogenesis introduction
2. Environmental assaults on human development
3. Teratogenic agents: Alcohol, Retinoic acid, Hydroflourocarbons and others
4. Role of degradation products used as refrigerants in teratogenesis
5. Possible role of drugs and neuro-toxicants such as Heroin in congenital defects
6. Heavy metal as teratogens
7. Pathogens: *Rubella*, *Toxoplasma gondii*, *Treponema pallidum* (Syphilis bacterium) inflicting teratogenesis
8. Endocrine disruptors such as diethylstilbestrol (drug used to prevent premature births) causing inborn defects

9. Possible roles of Nonylphenol(Plastic wrappings around food) andBisphenol(a water bottles, baby feeders) in prenatal and postnatal developmental errors
- 10.Tobacco and Cannabis causing embryonic and postembryonic disruptions
- 11.Alcoholism and fetal alcohol syndrome
- 12.Antimalarial and antiprotozoal medicines as developmental disruptors
- 13.Role of tranquilizers, anti-nauseant and anti-hyperglycemic medicines in embryonic development
- 14.Oxidative stress and embryonic development
- 15.Ectopic pregnancies
- 16.Placental errors, Breach babies
- 17.Polyhydromenosis and oligohydomenosis
- 18.Major inborn defects like imperforated anus, cardiac sepatal defects, intestinal atresia, cleft lip and cleft palate
- 19.Organ ectopia, hydrocephaly, microcephaly
- 20.Congenital neural tube and nervous system defects
- 21.Testicular dysgenesis and declining sperm counts.
- 22.Developmental biology and future of medicine
- 23.Germ-line gene therapy
- 24.Stem cell therapy
- 25.Regenerative medicine
- 26.Regeneration therapy
- 27.In utero surgeries
- 28.Neonatal surgeries
- 29.Biophysical organ transplants
- 30.Regenerative organs and organoids
- 31.Fraternal and monozygotic twinning
- 32.Organ twinning

Practicals:

1. Hospital visits to observe the cases of developmental abnormalities.
2. Impact of various Teratogens on J774.2 macrophage like cell line *in vitro*
3. Potentially toxic insult of *reactive oxygen species* generation in response to various teratogens
4. Various environmental toxicants causing membrane dysfunction, **lipid** peroxidation, DNA damage and inactivation of proteins.

Books and Articles Recommended:

- a. Gilbert, S.F. (2006). Developmental Biology Carlson BM (2014) Human Embryology and Developmental Biology, 5th Edition, Mosby Elsevier.
3. Moore K, Persaud T V N, Torchia M (2015) The Developing Human Clinically Oriented Embryology 10th Edition. Elsevier inc
4. Ema M, Naya M, Yoshida K and Nagaosa R. (2010).Reproductive and developmental toxicity of degradation products of refrigerants in experimental animals. Reproductive Toxicology Volume 29, Issue 1, January 2010, Pages 1-9.

5. Azim HA, Peccatori FA and Pavlidis N. (2010). A systematic Review C:\Users\akram\Documents\Teratology-cancers in pregnancy 2010.htm - hit2 on the use of cytotoxic, endocrine, targeted agents and immunotherapy during pregnancy. Part I: Solid tumors. *Cancer Treatment Reviews*. Volume 36, Issue 2, April 2010, Pages 101-109
6. Bedard PL and Cardoso F. (2008), Recent advances in adjuvant systemic therapy or early-stage breast cancer, *Ann Oncol* 19 (Suppl 5) pp. 122–127
7. Powers CM, Yen J, Linney EA, Seidler FJ, Slotkin TA. (2010). Silver exposure in developing zebrafish (*Danio rerio*): Persistent effects on larval behavior and survival. *Neurotoxicology and Teratology*, Volume 32, Issue 3, May-June 2010, Pages 391-397
8. Cassina M, De-Santis M, Cesari E, van-Eijkeren M, Berkovitch M, Eleftheriou G, Raffagnato F, Di-Gianantonio E, Clementi M. (2010). First trimester diclofenac exposure and pregnancy outcome. *Reproductive Toxicology*, Available online 1 May 2010
9. Guidelines for Human Embryonic Stem Cell Research (2005). <http://www.nap.edu/catalog/11278.html> (free download is available)
10. Understanding stem cells: An overview of the science and issues from the national academies USA. Copyright © 2009. National Academy of Sciences. All rights reserved. 500 Fifth St. N.W., Washington, D.C. 20001 <http://www.nap.edu>

48. **Conservation Biology**

CONSERVATION BIOLOGY

Credit Hours: 2+1
Practical= 01

Theory =02
Total=3

Course Objectives:

The objective of this course is

1. to enable the student to understand and investigate the diversity of living world,
2. to understand the effect of human activities on species, communities and ecosystems; and
3. to develop a practical interdisciplinary approach to protect and restore biological diversity.

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about the phenomena that affect the maintenance, loss, and restoration of biological diversity.
2. UNDERSTAND the ecological and evolutionary principles of biological diversity which influence the conservation of wildlife at spatial and temporal scales in Pakistan as well as abroad.

3. SOLVE the conservation issue by applying the scientific principles and modern technologies.
4. ANALYSE, interpreting and synthesize data and other information about the determinants of the conservation problems.
5. EVALUATE the conservation actions taken by the biologists for solving the conservation problems across biological scales (genes to landscapes) and geographical scales (local to global).
6. DEMONSTRATE sound research skills based on ecological and evolutionary principles in investigating problems in conservation biology.

Course Outline:

1. **Introduction to Conservation Biology:**
 - a. Definition,
 - b. History and
 - c. Scope.
2. **Biodiversity:**
 - a. Species Diversity; Genetic Diversity; Ecosystem Diversity;
 - b. Measurement of Biological Diversity;
 - c. An Overview of World's Biodiversity;
 - d. The Value of Biodiversity
3. **Threats to Biodiversity:**
 - a. Human Population Growth;
 - b. Habitat Destruction; Habitat Fragmentation;
 - c. Environmental Degradation and Pollution;
 - d. Global Climate Change;
 - e. Overexploitation;
 - f. Invasive Species
4. **Extinctions:**
 - a. Extinction and Mass Extinctions;
 - b. Rates of Extinction; Island Biogeography;
 - c. Vulnerability to Extinction;
 - d. Problems of Small Populations; Minimum Viable Population (MVP);
 - e. Loss of Genetic Diversity; Effective Population Size;
 - f. Demographic and Environmental Stochasticity
5. **Conserving Populations and Species:**
 - a. Applied Population Biology; Monitoring populations; Population viability analysis; Metapopulations,
 - b. International agreements for conservation of fauna and flora; Role of national and International Laws in Protection of Species;
 - c. Ex Situ Conservation Strategies; Zoos; Aquariums; Botanical gardens; Seed banks.
 - d. Protected Areas and their Establishment and categories;
 - e. Managing Protected Areas; Challenges to Protected Areas Management.
 - f. Unprotected Public and Private Lands
 - g. Ecosystem Management

- h. Integration of Local Community in Conservation
- i. Restoring Damaged Ecosystems
- 6. **Sustainable Development:**
 - a. Challenges Involve in Conservation and Sustainable Development at the Local Level
 - b. International Approaches to Sustainable Development
 - c. Funding for Conservation by the World Bank and international NGOs;
 - d. Conservation Education and the Role of Conservation Biologists

Practicals:

1. Conservation issues in protected areas of Pakistan.
2. Study of the role of local community in protected areas of Pakistan.
3. Challenges to sustainable development and their solution in Pakistan.

Teaching Methodology

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Richard B. Primack, 2012. A Primer of Conservation Biology; 5th Edition: Sinauer Associates, Inc. Publishers Sunderland, MA U.S.A.
2. Groom, M.J., G.K. Meffe and C.R. Carroll, 2006, Principles of Conservation Biology, 3rd edition, Sinauer Associates, Sunderland, MA.
3. Malcolm L. Hunter, Jr. 2001. Fundamentals of Conservation Biology, 2nd Edition. Blackwell Science Inc.
4. Mills, L.S. 2007. Conservation of Wildlife Populations: Demography, Genetics and Management. Blackwell Publishing, USA.
5. Richard B. Primack. 2002. Essentials of Conservation Biology. 3rd Edition. Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, U.S.A.

49. **Conservation Biology of Wildlife**

CONSERVATION BIOLOGY OF WILDLIFE

Credit Hours: 03

Theory =03

Total =03

Course Objectives:

The objective of this course is to enable the student to

1. Understand the principles and advanced techniques of conservation biology in conservation management of wildlife.
2. Identify different factors involved in the depletion of wildlife resources.
3. Develop the personal skills and capabilities to apply these principles and techniques for the protection and restoration of wildlife and their habitats.

Course Learning Outcomes:

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

1. GAIN THE theoretical knowledge about the principles and advanced techniques of conservation biology used for conservation management of wildlife.
2. DETERMINE different threats and the underlying climatic and anthropogenic factors to the wildlife resources.
3. DEMONSTRATE sound research skills based on ecological and evolutionary principles in investigating problems in conservation biology of wildlife.
4. RESOLVE the conservation issue of wildlife by applying the scientific principles through modern techniques and technologies.

Course Outline

1. Introduction:

- a. An Overview of the Wildlife Biodiversity
- b. The Importance of Wildlife Biodiversity
- c. Conservation values and ethics
- d. Techniques involved in Measurement of Biological Diversity;

2. Threats and challenges involved in Wildlife conservations

- a. Mass Extinction and Global Climate Changes,
- b. Habitat Degradation and Loss,
- c. Habitat Fragmentation
- d. Island Biogeography,
- e. Overexploitation,
- f. Species invasion
- g. Inbreeding and Outbreeding Depressions,
- h. Loss of Genetic Variability,
- i. Human factors; economic factors, politics and cultures.

3. Assessment of Extinction Vulnerability of Wild Populations:

- a. Monitoring techniques for wildlife populations

- b. Risk assessment, diagnosis of declines,
- c. Population viability analysis;
- 4. **Approaches to conserve wildlife**
 - a. Species and Landscape Approaches to Conservation
 - b. Ecosystem Approaches to Conservation
 - c. Protected Areas and their management
 - d. Restoration of Damaged Ecosystems and Endangered Populations
 - e. Sustainable Development

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Richard B. Primack, 2012. A Primer of Conservation Biology; 5th Edition: Sinauer Associates, Inc. Publishers Sunderland, MA U.S.A.
2. Groom, M.J., G.K. Meffe and C.R. Carroll, 2006, Principles of Conservation Biology, 3rd edition, Sinauer Associates, Sunderland, MA.
3. Caughley, G. and A. Gunn. Conservation biology in theory and practice. Blackwell Science Publication.
4. Eric. G. Bolen and William L. Robinson. 1995. Wildlife Ecology and Management. 3rd Edition. Prentice Hall, Upper Saddle River, New Jersey.
5. Hosetti, B. B. and Venkateshwarlu, M. 2001. Trends in Wildlife Biodiversity, Conservation and Management. Daya Publishing House Delhi-11035.
6. Malcolm L. Hunter, Jr. 2001. Fundamentals of Conservation Biology, 2nd Edition. Blackwell Science Inc.
7. Mills, L.S. 2007. Conservation of Wildlife Populations: Demography, Genetics and Management. Blackwell Publishing, USA.
8. Richard B. Primack. 2002. Essentials of Conservation Biology. 3rd Edition. Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, U.S.A.

9. Soule, M. E. 1987. Viable populations for Conservation. Cambridge University Press. Cambridge.
10. Soule, M.E. and B.A. Wilcox. 1980. Conservation Biology. Sinauer Associates Inc. Sunderland. Massachusetts.

50. **Desert Zoology**

DESERT ZOOLOGY

Credit Hours: 3(2+1)

Course Objectives:

The course aims to:

1. Impart the knowledge in biology and Environmental sciences related to the desert organisms.
2. Develop concepts about threats/risk factors of animals in desert.
3. Study the history of desertification.
4. Explore the ecological processes of desert biomes.
5. Demonstrate the identification of desert fauna.

Course Contents:

1. **Origin of desert life**
 - a. Exhibited features including soil, water, temperature, atmospheric pressure and oceanic role.
2. **Desert Ecology:**
 - a. Introduction to local habitats,
 - b. identification of local animals
 - c. Morphological and physiological adaptations of desert organisms
 - d. Principles of classifying and naming species.
3. **Desert biomes:** (Hot and Dry, semiarid, Costal and Cold).
 - a. Desertification its Causes and impacts on animals. Deserts of Pakistan.
 - b. Conservation of Animals:
 - c. Advantages and disadvantages of Deserts,
 - d. Major threats/risk factors and management strategies to conserve the animals in deserts.

Practical:

1. Field trips of deserts
2. Collection of samples.
3. Visits of National Parks
4. Identification of indigenous fauna

Assessment:

Mid Term(40%)

- Written(long Questions,Short Questions,MCQs) 50%
- Presentation 20%

- Assignments 20%

Final Term(60%)

- written(long Questions,short Questions,MCQs)50%
- Presentation 20%
- Assignments20%
- Report Writing10%

Recommended Books:

1. D. Ward, 2016. The Biology of Deserts. Oxford University Press. 416p.
2. G. W Brown, 2013.Desert Biology: Special Topics on the Physical and Biological
3. Aspects of Arid Regions. Elsevier. 148322371X, 9781483223711. 654P.
4. W. G. Whitford, 2002. Ecology of Desert Systems. Academic Press. 343 pages

51. Ecosystem Engineering

ECOSYSTEM ENGINEERING

Credit Hours: 03
Practical= 01

Theory =02
Total = 03

Course Objectives:

The objective of this course is

1. To enable the student to understand basic science and fundamentals of water quality assessment,
2. To understand the thermodynamics in Environmental Engineering and solid waste calculations.
3. To understand how anthropogenic activities influence on Ecosystem

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge water quality, solid waste and Air pollution
2. UNDERSTAND the fundamentals of Environmental Engineering along with energy and material flows in Ecosystems
3. SOLVE the threats to Ecosystem, Nutrients and Water bodies.
4. ANALYSE,interpreting and synthesize data and other information about solid waste,
5. EVALUATE the disposal management by government department, National and International organisations
6. DEMONSTRATE the ecological assessment and waste disposal.

Course Outline:

1. **Water Quality Assessment and Control**
 - a. Basic Science and Fundamentals
 - b. Streams and rivers

- c. Lakes and Reservoirs
- d. Groundwater
- 2. **Fundamental and Treatment Plant Hydrolics**
 - a. Public water supply
 - b. Wastewater Engineering
- 3. **Solid Waste Calculations**
 - a. Thermodynamics used in Environmental Engineering
 - b. Basic Combustion and Incineration
 - c. Practical Design of Waste Incineration
 - d. Calculations for Permitting and Compliance
- 4. **Calculations procedures for**
 - a. Ash stabilization and solidification
 - b. Incineration Technologies
 - c. Facility Requirements
- 5. **Air Pollution Control Calculations**
 - a. Air Emission Control
 - b. Particulate Emission Control
 - c. Wet and Dry Scrubbers for Emission Control
 - d. Air Toxic Risk Assessment
 - e. Fundamentals of full cell technologies
- 6. **Energy and Material Flows in Ecosystems**
 - a. Human Influence on ecosystems
 - b. Effect of Pesticides on an Ecosystem
- 7. **Effect of Nutrients on a Lake Ecosystem**
- 8. **Effect on organic wastes on Stream Ecosystem**
- 9. **Effect of Design on an Ecosystem**
- 10. **Green Engineering**

Practical:

- 1. Solving the environmental problems with numerical calculations

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%

- Assignments 20%
- Report writing 10%

Recommended Books:

1. Van Eeten M. J. G, Roe, E., 2002. Ecology, Engineering, and Management: Reconciling Ecosystem Rehabilitation and Service Reliability. Oxford University Press USA.
2. Matlock, M. D., Morgan, R., 2011. Ecological Engineering Design: Restoring and Conserving Ecosystem Services. John Wiley and Sons.
3. Yackinous, W. S., 2015. Understanding Complex Ecosystem Dynamics: A Systems and Engineering Perspective. Academic Press.

52. Ecotourism Planning and management

ECO-TOURISM PLANNING AND MANAGEMENT

Credit Hours: 04

Theory =03

Practical= 01

Total = 04

Course Objectives:

The objective of this course is

1. To enable the student to understand significance of Eco-tourism , planning and conservation of protected areas.
2. To understand how National and International agencies involved in conservation and management of wildlife
3. To understand challenges and management of tourism

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about planning, significance and management of Eco-tourism.
2. UNDERSTAND tourism and protected area system, its positive and negative impacts of tourism.
3. SOLVE problems related to negative impacts and visitor management problem.
4. ANALYSE,interpreting and synthesize data and other information about the population of wildlife
5. EVALUATE the tourism promoting effort by government department, National and International organizations
6. DEMONSTRATE the significance of Eco-tourism in certain areas.

Course Outline

1. **Origin of eco-tourism**
2. **Tourism and Protected Areas**
3. **Tourism as a tool for conservation**

- a. Support of protected areas
- b. Global trends affecting tourism
- c. Principles and direction for tourism in protected areas
4. **SWOT analysis**
5. **Tools for visitor management**
 - c. Economics of tourism in protected areas
 - d. Financial aspects of tourism in protected areas
6. **Negative impacts of tourism**
7. **Challenges of tourism and their management**

Practicals:

1. SWOT analysis
2. Elements of Eco-tourism planning
3. Identification of tourism potential
4. Conventional and participatory approaches
5. Sustainable tourism planning model

Teaching Methodology

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Recommended Books:

1. Bushell. R & Eagles, P. F. J. 2007. "Tourism and Protected Areas: Benefits beyond boundaries" edited by CABI International.
2. Lind berg, K. 1991. Policies for maximizing Nature Tourism's ecology and Economic Benefits. Washington, World Resources Institute.
3. Hawkins L. K. and E. Doneld. 1993. Ecotourism: A Guide for Planers and Managers, Vermont.
4. Eagles, P. F. J: McCool, S. F: and Haynes, C. D: (2002) "Sustainable Tourism in Protected Areas: Guidelines for Planning and Management". Best Practice Protected Area Guidelines Series No. 8, series editor;

Phillips, A. World Commission on Protected Areas (WCPA). IUCN – The World Conservation Union.

