UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that the Vice-Chancellor has, in exercise of the powers vested in him under Section 15(3) of the University of the Punjab Act, 1973 and in anticipation of approval of the relevant bodies, approved the recommendations made by the Board of Faculty of Life Sciences at its meeting dated 08-07-2021 ragarding approval of Syllabi & Courses of Reading for BS (4-Years) Program for the Institute of Zoology and Affiliated Colleges with effect from the Academic Session, 2021 and onward.

The Syllabi & Courses of Reading for BS (4-Years) Program is attached herewith, vide Annexure 'A'.

Sd/-
Dr. Muhammad Khalid Khan
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

No. D/ 10398 /Acad. **Dated: 19-11-2021.**

Copy of the above is forwarded to the following for information and further necessary action: -

1. Dean, Faculty of Life Sciences
2. Director, Institute of Zoology
3. Principals of Affiliated Colleges
4. Controller of Examinations
5. Director, IT
6. Deputy Registrar (Affiliation)
7. Deputy Registrar (Secrecy)
8. Secretary to the Vice-Chancellor
9. Secretary to the Registrar
10. Assistant Syllabus (with File)

Assistant Registrar (Academic)
for Registrar

Annexure-A

CURRICULUM
OF
B.S. ZOOLOGY
For
BS 4-Years Program

①

Program Title: BS Zoology (4 Years) Program
Department: Institute of Zoology
Faculty: Faculty of Life Sciences

1. **Mission of the Institute**

Our mission at the Institute of Zoology is to help our students and community by staying true to the ontological and epistemological traditions of our discipline. In an open and interactive environment, we encourage our students and faculty to understand ourselves as human beings, our interdependence on each other and the trends of cooperation and conflict that influence our mutual existence. As educators and social scientists, we endeavor to imbue our students with a sense of 'self' that is innately connected to the 'collective'. It is our hope and belief that our pedagogical style will promote peace and compassion through learning. We intend to create indigenous sociological knowledge and apply professional research skills to influence social policies for desirable social change in our own cultural domain. This has the aim of improving our social and cultural environment and raising the quality of life in Pakistan.

2. **Introduction of the Institute**

The Institute of Zoology, formerly Department of Zoology was established in 1921 and at present it offers BS (Morning & Evening), MS/MPhil (Morning & Evening), M.Phil (In-Service) and Ph.D. programs. The Institute has highly qualified and experienced faculty members to supervise these programs.

The Institute of Zoology is a student-centered and research-oriented institution. It offers a range of high-quality educational programs at undergraduate, graduate, and postgraduate levels. The Institute of Zoology is dedicated to the discovery, sharing and application of knowledge to aid in the due progress of our society and the nation. The core value of the Zoology remains the pursuit of useful knowledge for improving human life.

The Institutional labs are fully equipped with modern research facilities. The Institution has established research collaboration with INMOL, Lahore, PCSIR, Lahore, Post Graduate Medical Institute, Sheikh Zayed Hospital, Lahore, NIBGE, Faisalabad, NIAB, Faisalabad, University of Agriculture, Faisalabad, Departments of Live Stock, Wildlife and Fisheries.

Zoology is an exceptionally broad discipline covering diverse fields such as Biochemistry, Cell Biology, Molecular Biology, Physiology, Microbiology, Developmental Biology, Genetics, Palaeontology, Fisheries, Entomology, Wildlife, Evolution, Environmental Biology and, etc.

Our goal is to provide balanced knowledge of the discipline to students. A Zoologist must be acquainted with all core biological disciplines deriving from major branches of Zoological Sciences. The manpower trained in the subject of Zoology gets accommodated in the academic and research organizations like Education, Health, Agriculture, Fisheries, Wildlife, Environmental sector, Pharmaceutical and Pesticide producing industries.

3. **Program Introduction**

Zoology as a subject is multidisciplinary in nature involving studies of organisms and their genetic, morphological and physiological attributes, their surrounding environment, and role in conservation of environment. This subject has significant role in human resource development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.The BS in Zoology is an undergraduate degree program that is designed to produce qualified zoologists/professionals who are able to make meaningful contribution in enhancing understanding about zoological issues of Pakistan. This program is a blend of theoretical and practical knowledge to equip students with current data in this field. This is achieved through providing high quality education and training to our students. Like most of the developing countries, Pakistani population has been suffering from a variety of nutritional deficiency disorders ranging from protein malnutrition to specific micro-nutrients in certain areas of the country. These nutrient deficiencies are propagated by multiple factors like dietary insufficiencies of micronutrients, poor maternal and child health, high burden of morbidity, low levels of micronutrients in the soil, bioavailability issues and have resulted in retardation of growth and mental development and various types of physical disabilities. Increasing rates of

chronic and acute malnutritions in the country is primarily attributed to poverty, high illiteracy among the mothers, nutritional insecurity and lack of cutting edge research to devise local solutions to curb this situation.

It is a multidisciplinary program comprising of 137 credit hours to be completed in eight semesters. Apart from compulsory and basic courses, this program consists of major and minor courses, including internship and research thesis. This BS Zoology (4 Years) Program is being offered at the Institute of Zoology and in the affiliated colleges.

4. **Program Objectives**

The objective of this degree program is to create undergraduates in core subjects of Zoology with wide-ranging theoretical, practical, and methodological competencies to enable them:

1. Acquire 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 biological data and its utilization in practical life.
3. To trained students for advance studies and specialization on recently emerging technological and multidisciplinary fields such as Biotechnology, Biodiversity, Environmental Science, Wildlife and conservation, Fisheries and Aquaculture, Pests and Pest Management, etc. After completing the degree /the students will be able to apply their knowledge to their respective fields effectively.
4. To equip the 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/ administrative positions in wide range of professions in national and international organizations.

6. **Market Need / Rationale of the Program**

This degree program will enable the students to professionally excel in the zoological field through meeting today's market requirements. The students after graduation will be able to demonstrate their expertise in multiple fields which include:

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

a) Scope

i. Public Sector:

- Public Sectors Departments
- School, Education Deparatments/Programs
- Research and Teaching Institutes
- International Organizations: UNICEF, UNDP, WHO, FAO, World Bank
- Non-Governmental Organizations
- Community Development Program
- Motivational speaker

ii. Private Sector:

- Multinational Companies
- Independent Private Practice
- Fisheries Departments
- Food Industries
- Pharmaceuticals Industry
- Hospitality industry
- Private Companies and Hospitals

iii. Foreign Countries:

- Public Departments in Middle East, Europe etc.
- Independent Private Practices

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7. **Admission Eligibility Criteria**

• Years of Study Completed	12 Years F.Sc. Premedical/A level (with Biology and Chemistry)
• Study Program/Subject	BS (4 Years) In Zoology
• Percentage/CGPA	As per university rules and regulations
• Entry Test (If applicable) with Minimum requirement	No Entry Test (Open Merit) N/A
• Any Other (if applicable)	F. Sc. or equivalent or 50%

8. **Duration of Degree Program**

Minimum duration 4 Years
Total number of Credit hours (Flexible from 124-137)
Semester duration 16-18 weeks
Semesters 8
Course Load per Semester 12-18 Cr hr
Number of courses per semester 4-6

9. **Assessment Criteria**

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 mark

10. **Categorization of course as per HEC Recommendation and Difference**

		Credit H			
		Fundamental Course	M Elective	Elective	General
1	• English-I (Functional English) • Pakistan Studies	• Animal Diversity-I (Invertebrates)			• Mathematics-I • Botany-I • Chemsitry-I
2	• English-II • (Communication Skills) • Islamic Studies/Ethics	• Animal Diversity-II (Chordates) • Cell Biology			• Botany-II • Chemsitry-II
3	• English-III • (Technical Writing & Presentation Skills)	• Animal Form & Functions-I			• Botany-III • Chemsitry-III • Social Sciences
4	• Introduction to Computer • English –IV/Univ Option	• Animal Form & Functions-II • Biochemistry-I	• Animal Behavior • Biological Techniques		Psychology/Geography/Etc.
5	• تدریسِ ترجمہ قرآن (Sem. 1st to 8th)	• Economic Zoology • Biochemistry-II • Evolution	• Physiology • Ecology		
6		• Principles of Systematics Zoology	• Research Methodology • Developmental Biology • Genetics • Wildlife		
7	Biostatistics/Univ option	• Infant and Young Child Feeding	• Special paper / thesis/Research Project/ Internship	• Special paper • Univ Option	

			(Univ Option) • Molecular Biology •		
8	Bioinformatics		• Special paper / thesis/Research Project/ Internship (Univ Option) • Zoogeography & Palaeontology	• Special paper • Univ Option	
HEC Guidelines		YES			
Difference (HEC) & PU		Lists of Readings Books have been updated and course objectives have been revised. Nevertheless, all the subjects offered strictly follow the HEC Curriculum. However, the HEC recommended syllabus has been adopted.			

- Total numbers of Credit hours 137
- Duration 4 years
- Semester duration 16-18 weeks
- Semesters 08
- Course Load per Semester 17-18 Credit Hours
- Number of courses per semester 4-6
-

11. Curriculum Difference

The designed courses of BS Zoology (4 Years) Program have total 124 (flexible to 137 cridit hours) as per the requirement of HEC curriculum. All the courses have been taken from HEC Scheme of Studies for B.S Zoology 4 Years Program, however, Quran classes have been added as compulsory courses from 1st to 8th semesters which is equvilant to 1 cridet hour in even sermesters.

SCHEME OF STUDIES FOR BS ZOOLOGY (4 YEARS PROGRAM)

Sr. No.	Course Code	Title of Course	Course Type	Pre-requisite	Credit Hours
Semester-I					
1.	Z-101	English-I: Functional English	Compulsory		3(3-0)
2.	Z-102	Pakistan Studies	Compulsory		(2-0)
3.	Z-103	Mathematics-I	Compulsory		(3-0)
4.	Z-104	تدریس ترجمہ قرآن	Compulsory		0(0+0)
5.	Z-105	Botany-I	General		3(2-1)
6.	Z-106	Chemistry-I	General		3(2+1)
7.	Z107	Animal Diversity-I (Invertebrates)	Foundation		4(3+1)
					18
Semester-II					
1.	Z-108	English-II: Communication Skills	Compulsory		3(3+0)
2.	Z-109	Islamic Studies / Ethics	Compulsory		2(2+0)
3.	Z-110	تدریس ترجمہ قرآن	Compulsory		1(1+0)
4.	Z-111	Animal Diversity-II (Chordates)	Foundation		4(3+1)
5.	Z-112	Botany-II	General		3(2+1)
6.	Z-113	Chemistry-II	General		3(2+1)
7.	Z-114	Cell Biology	Foundation		3(2+1)
Semester-III					
1.	Z-201	**English-III:** Technical writing and presentation skills	Compulsory		3(3+0)
2.	Z-202	Introduction to Computer	Compulsory		3(1+2)
3.	Z-203	تدریس ترجمہ قرآن	Compulsory		0(0+0)
4.	Z-204	Botany-III	General		3(2+1)
5.	Z-205	Chemistry-III	General		3(2+1)
6.	Z-206	Social Sciences	General		2(2+0)
7.	Z-207	Animal Form & Function–I	Foundation		4(3+1)
Semester-IV					

(7)

1.	Z-208	English-IV / Univ. Option	Compulsory		3(3+0)
2.	Z-209	تدریس ترجمہ قرآن	Compulsory		1(0+1)
3.	Z-210	Animal Behavior	Major		3(3+0)
4.	Z-211	Biochemistry-I	Foundation		3(2+1)
5.	Z-212	Biological Techniques	Major		3(1+2)
6.	Z-213	Animal Form & Function-II	Foundation		4(3+1)
7.	Z-214	Psychology/Geography/Etc	General		2(2+0)
Semester-V					
1.	Z-301	تدریس ترجمہ قرآن	Compulsory		0(0+0)
2.	Z-302	Economic Zoology	Foundation		3(2+1)
3.	Z-303	Biochemistry-II	Foundation		3(2+1)
4.	Z-304	Physiology	Major		4(3+1)
5.	Z-305	Ecology	Major		3(2+1)
6.	Z-306	Evolution	Foundation		2(2+0)
Semester-VI					
1.	Z-307	تدریس ترجمہ قرآن	Compulsory		1(0+1)
2.	Z-308	Research Methodology	Major		2(2+0)
3.	Z-309	Principles of Systematics	Foundation		3(2+1)
4.	Z-310	Developmental Biology	Major		4(3+1)
5.	Z-311	Genetics	Major		4(3+1)
6.	Z-312	Wildlife	Major		3(2+1)
Semester VII					
1.	Z-401	Biostatistics/Univ option	Compulsory		3(2+1)
2.	Z-402	تدریس ترجمہ قرآن	Compulsory		0(0+0)
3.	ES…	Special Paper / Thesis/ Research Project / Internship	Major		3(2+1) /3
4.	ES …	Special Paper / Univ. opt	Elective		3(2+1)
5.	Z-ES	Univ. opt	Elective		3(2+1)
6.	Z-403	Molecular Biology	Major		3(2+1)
Semester-VIII					
1.	Z-404	تدریس ترجمہ قرآن	Compulsory		1(0+1)
2.	Z-405	Bioinformatics	Major		3(1+2)
3.	ES…/ Z-406/407/408	Special Paper B1/ Thesis/ Research Project / Internship	Major		3(2+1) 3
4.	ES….	Special Paper B2/Univ. opt	Elective		3(2+1)
5.	ES….	Univ. opt	Elective		3(2+
6.	Z-409	Zoogeography & Paleontology	Major		3(2+

18+ 19+18+19+15+17+15/+16=137

12. **Research Thesis/ Project and Internship**
Thesis/ Project: 6 Credit hours

13. **Award of Degree**
The degree will be awarded as per University of the Punjab rules and regulations. The students have to complete 137 credit hours, to qualify for the degree.

14. **Faculty Strength**

Degree	Area/Specialization	Total
PhD	Molecular Biology, Developmental Biology, Fisheries, Environmental Biology, Evolutoion, Ecology, Genetics, Biochemistry, Biodiversity, Environmental Science, Wildlife and conservation, Fisheries and Aquaculture, Pests Management, Biotechnology, Anatomy, Physiology, Microbiology, Immunology	15
Total		15

15. **Present Student Teacher Ratio in Institute**
Not Applicable

16. **NOC from Professional Councils (If Applicable)**
Not Applicable

DETAIL OF COURSES SEMESTER-WISE

FIRST SEMESTER

Course Code	Title of Course	Credit Hours
Z-101	English-I: Functional English	3(3-0)
Z-102	Pakistan Studies	(2-0)
Z-103	Mathematics-I	(3-0)
Z-104	تدریس ترجمہ قرآن	0(0+0)
Z-105	Botany-I	3(2-1)
Z-106	Chemistry-I	3(2+1)
Z107	Animal Diversity-I (Invertebrates)	4(3+1)
Total Credit Hours		

Z-101: ENGLISH-I: FUNCTIONAL ENGLISH Cr. 3(3+0)

Course Objectives:

The course aims to:

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

Course Contents:

1. **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.
2. **Comprehension:** Answers to questions on a given text
3. **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)
4. **Listening:** To be improved by showing documentaries/films carefully selected by subject teachers
5. **Translation skills**: Urdu to English
6. **Paragraph writing:** Topics to be chosen at the discretion of the teacher
7. **Presentation skills:** Introduction to presentations and delibrations

Note: Extensive reading is required for vocabulary building

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos /films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

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Z-102 PAKISTAN STUDIES Cr. 2(2+0)

Objectives:

The course aims to:

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

Course Contents:

1. **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.
2. **Government and Politics in Pakistan:** Political and constitutional phases:1947-58; 1958-71; 1971-77; 1977-88; 1988-99; 1999 onward.
3. **Contemporary Pakistan:** Economic institutions and issues,
4. Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 Banglades., 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.

Z-103 MATHEMATICS-I Cr. 3(3+0)

Objectives:

The course aims to:

1. Prepare the students with the essential tools of algebra
2. Develop skills to apply the concepts and the techniques

Course Contents:

1. **Preliminaries:** Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.
2. **Matrices**: Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.
3. **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.
4. **Sequences and Series**: Arithmetic progression, geometric progression, harmonic progression.
5. **Binomial Theorem:** Introduction to mathematical induction, binomial theorem with rational and irrational indices.Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Books Recommended:

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

Z-104 تدریس ترجمہ قرآن Cr. 0(0+0)

سورۃ الفاتحہ تا سورۃ آلِ عمران

Z-105 BOTANY–I (PLANT DIVERSITY) Cr. 3(2+1)

Theory:

Course Outline:

Comparative study of the different plant groups with representative examples, including Viruses, Bacteria, Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperm

Course Detail:

1. General account including morphology, habitat, reproduction and economic signification of:-
2. Viruses (General Characteristics)
3. Bacteria and Cyanobacteria
4. Algae: *Spirogyra, Pinnularia* and *Polysiphonia*
5. Fungi: *Mucor, Penicillium, Ustilago, Puccinia* and *Agaricus*
6. Lichens
7. Bryophytes: *Riccia, Anthoceros, Funaria*

8. Pteridophytes: Major Groups and their Affinities, Psilopsida (*Psilotum*), Lycopsida (*Selaginella*), Sphenopsida (*Equisetum*), Pteropsida (*Marsilea*), Seed Habit.
9. Gymnosperms: (*Cycas, Pinus* and *Ephedra*).
10. Angiosperms: (Dicot and Monocot).