5. Ceballos-Lascuráin, H: (1996) “Tourism, Ecotourism, and Protected areas”, IUCN Protected Areas Programme (IV World Congress on National Parks and Protected Areas)
6. Nurphy, P. E. 1985. Tourism: A community Approach. The ecotourism Society.
7. World Tourism Organization (1992) Guidelines: Development of National Parks and Protected areas for Tourism. Aadrid

53. **Endocrine Toxicology**

N.A

54. **Environmental Biotechnology**

ENVIRONMENTAL BIOTECHNOLOGY

Contact Hours:

Theory = 48

Practical = -

Total = 40

Credit Hours:

Theory = **3.0**

Practical = -

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To make the students understand what environment and ecosystem are;
2. To illustrate the intrinsic role of microorganisms in a clean environment;
3. To emphasize the active role of microorganisms in relation to biotechnology

Course Learning Outcomes:

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

1. **ACHIEVE** the foremost know-how about environment and ecosystem in connection with biotechnology
2. **BE ACQUAINTED WITH** the imperative role of microbes in relation to contamination-free environment
3. **DIGOUT** the vivacious capability of microbes in various technologies like bio- and phyto-remediation
4. **CONFIRM** the rational link of microbes with pure environment through biotechnology
5. **APPLY** the methodical information in the right direction.

Course Outline:

1. **Introduction to Environmental Biotechnology**
 - a. Microorganisms in the environment
 - b. Microbial physiology
2. **Role of microorganisms in an ecosystem**

3. **Environmental pollutants and their microbial transformation**
 - a. Organic pollutants
 - b. Inorganic pollutants

4. **Biological Waste Water Treatment:**
 - a. Elimination of organic carbon
 - b. Nitrification
 - c. Denitrification
 - d. Membrane bioreactors
 - e. Waste Water Reuse

5. **Biological Sewage Sludge Treatment:**
 - a. Aerobic/anaerobic stabilization
 - b. methane formation
 - c. sludge disintegration
 - d. sludge utilization

6. **Bioremediation:**
 - a. Fundamentals
 - b. Methods and strategies of application (biostimulation, bioaugmentation)
 - c. Technological aspects of bioremediation (*in situ*, *ex situ*)
 - d. Application of microbes in bioremediation

7. **Phytoremediation:**
 - a. Fundamentals and description of major methods of application
 - phytoaccumulation,
 - phytovolatilization,
 - rhizofiltration
 - phytostabilization

8. **Role of Environmental Biotechnology in Agriculture:**
 - a. Bioinsecticides (*Bacillus thuringiensis*, Baciloviruses), genetic modifications and aspects of safety in their use.
 - b. Biofungicides (e.g. *Trichoderma*, *Pseudomonas fluorescens*) - mode of actions and mechanisms
 - Biofertilizers: Symbiotic systems between plants – microorganisms, Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application

9. **Environmental Biotechnology and biofuels:**
 - a. biogas
 - b. bioethanol
 - c. biodiesel
 - d. biohydrogen

10. **Microbially enhanced oil recovery (MEOR)**
 - a. What is (MEOR)?
 - b. **The logic behind MEOR**

- c. Advantages of MEOR
- d. Disadvantages of MEOR

11. Industrial applications of Environmental Biotechnology

Teaching Methodology

- Lecturing
- Written Assignments
- Quiz
- Presentations

Assessment

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs)

Final Term (50%)

- Written (Long Questions, Short Questions, MCQs)

Sessional (20%)

- Presentation 10%
- Assignments 5%
- Report Writing 5%

Text and Reference Books:

1. Modern Biotechnology: Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals by NS Mosier and MR Ladisch.
2. Biotechnology by John E. Smith
3. Environmental Microbiology: Methods and Protocols, 2nd Edition, Ian T. Paulsen, Andrew J. Holmes
4. Advances in environmental biotechnology by Raman Kumar, Anil Kumar Sharma, Sarabjeet Singh Ahluwalia.
5. Principles and Applications of Environmental Biotechnology for a Sustainable Future by Rakuten Kobo

55. Environmental health policy and law

ENVIRONMENTAL HEALTH POLICY AND LAW

Credit Hours: 04

Practical = 01

Theory = 03

Total = 04

Course Objectives:

The objective of this course is

1. To enable the student to understand environmental policies and law
2. To understand the overall objectives of studying Water supply, Air quality, Biodiversity, Environment and their Conservation.
3. To understand how National and International agencies involved in conservation and management of various aspects of Environmental health and Wildlife.

Course Learning Outcomes:

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

1. Acquire theoretical knowledge about the national policy, capacity development, climate change and Sectoral policies.
2. Understand the National Environmental Action Plan, National Environmental Quality Standards for Ambient Air.
3. Solve the management problems by applying the scientific principles and modern technologies.
4. Analyze Main laws and Regulatory framework
5. Evaluate the Local Government structures and National level agencies mandated to address urban air quality
6. Demonstrate the ecological assessment and importance of health policies to certain area.

Course Outline

1. **The National Policy**
 - a. Goal
 - b. Objectives
 - c. Water supply and Management
 - d. Air quality and Noise
 - e. Waste Management
 - f. Forestry
 - g. Biodiversity and Protected Areas
2. **Environmental factors**
 - a. Climate change
 - b. Ozone depletion
 - c. Energy Efficiency and Renewables
3. **Agriculture and Livestock**
4. **Multilateral Environmental Agreements**
 - a. Poverty and Environment
 - b. Population and Environment
 - c. Gender and Environment
 - d. Health and Environment
 - e. Trade and Environment
 - f. Environment and Local Governance
 - g. Natural Disaster Management
 - h. Integration of Environment into Development Planning
5. **Legislation and Regulatory Framework**
6. **Capacity Development**
7. **Economic and Market based Instruments**
8. **Public Awareness and Education**
9. **Public-Private-Civil society Partnership**
10. **Key-environmental Issues**
 - a. Limitation and Constraints
 - b. Trends in air quality and link to health

- c. Environmental institutions in Pakistan
- d. Sectorial Policies in Air Quality Management
- e. Environment and the Judiciary
- 11. Analysis of main laws and regulatory framework**
 - a. Internal Sectoral Coordination
 - b. National programs to support local governments
- 12. Transport of air pollutants across border and its likely impacts on local air quality**
- 13. Overview of air quality**
 - a. Overview of air quality in the selected city
 - b. Local government structure and functions
 - c. Cites focus of Air Quality Management
 - d. Involvement of local government
 - e. Public participation and access to Information
- 14. National environmental action plan**
- 15. Poverty and environment nexus**
- 16. Promoting Private Sector Involvement Role**
 - a. Involvement of citizens
 - b. Involvement of NGOs
- 17. National Environmental Quality Standards for Ambient Air**
- 18. Environmental Protection Act, 1997**
- 19. National Environmental Quality Standards for Motor Vehicle Exhaust and Noise**
- 20. WHO standards**

Practicals:

1. Solving environmental problems with numerical calculations

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Recommended Books:

1. Government of Pakistan, 2009. Institutional Analysis of Air Quality Management in Urban Pakistan (Draft report) Pak EPA, Ministry of Environment, pp. 109
2. Government of Pakistan, 2005. National Environmental Policy, Ministry of Environment, pp. 16
3. Ball, D., 2006. Environmental Health Policy (Understanding Public Health).
4. Rom, W. N., 2011. Environmental Policy and Public Health: Air Pollution, Global Climate Change, and Wilderness (Public Health Environmental Health). Jossey-Bass
5. Ball, John, D., 2006. Environmental Health policy. McGraw Hill/Open University Press

56. **Environmental Toxicology**

N.A

57. **Fish and Aquatic Toxicology**

FISH AND AQUATIC TOXICOLOGY

Credit Hours:

Practical =1.0

Theory = 2.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To review the basic toxicological principles of uptake, elimination, and bioaccumulation, emphasizing processes unique to aquatic organisms.
2. To learn the relationships between abiotic and biotic processes of aquatic environments and their effects on contaminant distribution and subsequent exposure, accumulation, and toxicity in aquatic environments.
3. To become familiar with the concept of risk assessment and to extend its use to assess ecological risks resulting from aquatic pollution.

Course Learning Outcomes:

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

1. **ACQUIRE** the knowledge of the various toxic agents and their sources in aquatic ecosystem
2. **UNDERSTAND** the effects of toxic substances on fishes and other aquatic organisms
3. **SOLVE** the pollution problems in aquatic system
4. **ANALYZE** the toxicity on different organs of fish
5. **EVALUATE** the bioaccumulation pattern of pollutants in aquatic organisms
6. **DEVELOP** critical thinking to solve aquatic pollution problems

Course Outline:

1. **Introduction to Aquatic Toxicology**

- a. History of Aquatic Toxicology
 - b. Main Present and Future Challenges
 - c. Classification and Types of Toxicity
 - d. Effects of Aquatic Toxicology on Organisms
 - e. Bioindicators and Biomarkers
2. **Sources and Causes of Aquatic Contamination**
 - a. Major Sources of Pollutants
 - b. Transport of Pollutants in the Environment
 - c. Metals, Metalloids, and Organometallic Compounds
 - d. Other Inorganic Compounds, Including Factors Causing Eutrophication
 - e. Organic Compounds
 - f. Nanomaterials
 - g. Radiation
 - h. Genetic Modification
3. **Uptake, Distribution, Detoxification and Excretion of Compounds in Aquatic Organisms**
 - a. Uptake of Compounds by Organisms
 - b. Distribution and Storage Sites of Chemicals in Organisms
 - c. Biotransformation and Detoxification
 - d. Cellular Excretion
 - e. Excretion from Gills, Kidney and Other Excretory Organs
 - f. Excretion in Bile Via the Intestine
 - g. Excretion From Multicellular Plants and Algae
4. **General Principles of Toxicology in Fishes**
 - a. Bioavailability of Chemical Contaminants in Aquatic Systems
 - b. Toxicokinetics in Fishes
 - c. Toxicodynamics in Fishes
 - d. Biotransformation in Fishes
 - e. Bioaccumulation of Toxicity in Fishes
 - f. General approaches to diagnosis and treatment of toxicity
5. **Toxicity in Fishes**
 - a. Toxicity caused by metal and non-metals,
 - b. Phytotoxins
 - c. Drug toxicity and toxicity caused by agrochemicals.
 - d. Mycotoxins
 - e. Bacterial toxins
6. **Key Target System in Fish and Organismal Effects**
 - a. Liver Toxicity in Fishes
 - b. The Osmoregulatory System of Fish
 - c. Toxic Responses of the Fish Nervous System
 - d. The Endocrine System

- e. The Immune System of Fish: A Target Organ of Toxicity
- f. Chemical Carcinogenesis in Fishes
- g. Toxicity Resistance in Fishes

Practical:

1. Study of eutrophication
2. Study of behavioral responses of aquatic organisms to toxicants
3. Spot tests for metals
4. Demonstration of drug toxicity
5. Detection of heavy metal poisoning
6. Study of biotoxicity assay for LC₅₀
7. Case studies in toxicology

Teaching Methodology:

- Lecturing
- Demonstration
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Marquardt, H., Schafer, S.G., McClellan, R. and Welsch, F., 1999. *Toxicology*, Academic press, San Diego.
2. Rand, G.M., *Fundamentals Of Aquatic Toxicology: Effects, Environmental Fate And Risk Assessment*. 2nd Edition.
3. Nikinmaa, M., 2014. *An Introduction to Aquatic Toxicology*. 1st Edition. Academic Press.
4. Giulio, R.T.D. and Hinton, D.E., 2008. *The Toxicology of Fishes*. CRC Press, Taylor and Francis Group.
5. Whitacre, D. M. (Editor) 2012. *Reviews of Environmental Contamination and Toxicology*. Vol. 223. Springer, Switzerland.

58. Fish Breeding and hatchery management

FISH BREEDING AND HATCHERY MANAGEMENT

Contact Hours:

Theory =45
Practical = 45
Total = 90

Credit Hours:

Theory = 3
Practical = 1
Total = 4

Course Objectives:

The objectives of the course are to

1. Enable students to produce quality fish seeds (fry, fingerlings and juveniles)
2. Exchange necessary skills with students in site selection, design, construction and management of fish hatchery
3. Transfer basic knowledge for transportation of fish seeds and control of diseases in fish hatchery
4. Provide students with opportunities to develop fish seeds production skills such as brood stock management, fertilization and incubation of eggs, larval and fingerlings rearing.

Course Learning Outcomes:

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

1. Explain the different methods of artificial propagation of fish seeds and its importance
2. Demonstrate the various types of fish hatcheries and their management
3. Describe the various techniques of rearing fry, fingerlings and juveniles and their management
4. Use of synthetic and non-synthetic hormones to stimulate maturation and ovulation in fertilization and incubation of fish eggs

Course Outline:

1. **Fish Breeding**
 - a. Sexuality in fishes
 - b. Sexual dimorphism; Reproductive cycle
 - c. Courtship and mating
 - d. Fecundity and spawning
 - e. Natural and Artificial propagation of fishes
 - f. Gonad anatomy and reproductive mechanisms
 - g. Development of gametes in male and female fish
 - h. Hormonal control of reproduction
 - i. Spawn quality and quantity indices
 - j. Sexual maturity and breeding season of various cultivable species
 - k. Fish egg and embryonic development
 - l. Parental care in fishes

2. **Brood Husbandry:**
 - a. Brood availability, transport
 - b. Selection of brood stock for rearing
 - c. Brood captive rearing and maturation
 - d. Nutritional and environmental requirement for broodstock
 - e. Nutritional and environmental manipulation for early maturation of brood stock
 - f. Brood health care and stress management

3. **Methods of breeding**
 - a. Criteria for selection of mature brood fish induce spawning
 - b. Wet and dry method of breeding
 - c. Factors affecting maturation and spawning in fishes
 - d. Fish pituitary gland, its structure, collection, preservation and preparation of extract for injection.
 - e. Synthetic hormones used for induced breeding of carps
 - f. Dosages and methods of injection
 - g. Collection and hatching of egg
 - h. Causes of mortalities of eggs and spawn and their remedies
 - i. Improvement of seed quality

4. **Fish Hatchery Management**
 - a. Criteria for site selection of hatchery and nursery
 - b. Types of hatchery
 - c. Design and construction of modern hatchery
 - d. Operation, management and hatchery technology for seed production of important fish species
 - e. Spawn rearing techniques and its nutritional requirements
 - f. Monitoring of different water quality parameters in fish hatcheries
 - g. Hatchery standards and bio-security
 - h. Disease management and their control in fish hatcheries
 - i. Better management practices
 - j. Use of anesthetics in fish breeding and transport
 - k. Seed packaging and transportation methods
 - l. Economics of seed production

Practical:

1. Study of maturity stages in fishes
2. Collection and preservation of fish pituitary gland
3. Calculation of fecundity
4. Brood-stock maintenance and selection of breeders for injection
5. Histological studies of ovary and testes
6. study of fish eggs and embryonic developmental stages
7. Water quality monitoring in fish hatcheries and nurseries
8. Use of disinfectants and antibiotics in fish breeding
9. Visit to different fish hatcheries

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Pillay.T V R and M N Kutty, 2005, Aquaculture- principles and practices,Blackwell sciences, UK
2. Thomas.P.C et al, 2003. Breeding and seed production of finfish and shellfish,Daya publishing house, New delhi
3. Mathew Landau, 1992. Introduction to Aquaculture, John Wiley and sons, INC,New york
4. Jhingran. V G, 1991, Fish and Fisheries of India, Hindustan Publishers.
5. Rath, P K, 2000, Freshwater Aquaculture, Scientific Publishers, Jodhpur
6. Jhingran VG and Pullin R S V, 1985, Hatchery Manual for the Common, Chineseand Indian major carps, ICLARM
7. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India
8. Hart, P. J. B. and J. D. Reynolds. 2008. Handbook of Fish Biology and Fisheries, Volume 2. Blackwell Science Ltd., New York, USA
9. Huet, M. 1998. Text Book of Fish Culture - Breeding and Cultivation of Fish. Fishing News, London, UK.

59. Fish Nutrition and Health

FISH NUTRITION AND HEALTH

Credit Hours:

Practical =1.0

Theory = 2.0

Total = 3.0

Course Objectives:

The course is designed to familiarize students with:-

1. Physiological aspects of nutrition and response of fish to diet in relation to feed additives and immunity.
2. Recent advancement in aquaculture nutrition, nutritional constituents and their energetics, nutritional deficiency and diseases.
3. Fish feed formulation procedures and processing practices.
4. Risk associated factors to the aquaculture nutritional balance and management of the feed stocks

Course Learning Outcomes:

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

1. Acquire knowledge about fish nutrition and methods of feeding for sustainable fish production.
2. Interpret various macro and micro-nutrients, energetics and digestibility of nutrients.
3. Demonstrate manufacturing techniques of various types and size of fish feed, feeding regimens in relation to the species cultured and the type of culture facility.
4. Locate feed additives and feeding stimulants to enhance fish growth and immune response.
5. Analyze anti-nutritional factors present in feed ingredients and toxic agents that affect fish growth.
6. Calculate feeding rations and feed conversion ratio,
7. Identify factors affecting feed intake related to fish species and their life stages.

Course Outlines:

1. **Introduction:** Introduction to nutrients (macronutrients and micronutrients) and their importance; carbohydrates, lipids, protein, amino acids, vitamins, minerals, carotenoids.
Nutritional energetic: digestion process in fish, energy partitioning, bioenergetics model, methods of digestibility determination, factors affecting digestibility, nutrient digestibility.
2. **Types of fish feed:** natural and artificial; production of live feed; classification of fish feed on the basis of nutrient composition and texture.
3. **Feed Additives and anti-nutritional factors:** Introduction to feed additives; other dietary components (water, fiber, hormones, antibiotics, pigments, pellet binders, stimulants). Anti-nutritional factors, types of anti-nutrients and their sources.
4. **Introduction to toxic agents and anti-oxidants:** Toxic agents, non-nutrient diet components; antioxidants in compounded feeds.
5. **Nutritional disorders:** Nutritional fish diseases; nutrients and immune response; feed rancidity.
6. **Feed Rationing and Frequency:** Feeding ratio; feeding frequency; feed conversion ratio; feed digestibility; pre-biotics and pro-biotics.
7. **Novel diets for aquaculture:** Encapsulated diets, medicinal diets and experimental diets.