Practicals:

1. Culturing and staining of microbial types.
2. Maintenance and preservation of cultures of microbes (Bacteria / Cyanobacteria / Algae / Fungi)
3. Identification of various types mentioned in the syllabus from fresh / preserved specimens and prepared slides.
4. Study of morphology and reproductive structures of the types mentioned in theory (Specimens/ prepared slides)

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended Readings:

1. Lee, E. R. (2007). Phycology. (4th Ed.) Cambridge University Press U.K.
2. Sambamurty, A.V.S.S. (2005). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International Pvt. Ltd. New Delhi, Banglore, Mumbai. 573 pp.
3. Agrios, G.N. (2004). Plant Pathology. (8th Ed.), Academic Press London.
4. Prescott, L.M., Harley, J.P. and Klein, A.D. (2004). Microbiology, (3rd Ed.) WM. C. Brown Publishers.
5. Mauseth. J.D. (2003). Botany: An Introduction to Plant Biology. (3rd Ed.) Jones & Bartlett Pub.UK.
6. Biswas, C, and Johri, B.M. (1999). The Gymnosperms. Narosa Publishing House. New Delhi and London.
7. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology. (4th Ed.) John Wiley and Sons, UK.

Z-106 CHEMISTRY-I (INORGANIC CHEMISTRY) Cr. 3(2+1)

Theory

Course Objectives

The Objective of the course are:-

1. To introduce students about the key introductory concepts of atomic structure and chemical bonding.
2. To introduce theories of acids and bases.
3. Survey of chemistry of p-block elements.
4. To learn about qualitative and quantitative analysis of inorganic compounds during laboratory work.

Course learning outcomes:

- Acquire the basic knowledge of determining molecular shapes.
- Understand the concepts of acids and bases and use them efficiently
- Solve the problems treated to pH, pKa, and buffer solutions
- Understand the properties of p-block elements.

- Carry to qualitative and quantitative analysis.

1. **Periodicity**
   Diagonal and vertical relationship of first row element, electro negativity of elements (Pauling and Mulliken scales), Polari ability and polarizing power of ions, periodicity in the properties of outer transition and inner transition elements.
2. **Chemical Bonding**
   Types of chemical Bonding, theories of chemical bonding, and prediction of molecular shapes using valence shell electron pair repulsion (VSEPER) Model, Molecular orbital theory applied to diatomic molecules, bonding in electron deficient compounds.
3. **Acid-Base Concept:**
   General concept of acids and bases, detail of Lewis concept of acids and bases, Soft and Hard acid-base (SHAB) concept and its application, relative strength of acids and bases based on pKa value, Leveling effect, reaction of acids and bases, relationship between redox reactions and acid base reaction, Indicators and theory of indicators.
4. **Chemistry of d- Block Element:**
   Electronic configuration and oxidation states of transition elements, Nomenclature & theories of coordination compounds, Valence Bond Theory (VBT), Molecular Orbital Theory (MOT), and Crystal Field Theory (CFT) for octahedral complexes, Chelates, Applications of Coordination compounds.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended Books:

1. Cotton, F, Albert, Geoffry Wilkinson and Paul L. Gaus, "Basic Inorganic Chemistry" John, Wiley Sons Ine, 3rd Edition (1995).
2. Lee, J.D., "Modem Inorganic Chemistry Champan & Hall, 5th Aditin (1996).
3. Jolly, William, L., "Modem Inroganic Chemsitry", McGraw Hill, 2nd Edition (1991)

Practical

1. Basic Introduction to preparation of different types of Solutions.

ARGENTOMETRY

MOHR,S Method

1. Determine the % purity of NaCl.
2. Determine the amount of Cl^{-1} in given sample solution.

REDOX TITRATIONS

1. Determine the amount/dm^3 of $FeSO_4.7H_2O$ hydrate using potassium dichromate.
2. Determine of % of Iron in ferric Alum using $K_2Cr_2O_7$.
3. Determination of no. of water molecules in $FeSO4.xH_2O$ using $K_2Cr_2O_7$.

ACID BASE TITRATIONS

1. Determine the strength of given acid/base solution.

SALT ANALYSIS

2. Separation and identification of two acid and two basic radicals from a mixture of two salts.

Books Recommended:

1. Vogel, "A.I.A. Test Book of Macro and Semi micro-qualitative Inorganic Analysis", Longam Green & Co., (1995).

2. Skoog, D.A., D.M. West and F.J. Holler, "Analytical Cehmistry", 6th Edition, Saunders College Publications, (1994).
3. Javed Iqbal, Admin, "Theory and Practice of chromatography", Higher Education Commission, Islamabad, (2002).

Z-107 ANIMAL DIVERSITY-I (INVERTEBRATES) Cr. 4(3+1)

Course Objectives:

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

Course Learning Outcomes:

This course will be based on following outcomes:

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

Course Contents:

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

1. INTRODUCTION

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

2. ANIMAL-LIKE PROTISTS: THE PROTOZOA

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

3. MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

- Evolutionary Prespective:
- Origins of Multicellularity; Animal Origins.

3.1. Phylum Porifera

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

3.2. Phylum Cnidaria (Coelenterata)

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

3.3. Phylum Ctenophora;

- Characteristics, body organization

4. THE TRIPLOBLASTIC AND WITH ACOELOMATE BODY PLAN

4.1. PHYLUM PLATYHELMINTHES

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

Phylum Numerate; Characteristics, body organization

Phylum Gastrotrica; Characteristics, body organization

5. PSEUDOCOELOMATE BODY PLAN PHYLUM PLATYHELMINTHES

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

6. PHYLUM MOLLUSCA

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

7. PHYLUM ANNELIDA

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

8. PHYLUM ARTHROPODA:

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

9. THE HEXAPODS AND MYRIAPODS:

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

10. PHYLUM ECHINODERMATA

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

11. SOME LESSER-KNOWN INVERTEBRATES;

- The Lophophorates, Entoprocts, Cycliophores, and Cheatognaths.

Practical:

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

- Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosome, Paramecium as

representative of animal like Protists.

- Study of prepared slides of sponges, spicules of songes, and their various body forms. Study of representatives of classes of Phylum Porifera.
- Study of principal representatives of classes of Phylum Coelenterata.
- Study of principal representatives of classes of Phylum Platyhelminthes.
- Study of representatives of phylum Rotifear, Phylum Nematoda.
- Study of principal representatives of classes of Phylum Mollusca.
- Study of principal representatives of classes of Phylum Annelida.
- Study of principal representatives of classes of groups of Phylum Arthropoda
- Study of representatives of classes of phylum Echinodermata.
- Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.
- Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.
- How to make grade-wise series for preparation of temporary and permanent slides.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.
7. BOOKS FOR PRACTICAL
8. Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), Singapore : McGraw-Hill.
9. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore : McGraw-Hill.

SEMESTER–II

Course Code	Title of Course	Credit Hours
Z-108	English-II: Communication Skills	3(3+0)
Z-109	Islamic Studies / Ethics	2(2+0)
Z-110	تدریس ترجمہ قرآن	1(1+0)
Z-111	Animal Diversity-II (Chordates)	4(3+1)
Z-112	Botany-II	3(2+1)
Z-113	Chemistry-II	3(2+1)
Z-114	Cell Biology	3(2+1)
Total Credit Hours		

Z-108 ENGLISH - II (COMMUNICATION SKILLS) Cr. 3(3+0)

Course Objectives:

The course aims to:

Enable the students to meet their real life communication needs.

Course Contents:

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

Note: documentaries to be shown for discussion and review

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Books Recommended:

1. Boutin, Marie-Chrisitine, 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.

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Z-109 (ISLAMIC STUDIES/ ETHICS) Cr. 2(2+0)

Objectives:

This course aims to:

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

Course Contents:

1. **Introduction to Quranic Studies:** Basic Concepts of Quran: History of Quran; Uloom-ul - Quran
2. **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)
3. **Study of Sellected 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)
4. **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
5. **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
6. **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**
7. **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
8. **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
9. **Islam & Science:** Basic Concepts of Islam & Science; Contributions of Muslims in the Development of Science; Quranic & Science
10. **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
11. **Political System of Islam;** Basic Concepts of Islamic Political System; Islamic Concept of Sovereignty; Basic Institutions of Govt. in Islam
12. **Islamic History:** Period of Khlaft-E-Rashida; Period of Ummayyads; Period of Abbasids
13. **Social System of Islam;** Basic Concepts of Social System of Islam; Elements of Family; Ethical Values of Islam

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks

Midterm Exam: 35 marks
Final Exam: 40 marks

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 ResearchInstitute, 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.

Z-110 تدریس ترجمہ قرآن **Cr. 1(1+0)**
سورۃ النساء تا سورۃ الانعام

Z-111 ANIMAL DIVERSITY II (CHORDATES) Cr. 4(3+1)

Course Objectives

The objectives of the course are:-

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

Course Learning Outcomes:

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

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

Course Outline:

1. **Protochordates**

- Classification of protochordates.
- Structure, anatomy and organ systems of Acorn worms, Urochor dates and Cephalochor dates
- Reproduction; life histories and metamorphosis of protochor dates.
- Phylogenetic relationships.

2. **Fishes:**

- Vertebrate Success in Water.
- Phylogenetic relationships of Pisces.
- Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli
- Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (Scoliodon) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).

3. **Amphibians:**

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

4. Reptiles:

- The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.
- Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia
- Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous andsensory functions, excretion and osmoregulation, reproduction and development of Helonia, Squamata, Rhynchocephalia and Crocodilian.
- Further phylogenetic considerations.

5. Birds:

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

6. Mammals:

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

Practicals:

- Classification and study of lab specimens of Hemichordates, Fishes, Amphibians, Reptiles, Birds and Mammals.
- Visit to Pakistan Museum of Natural History (PMNH) for the study of diversity of chordates.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 Principlesof Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.
5. Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.

Z-112 BOTANY–II (Plant Taxonomy, Anatomy and Development) Cr. 3(2+1)

Theory

Course Outline:

1. Introduction to Plant taxonomy, aims and objectives.
2. History of classification,
3. Introduction to nomenclature,
4. International Code,
5. Morphological Study of Families,
6. Anatomical study of cell wall and the Internal Structure (Tissues) of the Plant Body,
7. Simple and Complex Tissues Structure,
8. Functions and Relationships,
9. Developmental Embryology.

Course Detail:

1. **Taxonomy**:

- Introduction to Plant Taxonomy: Aims, Objectives and Importance.
- Classification: Systems of Classification (Artificial, Natural and Phylogenetic) with emphasis on Takhtajan's System of Classification.
- Nomenclature: Introduction: Importance of Latin Names and Binomial Nomenclature
- Morphology: Brief Account of various morphological characters of root, stem, leaf, Inflorescence, Flower, Placentation and Fruit Types.
- Diagnostic Characters: Economic Importance and Distribution Patterns of the following Families: Brassicaceae, Fabaceae, Rosaceae, Euphorbiaceae, Cucurbitaceae, Solanaceae, Lamiaceae, Apiaceae, Asteraceae, Poaceae.

2. **Anatomy:**

- Cell Wall: Cell Wall Structure and Chemical Composition. Simple Tissues: Parenchyma, Collenchyma, Sclerenchyma. Epidermis: Epidermis and Epidermal Appendages including Stomata. Complex Tissues: Xylem, Phloem. Meristem: Types of Meristem, Structure of Root, Stem and Leaf.

3. **Developmental Embryology:**

- *Capsella bursa-pastoris*: Structure of Anther, Microsporogenesis, Microgametophyte, Structure of Ovule, Megasporogenesis, Megagametophyte, Endosperm Formation.

Practicals:

- Identification of Families with the help of keys
- Description of Flowers (in technical terms) of following Families: Brassicaceae, Fabaceae, Rosaceae, Euphorbiaceae, Cucurbitaceae, Solanaceae, Lamiaceae, Apiaceae, Asteraceae, & Poaceae.
- Field tours shall be undertaken to study and collect local plants. Students are required to submit Forty (40) fully identified herbarium specimens.
- Study of Epidermis, Stomata and Trichomes.
- Study of Simple Tissues from fresh material and prepared slides as well.
- Study of Complex Tissues (Xylem), Maceration and Study of Xylem from Macerated Material.
- Study of a Transverse Section of Stem and Leaf of Angiosperm

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended Readings:

1. P.H. Raven, R.E. Even & S.E. Eichhom (2010). *Biology of Plants.* W.H. Freeman and Company worth Publisher.
2. G.H.M. Lawrence (2007). *Taxonomy of Vascular Plants.* (2nd Ed.). MacMillan and Co. New York.
3. F. Raymond & S.E. Eicbhorn (2005). *Esau's Plant Anatomy. Meristematic cells and tissue of the plant body*, (3rd Ed.) John Wiley and Sons Inc. New York.
4. B.P. Panday (2004). *A Text Book of Botany (Angiosperms).* S. Chand and Co. New Delhi.
5. R.C. Moore, W.D. Clark & Vodopich, D.S. (2003). *Botany.* McGraw Hill Company, U.S.A.
6. F. Foster (2002). *Practical Plant Anatomy.* John Wiley and Sons, New York.
7. J.D. Mauseth (1998). *An Introduction to Plant Biology*: Multimedia Enhanced. Jones and Bartlett Publisher. UK.
8. M.S. Zahur (1992). *The Taxonomy of Angiosperms.* Al-Hejaz Printers. Lahore.
9. A. Fahn (1990). *Plant Anatomy.* Pergamum Press Oxford.
10. P. Maheshawari (1971). *Embryology of Angiosperms.* McGraw Hill. New York.
11. K. Esau (1960). *Anatomy of Seed Plants.* John Wiley and Sons, New York.
12. G. Singh (2016). *Plant Systematics*; An Integrated Approach (3rd edition), University of Dehli, India.
13. M. G. Simpson (2018). *Plant Systematics* (3rd edition). Elsevier Academic Press, UK.
14. W.S. Judd, C.S. Campbell, E.A. Kellogg, P.F. Stevens & M.J. Donoghue (2015). *Plant Systematics*; A phylogenetic Approach, Sinauer, US.

Z-113 CHEMISTRY– II/ETC. Cr. 3(2+1)

1. Basic concept in Organic Chemistry

Localized and Delocalized bonding, conjugation and hyperconjugation; applications, resonance, resonance energy, rules of resonance, resonance hybrid, factor effecting the resonance, inductive effect and applications, steric effect and its applications, hydrogen bonding and its effect on various properties of organic compounds, tautomerism.

2. Chemistry of Hydrocarbons

Preparation of alkanes from coupling alkyl halide and alkyl boranes, , corey house synthesis, Free radical reactions of alkenes with halogens with mechanism, comparision of reactivities of halogens. Preparations of alkenes from Pyrolytic elimination reactions. Relative stability and reactivity of alkenes in terms of Hoffmann and Sytzeff rules, reaction of alkenes i.e.g simon-smith and Diels-Alder reactions.

Preparation of alkynes by alkylation of terminal alkynes, reaction of alkynes; hydroboration and hydration and formation of metal acetylides with mechanism.

Aromaticity, criteria for aromaticity, poly aromatic hydrocarbons like; benzene, naphthalene, antharacene and phenantharene, their resonance structures and relative stabilities, synthesis of naphthalene, orientation and reactivity of naphthalene, electrophilic substitution of naphthalene, oxidation and reduction reaction of naphthalene.

3. Chemistry of Functional Groups

Alcohols: preparation of alcohols by reduction of carbonyl compounds, reaction of alcohol with metals, organic and inorganic acid, oxidation, difference between primary secondary and tertiary alcohols.

Phenols: synthesis of phenols, physical properties, reactions like; carbonation, formylation and diazo coupling

Ethers: preparation of ethers from alcohols, alkyl halides and alkenes, physical properties, reactions of ethers.

Carboxylic acids: Physical properties of acids, effect of various parameters on the strength of aliphatic and aromatic acids, chemical properties like: nucleophilic acyl substitution, decarboxylation,Hunsdicker reaction, substitution at α- carbon.

Acetoacetic and malonic ester synthesis.

Alkyl Halides: Preparation of alkyl halides from carboxylic acids, Nucleophilic substitution (SN1 & SN2) and elimination reactions(E1 & E2) of alkyl halides, effect of various parameters on rate of substitution and elimination reactions.