8. **Aqua feed industry:** Introduction, economics of feed production and feeding; quality control in fish feed manufacturing; feed regulations.

Practical:

1. Introduction to various fish feed ingredients (plants and animal origin), feed additives.
2. Gut contents analysis.
3. Measuring feed conversion ratio and feed intake.
4. Calculation of specific growth rate of fish (SGR).
5. Proximate analysis of fish feed ingredients (Dry matter; moisture; crude protein; crude lipid; gross energy; ash content; etc).
6. Determination of Aflatoxins concentration in fish feed.
7. Analysis of anti-nutritional factors in fish feed ingredients.
8. Visit to fish feed mill.

Assessment:

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Recommended Books:

1. John Halver. 2013. Fish Nutrition, ELSEVIER.
2. Lovell, T., 2012. Nutrition and Feeding of Fish. 2nd Ed. Springer Science, USA
3. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
4. Pandey, B. N., S. Deshpande and P. N. Pandey. 2007. Aquaculture. APH Publishing Corporation, New Delhi, India.
5. Ojha, J.S. 2006. Aquaculture Nutrition and Biochemistry. GeetaSomaniAgrotech Publishing Academy, Udaipur, India.
6. Parker R. O., 2004. Aquaculture Science (4thed.). Delmar Learning, London.
7. Halver, J.E. and Hardy, R.W. 2002. *Fish Nutrition*. Academic Press. Boston, London,
8. Hertrampf, J.W., Pascual, F.P. and Ong, S.L. 2002. *Handbook on Ingredients for Aquaculture Feeds*. Kluwer Academic Publishers
9. Rajagopalsamy, C.B.T. and. Ramadhas. V. 2002. *Nutrient Dynamics in Freshwater Fish culture system*. Daya Publishing house, Delhi.
10. Rajagopalsamy, C.B.T. and. Ramadhas. V. 2002. *Nutrient Dynamics in Freshwater Fish culture system*. Daya Publishing house, Delhi.
11. Bhujel, R. C.; Yakupitiyage, A.; Turner, W. A. and Little, D. C. (2001). Selection of a Commercial Feed for Nile Tilapia (*Oreochromis niloticus*) Broodfish Breeding in Hapa-in-Pond systems. *Aquaculture* 194: 303-314.

12. Lovell, T. 1998. *Nutrition and Feeding of Fish*. Kluwer Academic Publishers Boston, London.
13. Brummett, R.E., (2000). Food organism availability and resource partitioning in organically or inorganically fertilized *Tilapia* ponds. *Aquaculture*, 183: 57-71 New York
14. George F., H. P.S. Makkar and Klaus B. (2001) Antinutritional factors present in plant-derived alternate fish feed ingredients and their effects in fish. *Aquaculture* 199: 197–227
15. Hardy, R. W. (1999). Collaborative Opportunities between Fish nutrition and Other Disciplines in Aquaculture: An Overview. *Aquaculture* 177: 217-230.
16. Agricultural Software Consultants, Inc. (1997). MIXIT-WIN. Feed Formulation for Windows 95 or NT. Virginia.
17. De Silva, S. S. and Anderson, T.A. (1995). *Fish Nutrition in Aquaculture*, Chapman and Hall. London.
18. Desilva, S.S. and Anderson, T.A. 1995. *Fish Nutrition in Aquaculture*. Kluwer Academic Publishers
19. NRC, 1993. Nutrient Requirements of Fish. National Academic Press, Washington, D.C.
20. Lovell, T. *Nutrition and Feeding of Fish*. Kluwer Academic Publishers, 2nd Edition
21. De Silva, S.S. and Davy, F.B., (1993). Fish nutrition research for semi-intensive culture systems in Asia. *Asian Fisheries Society* 5: 129-144.
22. Olvera-Novoa. M. A, Martinez-Palacios, C.A. and DE IEÓN, E.R. (1994). Nutrition of fish and crustaceans a laboratory manual. Food and Agriculture Organization of the United Nations – FAO Mexico City.
23. National Research Council (NRC), (1993). Nutrient Requirements of Domestic Animals. Nutrient Requirements of warm water fishes and shell fishes. Revised Edition. National Academy Press, Washington DC, USA, 114 p.

60. Fish Requirements* Dr. Noor

FISH REQUIREMENTS

Credit Hours:

Practical = 0.0

Theory = **3.0**

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To teach about basic concepts of fin fish feed requirements and recent trends in feed formulation and manufacturing.
2. To provide information about nutrient requirements of different commercially important fish species under variable environmental conditions.
3. Enable the students to understand recent trends in fish feed technology for economical fish production.

Course Learning Outcomes:

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

1. Learn about basics of artificial fish feed ingredients and feed requirements of various fin fish species.
2. Formulate and manufacture technology of various types of fish feed (floating and sinking pellets).
3. Explain recent advances in finfish feed preparation and manufacturing technology to increase fish yield with minimum cost.

Course Outlines:

1. Introduction to fish nutrition.
2. Digestion and absorption of nutrients.
3. Feeding types and anatomy.
4. Energy, protein, lipids, carbohydrate, mineral and vitamin requirements of fish.
5. Factors affecting nutrient requirements of fish.
6. Energy losses and partitioning in fish.
7. The role of other dietary components viz. water, fiber, hormones, antibiotics, antioxidants, pigments, pellet binders and feeding stimulants.
8. Anti-nutrients and toxins.
9. Forms and size of feed, feeding rates and feeding practices for different fish species.
10. Special purpose feeding.
11. Feed calculations, feed requirements and feed conversion ratios.
12. Feed ration and frequency, judging feeding response of cultured species, methods of feeding.

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Final Term (55%)

- Written (Long Questions, Short Questions, MCQs)

Recommended Books:

1. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf, 2015. *Aquaculture Handbook—Fish Farming and Nutrition in Pakistan*.
2. John Halver. 2013. *Fish Nutrition*, ELSEVIER.
3. Lovell, T., 2012. *Nutrition and Feeding of Fish*. 2nd Ed. Springer Science, USA
4. Hopher, B., 2010. *Nutrition of Pond Fishes*. Cambridge University Press, UK.
5. Halver, J.E., Ronald, W.H. and Daniel, M.H. 2004. *Fish Nutrition* (4thed.). Academic Press, N. York.
6. Pillay, T.V.R. 1999. *Aquaculture: Principles and Practices*. Fishing News Books, London.
7. N.C.R., 1998. *Nutrient Requirements of Fish*. National Academy Press, Washington D.C.

ii. FISH PARASITOLOGY

FISH PARASITOLOGY

Credit Hours:

Practical = 1.0

Theory = **2.0**

Total = **3.0**

Course Objectives

The objectives of the course are:-

1. To familiarize the students with common parasites of fish and their treatment methods
2. To equip students with a fundamental understanding of science and competence in parasitological methods.
3. To provide advanced knowledge, understanding, and critical judgment appropriate for professional employment in the field of Parasitology or a related discipline.

Course Learning Outcomes:

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

1. **OBTAIN** the basic knowledge of ecto and endo parasites.
2. **UNDERSTAND** very well about the life style of parasites and hosts. They can easily differentiate between various host and parasites.
3. **SOLVE** the problems of identification of fish parasites with the help of latest illustrations in the field of fish parasitology.
4. **ANALYZE** the problems by comparing the different fish parasites.
5. **EVALUATE** the problems by using the slides of nematodes, cestodes and trematodes.
6. **DEMONSTRATE** the dissection of fishes and showing the location of various endo and ecto parasites.

Course Outlines:

1. **Introduction to fish parasitology**
 - a. Host and parasite
 - b. Types of host and parasite
 - c. Ectoparasite and endoparasite concepts
 - d. Overview and Adaptation,
 - e. association of parasites:
 - f. symbiosis,
 - g. commensalism,
 - h. mutualism,
 - i. parasitism.
2. **Fish parasites**
 - a. Classes of fish parasites:
 - b. Ecto-parasites,
 - c. Endo-parasites.

- d. Identification of parasitic problems.
 - e. Methods of diagnosis, physical examination,
 - f. Pathogenesis,
 - g. Life cycles and treatment methods of following parasites:
 - h. Protozoa,
 - i. Monogenean trematodes,
 - j. Degenean trematodes,
 - k. Nematodes,
 - l. Cestodes,
 - m. Crustaceans,
 - n. Leeches.
3. **Medically important parasites**
- a. The medically important parasites,
 - b. Protection and the treatment of fish parasites

Practicals:

1. Identification of parasites
2. Life cycles of parasites
3. Isolation of fish parasites from host
4. Treatment methods
5. Prevention and control measures

Recommended Books/Readings:

1. Patrick T. K. W and K. Buchmann. 2012 Fish parasites: pathobiology and protection. 2012. CABI Publishers
2. Bremner, HA 2002. Safety and Quality Issues in Fish Processing. Woodhead Publishing Limited, Cambridge, England
3. Buchmann, K. 2007. An introduction to practical methods in fish parasitology. CABI Publishers
4. Bresciani, J., E. Ariel, K. Pedersen, I. H. Dalsgaard. 2009. Fish Disease: an introduction. CABI Publishers.

iii. Fish Processing and value addition

FISH PROCESSING AND VALUE ADDITION

Credit Hours:

Practical= 1.0

Theory = **2.0**

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To familiarize the students with the advancements in the fields of fish processing and post-harvest technology of freshwater and marine fish.
2. To provide an exposure on the various advanced preservation techniques of fish and fish products.

3. The importance of an efficient post-harvest and fish marketing chain promotes in accordance with consumer needs.
4. Visit various landing sites and fish processing plants.

Course Learning Outcomes:

Upon successful completion of the course students will be able to;

1. Acquire advanced knowledge about fish processing and post-harvest technology.
2. Learn techniques of preservation of fish and fish products.
3. Onsite demonstration of various landing sites and fish processing plants.
4. Develop various value added fish products and recipes.

Course Contents:

1. Introduction to fish processing and value addition.
2. Quality of fresh and frozen fish.
3. Methods of assessing and selecting for quality microbiology of products.
4. Identifying heavy metals in fish and shellfish.
5. Modern methods of fish handling and hygiene.
6. On board handling and on shore fish handling.
7. Icing procedures.
8. Transportation to fish markets.
9. Various ways of fish disposal.
10. Fish preservation and traditional processing methods (salting, curing, sun-drying, smoking, etc.), fish filleting and packing.
11. Shelf life of fish food products.
12. Packaging.
13. Deep freezing and thawing.
14. Chemistry of freezing.
15. Development of value added fish products; pickling, fish pastes, special processing procedures (minced fish, minced based value addition, fish surimi and surimi based products, gelatin).
16. Industrial fish processing; Fish meals, fish oils, fish protein concentrate.
17. Fishing by products.
18. International standards.
19. Food safety and laws.
20. Live fish handling, marketing.

Practical:

1. Biochemical analysis of various products.
2. Tests for freshness and food safety.
3. Detection of microorganisms; various techniques for microbial studies.
4. Fish filleting lines (filleting, trimming, processing, freezing equipment, vacuum packaging etc.).
5. Peroxides value determination.
6. pH value determination in meat.
7. Acid value determination.
8. Fish oil extraction procedure.

9. Development of value added fish products.
10. Visit to fish processing plant.

Assessment:

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Recommended Books:

1. Barry Leonard. 2011. Fish and Fishery Products, DIANE Publishing.
2. Fish Products and Processing, 2007. W. Horner & R. Robles, Blackwell Publications
3. FDA. 2003. *Fish and Fisheries Products Hazards and Control Guidance*. US Food and Drug Administration
4. Bremner, H. a. 2002. *Safety and Quality issues in fish processing*. Woodhead publishing Limited, Cambridge, England.
5. Pearson, A.M. and Dutson, T.R. 2002. *HACCP in Meat, Poultry & Fish Processing*. Kluwer Academic Publishers
6. Bremner, H.A. 2002. *Safety and Quality issues in fish processing*. Woodhead Publishing Limited.
7. Connell, J.J. 2001. *Control of Fish Quality*. Blackwell Science
8. Kestin, S.C. and Warriss, P.D. 2001. *Farmed Fish Quality*. Fishing News Books, Blackwell Science Ltd.
9. Pearson, A. M. and Dutson, T.R. 1999. *HACCP in Meat, Poultry and Fish Processing. Advances in Meat Research Series. Vol. 10*. ASPEN publication.
10. Martin, R.E., Collette, R.L. and Slavin, J. 1997. Fish Inspection, Quality Control, and HACCP, A Global Focus. Technomic Publishing Co. Inc.
11. Hall, G.M. 1996. *Fish Processing Technology*. Kluwer Academic Publishers
12. Regestein, J.M. and Regestein C.E. 1997. Introduction to fish Technology. CBS Publishers & Distributors, New Delhi.
13. Regestein, J.M. and Regestein, C.E. 1997. *Introduction to fish Technology*. CBS Publishers & Distributors, New Delhi.

Fisheries Extension Education

FISHERIES EXTENSION AND EDUCATION

Credit Hours:	Theory	=3.0
Practical= 0.0	Total =	3.0

Course Objectives:

The objectives of the course are:-

1. To familiarize students about fisheries & aquaculture sector and various stakeholders.
2. To impart knowledge on participatory approaches in fisheries extension programmes.
3. Insights into different concepts, principles, recent changes and emerging challenges in fisheries extension.
4. To acquire skills required to practice various fisheries extension approaches.

Course Learning Outcomes:

Upon successful completion of the course students will be able to;

1. Acquire knowledge about fisheries and aquaculture sector and various stakeholders.
2. Learn about participatory approach and onsite training demonstration, discussion with fish farmers and fishermen.
3. Explore ways to increase the awareness of fisheries and aquaculture through extension services.
4. Identify the loop holes in communications about the sector.
5. Solve problems of appropriate community groups dealing with fisheries and aquaculture.
6. Practical experience of community based fisheries management and co-management.

Course Outlines:

1. Overview of fisheries and aquaculture sector in Pakistan and world.
2. Scope and importance of fisheries and aquaculture extension.
3. Special characteristics of fisheries sector and its stakeholders.
4. Introduction to extension education, research, and service.
5. Overview of fisheries research, development and extension systems in Pakistan.
6. Critical review of philosophy, principles, concepts, and practices of fisheries extension systems and approaches.
7. Teaching, learning and colearning.
8. Fisheries extension – advantages and limitations of present welfare and subsidy oriented extension systems.

9. Development and extension approaches as practiced by public agencies like Department of Fisheries, NGOs, FAO, and by the private sector; participatory fisheries extension approaches.
10. Participatory approaches for aquatic resources management and development: need, importance and guiding principles.
11. Public-Private-Community Partnership.
12. Social change; social control, social problems and conflicts in fisheries; gender issues in fisheries; theories of learning, learning experience, learning situation.
13. Reviewing national and international case studies on participatory approach to aquaculture research and development.

Recommended Books:

1. Malhotra SP & Sinha VRP. 2007. *Indian Fisheries and Aquaculture in a Globalizing Economy*. Part II. Narendra Publ. House.
2. Ray, G. L. (2006). *Extension, Communication and Management*. 6th edition, Kalyani Publication (PD)
3. Ray GL. 2006. *Extension, Communication and Management*. 6th Ed. Kalyani.
4. Brown D, Derek S & Simon FS. 2005. *Mainstreaming Fisheries Co-Management in the Asia-Pacific*. Asia-Pacific Fishery Comm. Rep. Publ. 2005/24, FAO, United Nations Regional Office for Asia and the Pacific, Bangkok.
5. Robert SP. 2005. *Fisheries Co-Management: A Practical Hand Book*. CABI.
6. Chandrasekhar CS. (Ed.). 2004. *Privatization of Agricultural Extension in India*. MANAGE, Hyderabad.
7. Ramchandran C. 2004. *Teaching not To F(in)ish: A Constructivist Perspective on Reinventing a Responsible Marine Fisheries Extension System*. CMFRI, Kochi.
8. Edwards P, Little DC & Demaine H. 2002. *Rural Aquaculture*. CABI.
9. Rivera WM. 2000. *Agricultural Extension: Worldwide Institutional Evolution and Forces for Change*. Elsevier.
10. Kumar D. 1999. *Trickle Down System (TDS) of Aquaculture Extension for Rural Development*. RAP Publ.
11. Kumar D. 1996. *Aquaculture Extension Services Review: India*. FAO Fisheries Circular No. 906, Rome.
12. Chambers R, Arnold P & Thrupp LA. 1989. *Farmers First: Farmer Innovation and Agricultural Research*. Intermediate Technology Publ.
13. Chambers R. 1983. *Rural Development Putting the Last First*. Longman.

64. Fishing Gear Technology

FISHING GEAR AND TECHNOLOGY

Credit Hours:

Practical= 1.0

Theory = 2.0

Total =3.0

Course Objectives:

The objectives of the course are:-

1. To impart knowledge about importance of capture fisheries, various fishing gears and crafts.
2. To learn methods of fish handling, processing and preservation.
3. To learn about catch and by-catch and fish by-products.
4. To understand fisheries regulation, legislation, administrative organizations and administration.

Course Learning Outcomes:

Upon successful completion of the course students will be able to;

1. Describe various fishing gears and crafts used for fish catch.
2. Demonstrate methods of fish handling, processing and preservation.
3. Differentiate catch and by-catch of fish and fish by-products.
4. Familiarize with fisheries regulations and legislative development.

Course Outlines:

1. Capture fishery and its role in world food production.
2. Reasons for decline and development potential.
3. Stock assessment techniques.
4. Various fishing methods, account of fishing gears and crafts, their selectivity efficiency catch per unit effort (CPU).
5. Gears and crafts of Pakistan.
6. Post-harvest handling, transportation.
7. Processing technology and product development of fish and shellfish.
8. Methods of fish handling and processing (drying, salting, smoking, canning, freezing).
9. Fish by-products (fish meals, fish body oil, fish glue etc).
10. Regulation of fishing.
11. Enactment of fishery legislation with special reference to Pakistan.
12. Fisheries administration and organization.