Recommended Books:

1. C.K. Ingold, "Structure and Mechanism in organic chemistry", C.B.S.
2. I.L. Finar, "Organic Chemistry", Vol. I, Pearson Education, L.P.E.
3. I.L. Finar, "Organic Chemistry", Vol. II 5th Edition, L.P.E.
4. Jerry March, "Advanced organic Chemistry, Reaction, Machnism and Sturcture", 5th Edition, Viley Inter Science
5. Morision and Boyd, "Organic Chemistry", 6th Ediciton Prentice Hall.
6. Syhan N. Ege, "Organic Chemistry Structure and Reactivity", 3rd Edition, the University of Michigan, A.I.T.B.S. Publishers & Distributions (Regd.).
7. Thomas H.Lowry, Kathleen Schueller Richardson "Mechanism and Theory in Organi Chemistry", 3rd Edition, harper and Row publishers, New York.
8. Alder, Baker, Brown, "Mechanism in Organic Chemsiry", Wiley Publishers.
9. Atkins Carey, "Organic Chemistry", A Breaf Course, 2nd Edition.
10. Peter Sykes, "A guid book to mechanism in organic chemistry", 6th Edition, Pearson Education, Singapore.

Practicals:

1. **Compound Analysis**

- Identification of organic compounds containing only one functional group with special
- emphasis on compounds containing following functional groups.
- -COOH, -OH, C=O, -NH2, and $-CONH_2$

2. **Basic Experimental techniques used in organic chemistry**

- Filtration
- Simple and fractional distillation
- Solvent extraction
- Sublimation
- Re-crystallization

3. **Estimations (volumetric)**

- Determination of molecular weight of a carboxylic acid.
- Estimation of glucose.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended Books:

1. K.M.Ibne Raza, M.A. Rehman, Abdur Rehman, "Organic Chemistry", The Carvan Book House, Lahore.
2. B.S. Furniss, "Vogel's T.B of Practical Organic Chemistry", Addison Wesley Longman, Inc. 1989.
3. Frederick George Mann and Saunder, "Practical Organic Chemistry", The English Language Book Society, 1960.
4. Daniel R. Palleras, "Experimental Organic Chemistry , John Willey & Sons" Inc., 2000.
5. James A. Moore, "Experimental methods in Organic Chemistry", Holt-Saunders Int., 1983.

Z-114 CELL BIOLOGY Cr. 4(3+1)

Course Objectives:

The objectives of the course are:-

1. To explain the basic concepts of cell biology.
2. To understand cellular structure, composition of the organelles, cell growth and cell 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 to cell structure and function
- Cell theory
- Comparison of plant and animal cells
- Comparison of prokaryotic and eukaryotic cells

2. Cell membranes
- Structural models
- Chemical composition and function

3. Cell Organelles (structure and function)
- Endoplasmic reticulum
- Golgi Bodies
- Mitochondria
- Lysosomes
- Peroxysomes
- Ribosome

4. Nucleus
- Structure and function
- Nuclear membrane
- Chromatin

5. Cytoskeleton
- Structure and types
- Function of cytoskeleton

6. Cellular transport
- Diffusion and osmosis
- Facilitated and active transport
- Endocytosis and exocytosis

7. Cellular reproduction

- Cell cycle
- Mitosis
- Meiosis

Practical:

- Microscopy
- staining techniques (Gram staining)
- Identification of cell organelles (prepared slides)
- Preparation of temporary whole mount.
- Preparation of permanent whole mount.
- Squash preparation of onion root tip for mitotic stages.
- Study of mitotic and meiotic stages (prepared slides)

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 **THIRD SEMESTER**

Course Code	Title of Course	Credit Hours
Z-201	**English-III:** Technical writing and presentation skills	3(3+0)
Z-202	Introduction to Computer	3(1+2)
Z-203	تدریس ترجمہ قرآن	0(0+0)
Z-204	Botany-III	3(2+1)
Z-205	Chemistry-III	3(2+1)
Z-206	Social Sciences	2(2+0)
Z-207	Animal Form & Function–I	4(3+1)
Total Credit Hours		**18**

Z-201 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

(26)

Course Contents:

1. **Presentation skills: Essay writing:** Descriptive, narrative, discursive, argumentative
2. **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)
3. **Technical Report writing:**
4. **Progress report writing:**

Note: Extensive reading is required for vocabulary building

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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).

Z-202 INTRODUCTION TO COMPUTER Cr. 3(1+2)

Course Objectives

After completing this course, a student will be able to:

1. Understand different terms associated with ICT
2. Identify various components of a computer system
3. Identify the various categories of software and their usage
4. Define the basic terms associated with communications and networking
5. Understand different terms associated with the Internet and World Wide Web.
6. Use various web tools including Web Browsers, E-mail clients and search utilities.
7. Use text processing, spreadsheets and presentation tools
8. Understand the enabling/pervasive features of ICT

Course Content

1. **Introduction**
- Basic Definitions and Concepts
2. **Hardware**:
- Computer Systems & Components
- Storage Devices,
- Number Systems
3. **Software:**
- Operating Systems,
- Programming and Application Software
4. **Introduction to Programming,**
- Databases and Information Systems
- Networks

- Data Communication

5. The Internet,

- Browsers and Search Engines
- Email, Collaborative Computing and Social Networking
- E-Commerce

6. IT Security and other issues

7. Project Week Review Week

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended readings

1. Norton, P. & McGraw-Hill. Introduction to Computers, (6th International Ed).
2. Sawyer, W. & McGraw-Hill. Using Information Technology: A Practical Introduction to Computer & Communications (6th Ed).
3. Sawyer, S.C. & Sarah, E. Computers, Communications & information: A user's introduction.
4. Alexis, L. Mathews, L. & Press, L. Fundamentals of Information Technology

Z-203 تدریس ترجمہ قرآن **Cr. 0(0+0)**
سورۃ الاعراف تا سورۃ یونس

Z-204 CELL BIOLOGY, GENETICS AND EVOLUTION / ETC. Cr. 3(2+1)

Theory

Course Outline:

1. An introduction to morphology and functioning of cell, cellular organelles and mechanisms of cell division, study of genes and their inheritance patterns, concept of evolution.

Course Detail:

1. **Cell Biology:**
   Structures and brief introduction of biomolecules, carbohydrates, lipids, proteins, nucleic acid.
2. **Cell:**
   Physico-chemical nature of plasma membrane and cytoplasm. ultrastructure of plant cell wit brief description and functions of the following organelles: Endoplasmic reticulum, Plas Mitochondria, Ribosomes, Dictyosomes, Vacuole, Microbodies (Glyoxysomes Peroxisomes)
3. **Nucleus:**
   Nuclear membrane, nucleolus, ultrastructure and morphology of chromosomes, karyotyp analysis; Reproduction in somatic and embryogenic cell; Mitosis and meiosis; Cell cycle Chromosomal aberrations; Changes in the number of chromosomes, aneuploidy and euploidy; Changes in the structure of chromosomes, deletion, duplication, inversion and translocation special types of chromosomes, Chromosome systems (parthenogenesis and apomixis).
4. **Genetics and Evolution:**
   Introduction, scope and brief history of genetics, Mendelian inheritance; Laws of segregation and independent assortment, back cross, test cross; Dominance and incomplete dominance; Sex linked inheritance, Sex Linkage in *Drosophila* and Man (Color blindness), XO, XY, WZ mechanisms, Sex limited and sex linked characters, Sex determination. linkage and crossin over;; Recombination; DNA replication; Nature of gene, Genetic code; Transcription

Translation; Regulation of gene expression (*e.g. lac* operon); Transmission of genetic material in bacteria; conjugation and gene recombination in co-transduction and transformation; Principles of genetic engineering. The process and concept of evolution.

Practicals:

Cell Biology

1. Study of cell structure using compound microscope
2. Elucidation of ultrastructure of cell from electron microphotographs
3. Measurement of cell size
4. Study of mitosis and meiosis by smear/squash method and from prepared slides
5. Study of chromosome morphology
6. Study of variation in chromosome number
7. Extraction and estimation of carbohydrates
8. Extraction and estimation of proteins
9. Extraction and estimation of RNA and DNA from plant material.

Genetics:

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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended Readings:

1. A. Bretscher (2007). Molecular Cell Biology. W. H. Freeman and Company
2. R. F. Weaver (2008). Molecular Biology. McGraw Hill, St. Louis.
3. J. F. Griffiths, J. H. Miller, D. T. Suzuki, R. C. Lewontin, and W. M. Gelbart (2010). An Introduction to Genetic Analysis. W.H. Freeman and Company.
4. U. Sinha, and S. Sinha (2003) Cytogenesis, Plant Breeding and Evolution. Vini Educational Books, New Delhi.
5. M. V. Strickberger (2003). Genetics. MacMillan Press Ltd., London.
6. G. Karp (2002). Cell and Molecular Biology. Concepts and Experiments. (4th Ed.), John Wiley and Sons. New York.
7. P. M. Gilmartin, and C. Bowler (2002). Molecular Plant Biology. (Vol. 1 & 2). Oxford University Press. UK.
8. S. B. Carroll, J. K. Grenier, and S. D. Velnerbee (2001). From DNA to Diversity—Molecular Genetics and the Evolution of Aminal Design. Blackwell Science.
9. A. R. Hoelzel (2001). Conservation Genetics. Kluwer Academic Publishers.
10. H. Lodish (2001). Molecular Cell Biology. W.H. Freeman and Company.
11. V. R. Dyonsager (2000). Cytology and Genetics. (3rd Ed.), TATA and McGraw Hill Publication Co. Ltd, New Delhi.

Z-205 CHEMISTRY- III/ ETC (PHYSICAL CHEMISTRY) Cr. 3(2+1)

Theory

1. Chemical Thermodynamic

- Equation of states, ideal and real gases, the vander waals equation for real gases, critical phenomena and critical constants.

- Extensive and intensive properties, molar heat capacities, second law of thermodynamics, concept of entropy, entropy change in reversible and irreversible process, entropy change for an ideal gas, entropy change due to mixing of ideal gases, effect of temperature and pressure on entropy, concept of free energy, effect of temperature and pressure on free energy, relationship between standard free energy and equilibrium constants.

2. **Chemical Kinetics**

- Derivation of kinetics expression of zero order, first order, second order (with same and different concentrations), nuclear decay as first order reaction, derivations for determining rate constants and half life periods, measurement of order of the reaction with different methods, Arrhenius equation and determination of various Arrhenius parameters.

3. **Solutions and Colloids**

- Physical properties of liquids , surface tension, viscosity, refractive index etc.
- Osmotic pressure and its measurements, abnormal colligative properties (association and dissociation of solutes), fractional distillation and concept of azeotrops, concept of colloids, classification of colloids, dialysis, electro-dialysis, sedimentation, precipitation, ultra filtration, emulsions and gels, tyndall cone effect.

4. **Surface Chemistry**

- Interface, Adsorption, types of adsorption at liquid surface, adsorption isotherms (Freundlich and Langmuir), catalysis, and kinetics of enzyme catalysis.

Practicals:

- Preparation of standard molar, normal, molal and percentage solutions.
- Standardization of secondary standard acids and bases solutions by volumetric methods.
- Determination of surface tension, parachor and percentage composition by surface tension measurement.
- Determination of viscosity, rheochor and percentage composition by viscosity measurement.
- Determination of refractive index, molar refractivity and percentage composition by refractive index method.
- Conductometeric and potentiometric strong acid-base titrations using conductometer and pH meter respectively.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Recommended Books

1. Crocleford, H. D.,Biard, H. W., Getzen F. W. andNowell, J. W.,*Laboratory Manual of Physical Chemistry,*2nd ed., John Wiley & Sons, (1976).
2. Das, R. C. and Behera, B., *Experimental Physical Chemistry,* Tata McGraw Hill Publishing Company Ltd., (1984).
3. Levitt, B. P.,*Findlay's Practical Physical Chemistry,*9thed., Longman Group Limited, (1972).
4. Bhatti, H.N. and Farooqi, Z. H.,*Physical Chemistry Laboratory Manual for B.Sc Students,*Revised ed., Caravan Book House, (2014).

Z-206 SOCIOLOGY (SOCIAL SCIENCES / UNIVERSITY OPT Cr. 2(2+0)

Course Outlines

1. **Introduction**
- What is sociology
- Sociology & other social sciences
- Sociology & Common sense/Stereotypes
- Key terms – Social Problem/Sociological Issues
- Sociological Perspective

A Structuralism

- Structural Functionalism
- Social Conflict

B Social Action

- Symbolic Interactionism

2. **Culture**
- What is culture?
- Elements of Culture
- Cultural Diversity

3. **Socialization**
- Socialization & its importance
- Agents of Socialization
- Socialization through the life course
- C.H. Cooley
- George Herbert Mead

4. **Social Interaction**
- **Social Structure**
- Status
- Status Set
- Achieved & Ascribed
- Master Status
- Role
- Role Set
- Role Conflict
- Role Strain

Theories of Social Interaction (Brief)

- Social Construction of Reality
- Ethno methodology

5. **Groups & Organizations**
- Types of Groups
- Studies of Group Behaviour
- Bureaucracy & its Characteristics

6. **Deviance**
- Deviance, Crime & Social Control
- Types of Crime

Recommended Books:

1. Anderson, Margaret and Howard F. Taylor. (2001) Sociology the Essentials. Australia: Wadsworth.
2. Brown, Ken. (2004). Sociology. UK: Polity Press
3. Gidden, Anthony (2002). Introduction to Sociology. UK: Polity Press.
4. Macionis, John J. (2006). Sociology. 10th ed. New Jersey: Prentice-Hall

5. Tischler, Henry L. (2002). Introduction to Sociology. 7th ed. New York: The Harcourt Press.

Z-207 ANIMAL FORM AND FUNCTION- I (A Comparative Perspective) Cr. 4(3+1)

Course Objectives:

The Objectives of the courses are:

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

Course Learning Outcomes:

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
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:**

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

2. **Communication I:**

- Nerves: Neurons: structure and function.

3. **Communication II:**

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

4. **Communication III:**

- The Endocrine System and Chemical Messengers: Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action
- Hormones with principal function each of Porifera, Cnidarians, Platyhelminthes, Nemerteans, Nematodes, Molluscs, Annelids, Arthropods, and Echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

5. **Circulation and Immunity**:

- Internal transport and circulatory systems in invertebrates

- Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells
- transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response

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)* andrabbit (*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 Catla catla 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).

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 Principlesof 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. NewYork: McGraw-Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology. Singapore: McGraw-Hill.

SEMESTER–IV

Course Code	Title of Course	Credit Hours
Z-208	English-IV / Univ. Option	3(3+0)
Z-209	تدریسِ ترجمہ قرآن	1(0+1)
Z-210	Animal Behavior	3(3+0)
Z-211	Biochemistry-I	3(2+1)
Z-212	Biological Techniques	3(1+2)
Z-213	Animal Form & Function-II	4(3+1)
Z-214	Psychology/Geography/Etc.	2(2+0)
Total Credit Hours		18

Z-208 **(English- IV/ Univ. Option) Cr. 3(3+0)**
As per university decision

Z-209 تدریسِ ترجمہ قرآن **Cr. 1(1+0)**
سورۃ ھود تا سورۃ الکھف

Z-210 ANIMAL BEHAVIOUR Cr. 3(3+0)

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. Learn 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 behaviour; displays.
5. INTEGRATE the animal behaviour as balanced mechanism to develop animal personality.

Course Outline (Contents)

1. Introduction
2. Behaviour and its types
3. Proximate and ultimate causes of behaviour.
4. Development of behaviour and impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses. Physiology of behaviour in changed environments.
5. Hormones and behaviour in animals.
6. Innate behavior and innate releasing mechanisms; built in programmed performance by offspring to that of parents. Innate behaviour of three spined stickle back fish.
7. Learned behaviour 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.
8. Circadian rhythms and concept of bio-rhythmicity in animals. Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities.
9. Costs and benefit ratios in behavior; successful foragers and winners of predator-prey relationships. Altruism and parental sacrifice to nurture the young.
10. Competition for resources; survival of the most suitable individuals; evolutionary arms races in behavior.
11. Social organization in animals and concept of group living; benefits and losses. Aggressi appeasement and selfish individuals. Social organization in insects and mammals.
12. Communication in animals: Visual, Bioacoustic, electrical, chemical and tactile.
13. Various types of chemical signals in animals' behaviour and their importance in ecosystems.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Shor videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

Z-211 BIOCHEMISTRY-I Cr. 3(2+1)

Course Objectives:

1. To provide knowledge about macro molecules 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 structure, and the principles of molecular recognition;

Course Learning Outcome

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

1. Demonstrate 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**

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

2. **Amino acids, peptides & proteins:**

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

3. **Purification Techniques for Proteins**

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

4. **Organization of proteins:**

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

5. **Enzymes**

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

6. **Lipids**:

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

7. Classification and important characteristics;

- 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.

8. Nucleic acids

- Nucleic acids and their types; Structure and role of various Bases in nucleic acids,
- Nucleoside & Nucleotides;
- Structure of DNA and RNA molecules;
- 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 Disacchaide (Sucrose) & polysaccharide (Stanch) .
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 any unknown concentration of protein using Biuret technique.

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

Z-212 BIOLOGICAL TECHNIQUES Cr: 3(1+2)

Course Objectives:

1. To course aim to demonstrate the knowledge of skills
2. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
3. To develop basic understanding of the 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:

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

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

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

3. Specimen preparation for optical microscopy:

- Introduction to Microtomy and its types
- Tissue Fixation, dehydration, clearing, embedding, Section cutting (transverse, longitudinal section)

- Tissue mounting (dry mount, wet mount)
- Staining: Hematoxylin and Eosin staining

4. Separation and purification techniques:

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

5. Chromatography:

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

6. Spectrophotometry:

- Principle, applications, types
- Visible/UV spectrophotometry

7. Basic principles of Sampling and Preservation:

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

8. DNA sequencing

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

Practicals:

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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Sh videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentati and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 TropicalCountries. Part I. Cambridge University Press, UK.
3. Cheesbrough, M. 1998. District Laboratory Practice in TropicalCountries. 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: ForTechnician. 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.

Z-213 ANIMAL FORM AND FUNCTION–II (A Comparative Perspective) Cr.4(3+1)

Course Objectives:

The Objectives of the courses are:

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

Course Learning Outcomes:

1. **Acquire** the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g. gills in aquatic and lungs in terrestrial environment.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
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:

- Evolution of nutrition; the metabolic fates ofnutrients in heterotrophs; digestion
- Animal strategies for getting and usingfood, diversity in digestive structures of invertebrates.
- The mammalian digestive system: gastrointestinal motility and its control
- Oral cavity, pharynx and oesophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gall bladder in digestion.

2. Temperature and Body Fluid Regulation:

- Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals;
- Heat Production in Birds and Mammals
- Control of Water and Solutes (Osmoregulation and Excretion);
- Invertebrate and Vertebrate

- Excretory Systems; how vertebrates achieve osmoregulation; vertebrate kidney variations; mechanism in metanephric kidney functions. Reproduction and Development

3. **Reproduction:**

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

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 vertebraes and invertebrates.

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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 Principlesof 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. NewYork: McGraw-Hill.
6. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in IntegratedPrinciples of Zoology Singapore: McGraw-Hill.

Z-214 **PSYCHOLOGY / GEOGRAPHY/ ETC. CR: 2(2+0)**

As per prescribed curriculum of the subject

YEAR–III SEMESTER–V

Course Code	Title of Course	Credit Hours
Z-301	تدریسِ ترجمہ قرآن	0(0+0)
Z-302	Economic Zoology	3(2+1)
Z-303	Biochemistry-II	3(2+1)
Z-304	Physiology	4(3+1)
Z-305	Ecology	3(2+1)
Z-306	Evolution	2(2+0)
Total Credit Hours		

Z-301 تدریسِ ترجمہ قرآن **Cr: 0(0+0)**
سورۃ مریم تا سورۃ الفرقان

Z-302 ECONOMIC ZOOLOGY Cr. 3(2+1)

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. **ACQUIRE** basic knowledge of Commerce and Economics with 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 h u m a n 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Text and Reference Books:

1. Economic Zoology. Ravindranathan, K. R. 2003. 1st ed. Dominent Publishers and Distributers. 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. 30.
11. Shukla, G.S. and Upadhayay, V.B., 1997. Economic Zoology, 3rd Ed. Rastogi Publications, Mearut, India, pp. 369.

Z-303 BIOCHEMISTRY II Cr. 3 (2+1)

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:

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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 Contants

1. **Bioenergetics**

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

2. **Metabolism**

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

3. **Lipid metabolism**

- Digestion, mobilization and transport of Fats; Biosynthesis of Triacylglycerol;
- Utilization of Triacylglycerol; Oxidation of Fatty acids; Activation of Fatty acids and their transportation to mitochondria;
- Beta (ß)-Oxidation; Bioenergetics of ß-oxidation; Omega (ω)- Oxidation pathway;
- Biosynthesis of Saturated Fatty acid, Supply of raw material for palmitic acid synthesis; Fatty acid synthetase (FAS) multienzyme complex;
- 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**

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

5. **Nitrogen metabolism**

- Metabolic fate of amino acids; Catabolism of amino acids; Deamination and Transamination;
- Role of glutamate, glutamine and alanine in transport of ammonia in tissues;
- Nitrogen excretion and urea cycle; Regulation of urea cycle;
- Pathways of amino acid degradation showing entry points in Citric acid cycle; Decarboxylation of amino acids to biological amines.
- Biosynthesis of some amino acids; Incorporation of ammonia in glutamate and glutamine;
- 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 unknown samples of 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.
7. James R. Mckee; Trudy Meckee, . 6th Edition.Oxford University Press.

Additional Readings:

1. Lubert Stryer, 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.
3. Harper's Biochemistry, McGraw Hill Bok Company, New York.
4. Elliott, W. H. and Elliot, D. C., 2002. Biochemistry and Molecular Biology, Oxford Medic Publications, Oxford University Press.
5. Voet, D., Voet, J. G. and Pratt, C. W., 1999. Biochemistry, John Wiley & Sons.
6. Zubay, G. 1993. Biochemistry, Wm. C. Brown Publishers, Oxford.

Z-304 PHYSIOLOGY Cr. 4(3+1)

Course Objectives:

Knowledge

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

1. Understand on the molecular and cellular mechanisms of physiological function as the basis of unity in diverse animals e.g. membrane excitability, exchange of respiratory gases, removal of nitrogenous wastes tissue, osmotic and organ physiological mechanisms underlying animal homeostasis and temperature effects.

2. Grasp the development of performing the function developed at molecular and cellular level in the complexity of the animals such as chemical & nervous integration, respiratory and excretory functions.
3. Know the strategy acquired to perform the functions in diverse environment such as in dry, aquatic 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 vertebrats.
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 re-absorption 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

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

Nerve and Muscle

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

Nervous System:

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

Hormones System:

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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Sho videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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

Z-305 ECOLOGY Cr. 3(2+1)

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 mittigation

Course Learning Outcomes:
Upon successful completion of the course, the student will be able to:
1. Understand and applythe basic concepts of Ecology
2. Acquiretheoretical 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
- Basic Concepts of and Types of Ecology
- Laws of thermodynamics, primary and secondary productions
- Trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.

2. Biogeochemical Cycle:
- Nitrogen, Phosphorus, Sulpher, Water, Carbon and nutrient.

3. Limiting Actors
- Basic Concepts, Temperature, Soil, Water and Humidity, Light and Fire.

4. Global Ecosystems:
- Atmosphere, Hydrosphere, Lithosphere and Ecosphere.
- An overview of Ecosystem with special reference to Ecological Niche, basic concepts and types
- Major ecosystem of world, Forest, Grassland, Desert, Tundra and Agricultural ecosystems.
- 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;
- Mineral, Agricultural Desalination, Weather Modification, Forest and Range Management, Landscape and Land use

8. Pollution:
- Definition, Types, Water, Air, Land and Noise, Sources and Management.

9. Radiation Ecology:
- Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws).

10. Exotic and Invasive Species
- Desertification, Deforestation, exotic and invasive species

Practical:

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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

Z-306 EVOLUTION Cr. 2(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 systematic 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 ofallometry, 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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Text and Reference Books:

1. Strickberger. M.W. 2012. Evolution. Jones & Barrett Publishers. Gower Street, London, England.
2. Ridley, M. 1993. Evolution. Blackwell Scientific Publications, New York, USA..
3. Moody, P.A. 1989. *Introduction to Evolution*, Harper and Row, Publishers, New York
4. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and Practical Practice of Phylogenetic systematics. 2nd Ed. Wiley-Blackwell.
5. Mayer, E. Principles of Systematic Zoology. 1994. McGraw-Hill, New York.

SEMESTER– VI

Course Code	Title of Course	Credit Hours
Z-307	تدریسِ ترجمہ قرآن	1(0+1)
Z-308	Research Methodology	2(2+0)
Z-309	Principles of Systematics	3(2+1)
Z-310	Developmental Biology	4(3+1)
Z-311	Genetics	4(3+1)
Z-312	Wildlife	3(2+1)
Total Credit Hours		

Z-307 تدریسِ ترجمہ قرآن **Cr. 1(0+1)**
سورۃ الشعراء تا سورۃ ص

Z-308 **RESEARCH METHODOLOGY** **Cr. (2+0)**

Course Objectives:

The course is aims at how to approach the solution of a problem.

1. To develop research skills Provide understanding how to design scientific research,

to collect data and its interpretation
2. To emphasize the importance of ethics in scientific research
3. To enable students to write a research proposal

Course Learning 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. **FAMILIARIZE** 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. **FAMILIARIZE** 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:**
- Objectives of Research, Motivations
2. **Research Process:**
- Research methods vs. research methodology, scientific method
- Types of research, general steps involved in research
- Problems of research in Pakistan
3. **Topic Selection:**
- Problem identification for research, criteria and evaluation
4. **Literature review:**
- Importance and sources
- Referencing and citation and Bibliography
- plagiarism
5. **Research Design:**
- Parts, important features, important concepts in research design
6. **Aims and objectives:**
- Research objectives, qualities of research objectives
7. **Material and methods:**
- Bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources
8. **Data Analysis:**
- Processing, statistics in research, hypothesis testing, t-tests and ANOVA
9. **Scientific Writing:**
- Difference between thesis/report/synopsis/research proposal
- 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

(50)

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 Quantitatvive 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.

Z-309 PRINCIPLES OF SYSTEMATICS Cr. 3 (2+1)

Course Objectives:

The course aims to:

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

(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.

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.

Z-310 DEVELOPMENTAL BIOLOGY Cr. 4 (3+1)

Course Objectives:

The course aims to:

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

Course Learning Outcomes:

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

1. **Gain** familiarity with features that make an organism model for the learning of developmental biology *e.g.,* fertilization in sea urchin with mammalian like mechanisms.
2. **Apprehend** the contributions of the sperm and the egg to form zygote
3. **Elucidate** the problems associated with cell differentiation through fate mapping.
4. **Arrange and investigate** the classical and modern experiments into "find it", "block it", and "move it" categories
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**
- History and Basic Concepts of Developmental Biology
- Principal features of developmental biology and embryology with special emphasis on vertebrate models
- Origin of sexual reproduction
- Developmental patterns

2. **Spermatogenesis**
- Mammalian spermatogenesis as model for all vertebrates
- Spermiogenesis or (spermateliosis)
- The role of Sertoli and Leydig cells in spermatogenesis
- Hormonal control of spermatogenesis

3. **Primates Menstrual cycle**
4. **Oogenesis**
- Mechanism of oogenesis among various classes of vertebrates.
- Vitellogenesis
- Hormonal control of Vitellogenesis and oogenesis

5. **Fertilization**
- External & Internal Fertilization
- Species-specific recognition of sperm and egg
- Fusion of male and female gametes
- Polyspermy: slow and fast blocks to polyspermy
- Activation of egg metabolism

6. ***IN VITRO* Fertilization (IVF)**

(52)

- History, Steps and advantages of IVF
- Disadvantages and risk factors

7. Cleavage & Blastulation

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

8. Gastrulation

- Fate maps
- Gastrulation in amphibians, birds and mammals

9. Early Vertebrate Development

- Neurulation, ectoderm, mesoderm and endoderm formation

10. Placenta and extra embryonic membranes

11. Cellular Basis of Morphogenesis

- Differential cell affinity, cell adhesion molecules
- Organogenesis
- Mechanism of Teratogenesis

12. Aging and Regeneration in vertebrates

Practical:

1. Study of the structure of gametes in some representative cases, *i.e.* Frog, Fish and Mammal.
2. Hen's egg internal and external structural details
3. Microscopic analysis of hen's egg yolk, albumin and shell membranes
4. Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.
5. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
6. Study of developmental stages of nematodes through microscopic analysis of animal dung
7. Semen analysis
8. Dactylography and its uses in Developmental Biology

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

Z-311 GENETICS Cr. 4(3+1)

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

- 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).
- Multiple Alleles: blood groups and coat color in rabbits.
- Genetics of Rh factor and Erythroblastosis Foetalis.

2. Chromosomal Basis of Inheritance:

- Chromosomal Theory of Inheritance

- Interaction of genes, Epistasis, Lethality and Pleiotropism.

3. **Chromosomal Aberrations**

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

4. **Pedigree Analysis:**

- Normal human chromosome complement; Karyotyping.
- Sex-determination and Sex-linkage:
- Sex determination in animals and humans,
- Sex linked (Hemophilia, muscular dystrophy, color blindness), sex influenced and sex limited traits,
- Prenatal Diagnosis: Amniocentesis and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics

5. **Chromosome mapping**

- Linkage, recombination (crossing over) and
- Chromosome mapping in eukaryotes.

6. **Molecular Genetics:**

- Gene Concept (classical and modern),
- Genetics of Viruses and Bacteria,
- Transposons,
- Mutation and DNA repair
- Molecular Genetic Analysis,
- Regulation of Gene Expression in Prokaryotes,
- Gene Regulation in Eukaryotes,
- Genetic basis of diseases, like cancer,
- Genetic control of animal development.
- The genetic control of the Vertebrate Immune System,

7. **Recombinant Technology**

- The Techniques of Molecular Genetics (elements of genetic engineering),
- PCR

8. **Human Genetics;**

- Single and Multifactorial Disorders:
- Autosomal anomalies, Pseudoautosomal genes,
- Single gene disorders: Gene mutation and disorders; Autosomal single gene disorders (Sickle cell anemia, Brachydactyly; Inborn errors of metabolism such as Phenylketonuria, alkaptonuria).
- Complex Inheritance Patterns, Polygenic traits- Cleft lip and cleft palate,

9. **Population Genetics:**

- Hardy-Wienberg equilibrium,
- 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. X2 test
18. Study of transformed bacteria on the basis of antibiotic resistance
19. PCR

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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
7. A.P. (Latest available Addition)
8. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.
9. Willium S. Klug, 2014. Concept of Genetics, ISBN-11: 978-0321948915
10. Lewin's Gene XI BY Jocelyn E.Krebs et al. 2013, isbn-13:978-1449659851,ISBN-10:1449659853
11. 10. Gene- XI by Lewin's,2013,ISBN:978-1449659851
12. Concepts of genetics 11th edition, William S.Klug,2014,ISBN-13:978- 0321948915

Z-312 WILDLIFE Cr. 3 (2+1)

Course Objectives:

The objective of this course is

1. to enable the student to understand philosophy and significance of wildlife conservation
2. to understand the wildlife management rules and regulations in Pakistan
3. to understand how National and International agencies are involved in conservation and management of wildlife

Course Learning Outcomes:

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

1. **ACQUIRE** theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan

2. **UNDERSTAND** the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks)
3. **SOLVE** the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).
4. **ANALYSE** interpret and synthesize data and other information about the population of wildlife
5. **EVALUATE** the conservation management by government department, National and International organisations
6. **DEMONSTRATE** the ecological assessment and importance of wildlife to certain area.

Course Outline

1. **Wildlife of Pakistan**
- Introduction
- Important Definitions
- Identification
- Distribution
- Status
- 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**
- Provincial Rules
- Federal Management of Wildlife (NCCW)

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

6. **Protected Areas in Pakistan**
- Sanctuaries
- Game Reserves
- National Parks

7. **Ramsar convention**
- Wetlands
- Ramsar Criteria
- Ramsar Sites

8. **Threatened species of Pakistan**
- Vulnerable
- Endangered
- Critically Endangered

Practicals:

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

Teaching-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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 Code	Title of Course	Credit Hours
Z-401	Biostatistics/Univ option	3(2+1)
Z-402	تدریس ترجمہ قرآن	0(0+0)
ES….	Special Paper / Thesis/ Research Project / Internship (Univ. Option)	3(2+1)
ES…..	Special Paper / Univ. opt	3(2+1)
Z-ES	Univ. opt	3(2+1)
Z-403	Molecular Biology	3(2+1)
Total Credit Hours		

Z-401 BIOSTATISTICS Cr. 2(2+1)

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 resea 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 t characterize and summarize data.

Course Contents:

1. **Introduction:**
- Definition, branches of statistics,
- Scope and importance of statistics

2. **Data:**
- Population and sample, variable, categorical and non-categorical data,
- Scales of measurements, errors of measurements

3. **Presentation of data:**
- Descriptive statistics

- Tabulation of data
- Parts of table and construction of table.
- Diagrams and graphs, pictogram, historigram, line chart, histogram, applications and uses of histogram
- Construction of histogram, comparison of data using histogram,
- Bar Chart, Multiple Bar Chart, Pie Chart, Gantt Chart, Timeline, Infograph, Pedigree Chart

4. **Frequency distribution:**

- Empirical FD, relative FD, Cumulative FD, Class frequency, Class limits, Class boundaries, Class mark, Class interval, Midpoints.

5. **Measures of Central Tendency:**

- Types of averages, arithmetic mean for grouped and ungrouped data, harmonic mean for grouped and ungrouped data, geometric mean for grouped and ungrouped data, median, quartiles, deciles, percentiles and mode.
- Advantages and disadvantages of arithmetic mean, harmonic mean, geometric mean, median and mode.