Practical:

1. Collection and identification of commercial species of fish.
2. Fish stock assessment.
3. Study of common fishing gears and crafts of Pakistan.
4. Study of nets (composition, design and operation).
5. Study of boats and nets used for fishing in Pakistan.
6. Method of gear selectivity and efficiency.

7. Visit to fish processing and fish meal factory.
8. Visit to fish harbors and processing plants.
9. Visit to fish landing and marketing centres.

Assessment

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

Recommended Books:

1. Joesph, E. 2016. Fishing Gears and Fishing Methods (Review Paper).Academia Publisher.
2. Vin T. Sparano. 2015. Complete Guide to Fresh and Saltwater Fishing: Conventional Tackle. Fly Fishing. Spinning. Ice Fishing. Lures. Flies. Natural Baits. Knots. Filleting. Cooking. Game Fish Species. Boating, Univers.
3. Badapanda, K.C. 2013. Basic of Fisheries Sciences, VOL III. Fishing Crafts and Gear Technology. H.D. Nedendera Publishing House. Publishers and Distributors.
4. O. Gabriel, K. Lange, E. Dalinand A.Twendt. 2005. Fish Catching Method of the World. Blackwell Publishing Ltd.
5. Huet, M. and Timmermans, J .2000. Text Book of Fish Culture. Blackwell Science Hameed, M.S. and M.R. Boopendernath. 2000. Modern Fishing Gear Technology. Diya Publishing House India
6. Ali, S.S., 1999. Freshwater Fishery Biology. Naseem Book Depot, Hyderabad
7. Regenstein, T.M. and C.E. Regenstein.1997. Introduction to Fish Technology CBS Pub. N. Delhi, India.
8. Joe, M. and Carrie, M. 1997. Introduction to Fish Technology Chapman and Hall, USA.
9. Windsor, M and Barlow, S. 1981. Introduction to Fishery Byproduct. Fishing News Books Ltd. England.

65. Forensic entomology

FORENSIC ENTOMOLOGY

Contact Hours:

Theory =96
 Practical =16
 Total = 112

Credit Hours:

Theory = **2.0**
 Practical =**1.0**
 Total = **3.0**

Course Objectives

The objectives of the course are:-

1. To impart knowledge about various insect groups
2. To solve medico-legal cases and different puzzling crimes.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge about the postmortem index by using insect population.
2. **UNDERSTAND** conventional means of forensic investigation.
3. **SOLVE** the criminal investigation problems.
4. **ANALYZE** any change in position of the corpse as well as the cause of death
5. **EVALUATE** possibilities of using forensic data based on insects and their larvae morphology, growth histories
6. **DEMONSTRATE** species distribution and toxic contents in tissue of insects in criminal investigation.

Course Outline:

- a. History and scope of Forensic Entomology.
- b. Study of various insect groups and other arthropods related to medico-legal investigations like puzzling events of murder, suicide, and trafficking determination of time or postmortem intervals and location of the death.
- c. Review and survey of insect life histories, life cycle and faunal succession of arthropods related to medicolegal cases and survey of the insects involved in forensic science.
- d. Review of classification of ages in decomposition of human and animal remains, uses of insect and arthropods in investigation of death and the duration of PMI.
- e. Forensic entomology in public health, arthropods borne disease, litigation and role of forensic entomology in formulation of health policy.

Practical:

1. Sampling, rearing, and preservation techniques in forensic entomology
2. Study of the decomposition of corpses and dead bodies;
3. Survey, identification and biology of insects and arthropods of forensic importance.
4. Study and analysis of court room proceedings regarding medico-legal cases.
5. Data processing and preparation of project reports.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker

- Field Visits
- Report Writing

Assessment

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs) 20%
- Presentation 05%
- Assignments 05%

Final Term (70%)

- Written (Long Questions, Short Questions, MCQs) 55%
- Practical 10%
- Attendance 05%

Text and Reference Books:

1. Byrd, J.H. and Costner, J.L. 2009. Forensic Entomology: The Utility of Arthropods in Legal Investigations, 2nd Edition, CRC Press, New York.
2. Catts, E.P. and Haskell N.H. 1990. Entomology and Death. A Procedural Guide. Joyce's Print Inc. Clemson, SC.
3. Goff, M. L. 2000. A fly for the prosecution: how insect evidence helps solve crimes. Harvard University Press, Cambridge.
4. Greenberg, B. and Kunich, J.C. 2002. Entomology and the Law: Flies as Forensic Indicators, Cambridge University Press, Cambridge.
5. Smith, K.G.V. 1986. A Manual of Forensic Entomology, Comstock's Publishing Associates, Cornell University Press, Ithaca, N.Y.

66. Freshwater Biology

FRESHWATER BIOLOGY

Contact Hours:

Theory =3.0

Credit Hours:

Practical =1.0

Total = 4.0

Course Objectives:

The objectives of the course are:-

1. To familiarize about freshwater resources, biology of commercial food fishes of Pakistan and fish culture.
2. To analyze about fertilizer and fish growth.
3. To impart the knowledge about various types of fish feeds, enemies, diseases and their control
4. To calculate fish growth by using different methods

Course Learning Outcomes:

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

1. **IDENTIFY** the basic familiarity of freshwater biology, different fish organs and their function.
2. **DISCRIMINATE** techniques of fish culture and survey fertilizer.

3. **SOLVE** the problems of fish diseases by using different drugs and also calculate the growth in fishes.
4. **EXAMINE** fish enemies and control them by using different conventional methods.
5. **MEASURE** the presence of different food items in the gut of fish.
6. **DEMONSTRATE** the methods of fish preservation.

Course Outlines:

1. **Introduction**

- a. Brief description of freshwater resources of Pakistan
- b. Biology of commercial food fishes of Pakistan (Morphology, anatomy, ecology and distribution)

2. **Fish Culture**

- a. History of fish culture
- b. Fish culture systems and types
- c. Cultivable fishes of Pakistan
- d. Criteria for farm site selection; Designing, construction
- e. liming and fertilization of fish pond
- f. Criteria for selection of fish species for culture
- g. Stocking
- h. feeding and maintenance of fish farms
- i. Ingredients of supplementary fish feed
- j. Introduction to integrated fish farming
- k. Water quality monitoring and management in fish pond

3. **Food and feeding**

- a. Food and feeding behavior and habits of fish
- b. methods of qualitative and quantitative analyses of food
- c. Factors affecting food consumption

4. **Growth**

- a. Measurement of growth
- b. Factors affecting growth rate

5. **Fish diseases**

- a. Viral
- b. Bacterial
- c. Fungal

6. **Fish enemies and their control**

- a. Insects
- b. Fishes
- c. Amphibians
- d. Reptiles
- e. Birds
- f. Mammals

7. **Fertilizers**

- a. Types of fertilizers (organic, inorganic and Organo-chemical)

8. **Fish handling and processing**

- a. Methods for handling

- b. processing and preservation of fish (drying, salting, curing, smoking and freezing)

Practicals:

1. Collection and Identification of commercially important fish of Pakistan.
2. Study of external features of fish.
3. Dissection of fish to expose its internal features, especially digestive, circulatory, respiratory, excretory and reproductive system.
4. Analyses of gut contents.
5. Assessment of age and growth of fish.
6. Visit of fish processing unit.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Moss, B.R., 2010. Ecology of Fresh Waters: A View for the Twenty-First Century. 4thed. Wiley-Blackwell, USA.
2. Bronmark, C. and Hansson, L., 2005. The Biology of Lakes and Ponds. Oxford University Press, UK.
3. J.G. Needham, J.G., 1962. Guide to the Study of Freshwater Biology 5thed. McGraw-Hill, USA. Maitland, P.S., 1990. Biology of Fresh Waters. Springer, USA
4. Ali, S.S. and Narejo, N.T., 2009. Fundamentals of Ichthyology. Sindh University Press, Jamshoro.
5. Ali, S.S., 1999. Freshwater Fisheries Biology. Naseem Book Depot, Pakistan.
6. Ricker, W.E., 2002. Methods of Assessment of Freshwater Fish Production. Blackwell Scientific Publications, USA.

7. Huet, M., 2010. Text Book of Fish Culture - Breeding and Cultivation of Fish. Fishing News, UK.

67. Gene Therapy

Gene Therapy

Contact Hours:

Theory = 64

Practical = 0.0

Total = 64

Credit Hours:

Theory = **4.0**

Total = 4.0

Course Objectives:

The course aims to:

1. To introduce students about somatic and germ line gene therapy
2. To enable the students to understand the gene replacement and gene addition, *in vivo*, *ex vivo* and *in vitro* gene therapy
3. To understand about the transgenic animal models and vehicles for gene transfer-viral vectors.
4. To understand the gene therapy of non-heritable disorders; recent advancements in Gene Therapy.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of sound scientific techniques and methods involved in the research and application of gene therapy.
2. **UNDERSTAND** the scientific principles which underlie the rationale for gene therapy.
3. **ANALYZE** the historical, current and future gene therapy treatment strategies.
4. **EVALUATE** the laboratory techniques that could be used in clinical trials of gene therapy.
5. **DEMONSTRATE** the techniques/strategies involved in the gene therapy research.

Course Outline:

- 1 **Introduction**
 - a. Therapeutic nucleic acids
 - b. Somatic and germ line gene therapy
 - c. Gene replacement and gene addition
2. ***In vivo* gene therapy**
 - a *In vivo*, *ex vivo* and *in vitro* gene therapy
 - b. Transgenic animal models
 - c. Vehicles for gene transfer-viral vectors

3. **Viral vectors**
 - a. Lentivirus
 - b. Recombinant SV40 virus
 - c. Non-viral vectors
 - d. DNA vaccines
 - e. Liposomes and lipoplexes
 - f. Transposons
4. **Cancer gene therapy**
 - a. Cancer gene therapy
 - b. RNA-DNA chimera
 - c. Gene therapies for Criglar-Najjar syndrome
5. **Gene Therapy and diseases-I**
 - a. Cystic fibrosis
 - b. Duchenne muscular dystrophy
 - c. Bleeding disorders
 - d. Tyrosinemia
6. **Gene Therapy and diseases-II**
 - a. Severe combined immunodeficiency syndrome (SCID)
 - b. Gene therapy of non-heritable disorders
 - c. Recent advancement in Gene Therapy
7. **Clinical application of gene therapy**
 - a. Cystic fibrosis
 - b. Familialhypercholesterolemia
 - c. Infectious diseases
 - d. Human trials for gene therapy
 - e. Ethical and regulatory consideration
 - f. Future prospects-Gene therapy

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speakers
- Hospital visits
- Report writing

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%

Text and Reference Books:

1. Nancy, S. T. 2015. Gene and cell therapy: Therapeutic Mechanisms and strategies, 4th Edition. CRC Press, United States of America.
2. Sherman, D. 2014. Gene Transfer, Gene therapy and genetic pharmacology: Principles, delivery and pharmacological and biomedical applications, National Scientific Research Centre (CNSR) ICP Text Books France
3. Joseph, P. P. 2014. Gene therapy: treating disease by repairing genes. Info Base Publishing. United Kingdom.
4. Perin, E. C., Miller, L. W., Taylor, D. A., & Willerson, J. T. 2016. Stem cell and gene therapy for cardiovascular disease. Waltham, MA : Academic Press
5. Friedman, T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor, NY: Cold Spring Harbor Lab. Press.
6. Knipe, D. M. & Howley, P. M. eds. 2001. Fields Virology. Philadelphia, PA: Lippincott Williams & Wilkins.
7. Hackett, N. R. & Crystal, R. G. 2000. Adenovirus vectors for gene therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker

68. Genomics and proteomics

GENOMICS AND PROTEOMICS

Contact Hours:

Theory = 48
Practical = 0
Total = 48

Credit Hours:

Theory = **3.0**
Practical = 0
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To enable the students to understand organization of Human genome.
2. To enable the students to analyze and predict protein models and genome database.
3. To train the students to run various databases necessary to predict the effect of certain mutations.

Course Learning Outcomes:

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

1. **Acquire** the basic knowledge of Human genome and its organization.
2. **Understand** the key features of various genome and protein databases.
3. **Solve** the problem by mutation detection through various databases.
4. **Analyze** the mutation through genome databases and predict its pathogenic effect.
5. **Evaluate** protein structure of protein through protein databases.
6. **Demonstrate** the protein structure through protein modeling.

Course Outline:

1. Introduction

- a. The Human Genome
- b. Contents and organization of genomes.
- c. Hemoglobin. From gene to protein to disease.
- d. Genomic features of model organisms.

2. Contents and Organization of Genomes.

- a. Chromosomes, organelles and Plasmids
- b. Genes
- c. Dynamic components of genomes
- d. Genome organization in Prokaryotes
- e. Genome organization in Eukaryotes.

3. Mapping, Sequencing and Annotation

- a. DNA sequencing
- b. Fredrick Sanger and development of DNA sequencing.
- c. Maxam Gilbert chemical cleavage method.
- d. Automated DNA sequencing.

4. Proteomics

- a. Protein structure and types
- b. Protein folding patterns
- c. Changes in folding patterns in protein evolution.

5. Separation and Analysis of protein

- a. Poly acrylamide gel electrophoresis (PAGE)
- b. SDS PAGE
- c. Mass spectrometry.

6. Protein Engineering

- a. Multiple Sequence Alignment
- b. Clustal Omega
- c. Ab initio

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Arthur Lesk (3rd Edition). Introduction to Genomics by Oxford University Press, USA; 2016.
2. Arthur Lesk (3rd Edition). Introduction to Genomics by Oxford University Press, USA; 2017
3. Strachan, T., A. P. Read, Human Molecular Genetics, 3rd edition, Garland Science/Taylor & Francis. 2003.
4. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st edition, Penguin USA Paper, 2002.
5. Relethford J. H., Genetics and the Search for Modern Human Origins, Wiley-Liss 2001.

69. **Herpetology**

HERPETOLOGY

3(2+1)

Course Objectives:

1. Understand the basic concepts of herpetology.
2. Enable to know history of Amphibians and Reptiles
3. Develop vision about systematics, mechanisms of speciation.
4. Evaluate role of Amphibians and Reptiles.
5. Demonstrate Economic values of Reptiles and Amphibians.

Course Outline:

- a. History of Amphibian and Reptilian biology,
- b. Early amphibian origins. Characteristics, taxonomy and systematic,
- c. Biogeography and mechanism of speciation,
- d. Evolution, reproductive strategies.
- e. Development, homeostasis and behavior in relation to biotic environment.
- f. Food, feeding, defense and conservation.
- g. Role of amphibians and reptiles containing pest populations.
- h. Medicinal importance of reptiles and amphibians.
- i. Economic values of reptiles and amphibians.

Practicals:

1. Identification of museum reptile and amphibian specimens.
2. Classification and taxonomic characteristics of reptiles.
3. Comparative study of skeleton of amphibians and reptiles.
4. Field visits national parks, zoos and different habitats.
5. Presentations of field reports/survey reports.

Assessment:

Mid Term(40%)

- Written (long Questions, Short Questions, MCQS) 50%
- Presentation. 20%
- Assignments 20%

Final Term(60%)

- Written (long Questions, Short Questions, MCQs) 50%
- Presentations 20%
- Assignments 20%
- Report Writing 10%

Recommended Books:

1. Stebbins, R. C. and Cohen, N. W. 2002. A Natural History of Amphibians. Princeton University Press, Princeton, N. Jersey.
2. Coleman, J. Freeman, W.H. and Olive, G. 1993. Introduction to Herpetology (3rd ed.), W.H. Freeman, N. York.
3. Vitt, L. J., & Caldwell, J. P. 2013. Herpetology: an introductory biology of amphibians and reptiles. Academic press.
4. Kerridge, R. (2014). Cold blood: Adventures with reptiles and amphibians. Random House.
5. Wells, K. D. 2010. The ecology and behavior of amphibians. University of Chicago Press.
5. Wells, K.D. 2007. The Ecology and Behavior of Amphibians. University of Chicago Press.

70. **Human Genetics**

HUMAN GENETICS

Contact Hours:

Theory = 48
Practical = 0
Total = 48

Credit Hours:

Theory = **3.0**
Practical = 0
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To understand the basic mechanism of gene mapping and sequencing.
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 congenital malformations.

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. **Mapping of Human Genome**
 - a. Genetic Mapping
 - b. Physical Mapping
 - c. Genome Sequencing
 - d. Disease Isolation.
2. **Human Karyotyping**
 - a. Staining
 - b. Chromosomal banding
 - c. Digital karyotyping
 - d. Multicolor Fish mFish and Spectral Karyotype
 - e. Chromosomal Abnormalities
3. **Congenital Malformations**
 - a. Structural Malformations
 - b. Metabolic Malformations
 - c. Causes of Congenital Malformations
 - d. Screening of Congenital Malformations
4. **Oncogenes and Cancer**
 - a. Proto-oncogenes
 - b. Activation of Oncogenes
 - c. Classification of Oncogenes
5. **In born Errors of Metabolism**
 - a. Disorder of carbohydrate metabolism
 - b. Disorder of amino acid metabolism
 - c. Disorder of Urea cycle
6. **Twin Studies**
 - a. Monozygotic Twins
 - b. Dizygotic Twins
 - c. Concordance
7. **Treatment of Genetic Diseases**
 - a. The current state of Treatment of Genetic Diseases
 - b. Special Consideration in Treating Genetic Diseases
 - c. Treatment strategies
 - d. The Molecular Treatment of Diseases
8. **Prenatal Diagnosis**
 - a. Indication of Prenatal diagnosis by Invasive Testing
 - b. Methods of Prenatal Diagnosis
 - c. Laboratory Studies
 - d. Emerging Technologies for Prenatal Diagnosis
 - e. Prenatal Prevention and management of Genetic diseases
 - f. Genetic counseling for Prenatal diagnosis
9. **Genetic Counseling and Risk Assessment**
 - a. The process of Genetic Counseling

- b. Determining Recurrence Risk
 - c. Application to Molecular genetics to determine Recurrence Risk
10. **Ethical Issues in Medical Genetics**
- a. Ethical Dilemmas in Medical Genetics
 - b. Eugenic and Dysgenic effect of Medical Genetics
 - c. Genetics in Medicine

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

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%

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. Lewin, B. Gene-VIII. Oxford University Press, Oxford, UK. 2004.
6. Nussbaum, McInnes and Willard. Thompson and Thompson Genetics In Medicine 7th Edition 2009.