6. **Measures of Dispersion:**

- Range, grouped and ungrouped data, coefficient of range
- Mean deviation of grouped and ungrouped data. Coefficient of mean deviation.
- Standard deviation and variance of grouped and ungrouped data, variance and standard deviation of population and sample data.

7. **Probability:**

- Definition, properties, experiment and random experiment, event, outcome, trial, multiplication rule, sample space and sample point, mutually exclusive event, combinations and permutations, probability distribution, binomial experiment

8. **Tests of Significance:**

- Hypothesis testing
- Steps of hypothesis testing
- Z-test
- T-test, types,
- Chi-square
- ANOVA, its uses and LSD
- Correlation
- 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

Z-402	**تدریس ترجمہ قرآن** **سورۃ الزمر تا سورۃ ق**	**Cr: 0(0+0)**
ES…	**Special Paper / Thesis/ Research Project / Internship (Univ. Option)**	**Cr: 3(2+1)/3**
ES…	**SPEICAL PAPER /UNIV. OPTION**	**Cr. 3 (2+1)**
ES…	**SPEICAL PAPER /UNIV. OPTION**	**Cr. 3 (2+1)**
Z-403	**MOLECULAR BIOLOGY**	**Cr. 3 (2+1)**

Course Objectives:

1. To impart knowledge about chemical, physical and biological properties of nucleic acids.
2. To understand different molecular mechanisms and their regulation in prokaryotes ar 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 Erokaryotes and Eukaryotes.
4. **APPLY** molecular knowledge to identify human genetic disorders and to understand underlying molecular mechanism

Course Outline:

1. Introduction

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

2. Replication

(60)

- DNA Replication in Prokaryotes
- DNA Replication in Eukaryotes
- Enzymology of replication
- DNA damage and repair

3. Transcription

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

4. Translation

- Role of Ribosomes
- Mechanism of Translation in prokaryotes and eukaryotes
- Various factors, and Posttranslational processing

5. Mutation

- Types of Mutations
- Base-Analogue Mutagens
- Chemical Mutagens

6. Gene expression and control

- Control of gene expression in Prokaryotes.
- Inducible and repressible operons.
- 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

Text and Reference books:

1. Weaver, R.F. 2020 Moleculer Biology, McGraw. Hill Companies. Inc. 6th Edition.
2. 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.
3. 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.
4. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.
5. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
6. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York.

SEMESTER–VIII

Course Code	Title of Course	Credit Hours
Z-404	تدریس ترجمہ قرآن	1(0+1)
Z-405	Bioinformatics	3(1+2)
ES…/ Z-406/ Z-407/Z-408	Special Paper B1/ Thesis/ Research Project / Internship (Univ. Option)	3(2+1)/ 6
ES…	Special Paper B2/Univ. opt	3(2+1)
ES…	Univ. opt	3(2+1)
Z-409	Zoogeography & Paleontology	3(2+1)
Total Credit Hours		

Z-404 تدریس ترجمہ قرآن سورۃ الزاریات تا سورۃ الناس **Cr: 1(0+1)**

Z-405 BIOINFORMATICS Cr. 3(1+2)

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. **USE** bioinformatics search tools on the internet for mining data, pairwise and multiple sequence alignments and predict protein structures.

Course Contents:

1. **Introduction:**
- Introduction to Bioinformatics,
- Scope of Bioinformatics, useful websites
- Aims of Bioinformatics, disciplines related to Bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools
- Human genome project

2. **Biological databases**
- Data and types of data, data acquisition
- Major DNA databases around the world, NCBI, BOLD, DDBJ
- Major protein databases in the world, protein sequence databases, protein structure databases
- Specialized databases, genome and organism databases
- Non sequence databases, pubmed, pubmed health, OMIM

3. **Genome mapping**
- Genetic and linkage mapping, physical mapping

4. **Gene family**:
- 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:**
- Searching sequence databases
- FASTA format

- retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data

6. **Primer Designing:**
- Primer and probe, qualities of primer, general rules for primer designing
- Websites used for primer designing

7. **Sequence Alignment**:
- Importance and significance of alignment, methods for sequence alignment
- Local and global alignment, pair-wise local alignment

8. **BLAST**: Introduction, types, uses, algorithm, BLAST Scores
9. **Multiple Sequence Alignment:**
- Introduction, tools for MSA, uses and importance

10. **Phylogenetic analysis**:
- Introduction, interpretation, rooted and unrooted tree,
- 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation, and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

ES../Z-406/Z-407/Z-408

Special Paper /Thesis/ Research Project / Internship **(Univ. Option)** **Cr. 3(2+1)**

ES…	**Special Paper B2/Univ. Option**	**Cr. 3(2+1)**
ES…	**Univ. Option**	**Cr. 3(2+1)**

Z-409 ZOOGEOGRAPHY AND PALEONTOLOGY Cr. 3(2+1)

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**
- Theories of continental drift and plate tectonics
- Pangea

2. **Animal distribution**
- Cosmopolitan distribution
- Discontinuous distribution
- Isolation distribution
- Bipolar distribution
- Endemic distribution
- Barriers and dispersal.

3. **Zoogeographical regions:**
- Zoogeographic Division and Boundaries
- Geographic Ranges, Physical Features
- Climates,
- Faunas and Affinities of Palaearctic, Nearctic Regions, Oriental,
- Ethiopian, Australian and Neotropical Regions
- Insular Fauna

4. **Zoogeography of Pakistan:**
5. **Paleontology: The Planet Earth**
- History, age, shells of earth
- Atmosphere, hydrosphere, biosphere and lithosphere.

6. **Rocks**:

- Types; lgneous rocks, sedimentary rocks and metamorphic rocks.

7. Fossil and Fossilization

- Fossil types and uses of fossils, nature of fossils.
- Fossilization
- Invertebrates and Vertebrates Fossil
- Biostratigraphy
- Fossils of Pakistan
- Paleontologically important areas of Pakistan.

8. Fossilization:

- Geological time scale.
- Pre-Cambrian life.
- Post Cambrian life,
- Paleozoic life
- Mesozoic life
- Cenozoic life.

9. Paleontological Techniques

- Excavation techniques
- Excavation tools and techniques
- Transportation and processing of fossils.
- Presentation of fossils
- Pre requisites for paleontological excavation.

10. Geochronometry:

- Uranium/Lead dating
- Radiocarbon dating, methods
- Index fossils
- Evolutionary history of man, elephant, horse and camel,
- 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-Learning Strategies

Teaching will be a combination of class lectures, class discussions, and group work. Short videos/films will be shown on occasion.

Assignments

The sessional work will be a combination of written assignments, class quizzes, presentation and class participation/attendance.

Assessments and Examination

Sessional Work: 25 marks
Midterm Exam: 35 marks
Final Exam: 40 marks

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.

ANNEXURE-I

LIST OF ELECTIVE AND SPECIALCOURSES:

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 totherequirements and expertise available.

Course Code	Title	Credit Hours
ES 01	Advances in Aquaculture-I	3(2+1)
ES 02	Advances in Aquaculture-II	3(2+1)
ES 03	Aerosol and Environmental Health	3(2+1)
ES 04	Agricultural Biotechnology	3(2+1)
ES 05	Air Pollution Monitoring	3(2+1)
ES 06	Animal Adaptations	3(2+1)
ES 07	Animal Communication	3(2+1)
ES 08	Animal Pests and Disease Producing Organisms	3(2+1)
ES 09	Apiculture I	3(2+1)
ES 10	Apiculture II	3(2+1)
ES 11	Applied Fisheries	3(2+1)
ES 12	Applied Helminthology	3(2+1)
ES 13	Applied Microbiology	3(2+1)
ES 14	Arachnology	3(2+1)
ES 15	Bacteriology	3(2+1)
ES 16	Basic Human Genetics	4(3+1)
ES 17	Behavioral Ecology	3(2+1)
ES 18	Biochemical Toxicology- I	3(2+1)
ES 19	Biochemical Toxicology-II	3(2+1)
ES 20	Biochemistry of Drug Action	3(2+1)
ES 21	Biodiversity and Wildlife*	3(2+1)
ES 22	Biodiversity of Inland and Terrestrial Molluscs*	3(2+1)
ES 23	Biomedical Technology	3(2+1)
ES 24	Biosafety Ethics	3
ES 25	Biotechnology	3(2+1)
ES 26	Biotechnology in Aquaculture	3(2+1)
ES 27	Cancer Biology	3(2+1)
ES 28	Cancer Chemical Biology	3(2+1)
ES 29	Cell and Tissue Culture	3(2+1)
ES 30	Cell Signaling System	3(2+1)
ES 31	Classification of Insect	3(2+1)
ES 32	Climate Change, Ecosystem Resilience and Stability	3(2+1)
ES 33	Clinical Biochemistry	3(2+1)
ES 34	Comparative Anatomy of Vertebrates	3(2+1)
ES 35	Comparative Developmental Biology	4(3+1)
ES 36	Comparative Vertebrate Endocrinology	3(2+1)
ES 37	Conservation Biology*	3(2+1)
ES 38	Diagnostic Parasitology	3(2+1)
ES 39	Ecological Genetics	3(2+1)

ES 40	Economic Zoology	3(2+1)
ES 41	Elements of Stratigraphy & Structural Geology	3(2+1)
ES 42	Endocrinology	3(2+1)
ES 43	Entomology (Classification of Insects and Pest Management)	3(2+1)
ES 44	Entomology (Morphology, Physiology of Insects)	3(2+1)
ES 45	Environmental Biology of Fishes	3(2+1)
ES 46	Environmental Issues*	3(2+1)
ES 47	Environmental Microbiology	3(2+1)
ES 48	Environmental Physiology	3(2+1)
ES 49	Environmental Pollution	3(2+1)
ES 50	Environmental Toxicology & Chemistry -I	3(2+1)
ES 51	Environmental Toxicology & Chemistry -II	3(2+1)
ES 52	Environmental Toxicology*	3(2+1)
ES 53	Epidemiology and Public Health	3(2+1)
ES 54	Epidemiology of Parasitic Disease	3(2+1)
ES 55	Evolution and Principles of Systematic Zoology	4(3+1)
ES 56	Exercise Physiology	3(2+1)
ES 57	Fish Bioenergetics	3(2+1)
ES 58	Fish Culture*	3(2+1)
ES 59	Fish Disease & Health Management	3(2+1)
ES 60	Fish Ecology*	3(2+1)
ES 61	Fish Endocrinology	3(2+1)
ES 62	Fish Feeding Management*	3(2+1)
ES 63	Fish Health Management	3(2+1)
ES 64	Fish Physiology & Breeding	3(2+1)
ES 65	Fisheries Management	3(2+1)
ES 66	Freshwater Fish Parasitology	3(2+1)
ES 67	Fundamentals of Fisheries	3(2+1)
ES 68	Fundamentals of Human Genetics*	3(2+1)
ES 69	Fundamentals of Microbiology*	3(2+1)
ES 70	General & Comparative Endocrinology	3(2+1)
ES 71	General Microbiology	3(2+1)
ES 72	General Parasitology	3(2+1)
ES 73	Genes and Disease	3(2+1)
ES 74	Genetic Counseling	3(2+1)
ES 75	Haematology	3(2+1)
ES 76	Helminthology	3(2+1)
ES 77	Helminthology and Host-Parasite Relationship*	3(2+1)
ES 78	Herpetology	3(2+1)
ES 79	Histology	3(2+1)
ES 80	Human Embryology & Teratology	3(2+1)
ES 81	Human Genetics	3(2+1)
ES 82	Ichthyology*	3(2+1)
ES 83	Immunochemistry	3(2+1)
ES 84	Immunology	4(3+1)
ES 85	Insect Bioaccoustics	3(2+1)
ES 86	Insect Biochemistry and Physiology	3(2+1)
ES 87	Insect Pathology	3(2+1)

ES 88	Insect Structure and Function	3(2+1)
ES 89	Insects of Veterinary and Medical Importance*	3(2+1)
ES 90	Integrated Pest Management	3(2+1)
ES 91	Introduction of Enviromnent	3(2+1)
ES 92	Introduction to Applied Fisheries	3(2+1)
ES 93	Introduction to Fish Biology	3(2+1)
ES 94	Invertebrate Palaeontology	3(2+1)
ES 95	Laboratory Technique	3(2+1)
ES 96	Limnology-I	3(2+1)
ES 97	Mammalogy	3(2+1)
ES 98	Mechanisms of Development	3(2+1)
ES 99	Medical Entomology	3(2+1)
ES 100	Medical Parasitology	3(2+1)
ES 101	Medical Virology	3(2+1)
ES 102	Microbial control of infectious disease	3(2+1)
ES 103	Microbiology and Biotechnology*	4(3+1)
ES 104	Microbiology of Extreme Environment	3(2+1)
ES 105	Molecular & Clinical Endocrinology	3(2+1)
ES 106	Molecular & Clinical Physiology	3(2+1)
ES 107	Molecular and Clinical Endocrionology	3(2+1)
ES 108	Molecular Biology of Cancer	3(2+1)
ES 109	Molecular Biology*	3(2+1)
ES 110	Molecular Genetics*	3(2+1)
ES 111	Molecular Physiology	3(2+1)
ES 112	Natural Photography	3(2+1)
ES 113	Neurobiology	3(2+1)
ES 114	Ornithology*	3(2+1)
ES 115	Pharmacological and Pathological Endocrinology	3(2+1)
ES 116	Physiological Systems and Adaptations	3(2+1)
ES 117	Physiology of Coordination	3(2+1)
ES 118	Physiology of Endocrinology	3(2+1)
ES 119	Physiology of Functional Systems	3(2+1)
ES 120	Physiology of Neuronal Integration & Behavior	3(2+1)
ES 121	Physiology of Reproduction	3(2+1)
ES 122	Population Biology	3(2+1)
ES 123	Principles & Methods in Physiology	3(2+1)
ES 124	Principles and Kinetics of Toxicology*	4(3+1)
ES 125	Principles of Fish Biology	3(2+1)
ES 126	Principles of Parasitology*	3(2+1)
ES 127	Principles of Toxicology-I	3(2+1)
ES 128	Principles of Toxicology-II	3(2+1)
ES 129	Proteomics	3(2+1)
ES 130	Protoparasitology	3(2+1)
ES 131	Protozoology I	3(2+1)
ES 132	Protozoology II	3(2+1)
ES 133	Quantitative Zoology	3(2+1)
ES 134	Radiation Biology	3(2+1)
ES 135	Reproductive Biology	3(2+1)

ES 136	Reproductive Endocrinology	3(2+1)
ES 137	Restoration Ecology	3(2+1)
ES 138	Restoration Ecology and Sustainable Development*	3(2+1)
ES 139	Seminar	2(2+0)
ES 140	Signal Transduction and Biomembranes	3
ES 141	Taxidarmy	3(2+1)
ES 142	Techniques in Fisheries Research	3(2+1)
ES 143	Teratology	3(2+1)
ES 144	Vector Biology	3(2+1)
ES 145	Vertebrate Palaeontology	3(2+1)
ES 146	Veterinary and Wildlife Parasitology	3(2+1)
ES 147	Virology	3(2+1)
ES 148	Wetlands Management	3(2+1)
ES 149	Wildlife Parasitology	3(2+1)
ES 150	Zoological Techniques	3(2+1)

(70)

COURSE CONTENTS OF SOME ELECTIVE AND SPECIAL COURSES*

ES 1 ADVANCES IN AQUACULTURE –I Cr. 3(2+1)

Physical problems in fish farm construction, hydrometrology in pond fish culture, application of lime and fertilizers in fish farm, new trends in fish farm management, warm water fish seed production, enhancing production of carp fingerlings by the use of growth promoting substances, intensive and semi-intensive culture of major carps, tillet flavour problem in fish culture, fish diseases and their control in aquaculture.

Practicals

1. Collection and preservation of water sample.
2. Eradication of weed plants/algal blooms.
3. Eradication of predators and predatory insects.
4. Stocking density and ratio of fish.
5. Control of parasites and diseases.
6. Identification of Indian major carps.
7. Fishing gears.
8. Determination of forage ratio of a given fish.

Textbooks

1. Pillay, T. V. R., 1999. Aquaculture: Principles and Practices. Fishing News Books.
2. Agrawal, V. P. 1999. Recent Trends in Aquaculture. Society of Biosciences. India.
3. Reddy, M. S. and K.R.S. SambasivaRao. 1999. A Text Book of Aquaculture. Discovery Publishing House, N. Delhi.

Additional Readings

1. Meade, J. W. 1998. Aquaculture Management. Chapman & Hall Inc. N. York.
2. Parker, R. 1994. Aquaculture Science. Delmar publishers, N. York.
3. Deborah, A. T. 1989. Aquaculture, Mansell, N. York.

ES 2 ADVANCES IN AQUACULTURE –II Cr. 3(2+1)

Introduction to advanced aquaculture. Culture of freshwater prawns shrimps and freshwater shrimps, Oyster culture, Aquaculture in raceways, Cages, enclosures and ponds with particulars references to the site and design of cages, use of agricultural and urban wastes in aquaculture, paddy culture.

Practicals

1. Determinant of water temperature.
2. Determination of water flow/velocity.
3. Determination of pH of the water.
4. Determination of total dissolved solid (DTS).
5. Determination of water salinity.
6. Determination of dissolved carbondyoxide.
7. Determination of water alkalinity.
8. Determination of various toxicant in water that may affect fish/shrimp growth.

Textbooks

1. Pillay, T. V. R., 1999. Aquaculture: Principles and Practices. Fishing News Books, London.
2. Agrawal, V. P. 1999. Recent Trends in Aquaculture. Society of Biosciences. India.
3. Karunasagar, I, I. Karunasagar and A. Reilly. 1999. Aquaculture and Biotechnology. Oxford & IBH Publishing Co., N. Delhi.

Additional Readings

1. Stickney, R.R. 1992. Principles of Warmwater Aquaculture. John Wiley & Sons, N. York.
2. Meade, J. W. 1998. Aquaculture Management. Chapman & Hall Inc. N. York.

3. Deborah, A. T. 1989. Aquaculture, Mansell, N. York.

ES 3 AEROSOL AND ENVIRONMENTAL HEALTH Cr. 3(2+1)

Course Contents:
An introduction to Air pollution, Criteria pollutants: types, properties and sources, Fundamentals of particulate pollution, Instrumentation for sampling and monitoring aerosols, Levels and limits of pollutants in the air, Bioaerosol sampling and analysis, Relationship between indoor and outdoor air quality, Global warming and its implications for humans, Other pollutants: their properties and sources.

Practicals

Measurement of PM_{10}, $PM_{2.5}$, and PM_1 in indoor and outdoor environments. Assessing other pollutants in the air.

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

Reference Books

1. Write.T.R., 2007. Environmental Science, towards a sustainable future. Pearson Prentice Hall.
2. Purohit, S.S. and Ranjan, R., 2003. Ecology, Environment and Pollution, Agrobios.
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. Baron, P.A. and *Willeke,* K., 2001. Aerosol Measurement van Nostrand Reinhold
7. Vincent, J.H. 2007. Aerosol Sampling: Science, Standards, Instrumentation and Applications, John Wiley
8. Friedlander, S., Smoke, K., 2000. Dust and Haze (2^{nd} edition), OUP
9. Tiwari, A. and Colls, J., 2010. Air Pollution, 3^{rd} ed. Rontledge.
10. Gurjar, B.R., Molina, C.T. and Ojha, C.S.P., 2010. Air Pollution, CRC-Press
11. Tarlo, S.M., Cullinan, P. and Nency, B., 2010. Occupational and Environmental Lung Disea Wiley-Blackwell.

ES 4 AGRICULTURE BIOTECHNOLOGY Cr. 3(2+1)

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 producingtransgenic 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**
- Introduction and its applications in crop improvements
2. **Cell and plant tissue culture**
- Introduction, types and methodology

- Improvement of plants via plant cell culture;

3. Plant molecular biomarkers

4. Gene Transformation

- Direct and indirect methods of plant and animal transformation
- Gene gun method of transformation
- *Agrobacterium* mediated transformation
- chloroplast transformation
- polyethylene glycol (PEG) mediated transformation;

5. Transgenic crops

- Transgenic crops with herbicide
- biotic and abiotic stress resistance
- problems related to transgenic plants

6. Genetically modified organisms (GMOs)

- Introduction
- Field evaluation and commercialization of GMOs
- Possible effects of releasing GMOs into the environment

7. Bio-fertilizers

- Introduction, bio-pesticides and their types
- Non-symbiotic nitrogen fixers
- 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 andcallus induction
3. Culturing *Agrobacterium* and using it to infect plant callus
4. Selection of transformant's; regeneration of plantlets and acclimatization
5. PlantDNA extraction and PCR for detecting introduction of foreign DNA into plants.

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, Horticultureand 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.

ES 5 AIR POLLUTION MONITORING Cr. 3(2+1)

Air pollutants : types, properties and sources, Global air pollution and climate, Gaseous air pollutants, Particulate matter and aerosols, Aerosol size, Aerosol optical properties, Aerosol type and sources, Air pollution and climate change, Bio indicators, Thresholds and injury, Genetic adaptation, Industrial melanism, Sensitivity and tolerance, Global warming, The greenhouse effect, Plant effects, Human implications.

Practicals

Study and analysis of PM 10 of ambient and indoor air.

Textbooks

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: 2ndedition; Longman Scientific and Technical.

Books Recommended

1. Write, T.R. 2007. Environmental Science, towards a sustainable future. Pearson Prentice Hall.
2. Purohit, S.S. and Ranjan, R. 2003. Ecology, Environment and Pollution, Agrobios.
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. Baron, P. A. and K .Willeke, 2001. Aerosol Measurement van Nostrand Reinhold.
7. Vincent, J. H. 2007. Aerosol Sampling: Science, Standards, Instrumentation and Applications, John Wiley.
8. Friedlander, S. K. Smoke, 2000. Dust and Haze (2nd edition), OUP.
9. Tiwari, A. and Colls, J. 2010. Air Pollution, 3rd ed. Rontledge.
10. Gurjar, B. R., Molina, C. T. and Ojha, C. S.P. 2010. Air Pollution, CRC-Press.
11. Tarlo, S. M., Cullinan, P. and Nency, B. 2010. Occupational and Environmental Lung Disease, Wiley-Blackwell.

ES 6 ANIMAL ADAPTATION Cr. 3(2+1)

Course outline to be prvided by the concered expertise

ES 7 ANIMAL COMMUNICATION Cr. 3(2+1)

Course outline to be prvided by the concered expertise

ES 8 ANIMAL PESTS AND DISEASE PRODUCING ORGANISMS Cr. 3(2+1)

Course outlineto be prvided by the concered expertise

ES 9 APICULTURE I Cr. 3(2+1)

The significance of the honeybees; Zoological position of honeybees; Definitions of some common beekeeping terms; Types of honeybees and their distribution, endemic and exotic species; Honeybee structure, functions and special organs; The colony and its organization; Biology of the honeybee, life history, food collection and functional behaviour; A good apiary site, hive location, placement of colonies moving and transporting bees; Beekeeping equipment and fundamental tools for bee breeding, honey production and harvesting/ processing of honey and beeswax; Major honey flows in different ecological areas; How to start, installing a bee hive and establishment of an apiary; Inspection techniques, introducing a queen, handling queens, recognizing robber bees, control of robbing and setting examination schedules; Supplemental feeding in floral dearth, medicinal feeding for disease prevention, queen breeding and stimulative brooding rearing; Combining two colonies, dividing and multiplying colonies and natural queen cells; The production of nectar and natural sources of nectar and pollen; Clustering in summer and winter seasons, absconding, laying workers and bee poisoning; Products from apiculture; Honey production, harvesting, processing and uses; Beeswax production, extraction, processing and its uses; Swarming, hive activity before swarming, hiving a swarm, prevention and control of swarming.

Practicals

1. Watching for the natural nest, contents of the cells, arrangement of the nest, colour of the combs.
2. Preparation of hive with frames and top bars.
3. Wiring frames, fixing foundations.
4. Use of bee veil, smoker, hive tool and other appliances.
5. Handling bees, stings, cleaning hives and ventilation.

6. Inspection of bees: opening bee hives, organization within the colony, removing frames, handling frames, fanning and food transmission.
7. Identification of queens, workers, drones, brood comb formation/ structure, honey and pollen stores, propolis and royal jelly.
8. Transferring bees in Langstroth hives, Observation hives and nuclei.
9. Hiving the swarm and preventive manipulations.
10. Removing honey crop, uncapping, handling cappings, honey extraction modern and traditional methods and preparation of honey for market.

Books Recommended

1. Ahmad, R. and 1984 Modern beekeeping (Urdu version). Pak. Agric. Rec. Council, Muzaffar, N. 350 pp.
2. Atwal, A.S. 2000. Essentials of beekeeping and pollination. Kalyani Publishers, India, 393 pp.
3. Blackiston, 2001. Beekeeping for dummies. Wiley Publishering Inc., USA, 303, pp.
4. Crane, E. 1976. Honey- A comprehensive survey. Inter. Bee Res. Assoe. Heinemann, London, 608 pp.
5. Dadant, C. 1986. The hive and the honeybee. Dadant and Sons, Hamilton, Illinois, USA, 740 pp.
6. Phillips, E.F. 2006 .Beekeeping. Ithaca, New York (1928), Agrobios Press, India, 490 pp.

ES 10 APICULTURE II Cr. 3(2+1)

Modern and traditional methods for honeybee breeding, merits of frame hive beekeeping and top bar hives; Migratory beekeeping; Seasonal management of colonies: Spring, Summer, Monsoon, Autumn and Winter seasons: fluctuations of colony populations of indigenous and exotic honeybees; Integrated management of honeybees for higher honey yield; Other by-products of Apiculture: pollen, propolis, royal jelly and bee venom production; Natural enemies of honeybees, symptoms, identification and control; American foulbrood disease of honeybee brood and its remedies; Mite diseases of honeybees and their control; Other diseases of honeybees and cures; Preparation of colonies for honeybee queen breeding, queen management, reserve queens and saving natural queen cells; Commercial queen rearing, improvement of stock and package bees; Manipulation techniques during honey flows, honey extraction and after honey harvest; Mating flights, prevention of drifting, equalizing the colonies and renewal of combs; Economics of beekeeping; Value addition products of apiculture; Conservation of indigenous honeybees and issues facing apiculture; Honey characteristics and quality control; Honeybees and wild bees in the environment and as pollinators; Honeybee pollinated crops and fruit trees; Preparation and management of colonies for pollination; A garden apiary and plan for a Bee Garden.

Practicals

1. Inspection of colonies: watching for diseases, pests, predators, their diagnosis and control.
2. Supplemental/ emergency feeding and making candy for queen breeding.
3. Moving colonies: Packing handing preparation and trams-portion techniques.
4. Queen rearing: preparation of colonies and queen cells.
5. Selection an breeding, grafting larvae, dry and wet methods.
6. Requeening of colonies, caging of queens and queen introduction.
7. Uniting colonies, harvesting pollen, propolis and royal jelly.
8. Recognizing robber bees, control of robbing.
9. Production of beeswax, harvesting and processing.
10. Preparation of value addition products of apiculture.

Books Recommended

1. Ahmad, R. 1984. Modern beekeeping (Urdu version). Pak. Agric. Rec. Council, 350 pp.
2. Atwal, A.S. 2000. Essentials of beekeeping and pollination. Kalyani Publishers, India, 393 pp.
3. Blackiston, 2001. Beekeeping for dummies. Wiley Publishering Inc., USA, 303 pp.

4. Crane, E. 1976. Honey- A comprehensive survey. Inter. Bee Res. Assoe. Heinemann, London, 608 pp.
5. Dadant, C. 1986. The hive and the honeybee. Dadant and Sons, Hamilton, Illinois, USA, 740 pp.
6. Phillips, E.F. 2006. Beekeeping. Ithaca, New York (1928), Agrobios Press, India, 490 pp.

ES 11 APPLIED FISHERIES Cr. 3(2+1)

Basic principles of fish culture: Extensive fish culture, Semi-intensive fish culture, Intensive fish culture.
Construction and management of fish farm: Ponds for fingerlings, Ponds for yearlings, Rearing ponds, Nursery ponds, Fattening ponds, Stocking ponds, Farm for large scale fish culture.
Construction and maintenance of fish seed hatchery: Hatchery for Salmonids, Hatchery for cyprinids, Hatchery for Catfishes.
Natural food and feeding: Phytoplanktons, Zooplanktons, Crustaceans (cladocera), Arthropods larvae, Annelids, Molluscs.
Artificial feed and feeding: Of plant origin, Of animal origin, Feed for Salmonids, Feed for Cyprinids, Feed pelleting, Adaptation of fish on pelleted feed.
Breeding and cultivation of Salmonids (rainbow trout & brown trout)**:** Natural breeding, Artificial breeding, Induced spawning, Hormonal induced spawning.
Breeding and cultivation of Cyprinids (major carps & Chinese carps)**:** Natural breeding, Artificial breeding, Induced spawning, Hormonal induced spawning, Fish diseases and their control: Viral disease, Bacterial diseases, Fungal diseases, Parasitic (protozoan, helminths, crustaceans, leeches, **Argulus** etc.).
Fish enemies and their control: Amphibians, Reptiles, Birds, Mammals, Chemicals and fertilizers. Fish harvesting and marketing, Netting, Transportation, Maintenance of flesh quality and price control.

Practicals

1. Morphological identification of important culturable fish species.
2. Study of gut contents of culturable fish species.
3. Diagnosis of important bacterial diseases in cyprinids.
4. Study of important parasites of fish.
5. Stripping of mature fish and artificial fertilization of eggs and sperms.
6. Study of early developmental stages.
7. Visit to various fish seed hatcheries during fish breeding season.

Books Recommended

1. Kestin. Farmed Fish Quality (2001). Multiline Books.
2. Ruth. Freshwater Aquaculture (2000). Multiline Books.
3. Bromage. Broodstock Management and Egg & Larval Quality (1995). Pak Book Corp.
4. Woo. Fish Diseases and Disorder: Protozoan and Metazoan Infections (1995). Pak Book Corp.
5. Brenabe. Aquaculture, Vol. I &II (1992). Fishing News Books Ltd, England.
6. C. Maseke. Fish Aquaculture (1987). Pergamon Press, Oxford.
7. M. Huet. Text Book of Fish Culture: Breeding andCultivation (1986). Fishing News Book Ltd, England.

ES 12 APPLIED HELMINTHOLOGY Cr. 3(2+1)

Classification of helminth Morphology and taxonomic characteristic of different species of helminthes. An introduction to Helminth culture. Modes of development of resistance in helminthes against anthelmintics. Methods of evaluation of anthelmintics.

Practicals

Collection of literature on helminthes.

Collection of helminth from slaughter houses.
Preparation of solutions for mounting and culturing the helminthes.
Preparation of permanents mounts of helminthes.
Culture of Helminthic ova for development of larvae for taxonomic studies detection of drug resistance.
Identification of helminthes.

Books Recommended

1. Soulsby, E. J. L., 1986. Helminths Arthropods and Protozoans of domesticated animals.
2. English Language Bok Society, Baillaire Tindall, London.
3. Kassai, T. 1999. Veterinary Helminthology. Butterworth Heinemann, Oxford.
4. Foreyt, W. J. 1999. Veterinary Parasitology Reference Mannual, 4th Ed. Blackwell, London.
5. Chowdhury, N and I. Tada. 1994. Helminthology. Narosa Publishing House. New Delhi.
6. Garcia, L.S. and D.A Bruckner. 1998. Diagnostic Medical Parasitology. Elsevier science publishing Co. Inc, New York 10010, U.S.A.

ES 13 APPLIED MICROBIOLOGY Cr. 3(2+1)

Control of microorganisms: Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapentic agents. Microorganisms and disease: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact disease. Infectious diseases of animals. Environmental Microbiology: Fundamentals of microbial ecology. Microbiology of Air. Soil microbiology. Microbiology of domestic water and sewage. Microbiology of food, milk and milk products. Industrial microbiology: Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

Practicals

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

Textbooks

1. Pelczar, M.J. Jr., Chan, E.C.S. and Krieg, N.R. 1986. Microbiology– McGraw Hill Inc., New York.
2. Benson, H.J., 1994. Microbiological applications. WmC Brown Publishers, Dubuque, USA.

Additional Readings

1. Alcamo, E. 1994. Fundamentals of Microbiology. The Bengamin/Cummings Publishing Co. Inc. Redwood city, CA 94065.
2. Pelczar, M.J. Jr., Chan, E.C.S. and Krieg, N.R. 1993. Microbiology concepts and applications – McGraw Hill Inc., New York.

ES 14 ARACHNOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 15 BACTERIOLOGY Cr. 3(2+1)

Laboratory equipment and procedures: Pure culture, pure culture technique, culture preservation, Aseptic technique, Sterilization, Chemical Sterilization, Staining techniques, Microscopy, visible light microscopy, Ultraviolet and electron microscopes.

Metabolic pathways: Life needs, growth factors, the environment, Classification: a Physiological

method, Energy production, Aerobic cellular respiration, Fat and protein metabolism, biosynthesis and metabolism, controlling metabolism.

Growth and reproduction: Increasing mass and populations, the population growth curve, the growth curve; home, industry and hospital, counting methods, viable cell count, Biomass determination, biological assay.

Collection, cultivation and identification of microbes:

Laboratory work, Symptoms, Collecting and handling specimens, Media selection and preparation, balancing the environment, Oxygen requirements for culturing.

The Control of Microbes: Different approaches to control, factors that influence success, surface active agents, the methods and material of control, the ideal antibiotic, the development of drug resistance, overcoming resistant pathogens.