71. Industrial Biotechnology

INDUSTRIAL BIOTECHNOLOGY

Contact Hours:

Theory = 48

Practical = -

Total = 48

Credit Hours:

Theory =3.0

Practical = -

Total =3.0

Course Objectives:

The objectives of the course are:-

1. To enable the students to understand the real significance of microorganisms
2. To understand the basic fermentative techniques
3. To grasp essential knowledge regarding metabolites produced by microorganisms

Course Learning Outcomes:

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

1. **GAIN** the essential knowledge about microorganisms
2. **UNDERSTAND** the empirical role of microbes in relation to industry
3. **EXPLOIT** the dynamic skill of microbes in human life
4. **AUTHENTICATE** the pragmatic relationship of microbes with industry
5. **APPLY** the scientific knowledge in an effective and appropriate manner

Course Outline:

1. **Fermentation Microbiology and Biotechnology**
 - a. Fermentation: an ancient tradition
 - b. Developments in Metabolic and Biochemical Engineering
 - c. Bioreactors, types and designs
 - d. Upstream and Downstream processing
 - e. Scope and Future of Fermentation Microbiology
2. **Industrial Media and the Nutrition of Industrial Organisms**
 - a. The basic nutrient requirements of industrial media
 - b. Criteria for the choice of raw materials used in industrial media
 - c. Some Potential Sources of Components of Industrial Media
3. **Screening for Productive Strains and Strain Improvement**
 - a. Sources of microorganisms used in biotechnology
 - b. Isolation of organisms producing desired metabolites
 - c. Strain improvement
4. **Microbiology of industrial fermentation**
 - a. Current trends in the fermentation and pharmaceutical industry
 - b. Applications of batch-fed two-stage fermentation in the production of biopharmaceuticals
 - c. Microbial fermentations and the production of biopharmaceuticals

5. **Biopulping**
 - a. Enzymes for biopulping
 - b. Process design and kinetics
 - c. Use of Fungi in Pulping Wood
6. **Biofuels**
 - a. First-generation biofuels
 - b. Second generation biofuels (2G)
 - c. Third generation biofuels
 - d. Fourth generation biofuels
7. **Biotechnology Of Raw-Ore Processing**
 - a. Ores
 - b. Mineral
 - c. Mineraloid
 - d. Mineral processing
 - e. Bioleaching
8. **Microbial Enhanced Oil Recovery (MEOR)**
 - a. **Types of MEOR**
 - b. **The logic behind MEOR**
 - c. MEOR advantages and disadvantages
9. **Enzymes**
 - a. Types of major industrial enzymes and desired modifications
 - b. Substrate degradation and product formation
 - c. Enzyme characteristics and kinetics
 - d. Role and advantages in food production
10. **Single Cell Protein (SCP)**
 - a. Substrates for Single Cell Protein Production
 - b. Microorganisms Used in SCP Production
 - c. Use of Autotrophic Microorganisms in SCP Production
 - d. Safety of Single Cell Protein
 - e. Nutritional Value of Single Cell Protein

Teaching Methodology:

- Lecturing
- Written Assignments
- Quiz
- Presentations

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs)

Final Term (50%)

- Written (Long Questions, Short Questions, MCQs)

Sessional (20%)

- Presentation 10%
- Assignments 5%
- Report Writing 5%

Text and Reference Books:

1. Modern Industrial Microbiology And Biotechnology by Nduka Okafor
2. Food Biotechnology by Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto and Robert E. Levin.
3. In introduction to Industrial Microbiology by K. Sukesh
4. Modern Industrial Microbiology and Biotechnology - CRC Press Book

72. Insect Toxicology

INSECT TOXICOLOGY

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives

The objectives of the course are:-

1. To provide theoretical knowledge and introduction to laboratory methods associated with toxicology in insects.
2. Scientific evaluation of the effects of interaction of insects with synthetic and naturally occurring compounds can lead to efficient environmentally friendly insecticides. Insecticide resistance, targeted pest control and protection of non-target species are some of the core problems plaguing insecticide use practices.
3. To educate about the types of insecticides, their effects on insects and potential strategies for addressing insecticide use issues.

Course Learning Outcomes:

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

1. Evaluate effects of interaction of insects with synthetic and naturally occurring compounds.
2. Practice about the types of insecticides, their effects on insects and potential strategies for addressing insecticide use issues.
3. Operate laboratory methods associated with toxicology in insects.

Course Outline:

1. **Introduction to Toxicology**
 - a. History of Toxicology
 - b. Toxic Agents and Substances
 - c. Natural and Synthetic Pesticides
 - d. Dose and its impact on toxicity
2. **Classification of Insecticides**
 - a. History and Classification of Insecticides
 - b. Chlorinated Hydrocarbon Insecticides
 - c. Organophosphorus Insecticides, Carbamate Insecticides, Thiocyanate Insecticides, Dinitrophenols, Fluoroacetate Derivatives,

Acaricidal Chemicals, Fumigants, Inorganic Insecticides, Synergists, Hormone Mimics, Cuticle Formation Inhibitors, Microbial Insecticides

3. **Modes and Mechanisms of Action of Insecticides**

- a. Insecticide Entry Routes into Insects
- b. Effects on the Insect Nervous System, Electron Transport System, Enzyme Inhibition, Chitin and Cuticle, Behavior Modification
- c. Insect Endocrinology

4. **Evaluation of Insecticide Toxicity**

- a. Toxicity Tests against Insects
- b. Methods for Testing Insect Toxicity (Injection, Dipping, Contact, Fumigation and Feeding Methods)
- c. Estimating LD₅₀, Biological and Biochemical Assays, Laboratory Bioassays and Field Assays Ames Test, Comet Assay

5. **Forensic Entomotoxicology**

Methods for detection of toxic substances in entomological specimens

6. **Problems in insect Toxicology**

- a. Insecticide Resistance
- b. Minimizing Human and Non-Target Species Toxicity
- c. Protecting Pollinator Species
- d. Effects of Insecticides on the Environment and Wildlife
- e. Pesticide Residue in Food and Threats to Domestic Animals

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%

Text and Reference Books:

1. Chemical Pesticides: Mode of Action and Toxicology. Stenersen, J. 2004. CRC Press, USA. ISBN 0-7484-0910-6.
2. Toxicology of Insecticides. Second Edition. Matsumura, F. 1975. Plenum Press, New York and London. ISBN 9781461344124.

3. Text Book of Insect Toxicology. Srivastava, R. P. and Saxena, R. C. 1989. Himanshu Publications. ISBN 8185167184, 9788185167183.
4. The Toxicology and Biochemistry of Insecticides. Yu, S. J. 2014. CRC Press. ISBN 9781482210606.

73.. **Molecular Immunology**

N.A

74. **Lab and Biosafety**

LAB AND BIOSAFETY

Contact Hours:

Theory =32

Practical = 48

Total = 80

Credit Hours:

Theory =**2.0**

Practical =1.0

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To impart knowledge to the students about biohazards, laboratory associated risks, risk assessment, safety issues, biosafety levels and role of biosafety committees
2. To create awareness about the safety involved in handling chemical, radioactive and biohazardous materials in the lab
3. To *provide guidelines* on how *students can protect themselves and their workplace* from physical, chemical, electrical and bio-hazards
4. To demonstrate the proper use of PPE, safety equipment, best lab practices, biological containment, biosafety requirements, storage, transportation and disposal of biohazardous waste

Course Learning Outcomes:

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

1. **ATTAIN** the practical knowledge of the safety equipment in the lab and use them efficiently.
2. **COMPREHEND** the concepts of risk groups, risk assessment and biosafety levels.
3. **APPREHEND** the principles of good lab practices and to ensure that adequate biosafety requirements are in place.
4. **ELUCIDATE** the role and responsibilities of biosafety committees in research labs.
5. **CONSIDER** the key safety issues and health problems related with lab acquired infections.
6. **ASSESS** the *hazards* and *potential risks* associated with the chemicals and *laboratory* operations.
7. **CONTRIBUTE** to the development of contingency plans and emergency procedures for lab safety.

8. **DEMONSTRATE** Biosafety Policy, Codes of Practice and National Biosafety Guidelines.

Course Outline:

1. **Introduction and History**
 - a. Introduction to biosafety, biological and biohazardous materials
 - b. History of biosafety, biological warfare, bioterrorism
 - c. Biosafety containment levels and controls
 - d. Classification of Risk groups
 - e. Risk assessment for chemical hazards and biohazards
2. **Laboratory Associated Risks**
 - a. Lab Acquired Infections (LAIs)
 - b. Blood borne Pathogens
 - c. Descriptive epidemiology of occupational infections of laboratory workers
 - d. Route of transmission and modes of exposure
 - e. Emergencies: accidents, incidents, chemical/microbial spills and exposures
 - f. Chemical fire and electricity safety
3. **Lab Safety and Compliance Requirements**
 - a. Personal Protective Equipment (PPE)
 - b. Lab Facilities and Safety Equipment
 - c. Disinfection, Decontamination and Sterilization
 - d. Contingency plans and emergency procedures
 - e. Practices for handling and disposal of infectious materials
 - f. Packaging, labeling, storage, transportation and disposal of lab waste/infectious agents
4. **Lab Biosafety Guidelines**
 - a. Safety management
 - b. General biosafety principles and requirements
 - c. Laboratory permits and registration of biological, chemical and radioactive materials
 - d. Biosafety Policies and Codes
 - e. National Biosafety Guidelines
5. **Role and Responsibilities of Biosafety Committees**
 - a. Occupational Safety and Health Administration (OSHA)
 - b. Cartagena Protocol on Biosafety (CPB)
 - c. National Biosafety Committee (NBC)
 - d. Technical Biosafety Committee (TBC)
 - e. Institutional Biosafety Committee (IBC)

Practical:

1. Personal hygiene, dress and safe laboratory work practices
2. Use of Personal Protective Equipment (PPE)
3. Lab facilities and safety equipment
4. Use of biosafety cabinets
5. Use of Laminar Flow Hood/Fume Hood

6. Use of Fire Extinguisher
7. Sterilization and Disinfection methods
8. Decontamination and Antimicrobials usage
9. Area cleanliness and organization
10. Manipulation techniques for minimizing aerosols
11. Practical cleaning of a spill
12. Microbial spills and clean up procedures
13. Microbial contamination checks
14. Packaging and transportation of biological materials
15. Arrangement of chemicals in the Lab

Teaching Methodology:

- Lecturing
- Written Assignments
- Lab/Field Activity
- Report Writing

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Group Work 10%
- Presentation 10%
- Assignments 10%
- Quiz 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Text and Reference Books:

1. Biosafety in Microbiological and Biomedical Laboratories, 5th ed., (2009) by L. Casey Chosewood and Deborah E. Wilson, U.S. Department of Health and Human Services, Public Health Service Centers for Disease Control and Prevention, National Institutes of Health, HHS Publication No. (CDC) 21-1112.
2. Labsafety Manual (2006) by Smida, A., Department of Health, Safety and Environment, University of Saskatchewan, Saskatoon, Canada.
3. Biological Safety, Principles and Practices, 4th ed.(2006) by Fleming & Hunt, ASM Press.
4. Biosafety Manual (2005) by Oles, A., Department of Health, Safety and Environment, University of Saskatchewan, Saskatoon, Canada.
5. National Biosafety Guidelines (2005), Pakistan Environmental Protection Agency, Government of Pakistan.
6. Laboratory Biosafety Manual, 3rd ed.(2004) by World Health Organization (WHO), Geneva.

74. Lac Insects

LAC INSECTS

Contact Hours:

Theory = 96
Practical = 16
Total = 112

Credit Hours:

Theory = 2.0
Practical = 1.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide the concepts of different species natural enemies .
2. To provide awareness about management of lac insects.
3. To provide knowledge about diseases of lac insects and their management.

Course Learning Outcomes:

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

1. **ACQUIRE** basic knowledge of Lac insect economics in relation to Zoology.
2. **UNDERSTAND** the concepts of the maintenance of natural enemy colonies.
3. **SOLVE** the problems related to bee production by applying theoretical knowledge with practical efficiency.
4. **ANALYZE** bio products of lac industry and their utilization.
5. **EVALUATE** the growing market potential for natural enemy and its products.
6. **DEMONSTRATE** practical information on various aspects of lac insects.

Course Outline:

1. Lac insect taxonomy, distribution and life cycle,
2. Lac host and crop management technology,
3. Processing of lac insects,
4. Bye-products of lac and their utilization,
5. Bionomics of lac insect, lac cultivation; Local practice, improved practice,
6. Propagation of lac insect, Inoculation period,
7. Harvesting of lac Natural enemies of lac insect and their management;
8. Lac host management;
9. Lac based production;
10. The problems and prospects of lac industry;
11. Lac and its Cultivation in Pakistan.

Practical:

1. Identification of life stages of lac insects
2. care and maintenance of host of lac insect
3. Identification of natural enemies of lac insect

4. visit to production units

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs) 20%
- Presentation 05%
- Assignments 05%

Final Term (70%)

- Written (Long Questions, Short Questions, MCQs) 55%
- Practical 10%
- Attendance 05%

Text and Reference Books:

1. Partiban S & David BV. 2007. Management of Household Pests and Public Health Pests. Namratha Publ.
2. Chennai. Singh S. 1975. Beekeeping in India. ICAR, New Delhi.
3. Chattopadhyay S. 2011. Introduction to lac and ac culture. tech. Bull. FBTI .

75. Mangroove Ecology

MANGROVE ECOLOGY

(Cr. Hrs.2+1)

Course Objectives:

1. To provide the knowledge about Mangrove forest
2. To provide review of the different environmental issues including ecological, conservation, pollution issues of Mangrove forest.
3. To impart knowledge about management and planning issues of Mangrove forest using case study.

Course Learning Outcomes:

1. **Acquire** basic knowledge about the Mangrove Ecology
2. **Understand:** the Mangrove forest management and restoration
3. **Solve:** students will able to solve the Mangrove biodiversity and environmental issues
4. **Analyze:** Students will able to identify and analyze Mangrove forest environmental issues
5. **Evaluate:** The process of restoration of Mangrove forest

6. **Demonstrate:** Mangrove identification, Community analysis and Zonation pattern , Collection, preservation and identification of mangrove fauna.

Course Contents:

1. Introduction

- a. Mangroves: evolution of mangroves
- b. Biogeography and Identification
- c. Adaptation to marine environment: mechanism of salinity tolerance
- d. Reproduction strategy and development
- e. Mangrove roots and respiration strategy
- f. Mangrove species- global distribution.
- g. Extent of mangroves in various countries- Past and present extent of distribution
- h. Tropical mangroves

2. Biodiversity

- a. Flora: Microbial Phytoplankton and seaweeds
- b. Fauna : Mangrove invertebrates and vertebrates
- c. Methods of assessing biodiversity

3. Ecological function

- a. Litter production, decomposition and nutrient enrichment
- b. Biomass: estimation of production.
- c. Food web and energy fluxes
- d. Feeding, breeding and nursery grounds
- e. Mangrove as a source of products

4. Impacts

- a. Effects of Urbanization;
- b. Navigation and industrial channelization
- c. Pollution effects on mangrove ecosystem.
- d. Threats due to shrimp aquaculture
- e. Oil exploration,
- f. charcoal production and port development
- g. Problem faced by mangroves in Pakistan:
- h. Indus delta as a case study

5. Mangrove management and restoration

- a. Mangrove and coastal protection.
- b. Ecotourism.
- c. Over-exploitation,
- d. sustainable management
- e. Conventions and current regulations
- f. Mangrove management for biodiversity
- g. Conservation and management strategies
- h. Conservation of mangrove in Pakistan
- i. Mangrove protected areas

Practicals:

1. Mangrove identification.

2. Study of leaf structure of different mangrove plants.
3. Collection, preservation and identification of mangrove fauna.
4. Study of effects of salinity on the growth of mangrove plant and animals.
5. Community analysis and Zonation pattern of mangrove fauna.
6. Field visit to mangrove forest.

Recommended Books:

1. James N Metras, 2011 Mangroves: Ecology, Biology and Taxonomy Nova Science publisher 384 pp
2. P. Saenger ,2002 Mangrove Ecology, Silviculture and Conservation Springer Science & Business Media, 360 pages
3. Volker Linneweber 2002 Mangrove Ecosystems: Function and Management (Environmental Science and Engineering) Springer NewYark 287pp
4. Hamilton, L.s. and snedaker.S.c. 1984. Handbook for Mangrove Area. Management. IUCN.Gland.Switzerland. UNESCO Paris and East-West Center, Hawaii: 123 pages.
5. Hogarth. P.J.1999. The Biology of Mangroves (Biology of Habitats). Oxford University Press. Inc. Oxford, UK.
6. Teas, H.J.1984. Physiology and management of mangroves. The Hague; Boston: Dr. W. Junk Publisher.
7. Stafford-Deitsch.J. 1995. Mangroves. Hyperion Books.
8. Saenger, P.2002. mangrove Ecology, Silviculture and Conservation. Kluwer academic Publishers.
9. Snedaker. S.C. 1985. The mangrove ecosystem: research methods.Pernetta.J.C.1993. mangroves forest, Climatic change and sea level rise. IUCN

76. **Medical and Veterinary Parasitology**

N.A

77. **Medical Biotechnology***

N.A

78. **Medical Entomology**

MEDICAL ENTOMOLOGY

Contact Hours:

Theory = 48

Practical = 32

Total = 80

Credit Hours:

Theory = **3.0**

Practical = 1.0

Total = **4.0**

Course Objectives:

The objectives of the course are:-

1. To provide the fundamental information necessary for understanding the role of arthropod vectors in the transmission of diseases in humans.

2. To establish the understanding about taxonomy, morphology, life history, ecology, behavior and public health concerns of the insects of public health importance.
3. To familiarize with management (IPM) techniques that are helpful in preventing and controlling disease vectors.