Practicals

Microscopic examinations of microorganisms' wet mount, hanging drop method; Gram's staining, Negative staining capsular ling staining Preparation and sterilization of growth media. Viable counting of bacteria, correlating number/cell mass with optical density, making and preservation of pure cultures of bacteria evaluating bacrteriostatic and bactericidal effects of antimicrobial agents, antibiotic susseptility of some bacterial isolates, some physiochemical tests of bacteria.

Textbooks

1. Pelczar, M.J. Jr., Chan, E.C.S. and Krieg, N.R. 1986. Microbiology– McGraw Hill Inc., New York.
2. Benson, H.J., 1994. Microbiological applications. WmC Brown Publishers, Dubuque, USA.

Additional Readings

1. Alcamo, E. 1994. Fundamentals of Microbiology. The Bengamin/Cummings Publishing Co. Inc. Redwood city, CA 94065.
2. Pelczar, M.J. Jr., Chan, E.C.S. and Krieg, N.R. 1993. Microbiology concepts and applications – McGraw Hill Inc., New York.

ES16 BASIC HUMAN GENETICS Cr. 3(2+1)

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

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

Course outline:

1. **Introduction**
   - Pedigree construction by using standard symbols.
   - Mode of Inheritance of genetic disorders
   - Autosomal dominant and autosomal recessive inheritance
   - X linked dominant and X linked recessive Inheritance.
   - Y linked inheritance.
   - Mitochondrial Inheritance
2. **Genetic Linkage**

- Linkage Analysis
- Genetic mapping
- Physical mapping
- Genetic linkage and LOD score calculation

3. Mutations

- Missense mutations
- Nonsense mutations
- Silent mutations
- Deletion mutation
- Duplication mutations

4. Prenatal Screening

- Ultrasonography
- amniocentesis
- Chorionic villi sampling
- Fetoscopy

5 Introduction to human Genome Project

- Application and proposed benefits of Human Genome project.
- Ethical, legal and social Issues.

6 Chromosomal Abnormalities

- Aneuploidy
- Euploidy

Practical:

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

Text and Reference Books:

1. Strachan, T., A. P. Read, Human Molecular Genetics, 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.

ES 17 BEHAVIORAL ECOLOGY Cr. 4(3+1)

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 synthesisof data and other information about animal behavior, competition and ecological relationships.

Course outline:

1. **Animal behavior and Ecology**
- Introduction
- Gene and Behavior
- Natural Selection and Behavior
- Ecology and Evolution

2. **Hypothesis and Testing**
- Comparative Approach
- Adaptations
- Social Organization and Experimental Studies
- Economic Decisions Made by Individuals
- Marginal Value Theorem and Reproductive Decisions
- Economics of Prey Choice
- Tradeoff and Optimality Models

3. **Competition for Resources in Individuals**
- Competition by Exploitation
- Competition by Resource Defense

4. **Merits and De-merits of living in Groups**
5. **Fighting Among Individuals**
- Role of Resource Values and Fighting Ability
- 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/Breading-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

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

ES18 BIOCHEMICAL TOXICOLOGY- I Cr. 3(2+1)

Course Outlines To be provided by the concerned expertise

ES19 BIOCHEMICAL TOXICOLOGY- II Cr. 3(2+1)

Course Outlines To be provided by the concerned expertise

ES20 BIOCHEMISTRY OF DRUG ACTION Cr. 3(2+1)

Course Outlines To be provided by the concerned expertise

ES21 BIODIVERSITY AND WILDLIFE Cr. 3(2+1)

Objectives

1. To enable student to understand biodiversity levels, functions and its importance.
2. To acknowledge Wildlife of Pakistan and itsimportance.

3. To learn Wildlife censustechniques.

Course Contents

Biodiversity: **Definition,Types, Levels, Status of Biodiversity; Importance.**

Natural Resources and Biodiversity: Ecological aspects of Biodiversity, Impacts on Biodiversity, Loss of Biodiversity, Protection/Conservation of Biodiversity.

Wildlife: **Introduction, important wild animals of Pakistan, Wildlife importance, Wildlife Management.**

Ecozonesof Pakistan:wildlife and its distribution in different majorecozones ofPakistan.

Wildlife census techniques: Modern census techniques for Mammals and Birds, diversity indices.

Practicals

1. Procedures for studying species richness, Simpson Index, Shannon and Weiner Function.
2. Population of some local subterranean animals.
3. Bird's population Census Techniques.
4. Mammal's population Census Techniques.
5. Study of Wildlife habitats.

Books Recommended

1. Kumar & Asija, 2000 Biodiversity, Principles andConservation.
2. Mary Jenking and Ann Boyce, 1987. The Diversity of Life. A. R. Rehmani and Salim Ali: Birds CensingTechniques.

ES22 **Biodiversity of Inland and Terrestrial Molluscs Biodiversity of Inland Terrestrial Mollusks** **Cr. 3(2+1)**

Course Outlines To be provided by the concerned expertise

ES23 **BIOMEDICAL TECHNOLOGY** **Cr. 3(2+1)**

Course Outlines To be provided by the concerned expertise

ES24 **BIOSAFETY ETHICS** **Cr. 3(2+1)**

Course Outlines To be provided by the concerned expertise

ES25 **BIOTECHNOLOGY** **Cr. 3(2+1)**

Course Objectives:

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

Course outcomes:

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

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

Course Content:

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

- Polymerase Chain Reaction, principle, requirements, procedures and applications, Gel electrophoresis, definition, principle, steps/methods involved, DNA ladder, allelic ladder

3. **Biotechnology and Justice**:
   - Sources of DNA, Forensic DNA testing,
   - Principles, techniques, types and applications
4. **Genetic Engineering**
   - Introduction, Steps, Vectors and its types, characteristics of vectors
   - Plasmids and its types, pBR322, pUC19, Ti-Plasmid
   - Restriction Enzymes, Screening, Blue White Screen, Negative and Positive Control, Competent Cells, Insulin as an example, genetically modified organisms
   - Cloning, its types of cloning, cell cloning, molecular cloning, organism cloning, applications and uses
5. **Animal and Insect Biotechnology:**
   - Introduction, reasons for producing GM animals,
   - Genetic manipulation, mammalian cloning, somatic cell nuclear transfer, procedure and uses, GM hormones and vaccines, GM insects
6. **Bioprocess Technology:**
   - Introduction, requirements of bioreactors, types of bioreactors
   - Bacterial and mammalian cell culturing, production of novel antibiotics, steps for production of antibiotics, production of industrially important chemicals
7. **Biotechnology and Medicine**:
   - Applications, monoclonal antibodies, importance, steps for production of monoclonal antibodies
8. **Stem Cell Biotechnology:**
   - Introduction, sources – embryonicstem cells, adult stem cells
   - Types of stem cells based on potency, applications of stem cells.
9. **Public Perception of Biotechnology:**
   - Current issues in bioethics (Autopsy, GMOs, Stem Cells, Euthanasia, Organ Transplant, Human Cloning, IVF, Surrogacy and sperm donor, etc)
10. **Bioethics and Islamic Bioethics**:
    - Introduction and principles of bioethics,
    - Concept of bioethics in different religions, principles of Islamic bioethics

Practicals:

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

Text and Reference Books:

1. Clark, D.B., Pazdernik, N.J. (2015) Biotechnology. 2nd Edition. Academic Cell
2. Glick, 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

ES26 BIOTECHNOLOGY IN AQUACULTURE Cr. 4(3+1)

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 onGynogenesis, Androgenesis,Cloned Populations and Molecular Markers
3. To provide an overview of the application of biotechnological tools inGenetic 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**
   - History of Biotechnology in Aquaculture
   - Biotechnological approaches in Aquaculture
2. **Gynogenesis, Androgenesis andCloned Populations**
   - Induction of Gynogenesis and Androgenesis
   - Performance of Gynogens and Androgens
   - Reproduction
   - Monosex Populations
   - Cloned Populations.
3. **Biochemical and Molecular Markers**
   - Isozymes and Enzymes.
   - Restriction Fragment Length Polymorphism.
   - Single Nucleotide Polymorphisms.
   - Relative Costs of Different Markers
   - Relative Effectiveness of Markers
4. **Combining GeneticEnhancement Programmes**
   - Sex Reversal and Triploidy
   - Genetic Engineering and Crossbreeding
   - Genetic Engineering, Selection, Crossbreeding, Strains and Hybrids
5. **Food Safety of TransgenicAquatic Organisms**
   - International Guidelines
   - Labelling
6. **Environmental Risk of Aquatic Organisms from Genetic Biotechnology**
   - Theoretical Risks
   - Environmental Risk Data on Transgenic Fish
   - Common Goals of Aquaculture and Genetic Conservation

Practicals:

1. DNA isolation from fish.
2. Electrophoresis, Agarose and polyacrylamind gel electrophoresis.

3. Demonstration of amplification of DNA through PCR.

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

ES 27 CANCER BIOLOGY Cr. 3(2+1)

Cancer, Properties of cancer cells, Major types of human cancers, Hallmarks of cancer. Cell signaling/Cell communication, Carcinogens: environmental and dietary carcinogens and their mode of action. Oncogenes: proto-oncogenes and viral oncogenes, Tumor suppressor genes. P53 as a model tumor suppressor gene. Role of p53 in cell cycle regulation and induction of apoptosis.

Practicals

Identification of cancer cells from prepared slides of various human cancer tissues.
Quantification of Live and dead cells using Trypan blue assay and Live/Dead assay.
Assessment of Nuclear morphological changes using PI and H33258 staining from prepared slides.
Cell culture: cell revival, Cell passage and cell freezing.

Textbooks

1. Introduction to the Cellular and Molecular Biology of Cancer, Margaret A. Knowles and Peter J. Selby. Oxford Biosciences.

Additional Readings

1. Cell biology and medicine, bettar E.E. John Wiley.
2. The cell in Medical Sciences, beck, F. Academic Press, New York.
3. Molecular cell biology, Lodish, Berk, Krieger, Kaiser, Scott, Bretscher, Ploegh and Matsudaira Ed. 6th W.H freeman.
4. Introduction to the Cellular and Molecular Biology of Cancer by L.M.Franks (Editor), N.M.Teich (Editor) 3rd Ed. Oxford.

ES 28 CANCER CHEMICAL BIOLOGY Cr. 3(2+1)

Course Objectives:

The main objectives of this course are

1. To enable the student to understand the cellular targets and molecular mechanism of conventional and targeted anticancer drugs.
2. To understand the limitations of existing cancer clinical drugs.
3. To provide the knowledge about the dietary nutraceuticals, important for cancer chemoprevention and treatment.
4. To address the importance of medicinal plants in anticancer drug discovery using local wisdom and resources.

Course Learning Outcomes:

On completion of the course, the students will be able to;

1. AQUIRE theoretical and practical knowledge about Cancer Chemical Biology
2. UNDERSTAND the basic principle for developing novel cancer drugs from natural sources
3. SOLVE the issues in identification of novel bioactive anticancer compounds from crude extracts with huge chemical diversity
4. ANALYSE the data critically and design experiments independently
5. EVALUATE the anticancer potential of novel bioactive molecules for anticancer drug development

6. DEMONSTRATE appropriate ability to design and conduct of research work in the field of Cancer Chemical Biology

Theory

Introduction and scope of cancer chemical biology, anticancer drugs, their types and molecular mechanism. Scope of anticancer drug discovery from plants. Plants-derived bioactive anticancer compounds, their classification, cellular targets and anticancer mechanism. Dietary nutraceuticals and their potential in cancer chemoprevention and treatment.

Practicals

Preparation of plant extracts, Identification of bioactive anticancer compounds from plant extracts, Determination of anticancer activity of new bioactive compounds,

Books Recommended:

1. Boik J, 2001. Natural Compounds in Cancer Therapy: Promising Nontoxic Antitumor Agents From Plants & Other Natural Sources. Oregon Medical Press,1st Edition
2. Kintzios S. E. and Barberaki M.G. (Ed), 2019. Plants that Fight Cancer. CRC Press, 2nd edition.

ES 29 CELL AND TISSUE CULTURE Cr. 3(2+1)

An overview of background, advantages, limitations, termsand definitions, growth of attachment-dependent andsuspended cells; cell lines. Biology of Cultured Cell, Culture environment, cell adhesion, cell proliferation, differentiation and evolution of cell line. Design, Layout and Equipment in Animal Cell Culture Construction, layout; essential, beneficial and useful equipment; consumable items. Aseptic Technique and Safety Objectives, element of aseptic environment, sterile handling, general safety, risk assessment, radiation and biohazard. Media and Serum-free Media Physicochemical properties, complete media, serum,selection, advantages and disadvantages of serum free media,replacement of serum, media development. Primary Culture and Cell Lines Type of primary culture cell. Isolation of tissues. Primary culture. Cloning Selection and Molecular Techniques An overview of suspension cloning, isolation of clones ,in situ molecular hybridization, production of monoclonal antibodies. Somatic cell fusion and DNA transfer. Cryopreservation and Quantification Preservation, cell banks, transporting cells. Quantification , Somatic Embryogenesis and Organogenesis, Micro-propagation.

Practicals

1. Isolation of Liver cells.
2. Cell culture in vitro.
3. Maintaining the cell lines.
4. Primary cell culture.

Textbooks

1. Freshney, R.I., 2000. Culture of Animal cell: A Manual of BasicTechniques, 4th Ed., Wiley Liss.
2. Dodds, J.H. and Roberts, L.W., 1995. Experiment in Plant TissueCulture, 3rdEd., Cambridge University Press.

Additional Readings

1. Harrison, M.A., & Rae, I.F., 1997. General Techniques of CellCulture, Cambridge University Press.
2. Dixon, R.A., 1985. Plant Cell Culture: Practical Approach, IRL Press.
3. Doyle, A., & Griffiths, J.B., 2000. Cell and Tissue Culture for Medical Research, John Wiley and Sons.
4. Chawla, H.S., 2002. Introduction to Plant Biotechnology, 2nd Ed., Science Publisher.

ES 30 CELL SIGNALING SYSTEM Cr. 3(2+1)

Course outline

Introduction to cell signaling system, Signal molecules, classification of signal molecules, Function

of signal molecules, Receptors, classification of receptors, Structure and function of Receptors (Receptor Tyrosine kinases, non-Receptor Tyrosine Kinases, Receptor tyrosine Phosphatases, G-protein coupled receptors, Death receptors). Regulation of cell signaling pathways (cAMP protein kinase pathway, STAT3 pathway, NF-κB Pathway, MAPK Pathway, PI3k/AKT pathway, wnt/β-catenin Pathway, Intrinsic and Extrinsic apoptosis pathways.

Practicals

Identification of antagonists/inhibitors of various cell signaling pathways

Textbook

1. John Hancock, Cell Signalling Ed 3rd, Publisher: Prentice Hall (November 19, 1997), ISBN-10: 0582312671

Additional Readings

1. Molecular Cell Biology (2007) 6th Edition. H. Lodish, C.A. Kaiser, M.Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H. Freeman.
2. Bastien D. Gomperts , Ijsbrand M. Kramer , Peter E.R. Tatham, Signal Transduction, Publisher: Academic Press; 2 edition (August 19, 2009), ISBN-10: 0123694418.
3. Friedrich Marks, Cellular Signal Processing: An Introduction to the Molecular Mechanisms of Signal Transduction, Garland Science; 1 edition (November 14, 2008), ISBN-10: 0815342152.
4. John Nelson, Structure and Function in Cell Signalling. Wiley; 1 edition (August 25, 2008), ISBN-10: 0470025514.

ES 31 CLASSIFICATION OF INSECTS Cr. 3(2+1)

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

Practicals

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

Books Recommended

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

ES32 Climate Change, Ecosystem Resilience and Stability Cr. 3(2+1
Course outline to be provided by the concerned expertise

ES33 CLINICAL BIOCHEMISTRY Cr. 3(2+1
Course outline to be provided by the concerned expertise

ES34: COMPARATIVE ANATOMY OF VERTEBRATES Cr. 3(2+1)

Origin of vertebrates. Classification (excluding fossil groups) of vertebrates and characteristics of each group. Comparative anatomy of various body systems in vertebrates.

Practicals

Study of skeleton of Labeo, frog, varanus, fowl and rabbit. Dissection and study of various systems in *Rita rita*, frog, uromastix, pigeon and rabbit. General survey of vertebrates.

Textbooks

1. Weichert, W.C. Anatomy of the chordates. W.B. Sundres. (Recent Ed.)

2. Kardong, K.V. 2002. Vertebrates, Comparative Anatomy, Function Evolution, 3rd Ed. McGraw Hills.

Additional Readings

1. Romer, A.S. and Parsons, T.S.1986. The Vertebrate Body, Saunders.
2. G.C. Kent. Comparative anatomy of vertebrates W.B. Sundres. (Recent Ed.)

ES 35 COMPARATIVE DEVELOPMENTAL BIOLOGY Cr. 4(3+1)

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**thefundamental 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

- Scope, Science of developmental biology and its applications
- Developmental patterns in metazoan.

2. Germ Cell

- Germ cell migration in amphibian, birds and mammals.
- Differentiation of germ cells into sperm or egg.