Course Learning Outcomes:

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

1. **IDENTIFY** important arthropods of medical importance.
2. **COMPREHEND** how each arthropod become involved in the transmission of causative agents of human diseases.
3. **DEVELOP** methods to control arthropod borne diseases based on knowledge of vector biology.

Course Outline:

1. General Introduction of arthropods of Medical Importance,
2. Problems caused,
3. Arthropods borne diseases,
4. Food Contaminants,
5. Toxins and Venoms,
6. Defense secretions and allergens.
7. **Introduction, lifecycle, medical importance and management strategies of**
 - a. Mosquitoes
 - b. Sandflies
 - c. Horse flies
 - d. Tsetse fly
 - e. Fleas
 - f. Lice
 - g. Bed bugs
 - h. Cockroaches
 - i. Houseflies
 - j. Black flies
 - k. Beetles
 - l. Butterflies and Moths
 - m. Bees and Wasps
 - n. Scorpions
 - o. Spiders
 - p. Ticks
 - q. Mites

Practical:

1. Field visits for sampling, collection of arthropods of medical importance.
2. Field visits for observation of prevalence of pest fauna of public health concern.

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%
- Quizzes 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Quizzes 10%

Text and Reference Books:

1. Mike Service, 2012. Medical Entomology for Students, Cambridge University Press.
2. Mullen, G. and Durden, L., 2009. Medical and Veterinary Entomology. 2nd Ed. Academic Press. San Diego, CA.
3. Ralph E William 2009, Veterinary Entomology: livestock & Companion Animals CRC press, 343 pp.
4. Marquardt, W.C., 2004. Biology of Disease Vectors, 2nd Ed., Elsevier Academic Press.
5. Aldridge, B., 2004. Medical Entomology: Text Book of Public Health and Veterinary. Chapman and Hall, London.
6. Service, M., 2004. Medical Entomology for Students. Cambridge University Press.
7. Tyagi, 2003, Medical Entomology: A Hand book of medically Important Insects & other arthropods Scientific Publisher 262 pp.
8. Eldridge F. Bruce & Edman, J.D. 2003. Medical Entomology: A text book on Public Health and Veterinary problems caused by Arthropods. Kluwer Academic Publishers 672 pp.
9. Kettle, D.S., 1995. Medical and Veterinary Entomology. (2nd Ed.), CAB International, UK.
10. Busvine, J.R., 1980. Insects and Hygiene. 3rd Ed. Chapman and Hall, London.
11. Harwood, R.F. and James, M.T., 1979. Entomology in Human and Animal Health. 7th Ed. Macmillan Publishing Co., Inc., N.Y.
12. James, M.T. and Harwood, R.F., 1969. Herms Medical Entomology. The Macmillan Company Canada.

79. Medical Virology

MEDICAL VIROLOGY

Contact Hours

Theory = 80

Total = 80

Credit Hours:

Theory = 3.0

Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide expertise in microbiology, with a particular focus on medical virology.
2. To achieve in-depth knowledge and understanding of medical virology.
3. Develop an understanding of the scientific basis of concepts, as well as practical skills in medical virology.

Course Learning Outcomes:

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

1. Understand differences between the lifecycles of major groups of viruses, in particular how different viruses exploit the molecular and cell biology of their hosts.
2. Understand the innate and adaptive defenses of mammals against viruses, and the strategies that viruses have evolved to evade these host defenses.
3. Understand strategies to prevent (vaccination) and to treat (antiviral therapy) viral infections.

Course Outline:

1. **Introduction to virology:**
 - a. Introduction of viruses.
 - b. History of virology.
 - c. Structure and classification of viruses.
 - d. Introduction to laboratory techniques.
2. **The viral replication cycle:**
 - a. Replication strategies for DNA and RNA genome viruses.
 - b. Viral receptors, attachment.
 - c. Entry of enveloped and non-enveloped viruses.
 - d. Uncoating and disassembly.
 - e. Structural, Nonstructural viral proteins.
 - f. Viral genome replication.
 - g. Assembly and maturation of virions.
3. **Pathogenesis – viral entry, spread and host response.**
 - a. Routes of entry and transmission.
 - b. Tissue tropism, evasion of host response.
 - c. Latency, Persistence, transformation.
 - d. Acute and persistent infections.
 - e. Transformation, viral oncogenes.

- f. Endogenous viruses.
4. **Virus evolution and emerging/re-emerging viral infections**
 - a. Variation and viral polymerases.
 - b. Natural selection, drift vs shift.
 - c. Recombination and reassortment.
 - d. Virus-host co-evolution.
 - e. Emergence and re-emergence.
5. **Transmission**
 - a. Transmission strategies.
 - b. Incubation and generation time.
 - c. Epidemic and endemic viruses, herd immunity.
 - d. Detection and Surveillance, eradication and control.
 - e. Viral vectors and gene therapy.
6. **Detection and prevention:**
 - a. Eradication of viral diseases.
 - b. Laboratory methods for detecting and classifying.
 - c. Techniques for developing viral vaccines.
 - d. Antiviral therapies.
7. **Virus family case studies.**
 - a. DsDNA viruses – adenoviruses, herpesviruses, poxviruses.
 - b. SsDNA viruses, Circoviruses and parvoviruses.
 - c. DsRNA viruses, reoviruses. Positive sense
 - d. ssRNA viruses, Picornaviruses, caliciviruses, flaviviruses, coronaviruses.
 - e. Negative sense ssRNA viruses orthomyxoviruses, paramyxoviruses, rhabdoviruses.
 - f. ssRNA viruses with Reverse Transcriptase – retroviruses.
 - g. DsDNA viruses with Reverse Transcriptase – hepadnaviruses.

Teaching Methodology:

- Lecturing
- Written Assignments
- Practical
- Guest speaker

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. Christopher Burrell Colin Howard Frederick Murphy. 2016. Fenner and White's Medical Virology, 5th Edition. Imprint: Academic Press. University of Texas Medical Branch, Galveston, TX, USA.
2. Dorothy H. Crawford. 2011. Viruses: A Very Short Introduction. Publisher Oxford University Press.
3. James H. Jorgensen, Michael A. Pfaller. 2015. Manual of Clinical Microbiology. 11th Edition Publisher American Society for Microbiology. Washington DC, United States.

80. Mariculture Technology

MARICULTURE TECHNOLOGY

Credit Hours:

Theory = **2.0**

Practical = 1.0

Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To educate and expand the knowledge about Techniques of Integrated Aquaculture and techniques of artificial breeding.
2. To provide an exposure on the various preservation techniques of fish and fish products to the undergraduates.
3. To impart the knowledge about the selective breeding and culture technology of Tilapia, practical techniques for shrimp farming, Monitoring and management of water quality in aquaculture, and disease occurrence and control strategy of mariculture organisms.

Course Learning Outcomes:

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

1. **Explain** the knowledge about advanced technology and management modes of mariculture with world characteristics.
2. **IDENTIFY** the problems related to Integrated Aquaculture in Shrimp Ponds, techniques of Marine Fish Artificial Breeding and Cage Culture, integrated and shell fish culture.
3. **SOLVE** problems related to aquaculture management and diseases management.
4. **ANALYZE** the problems of aquaculture and solve them by using different strategies.
5. **FORMULATE** integrated breeding techniques, diagnosis and control of diseases in commercially important fish species.
6. **DEMONSTRATE** and visit the marine aquaculture sites and also highlight the diseases control management.

THEORY:

1. **Mariculture**
 - a. History
 - b. Introduction to mariculture technology
 - c. A survey of mariculture in the world
2. **Mariculture technology**
 - a. Technology on artificial breeding of abalone
 - b. Techniques of larval rearing and farming in the white shrimp (*Litopenaeusvannamei*)
 - c. Living food organism and their cultivation
 - d. Practical culture techniques of Scylla
 - e. Breeding and rearing of grouper
 - f. Oyster farming techniques
 - g. Grey mullet culture techniques
3. **Marine algae culture**
 - a. History
 - b. Techniques
4. **Aquatic weeds**
 - a. Production techniques for aquatic feeds;
 - b. Artificial breeding and culture technique of ovate pompano
5. **Marine biodiversity**
 - a. Marine biodiversity protection and sustainable development of mariculture industry
 - b. Disease occurrence and control strategy of mariculture organisms;
 - c. Monitoring and management of water quality in aquaculture

Practical:

1. Aquaculture techniques of white shrimp (*Litopenaeusvannamei*)
2. Culture techniques of Scylla;
3. Breeding of abalone grouper; Oyster Grey mullet, ovate pompano
4. Production techniques for aquatic feeds; monitoring and management of water quality in aquaculture

Recommended Books/Readings:

1. Bensam, P. 1999. Development of Marine fisheries science in India Daya publishing House-Delhi.
2. Fish Catching Methods of the World IV Edition. 2005. O. Gabriel, K. Lange, E. Dahm & T. Wendt, Blackwell Publications
3. Fish Products and Processing, 2007. W. Horner & R. Robles, Blackwell Publications
4. Sustainable Fishery Systems, 2001. Anthony T. Charles, Blackwell Publications

81. **Molecular Endocrinology**

N.A

82. **Molecular Evolution**

MOLECULAR EVOLUTION

Cr 3 + (0)

Course Objectives::

1. To understand some basic principles of evolution and genetics.
2. To apply such principles to ecological, environmental and conservation research themes.
3. To interpret genetic data in an applied context.
4. To communicate and disseminate the results of their research in simplified language.

Course Learning Outcomes:

1. **Acquire** the information regarding the classical and recent approaches in evolution
2. **Understand** the range of molecular approaches that are currently used in ecological and evolutionary research themes.
3. **Solve** various queries regarding the different molecular processes that leads to changes in the genome and the evolutionary consequences.
4. **Analyze** genetic mechanisms as genetic drift, non-random mating and different forms of selection.
5. **Understanding** the connection between molecular processes in the genome and the evolutionary processes in speciation development.

Course Outline (contents):

1. An overview of the molecular genetic tools used to investigate ecological and evolutionary processes in natural populations.
2. Usefulness of some concepts of ecology, evolution, and genetics.
3. Evolutionary forces; vital force theory for living organisms.
4. Nucleotide sequence, gene structure, genetic code, and mutations. Dynamics of genes in populations.
5. Allele frequencies. Natural selection. Random genetic drift. Effective population size. Polymorphism and divergence.
6. Linkage disequilibrium. Sequence alignment. Evolutionary change of nucleotide sequences. Multiple substitution problem and the inference of the number of evolutionary events.
7. Rates and patterns of nucleotide substitution. Probability of fixation of a new neutral mutation. Rate of neutral substitution.
8. Gene trees and species trees. Methods of reconstruction. Branch length estimation. Molecular clocks. Over-dispersed clocks. Testing the neutral mutation hypothesis.
9. Positive selection and Genome evolution I. Evolution of gene duplications. Paralogy and orthology.

Text and Reference Books:

1. Wagner, G.P. 2014. Homology, Genes and Evolutionary Innovation. Princeton Univ. Press, New Jersey, USA.
2. Roderic, D.M., E.C. Holmes. 2000. Molecular Evolution: Phylogenetic approach: Blackwell Sci. Publ., Inc., USA.
3. Bromham, L., 2016. Molecular Evolution and Phylogenetics. Oxford Univ. Press, England.
4. Wiley, E.O., B.S. Lieberman. 2011. Wiley-Blackwell, New Jersey, USA.
5. Yang, Z. 2014. Molecular Evolution. Oxford Univ. Press, Clarent Street, England.

83. Molecular Immunology

MOLECULAR IMMUNOLOGY

Contact Hours:

Theory = 48
Total = 48

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To impart knowledge about molecular basis of innate immunity, acquired immunity, antigenicity and immune complexes.
2. To develop critical thinking about the mechanisms of autoimmune disorders and hypersensitivity reactions.
3. To develop analytical approach about the rejection of tissue graft and formation of infinite antibodies from the finite source of DNA.

Course Learning Outcomes:

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

1. **ACQUIRE** the knowledge about molecular basis of antigenicity and immune complexes.
2. **UNDERSTAND** the concepts of transplantation immunology and tumor immunology.
3. **ANALYZE** the histological feature of immune response in allergy and hypersensitivity cases.
4. **DEMONSTRATE** individually mechanism of immunization at molecular level and histological features of an exaggerated immune response.

Course Outline:

1. Immunology,
2. Immunobiology,
3. Immunophysiology,
4. Immunopathology,
5. Immunity,
6. Natural and acquired immunity,

7. Active and passive immunity,
8. Antigens and elicitation of immune response,
9. Molecular basis of cell mediated and humoral immunity,
10. Immunoglobulins,
11. Synthesis of antibodies and theories of antibody synthesis,
12. Antigenicity,
13. Interaction of antigens and antibodies,
14. Factors affecting immune response ,
15. Nature of antigens,
16. Genetic constitution of individuals and route of administration.
17. Detection and application of antigen –antibody reactions in vivo and in vitro.
18. Monoclonal antibodies,
19. Major histocompatibility complex and conservation of antigen binding site.
20. Cellular basis of immune response.
21. Specific response of individual lymphocytes to antigenic stimulation.
22. Histological features of immune response.
23. Hypersensitivity, anaphylactic,
24. antibody dependent cytotoxicity,
25. immune complex mediated,
26. delayed type hypersensitivity and stimulatory hypersensitivity.
27. Histological feature of allergic reactions and changes in immune response at molecular level,
28. Immunological tolerance and autoimmunity ,
29. Immuno potentiation and immunosuppression.
30. Transplantation Immunology,
31. Tumor immunology.
32. Immunity against infectious diseases.
33. Immuno deficiency diseases,
34. Immunization.
35. Immunization procedures ,
36. vaccines and their development.

Teaching Methodology:

- Lecturing
- Written Assignments
- Seminar
- Discussion
- Case study

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions) 50%
- Assignments 25%
- Quiz 25%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 10%
- Assignments 20%
- Quiz 20%

Text and Reference Books:

1. Bain, B., Bates, I., Laffan, M. and Lewis, M., 2012: Decie and Lewis Practical Hematology. 11th Ed. Churchill livingstone
2. Montanaro, A., 2015: Primary immunodeficiency Disorders. 1st Ed. Elsevier
3. O’Hehir, R.E., Holgate, S. T. and Sheikh, A., 2016: Middleton’s Allergy Essentails. 2nd Ed. Elsevier
4. Park,K., 2002: Park’s text book of Preventive and Social medicine. 2nd ed. MIS Barnarsid, India.
5. Richard, A. Goldsby, Thomas and Barbra,A. Kuby., 2007: IMMUNOLOGY. 6th edition. W.H Freeman and company Newyark

Additional Reading:

1. Abbas, L., and Pober, W., 1994: Cellular and molecular immunology. 2nd edition. B Saunders company London.
2. Roitt,I., 1990: Essential immunology. Black well Scientific Publication. 2nd ed. Oxford, UK.
3. Stities, D.P., Stobo, J.D., Fundnberg, H.H and Well, J.V., 1990: Basic and clinical Immunology. . Lange Medical Publication, USA.

84. Natural Photograph

NATURAL PHOTOGRAPHY

Credit Hours: 03
Practical= 01

Theory =02
Total = 03

Course Objectives:

The objective of this course is

1. to enable the student to Natural Photography
2. to understand the history of camera and its functions
3. to understand how to take photos of ecosystem landscapes, birds, mammals, insects

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about nature and its components
2. UNDERSTAND the camera and its functionsand the mechanics of imaging.
3. SOLVE and highlights the nature in photography
4. ANALYSE pictures and raw data of photographs
5. EVALUATE the key issues of nature
6. DEMONSTRATE the ecological assessment and importance of wildlife through photography

Course Outline

Ecology

1. **Biodiversity:**
 - a. Habitat:
 - b. Niche:
 - c. Biomes:
 - d. Biosphere:
2. **Ecosystems:**
 - a. Classes of Ecosystems:
3. **Aquatic Ecosystem:**
 - a. Marine Ecosystems:
 - b. Fresh Water Ecosystem:
4. **Terrestrial Ecosystem:**
 - a. Primary Terrestrial Ecosystems:
 - b. Tundra:
 - c. Taiga:
 - d. Temperate Deciduous Forest:
 - e. Tropical Rain Forest:
 - f. Grassland:
 - g. Deserts:
5. **Conservation Photography**
 - a. History:
 - b. Definition:
6. **Subjects of Conservation Photography:**
 - a. Application of Conservation Photography:
 - b. Photography of Birds
 - c. Photography of Small Birds:
 - d. Photography of Wading Birds:
 - e. Photography of Birds of Prey:
 - f. Photography of Birds in Flight:
7. **Photography of Animals, Flowers and Insects**
8. **Camera settings for the wildlife photographer:**
9. **Photographing the Portraits of Animal**
10. **Photographing Animals in Motion:**
11. **Photographing close ups of Flowers:**
 - a. Photography of Insects:
12. **Photographing potentially dangerous Insects:**
 - a. Photographing Forests,
 - b. Mountains and Water bodies
13. **Photographing the Trees in the Forest:**
 - a. Photographing Mountains:
 - b. Finding a center of interest:
 - c. Photographing Water bodies:
 - d. Photography of Water in Motion:
14. **Geotag Photography**
 - a. GPS
 - b. Georeferencing

Practicals:

1. Use of camera
2. Photographs of moving objects (animals)
3. Photographs of still objects (Landscape)
4. Geotagging and analysis of data on maps

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Recommended Books:

1. Brian Black 2017 DSLR Photography for Beginners: Take 10 Times Better Pictures in 48 Hours or Less! Best Way to Learn Digital Photography, Master Your DSLR Camera & Improve Your Digital SLR Photography Skills Kindle Edition
2. Tim Fitzharris 2018 National Audubon Society Guide to Nature Photography NASG USA
3. Thomas Heaton 2017 Landscape Photography On Location: Travel, Learn, Explore, Shoot Kindle Edition
4. Sean Arbabi 2011 The Complete Guide to Nature Photography: Professional Techniques for Capturing Digital Images of Nature and Wildlife Paperback
5. Art Wolfe 2013 The New Art of Photographing Nature: An Updated Guide to Composing Stunning Images of Animals, Nature, and Landscapes Paperback

85. Physical Oceanography

PHYSICAL OCEANOGRAPHY

(Cr. Hrs. 2+1)

Course Objectives:

1. To impart the concepts of physical oceanography
2. To know the important physical process in the Oceans
3. To know about effects of Physical process on water bodies

Course Learning Outcomes:

1. **Acquire** basic knowledge about the Physical Oceanography
2. **Understand:** the conceptual physical principles of oceans
3. **Solve:** students confidentially face with full command and expressing ideas about the physical processes of the oceans
4. **Analyze:** Students will able to categories the various physical processes of oceans.
5. **Evaluate:** To describe the significance of hydrographic and dynamic properties of sea water
6. **Demonstrate:** Measurements of hydrographic and dynamic properties of sea water , preparation of Tide charts, Isotherms

Course Contents:

1. **Introduction:**
 - a. History of physical oceanography
 - b. Origin and formation of the oceans,
 - c. Dimensions, topography and bathymetry.
2. **Physical properties of the sea water:**
 - a. Unique characteristic of water, Salinity as a thermodynamic variable,
 - b. Electrical conductivity, Density,
 - c. Thermal expansion, Compressibility,
 - d. Specific heat, Evaporation heat and diabetic temperature change, Vapor pressure, Freezing point, Boiling point
 - e. Viscosity, Surface tension, Acoustic and optical properties,
 - f. Sea ice and color of sea water.
3. **Temperature, Salinity and density distribution**
 - a. Diurnal variation and annual variations of surface temperature,
 - b. Salinity and density,
 - c. Distribution of temperature,
 - d. Salinity and density with depth and latitudes.
4. **Heat budget**
 - a. Transfer processes between ocean and atmosphere,
 - b. Incoming radiation, Back radiation,
 - c. Thermal conduction,
 - d. Evaporation, Precipitation, Continental run off,
 - e. Propagation of heat in oceans.

5. **Wind System**

- a. Wind circulation pattern, Pressure belts
- b. Climatic influence of oceans
- c. Pollution (wind and water driven) and its effects.

6. **Waves, Tides and Currents**

- a. Waves characteristics and Types of waves.
- b. Tides generating forces,
- c. Types of tides.
- d. Energy resource.
- e. Currents, Coriolis force, Convergence and divergence, Mixing processes, Upwelling and down welling, El-Ninos, Eddies,
- f. Tsunamis, Hurricanes, Storms, and Cyclones.

7. **Water Masses and Circulation of the Oceans:**

- a. Introduction, Wind-driven circulation, Mixing processes,
- b. Water masses and circulation in the Atlantic,
- c. Water masses and circulation in the Pacific,
- d. Water masses and circulation in the Indian,
- e. Water masses and circulation in the Arctic and Southern Oceans.

Practicals:

Oceanographic Instrumentation:

1. Provision of observing platform: Research vessels, moorings, satellites, submersibles, towed vehicles, floats and drifters.
2. Measurement of hydrographic properties (temperature, salinity, oxygen, nutrients, tracers): reversing thermometers, Nansen and Niskin bottles, CTDs, multiple water sample devices, Thermosalinographs and remote sensors.
3. Measurement of dynamic properties (currents, waves, sea level, mixing processes): Current meters, Wave measurements, Tide gauges and remote sensors.

Presentation of Data:

1. Preparation of tide charts, vertical and horizontal profiles of temperature and salinity; Current data plots; T-S diagrams and Sigma-tee.
2. Field visits.

Recommended Books:

1. Emery, W.J. & Thomson, R.E., 2004. Data analysis methods in physical oceanography. Elsevier Science.
2. Garrison, T., 1990. Oceanography, an invitation to Marine Science, 6th edition, Thompson-Brookes/Cole Publishing Co.
3. George Karleskint, Richard Turner & James Small, 2005. Introduction to Marine Biology (with InfoTrac), 2nd edition, Brooks Cole.
4. James W. Nybakken & Mark D. Bertness, 2004. Marine Biology: An Ecological Approach, 6th Edition, Benjamin Cummings.
5. Keith A. Sverdrup & Virginia Armbrust, 2006. An Introduction to the World's Oceans, 9th edition McGraw-Hill Science/Engineering/Math Publisher.

6. Knauss, J.A., 1997: Introduction to physical oceanography, 2nd edition, Prentice Hall.
7. Peter Castro & Michael E. Huber, 2005. Marine Biology, 6th edition, McGraw-Hill Science/Engineering/Math.
8. Pickard, G.L. and W.J. Emery 2011. Descriptive Physical Oceanography . 6th edition Pergamon Press. 545pp
9. Wells, N.C. 1997. The Atmosphere and Ocean, John Wiley.

86. Principles of aquaculture

PRINCIPLES OF AQUACULTURE

Credit Hours:

Theory = 2.0
 Practical = 1.0
 Total = 3.0

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. Identification of important fish diseases; artificial fish breeding; injection; striping and fertilization.
9. Visit of aquafarms and fish hatcheries to study aquaculture effluents and polluted sites.

Assessment:

Mid Term (20%)

- Written (Long Questions, Short Questions, MCQs)

Assignment (15%)

Practical (20%)

Final Term (45%)

- Written (Long Questions, Short Questions, MCQs)

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 Publishing, 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.

87. **Principles of Wildlife Management***

N.A

88. **Recombinant DNA Technology**

RECOMBINANT DNA TECHNOLOGY

Contact Hours:

Theory = 64

Total = 64

Credit Hours:

Theory =**4.0**

Total= 4.0

Course Objectives:

The course aims to:

1. To provide thorough knowledge about principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms, and gene therapy
2. To explore applications of recombinant DNA technology in medical and industrial settings.
3. To familiarize students with the wide variety of research options currently available in biotechnology
4. To provide theoretical background regarding the applicability of various techniques of recombinant DNA technology to specific scientific inquiries.

Course Learning Outcomes:

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

1. **ACQUIRE** basic principles of recombinant DNA technology.
2. **UNDERSTAND** strategies/research methodologies employing genetic engineering techniques.
3. **ANALYZE** creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
4. **EVALUATE** applications of recombinant DNA technology in biotechnological research.

5. **DEMONSTRATE** various research problems by using genetic engineering methodologies.

Course Outline:

1. **SALIENT FEATURES OF CLONING VECTORS**
 - a. Types of cloning vectors
 - b. Plasmids, cosmids, ssDNA Phages, Yeast cloning vectors
 - c. Animal viruses, Ti plasmids and Cauliflower Mosaic Virus.
2. **PLASMID BIOLOGY**
 - a. Structural and functional organization of plasmids
 - b. Plasmid replication
 - c. Stringent and relaxed plasmids
 - d. Incompatibility of plasmid maintenance
3. **BIOLOGY OF BACTERIOPHAGE LAMBDA**
 - a. Lambda phage as a natural *in vivo* vector
 - b. *In vitro* construction of lambda vector
 - c. Classes of vectors and their use
4. **ENZYMES IN GENETIC ENGINEERING**
 - a. DNA polymerase, polynucleotide kinase, T4 DNA ligase
 - b. Nick translation system
 - c. Terminal deoxynucleotidyl transferase, Reverse transcriptase
Restriction endonucleases Type I & II.
5. **ISOLATION OF GENOMIC AND NUCLEAR DNA**
 - a. DNA digestion and restriction fragment analysis
 - b. Sequencing by chemical, enzymatic and big-bye terminator methods
6. **CLONING AND SUBCLONING STRATEGY**
 - a. Construction of recombinant DNA and preparation of competent cell transformation
 - b. Transfection, recombinant selection and screening; Genomic DNA library; cDNA synthesis strategies—Linkers—Adapter homopolymer tailing
 - c. Genomic and cDNA libraries in plasmids and phages. PCR product cloning (TA cloning). Cloning strategies in yeast (*Saccharomyces cerevisiae*) and bacteria (*E. coli* and *B. subtilis*).
7. **SELECTION OF rDNA CLONES AND THEIR EXPRESSION PRODUCTS**
 - a. Direct and indirect methods. Drug resistance, gene inactivation
 - b. DNA hybridization, colony hybridization and *in-situ* hybridization (Southern, Northern and Dot blots and immunological techniques, Western blotting).
8. **GENE MODIFICATION & APPLICATION OF RECOMBINANT DNA TECHNOLOGY**
 - a. Mutagenesis-Deletion mutagenesis, Oligonucleotide derived mutagenesis, Site directed mutagenesis
 - b. Applications of rDNA technology in Diagnostics; Pathogenesis
 - c. Genetic diversity; Therapeutic proteins-vaccines.
 - d. Molecular probes (Production, labelling and uses)

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speakers
- Research centers visits
- Report writing

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%

Text and Reference Books:

1. Brown, T. A., 2016. Gene Cloning and DNA Analysis: An Introduction; 7th Edition, John Wiley and Sons Ltd., Chicester, UK.
2. Glick, B. R., Pasternak, J. J. and Cheryl L. Patten, C. L. 2009. Molecular Biotechnology: Principles and Applications of Recombinant DNA; 4th Edition, ASM Press, Washington, USA.
3. Green, M. R. and Sambrook, J. 2012. Molecular Cloning: A Laboratory Manual; 4th Edition, Cold Spring Harbor Laboratory Press, New York, USA.
4. Howe, H. 2007. Gene Cloning and Manipulation, Cambridge University Press, New York, USA.
5. Jeremy W. Dale, J. W., Malcolm von Schantz, M. V. and Plant, N. 2011. From Genes to Genomes: Concepts and Applications of DNA Technology; 3rd Edition, John Wiley and Sons Ltd., Chicester, UK.
6. Nicholl, D. S. T. 2008. An Introduction to Genetic Engineering; 3rd Edition. Cambridge University Press, Singapore.
7. Old, R. W. and Primrose, S. B. 2009. Principles of Gene Manipulation, an Introduction to Genetic Engineering, 5th Edition, Blackwell Scientific Publications, USA.
8. Primrose, S. B. and Twyman, R. M. 2015. Principles of Gene Manipulation and Genomics; 8th Edition, Wiley-Blackwell, Oxford, UK.
9. Watson, J. D., Meyers, R. M., Caudy, A. A. and Witkowski, J. A. 2007. Recombinant DNA: Genes and Genomes A Short Course; 3rd Edition, Cold Spring Harbor Laboratory Press, New York, USA.
10. Watson, R. R. and Preedy, V. R. 2016. Genetically modified organisms in food: Production, safety, regulation and public health. Amsterdam: Elsevier Science

89. Reproductive Physiology

REPRODUCTIVE PHYSIOLOGY

Contact Hours:

Theory = 16
Practical = 96
Total = 112

Credit Hours:

Theory = 1.0
Practical = 2.0
Total = 3.0

Course Objectives:

The objectives of the course are:-

1. To provide a basic grounding in the physiology of the reproductive system of both males and females
2. To demonstrate reproductive cyclicity in mammals
3. To elaborate the mechanism of reproductive aging in male and female

Course Learning Outcomes:

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

1. **UNDERSTAND** the physiology of both male and female reproductive organs
2. **DESCRIBE** the interrelationships between various hormonal systems (both male and female) and their effect on reproduction
3. **PORTRAY** the patterns of reproductive cyclicity in domestic animals
4. **EXPLAIN** the process of reproductive aging in males and females

Course Outline:

1. **Introduction : Overview of physiology of reproduction**
 - a. Reproductive strategies
 - b. comparative aspects
2. **Anatomy of the male reproductive system**
3. **Anatomy of the female reproductive system**
4. **Functional histology of male and female reproductive system**
5. **Neuroendocrine control of reproduction**
 - a. Pituitary and hypothalamus
 - b. Pineal gland
 - c. Adrenal gland
6. **Physiology of ovarian function**
 - a. Folliculogenesis
 - b. Oocyte maturation
 - c. Endocrinology
 - d. Ovulation
7. **Physiology of testicular function**
 - a. Organization
 - b. Endocrinology
 - c. Regulation
 - d. Immunology

8. **Physiology of sperm maturation and fertilization**
 - a. Spermatogenesis and spermiation
 - b. Epididymal function
 - c. Functions of accessory sex glands
 - d. Capacitation and acrosome reaction
 - e. Fertilization
9. **Physiology of gestation and early embryonic development**
 - a. Development in oviduct
 - b. Implantation and placentation
 - c. Maintenance of pregnancy
10. **Reproductive cycles**
 - a. Pre- and neonatal development
 - b. Puberty,
 - c. Estrous cycle
 - d. Breeding seasons
11. **Aging**
 - a. Physiology of menopause
 - b. Senescence in male

Practical:

1. Demonstration of male reproductive system in vertebrates.
2. Demonstration of female reproductive system in vertebrates.
3. Morphological studies of sperm in the buffalo/cattle.
4. Morphological studies of ova (buffalo/cattle/goat/sheep).
5. Histological studies of ovaries & oviduct
6. Histological studies of uterus at different phases of cycle
7. Histological studies of cervix and vagina
8. Histological studies of testes and epididymis
9. Radioimmuno assays of different hormones.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Report Writing

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%

Text and Reference Books:

1. Essential Reproduction by M. H. Johnson. 8th edition (2018). Published by Wiley-Blackwell, USA.
2. Pathways to Pregnancy and Parturition by P. L. Senger. 3rd edition (2012). Published by Current Conceptions Incorporated USA.
3. Andrology by E. Nieschlag, H. M. Behre and S. Nieschlag. 3rd edition (2010). Published by Springer, USA.
4. Knobil & Neill's Physiology of Reproduction by *T. M. Plant and A. J. Zeleznik*. 4th edition (2014). Published by Springer, USA.

90. **Research Methods in Entomology**

RESEARCH METHODS IN ENTOMOLOGY

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = **3.0**
Total = **3.0**

Course Objectives:

The objectives of the course are:-

1. To enable students get familiarized with modern equipment used in Entomological Research
2. To provide concept of software in data analysis.

Course Learning Outcomes:

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

1. Acquire the basic knowledge of modern equipment used in Entomological Research
2. Understand the concepts of basic drawing techniques and use them efficiently.
3. Demonstrate software in data analysis.

Course Outline:

1. **Introduction**
 - a. Techniques and apparatus employed in entomological research
 - b. Temporary and permanent mounts
2. **Microtomy**
 - a. use of ocular grid
 - b. micrometry
 - c. scientific photography
3. **Bio-assay techniques**
 - a. Atomic absorption spectrophotometer,
 - b. Gas chromatography,
 - c. High performance liquid chromatography

- d. UV-visual spectrophotometer
- e. Amino acid analyzer
- f. Electrophoresis
- 4. **Recombinant DNA techniques**
 - a. PCR
 - b. Ultra-centrifugation
- 5. **Microscopy**
 - a. Scanning electron microscopy
 - b. Transmission electron microscopy
- 6. **Computer software in entomology**
 - a. Methods of sampling
- 7. **Analysis of data**
 - a. Report writing
 - b. Lab/field experimental techniques.

Teaching Methodology:

- Lecturing
- Written Assignments
- Field Visits
- Report Writing

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%

Text and Reference Books:

1. Bancroft, J.D. and Stevens, A. 1990. Theory and Practice of Histological Techniques. Chaschill Livingstone, London.
2. Binns, M.R. 2000. Sampling and Monitoring in Crop Protection. CABI Publishing Company
3. Cappiello, A. 2007. Advance in LC-MS Instrumentation. Elsevier Publishers, USA.
4. Erlich, H. 1992. PCR Technology: Principles and Applications for Amplification. W.H. Freeman & Company, New York.
5. Singh, P. and Moore, R.F. 1985. Handbook of Insect Rearing. Vol, I & II, Elsevier, U.S.A.

91. Sea Food Processing

SEA FOOD PROCESSING

(Cr. Hrs. 3(2+1))

Course Objectives:

1. Enable the students to work with sea food processing industry
2. To provide the information about sea food processing
3. To know about the handling of sea food

Course Learning Outcomes:

1. **Acquire** basic knowledge about the handling and processing of sea food
2. **Understand:** the basic techniques of processing and preservation of sea food
3. **Solve:** students have full command on handling and processing of sea food.
4. **Analyze:** Students will able to analyze the various chemical and spoilage aspects, sea food products.
5. **Evaluate:** To describe the significance of Sea food handling and processing
6. **Demonstrate:** Quality evaluation of sea food processing

Course Outlines:

1. **Introduction**
 - a. Sea Foods of the world, History, Scope.
 - b. Statistics and potential of the Industry with respect to Pakistan and the World.
2. **Sea Foods Classification**
 - a. Biological, Environmental;
 - b. Body Form and Compositional Basis.
3. **Chemistry**
 - a. Composition; Post-mortem Changes.
 - b. Chemical and Biochemical changes during storage and processing.
4. **Spoilage**
 - a. Chemical, Biological, Microbial Enzymatic and Environmental factors.
5. **Quality Evaluation**
 - a. Laboratory indices.
 - b. Scientific measures of fish quality.
 - c. Torrey freshness scoring system.
 - d. Determinates and perceptions, Initial biological condition
 - e. Workman-ship,
 - f. postmortem biology and consumer perception.
6. **Fish Handling and Processing**
 - a. Onboard handling: sturnng, brain spiking, bleeding techniques and rapid chilling.
 - b. Sachimi-grade.

- c. Icing procedures and storage.
 - d. Off loading,
 - e. Onshore handling
 - f. Fish markets :
 - g. Pre and Post-Filleting handling.
 - h. Freezing, Drying, Salting, Smoking, Pickling, Canning, Irradiation and Acidification.
7. **Sea Food Products**
- a. Minced, Fish Meal and Oil, Hydrolysate, Protein concentrate.

Practicals:

- 1. Sensory evaluation of fish freshness.
- 2. Torrey and E.U. Sensory Schemes.
- 3. Analysis of different sea foods.
- 4. Determination of TMA and TBA.
- 5. Product development.

Recommended Books:

- 1. Martin R.E. & Flick G.J. 1990. The Sea Food Industry, Van Nostrand Reinhold, USA.
- 2. Regenstein J.M. And Regenstein C.E. 1991. Introduction to Fish Technology, Van Nostrand Reinhold, USA.
- 3. Ruiter A. 1995. Fish and Fishery products, CAB International, U.K.
- 4. Shahidi F., Johns Y. nad Kitts D.D. 1997. Sea Food Safety, processing and Biotechnology, Technomic publishing Co. Inch. USA.

92. **Sericulture**

SERICULTURE

Contact Hours:

Theory = 96
 Practical = 16
 Total = 112

Credit Hours:

Theory = 2.0
 Practical = 1.0
 Total = 3.0

Course Objectives:

The objectives of the course are:-

- 1. To equip the students with sericulture cottage industry for rural development, multiple uses of forests, and sustainable forest resources management.
- 2. To have better understanding about the status, classification, season of occurrence and life cycle of pests infesting mulberry and silkworm.
- 3. This course will provide an opportunity to the students to gain knowledge on the status, classification, season of occurrence and disease cycle of causal organism infecting both mulberry and silkworm.

Course Learning Outcomes:

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

1. **ACQUIRE** basic knowledge of the detailed aspects of pests and diseases of both mulberry and silkworm.
2. **UNDERSTAND** the Economic relationship of host and pest.
3. **SOLVE** problems related to pest management by applying theoretical knowledge with practical efficacy.
4. **ANALYZE** and enhance silk techniques by using different Entrepreneurship skills
5. **EVALUATE** problems using practical knowledge in Zoology
6. **DEMONSTRATE** the diseases of mulberry through various methods including integrated approaches.

Course Outline:

1. Introduction to Sericulture; what is Sericulture, Scope of Sericulture, Origin and history of Sericulture.
2. World output of Silk, other natural fibers- Present status of silk production. Importance of natural fiber vis-a-vis manmade fibre, Role of silk fiber amongst natural fibers. By-products of sericulture.
3. Introduction to mulberry silkworm *Bombyxmori*; what is mulberry sericulture
4. Basic requirements for silkworm rearing House: Requirements for ideal rearing house – site selection- size of rearing house. Orientation – Model rearing house - B Model – advantages and disadvantages rearing houses.
5. Incubation of silkworm eggs, environmental conditions required for incubation – their influence in egg development – incubation method – low cost- incubation devices – earthen pot, double brick wall chamber – black boxing
6. Silkworm rearing techniques/methods and ecological requirements Brushing – methods – loose eggs and short eggs – capping and net Method – selection of Leaf brushing – advantages and disadvantages of different types of brushing – cellular and mass brushing.
7. Mechanization in sericulture
8. Mounting, types of mountages, and cocoon quality parameters
9. Diseases of silkworm and their management
10. Economics of sericulture, concepts of benefit-cost ratio, marketing
11. Extension education in sericulture

Practical:

1. Sericulture maps.
2. Identification and study of sericulture products
3. Cocoon and silk yarn -different types,Pupae, Silk waste, Spun Yarn, Noil Yarn,Other by products.
4. Study of Morphology of silk worm : a Mouth parts of silkworm b External morphology of egg, larva, pupa and moth c Sex separation of larva, pupa and moth

5. Cocoon characters of uni, bi and multivoltine races.
6. Identification of different non mulberry cocoons
7. Rearing Technology : Study of a model rearing house
8. Study visits to any Sericulture cottage industry and submit study report as well.

Assessment:

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Mid Term (30%)

- Written (Long Questions, Short Questions, MCQs) 20%
- Assignments 05%
- Presentation 05%

Final Term (70%)

- Written (Long Questions, Short Questions, MCQs) 55%
- Practical 10%
- Attendance 5%

Text and Reference Books:

1. Eikichi Hiratsuka .2000.Silkworm breeding, Oxford and IBH publications, New Delhi.
2. Nobumasa Hojo .2000. Structure of the Silk yarn, Oxford and IBH publications, New Delhi. Devaiah M.C et al. 2001; Advances in Mulberry Sericulture. Dept. of Sericulture, UAS, Bangalore.
3. Yasuji Hamamura. 2001. Silkworm Rearing on artificial diet- Oxford & IBH Publishing Co.Pvt .Ltd. New Delhi & Calcutta.
4. S.Morohosi.2000. Development Physiology of Silkworms (Translated Japanese) Oxford & IBH Publishing Co.Pvt .Ltd. New Delhi , Calcutta.
5. Silk Dyeing and Finishing Handbook.2000.(Translated from Chinese) Compiled by Shanghai Silk Industry Corporation,China.Oxford & IBH Publishing Co.Pvt .Ltd. New Delhi & Calcutta.

93. **Toxicology**

TOXICOLOGY

Contact Hours:

Theory = 30
Total = 30

Credit Hours:

Theory = 3.0
Total = 3.0

Course Objectives

The course objectives are:

1. To provide knowledge about the different carcinogenic, mutagenic and teratogenic agents and their mode of action
2. To study the effects of different chemicals on living cell.

Course Learning Outcomes:

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

1. To understand different carcinogenic, mutagenic and teratogenic agents and their mode of action.
2. To analyze the effects of different chemicals on living cell

Course Outline

1. Introduction to Principles of Toxicology

- a. The science of poison, early fundamental development
- b. Types of toxicology, Common terms and Nomenclature
- c. Applications of toxicology: Research, Regulatory toxicology, Forensic toxicology, Clinical toxicology
- d. Classification of toxic agents according to use: Pesticides, food and industrial additives, Therapeutic drugs, Sources of toxins: Botanical, Environmental.

2. Effects of Chemicals

- a. Toxicological effects: General classification, Chemical allergies, Immediate versus delayed hypersensitivity, Local versus systemic effects, Mutagenic and carcinogenic effects, Biochemical properties
- b. Exposure: Route: Oral administration, Intranasal administration, Inhalation, Dermal and Parenteral routes, Duration and frequency
- c. Accumulation: According to physiological compartment, According to chemical structure, Chemical interactions, Dose-Response relationship, Criteria for measurement

3. Toxicokinetics

- a. Relationship to pharmacokinetics: Applications to toxicology testing
- b. Absorption: Ionic and non-ionic principles, Henderson- Hasselbach equation, Absorption in nasal and respiratory mucosa
- c. Distribution: Fluid compartments, Plasma protein binding, Lipids, Liver and kidney, Blood-brain barrier
- d. Biotransformation: Principles of detoxification, Biochemical pathways, Enzyme systems
- e. Elimination: Urinary excretion, Fecal elimination, Pulmonary elimination, Mammary gland secretion, other secretion

4. Descriptive Animal Toxicology

- a. Correlation with human exposure, Animal welfare and US animal welfare act
- b. Chemicals: Selection of chemicals, Route of administration
- c. Species differentiation: Selection of appropriate animal species, Methodologies

5. Acute Toxicology

- a. Objectives of acute toxicology, LD50 and acute toxicology, Organization of studies
- b. Range finding tests: Up-and-down procedure (UDP), Fixed dose procedure (FDP), Acute toxin class method (ATCM)
- c. Classical LD50: Oral, Dermal and inhalation LD50, Other considerations with LD50 determinations, Applications of LD50.

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%

Text and Reference Books:

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

94. Vaccinology

VACCINOLOGY

Contact Hours:

Theory = 72
Total = 72

Credit Hours:

Theory = 4.0
Total = 4.0

Course Objectives:

The objectives of the course are:-

1. To be able to know the history of vaccines.

2. To provide students with knowledge of different mechanisms of vaccine working.
3. The students will be able to describe vaccine types and their advantages.
4. To be able to describe how vaccine can be produced

Course Learning Outcomes:

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

1. **Explore** the basic knowledge about vaccine history
2. **Describe** the concepts about the role of vaccine working mechanism.
3. **Interpret** the problems using vaccine production techniques.
4. **Detect** the problems using the same techniques for valuable vaccine production.
5. **DEMONSTRATE** individually the ways through which different types of vaccine can be produced and evaluated for further use.

Course Outline:

1. **History of vaccines**
 - a. How vaccine originated
2. **Target ed proteins as Vaccine**
 - a. Viral proteins as potential targets for vaccine
3. **Types of Vaccine and Production**
 - a. Live versus attenuated vaccines
 - b. Role of multinational companies in vaccines production
 - c. DNA as vaccine
 - d. Peptide & Subunits vaccine
 - e. Adjuvants in vaccines
 - f. Population Genetic analysis: immunity to vaccine
 - g. Recombinant vaccine
4. Animal models of vaccine testing
5. Cost-effective approaches for production of new vaccines
6. Human testing and efficacy of vaccines: ethical issues
7. Recommendations of the Advisory Committee on Immunization Practices (ACIP)
8. Quadrivalent vaccine against human papillomavirus to prevent high-grade cervical lesions
9. Understanding the demand and supply of popular vaccine
10. Launching of vaccine and clinical trials
11. Anti-rabies immunoglobulin preparation based on F(ab')₂ fragments
12. Effect of Panavir/Zanamivir on influenza A virus reproduction
13. Vaccine safety

Teaching Methodology:

- Lecturing
- Written Assignments
- Visits to a Multinational company

- Analysis/interpretation of diagnostic Tests results

Assessment:

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Sessional tests 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Sessional tests 10%

Text and Reference Books:

1. Recombinant vectors in vaccine development by Fred Brown.
2. The Vaccine book by Barry R. Bloom.
3. Vaccine S by Plotkin_Orenstein.
4. Mass vaccine global aspect-progress and obstacles by Plotkin.
5. Pre-clinical and Clinical development of new vaccines by Fred Brown.

Journals Recommended

1. VACCINE, JOURNAL OF ANTIMICROBIAL CHEMOTHERAPY
2. CLINICAL IMMUNOLOGY AND IMMUNOPATHOLOGY
3. MEDICAL MICROBIOLOGY AND IMMUNOLOGY

95. **Wetlands Management**

WETLANDS MANAGEMENT

Credit Hours: 03

Practical= 01

Theory =02

Total = 03

Course Objectives:

The objective of this course is

1. To enable the student to understand basics of wetlands, wetlands in Pakistan and its significance
2. To understand values, valuation and management of wetlands
3. To understand how National and International agencies involved in conservation and management of wetlands

Course Learning Outcomes:

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

1. ACQUIRE theoretical knowledge about wetlands in Pakistan, its importance with reference to migratory birds.
2. UNDERSTAND the changes in climate affecting wetlands

3. SOLVE the threats to wetlands due to climate change and anthropogenic activities.
4. ANALYSE, interpreting and synthesize data and other information about wetlands and related diversity.
5. EVALUATE the wetland conservation management by government department, National and International organizations
6. DEMONSTRATE the ecological assessment and importance of wetlands to certain area.

Course Outline

1. **Wetlands of Pakistan**
 - a. Aquatic ecosystems
 - b. Introduction to Wetlands
 - c. Classification
 - d. Wetlands hydrology
 - e. Clarity on wetlands and Water Use
 - f. Wetlands and Water Quality
 - g. Wetlands and Environmental Flows
2. **Biogeochemistry**
3. **Wetlands and Climate change**
4. **Human Impacts and Management of wetlands**
5. **Values and valuation of wetlands**
 - a. Lakes and rivers
6. **Degradation of aquatic ecosystems**
7. **Wetlands and Nutrient Retention**
8. **Restoration of wetlands**
 - a. Passive restorations
 - b. Active Restoration
9. **The Ramsar strategic plans**
10. **Research on Sustainable Agriculture and Wetlands**

Practicals:

Preparation of a conservation project for wetlands

1. Wetlands without outlets
2. Wetlands with outlets
3. River and marsh lands
4. Coastal wetlands

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation 20%
- Assignments 20%
- Report writing 10%

Recommended Books:

1. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley & Sons, Inc.
2. Greipsson, S. 2011, Restoration Ecology, Biology and Physics Department, Kennesaw State University, Kennesaw, Georgia
3. Parikh, J. and Dattye, H. (2003). Sustainable Management of Wetlands Biodiversity and beyond. Sage Publications New Delhi Thousand Oaks London. Pp.444.
4. Verhoeven, J. T. A., Beltman, B., Whigham, D. F., Roland Bobbink. (2006). Wetlands and Natural Resource Management. Verhoeven, J. T. A., Beltman, B., Whigham, D. F., Roland Bobbink (eds). Springer-Verlag Berlin Heidelberg

96. Wildlife Conservation and Management

WILDLIFE MANAGEMENT AND CONSERVATION

Credit Hours: 04

Practical= 01

Theory =03

Total = 04

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 wildlife management rules and regulations in Pakistan
3. 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 (population estimate technology) of fishes, 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 Outline:

1. **Wildlife of Pakistan**
 - a. Introduction
 - b. Important Definitions
 - c. Identification
 - d. Distribution
 - e. Status
 - f. Wildlife values
 - g. Conservation and Management (population estimate technology) of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan
2. **Objectives of wildlife conservation**
3. **Problems in wildlife conservation**
4. **Wildlife rules and regulations in Pakistan**
 - a. Principles of Reintroduction
 - b. IUCN categories of Wildlife
 - c. Zoo rules
5. **National and International agencies involved in conservation and management of wildlife**
 - a. National Organizations
 - b. International Organizations
6. **Protected Areas in Pakistan**
 - a. Sanctuaries
 - b. Game Reserves
 - c. National Parks
7. **Threatened species of Pakistan.**
 - a. Vulnerable
 - b. Endangered
 - c. Critically Endangered
8. **Modern Techniques for Control of Environmental Pollution in Wildlife Areas**
9. **Endangered Species Causes and Measures for the Conservation**
10. **International Conventions**

Practicals:

1. Visit to National Parks, Wildlife Sanctuaries, Game Reserves.

2. Population Studies of some Reptiles, Birds and small Mammals.
3. Report on Endangered species

Teaching Methodology:

- Lecturing
- Written assignments
- Guest speaker
- Field visits
- Report writing
- Assessment

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Recommended Books:

1. Mills, S. 2007. Conservation of Wild population. Blackwell Publishing & Co. London, UK.
2. Sinclair, A. R. E., Fryxell, J. M. and Caughley, G. 2006. Wildlife Ecology, Conservation and Management. Blackwell Publishing & Co., London, UK.
3. Sutherlands, W. J. 2000. The Conservation handbook, Blackwell Science.
4. Sexena, M.M., 1990. Applied Environmental Biology, Agro Botanical Publ. India.
5. Rigger. P.G. 1991. Long Term Ecological Research, an International Perspective. John Wiley.
6. Sheehun et. al. P. J. 1984. Effects of Pollution on the Ecosystem. John Wiley.

97. Wildlife of Pakistan

WILDLIFE OF PAKISTAN

Contact Hours:

Theory = 1.0
Total = 3.0

Credit Hours:

Practical =2.0

Course Objectives:

The objectives of the course are:-

1. To familiarize the students with the wildlife fauna of Pakistan

2. To create the awareness among the students about the important wildlife species
3. To equip the students with the knowledge of wildlife management and conservation

Course Learning Outcomes:

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

1. Acquire the basic knowledge about the wild species of Pakistan
2. Evaluate the problems faced by each wildlife species in their ecosystem
3. Demonstrate the wildlife values and threats to wildlife fauna due to environmental aspects

Course Outline:

1. Introduction

- a. An Introduction to Wildlife of Pakistan:
- b. Existing Wildlife in Pakistan (Province)
- c. Wildlife biology
- d. Wildlife Population Ecology
- e. National and International organizations involved in conservation and management of wildlife

2. Wildlife Management

- a. Wildlife Management at Wetlands
- b. Terrestrial Wildlife Management
- c. Wildlife Damage Management
- d. Captive Wildlife Management

3. Wildlife Conservation

- a. Philosophy and significance of wildlife conservation.
- b. Essentials of Wildlife Conservation and National Perspectives
- c. Conservation of Amphibians and Reptiles
- d. In-situ conservation and Ex-situ conservation

4. Biodiversity of Pakistan:

- a. Biodiversity and sustainability of wildlife
- b. Identification, distribution, status and endangered species
- c. Mammals, Birds, Reptiles and Amphibians
- d. Fresh water and Marine fish fauna of Pakistan, Insects and plants

5. Wildlife Conservation

- a. Philosophy and significance of wildlife conservation.
- b. Essentials of Wildlife Conservation and National Perspectives
- c. Conservation of Amphibians and Reptiles
- d. In-situ conservation and Ex-situ conservation

6. Biodiversity of Pakistan:

- a. Biodiversity and sustainability of wildlife
- b. Identification, distribution, status and endangered species
- c. Mammals, Birds, Reptiles and Amphibians
- d. Fresh water and Marine fish fauna of Pakistan, Insects and plants

7. Protected Areas

- a. Protected Areas Systems, Zoo and Breeding Centers

- b. Wildlife Sanctuaries, National Parks and Game Reserves
- c. Wetlands and Ecological Zones
- 8. **Issues and challenges**
 - a. Threats to Wildlife
 - b. Species of Special Concern and Invasive species
 - c. Habitat destruction and fragmentation
 - d. Deforestation and urbanization
- 9. **Wildlife Rules and Regulations and importance**
 - a. Laws, Policy and social issues
 - b. Values and Economics of Wildlife

Practical:

1. Autopsy of animals, micro-histological studies and food/diet composition analysis,
2. Study of distribution description, biology, food, predators and status of wild animals of a zoo or Zoological park of Pakistan.
3. Adaptive features of animals in relation to food and environment
4. Construction of food chain and food webs of wild animals.

Teaching Methodology:

- Lecturing
- Written Assignments
- Guest Speaker
- Field Visits
- Report Writing

Assessment:

Midterms (40%)

- Written (Mcqs, Short and Long Questions)
- Presentation
- Assignments
- Report writing

Final Term (60%)

- Written (Mcqs, Short and Long Questions 50%)
- Presentation
- Assignments
- Report writing

Text and Reference Books:

1. Wildlife of Pakistan, 2002. Published by Punjab Wildlife Department, Lahore.
2. Miller, G.T. 2002. Living in the Environment: Principles, Connections and Solution. 12th Edition. Thomson Learning Inc., Australia.
3. Roberts, T.J., 1998. The Birds of Pakistan, Vol. II, Oxford.
4. Roberts, T.J., 1992. The Birds of Pakistan, Vol. II, Oxford.
5. Roberts, T.J., 1998. Mammals of Pakistan, Ernest Benon Ltd. London.

6. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management, McMillan, Cambridge.
7. <http://www.wildlifeofpakistan.com>

98. **Wildlife Techniques and Data Analysis**
N.A