3. Spermatogenesis

- A detailed study of the spermatogenesis in vertebrates and gene expression during sperm development.

4. Oogenesis

- Oogenic meiosis
- Maturation of oocyte in amphibian
- Role of estrogen and progesterone in oogenesis
- Gene transcription in oocyte

- Vitellogenesis

5. Fertilization

- Contact recognition between sperm and egg
- Acrosomal reaction
- Gametes bindings and fusion (roleof egg membranes)
- Egg activation

6. Creation of multicellularity

- Cleavage characteristics
- Patterns of cleavage (radial holoblastic, bilateral holoblastic, spiral holoblasric, rotational holoblastic and meroblastic)
- Gastrulation in avian and amphibians (frog and chick)
- Concept of fate maps (chick and frog)

7. Organizers and induction

- Primary embryonic induction
- Regional specificity of induction
- Molecular mechanism of primary embryonic induction

8. Early vertebrate development

- Neuralation and development of ectoderm
- Organization of mesoderm and endoderm

9. Differentiation

- Cell commitment and differentiation
- Chemical basis of differentiation

10. Organogenesis

- Development of rudimentary organs in amphibian and mammals
- Cellular interactions during the development of limb, brain, eye, heart and liver

11. Placenta

- Development of placenta and its different types
- Placental hormones and their functions/ importance

12. Multiple ovulation and Embryo transfer technology

- *In vitro* oocyte maturation
- Cryopreservation
- Embryo transfer technology

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.

ES 36 COMPARATIVE VERTEBRATE ENDOCRINOLOGY Cr. 3(2+1)

General concepts in comparative Endocrinology; Comparative Morphology of Endocrine Tissues in Vertebrates; The chemical structure, polymorphism and evolution of hormones; The life history of hormones.

Hormones and Nutrition; Hormones and the Integument; Hormones and Osmoregulation; Hormones and Reproduction.

Practicals

Demonstration of endocrine glands in representative vertebrates; Histological studies of endocrine glands in various vertebrates; Experiments on functional diversity in hormones in vertebrates; Studies in evolution of chemistry of hormones in vertebrates.

Textbook

1. Bentley, P.J., 1998. Comparative Vertebrate Endocrinology, 3rd Ed.. Cambridge University Press, Cambridge.

ES 37 CONSERVATION BIOLOGY Cr. 3(2+1)

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. UNDERSTANDthe 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. EVALUATEthe conservation actions taken by the biologists for solving the conservation problems across biological scales (genes to landscapes) and geographical scales (local to global).
6. DEMONSTRATEsound research skills based on ecological and evolutionary principles in investigating problems in conservation biology.

Course Outline:

1. **Introduction to Conservation Biology:**
- Definition,
- History and
- Scope.

2. **Biodiversity:**
- Species Diversity; Genetic Diversity; Ecosystem Diversity;
- Measurement of Biological Diversity;
- AnOverview of World's Biodiversity;
- The Value of Biodiversity

3. **Threats to Biodiversity:**
- Human Population Growth;
- Habitat Destruction; Habitat Fragmentation;
- Environmental Degradation and Pollution;
- Global Climate Change;

- Overexploitation;
- Invasive Species

4. **Extinctions:**

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

5. **Conserving Populations and Species:**

- Applied Population Biology; Monitoring populations; Population viability analysis; Metapopulations,
- International agreements for conservation of fauna and flora; Role of national and International Laws in Protection of Species;
- Ex Situ Conservation Strategies; Zoos; Aquariums; Botanical gardens; Seed banks.
- ProtectedAreas and theirEstablishment and categories;
- Managing Protected Areas; Challenges to Protected Areas Management.
- Unprotected Public and Private Lands
- Ecosystem Management
- Integration of Local Community in Conservation
- Restoring Damaged Ecosystems

6. **Sustainable Development:**

- Challenges Involve in Conservation and Sustainable Development at the Local Level
- International Approaches to SustainableDevelopment
- Funding for Conservation by the World Bank and international NGOs;
- 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.

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.

ES38 DIAGNOSTIC PARASITOLOGY Cr. 3(2+1)

Philosophy and approach to diagnostic Parasitology; Artifacts that can be confused with parasite organisms; Quality control procedures for diagnostic parasitology laboratory; Diagnosis of important protozoal, Helminth and arthropod diseases; Conventional, sero-diagnostic and specific procedures, parasitic infection and clinical correlation; Histological identification of parasites; Significance of Haematology and biochemistry as a diagnostic aid in parasitic infections; Xenodiagnosis and animal inoculation tests; Differential diagnosis of larval cestode infections and haemoprotozoan parasites; Taxonomical differentiation of nematode larvae; Parasitic and non-parasitic larvae; Keys for the identification of helminthes, insects and arachnids; significance of

stigmal plates in the identification of larval fly infestations.

Practicals

1. Diagnosis of important protozoal infections.
2. Diagnosis of important Helminth diseases.
3. Diagnosis of disease caused by insects and arachnids.
4. Observations on various haematological parameters of parasitized and healthy individuals.
5. Observations on various biochemical parameters in parasitized and healthy individuals.
6. Animal inoculation tests for detection of parasites.
7. Demonstration of variations among different larval cestode forms.
8. Demonstration of variations among different haemoprotozoan parasites.
9. Demonstration of variations among different nematode larvae
10. Identification of larval fly infestations.
11. Review of literature.

ES39 ECOLOGICAL GENETICS Cr. 3(2+1)

Course Contents To be provided by the concerned expertise

ES40 ECONOMIC ZOOLOGY Cr. 3(2+1)

Course Objectives:

The objectives of the course are:-

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

Course Learning Outcomes:

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

1. **ACQUIRE** basic knowledge of Commerce and Economics in relation to Zoology
2. UNDERSTAND the Economic relationship of Animals with Humans
3. **SOLVE** problems related to animal husbandry and pest management by applying theoretical knowledge with practical efficacy
4. **ANALYZE** and enhance Animal husbandry techniques by using different Entrepreneurship skills
5. **EVALUATE** problems using practical knowledge in Zoology
6. **DEMONSTRATE** the Economy based interactions of Man and Animals

Course Outline:

1. Basic concepts in Economic Zoology.
2. Parasitic protozoans and human disease. Economic importance of protozoa.
3. Vectors of human and domestic animals.
4. Ecto- and Endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and Arachnida).
5. Pests of pulse crops. Pests of oil seed crops. Stored grain pests. Pests of cotton. Pests of vegetables. Pests of fruits. Pests of tea.
6. Apiculture, and Sericulture, Lac insect culture and Pearl culture

7. Aquaculture and Fisheries (Edible Fresh water, Pond and Marine fish, Prawns, Pearl oysters). Economic importance of fishes.
8. 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.

Text and Reference books:

1. Economic Zoology. Ravindranathan, K. R. 2003. 1st ed. Dominent Publishers and Distributers. 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, Mearut, India, pp. 369.

ES41 ELEMENTS OF STRATIGRAPHY AND STRUCTURAL GEOLOGY Cr. 3(2+1)

Course Contents To be provided by the concerned expertise

ES42 ENDOCRINOLOGY Cr. 3(2+1)

Course Objectives:

1. To discuss the definition of hormone in terms of its general properties.
2. To differentiate among endocrine, paracrine and autocrine system.
3. To describe different classes and chemical structure of hormone.
4. To explain the roles of the endocrine system in maintain homeostasis, integrating growth and development, responding to environmental insult and promote successful reproduction.
5. To identify the glands, organs, tissues and cell that synthesize and secrete hormones, hormone precursors and associated compounds.
6. To describe synthesis and mode of secretion of hormone, regulation of hormone secretion of hormone, including the principles of negative and positive feedback mechanism.
7. To explain the importance of patterns of hormone secretion such as pulsatile, diurnal,cyclicle and how hormones are transported in the blood and consequences of reversible binding of many hormones by plasma proteins
8. To 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 cyclicle.
9. Explain how hormone are transported in the blood and consequences of reversible binding of many hormones by plasma proteins
10. Explain the basis of hormone assays and assessment of biological activity
11. Describe how hormone is 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**:
   - 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. RIA, RIMA, ELISA, bioassay and receptor assay
2. **Hypothalamus and pituitary:**
   - Hypothalamic hormones: Origin, chemistry and actions and mechanism of action;
   - Anterior pituitary & hormones: Hypothalamic pituitary regulation,
   - General chemistry, Physiological action, mechanism of 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.
   - Causes and effect of over and under production of hypothalamic and pituitary hormones
   - Hypothalamic, pituitary and thyroid, adrenocortical, gonadal and other axis.
3. **Thyroid gland:**
   - Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Functionof thyroid hormone,
   - Mechanism of action; regulation and factors affecting thyroid function.
   - Causes and effect of Hypothyroidism and hyperthyroidism
4. **Calciotrophic and Mineral Metabolism Hormones:**

- Chemistry, physiological actions, mechanism of action and
- metabolism of parathyroid hormone,
- Causes and effect of over and under production of hormone
- Calcitonin and calciferols; action and mechanism of action
- Homeostasis of calcium, phosphate and magnesium.

5. **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.
   - Causes and effect of over and under secretion of pancreatic hormones
   - Glucose homeostasis
6. **Adrenal Medulla and Catecholamines:**
   - Chromaffin cell and organization; Structure of adrenal medulla;
   - Biosynthesis, storage, release and metabolism;
   - Adrenergic receptors and mechanism of action;
   - Disorder of Adrenal medulla (pheochromocytoma)
7. **Adrenal Cortex:**
   - Anatomy and Steroid biochemistry;
   - Physiological actions of corticoid hormones and mechanism of action;
   - Regulation and metabolism of glucocorticoids,
   - Mineralocorticoids and adrenal sex steroids.
   - Disorder of adrenal cortex hormones
8. **Testes: Androgenic tissue:**
   - Anatomy, structure, chemistry, synthesis and transport of hormone,
   - Metabolism, action and mechanism of action.
   - Testicular disorder
9. **Ovaries:**
   - Ovarian Anatomy, hormones: Steroid biochemistry and biosynthesis;
   - Transport, metabolism, action and mechanism of action.
   - Cyclic changes, menopause
   - Ovarian disorder
10. **Endocrinology of Pregnancy:**
    - Hormones in conception and implantation;
    - Hormonal actions and
    - Adaptation in pregnancy and parturition.
11. **Fetus Endocrinology**
    - Endocrinology of developing fetus
12. **Endocrinology of Lactation:**
    - Hormones in lactation.
13. **Endocrinology of development of growth**
    - Growth and Puberty
    - Disorders of growth and puberty
14. **Endocrinology of**
    - Heart, Kidney,
    - Immune system:
    - Growth and pineal gland.
15. **Functional diversity of vertebrate hormo nes**
    - Functional diversity of hormones in different vertebrates
16. **Overview of Endocrine Mechanisms in Invertebrates**
    - Hormones of invertebrates

17. Geriatric Endocrinology

- 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 aneroxia;
13. Studies of hormonal status in puberty and aging

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.

ES43 ENTOMOLOGY (Classificationof Insects and Pest Management) Cr. 3(2+1)

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 atdifferent 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**
- Evolutionary history of insects
- Phylogenetic arrangement of orders and families

2. **Classification of insect orders: General account of apterygota**

Subclass: Apterygota

- Order Collembola
- Order Diplura
- Order Zygentoma
- Order Protura
- Order: Archaeognatha

3. **Subclass: Exopterygota**
- Order Dermaptera
- Order Dictyoptera
- Order Embiidina
- Order Neuroptera
- Order Strepsiptera
- Order Mantophasmatodea
- Order Mecoptera
- Order Orthoptera
- Order Phasmatodea
- Order Phthiraptera
- Order Plecoptera
- Order Psocoptera
- Order Siphonaptera
- Order Zoraptera
- Order Megaloptera
- Order Raphidioptera
- Order Ephemeroptera
- Order Odonata

4. **Endopterygota**
- Order Megaloptera
- Order Hymenoptera
- Order Coleoptera
- Order Lepidoptera
- Order Trichoptera
- Order Siphonaptera
- Order Diptera
- Order Neuroptera
- Order Mecoptera
- Order Raphidioptera
- Order Strepsiptera

5. **Knowledge of insect pests of**
- Rice
- Cotton

- Sugarcane
- Wheat

6. **Brief account of different insect pest management strategies as:**

- Cultural Control
- Physical and Mechanical Control
- Host Plant Resistance
- Biological Control
- Chemical Control
- 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

Practical:

- Written (Long Questions, Short Questions, MCQs, identification etc) 40%
- Collection of Insects 30%
- Assignments 20%
- 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.

ES44 ENTOMOLOGY (Morphology, Physiology of Insects) Cr. 3(2+1)

Course Contents

1. General characteristics of insects. Relationship with other Arthropoda,
2. **Hard Parts:** General segmentation, Cuticle: Detailed structure. Epidermal layer; its structure and function. Basement membrane. Colours of insects. Cuticular outgrowths and appendages, sclerotization. Metamorphosis.
3. **Head:** Cephalization, Sclerites, Modifications. Antennae: Different modes of ingestion and types of mouth parts.
4. **Thorax**; legs, their different modifications and functions.
5. **Wings:** Different regions. Development. Basal attachments. Main veins and their branches (generalized insects). Wing coupling apparatus.
6. **Abdomen:** Secondary appendages and external genitalia. Endoskeleton: Head, thorax and abdomen.
7. **Comparative structure of all the systems**, e.g., digestive, excretory, respiratory, circulatory, and nervous system and their physiology. Sense organs: sound and light producing organs. Exocrine and Endocrine glands including pheromones and their functions.
8. **Reproduction:** Reproductive organs and different types of reproduction in insects. Types of larvae and pupae.

Practicals

Preparation of permanent slides. All the hard parts (terminal segments, wings, antennae, legs, mouth parts). Different systems, especially digestive, reproductive of the following insects. American cockroach, grasshopper, housefly, mosquito, any common beetle. Sympathetic nervous system of cockroach.

Textbook

1. General Text Book of Entomology. Imm. Richards and Davies, Vol.1.

Additional Readings

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

ES45 ENVIRONMENTAL BIOLOGY OF FISHES Cr. 3(2+1)

Course Contents

1. Fish and their Environments.
2. Feeding and Nutrition.
3. Environmental Biology of Fish Growth.
4. Osmoregulation and Ion Balance.
5. Environmental Biology of Reproduction.
6. Behaviour.
7. Water Pollution.
8. aste Management.
9. Sustainability and Environmental Issues.

Practicals

Weight length and condition factor in relation to different environments. Gut contents of different fish species. Effect of temperature on fish growth. Effect of salinity on fish growth. Induce spawning. Effect of different pollutants on survival of fish. Assignment.

Books Recommended

1. Weatherley, A.H., 1972. Growth and Ecology of Fish Populations.
2. Wootton, R.J., 1990. Ecology of Teleost Fishes. Chapman and Hall, London.
3. Wootton, R.J., 1998. Ecology of Teleost Fishes. 2nd Edition, Kluwer.
4. Jobling, M., 1995. Environmental Biology of Fishes. Chapman & Hall, U.K.
5. Weatherley, A.H. and Gill, H.S., 1987. The Biology of Fish Growth. Chapman & Hall, U.K.
6. Evans, D.H., 1998. The Physiology of Fishes, 2nd Ed. CRC Press, Boca Raton, New York.
7. Boyd, C.E. and Tucker, C.S., 1998. Pond Aquaculture Water Quality management, Boston, Kluwer.

ES 46 ENVIRONMENT ISSUES Cr. 3(2+1)

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:

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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**:

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

2. **Hazardous Chemicals:**

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

3. **Sewage Pollution**:

- Sprawl andSewage hazards and sewage managements,

4. **Solid waste**:

- ndfills, incineration, management and solutions

5. **Pest and pest control:**

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

6. **Major atmospheric Changes:**

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

7. **Environmental Issues in Pakistan:**

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

8. **Energy resources:**

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

9. **Major threats to biodiversity**

- 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.

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, 1. K. John Wiley and Sons Inc. UK.
4. Environmental Science (Systems and solutions). 1998. McKinney, M. L. and Schoch, R. M. Jones and BartItt Publications Inc. USA.
5. Pakistan- A Descriptive Atlas (A comprehensive geo-politics course). 2000. 1st ed. Ahmad, R. Z. Ferozsons Pvt. Ltd. Lahore Pakistan.
6. A Geography of Pakistan Environment (Environment, people and economy). 1993. 1st Ed., Khan, F. K. Oxford University Press. New York USA.
7. Daily newspapers for current issues.

ES 47 ENVIRONMENTAL MICROBIOLOGY Cr. 3(2+1)

Fundamentals of microbial ecology: The nature of microbial communities. Life at low nutrient concentrations. Physicochemical factors affecting the environmental fate of Microorganisms. Competitive strategies of microorganisms. Interactions involving microorganisms. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage. Microbiology of food, milk and milk products.

Practicals

Isolation and identification of coliform from water, milk and vegetables samples. Bacterial examination of food and raw milk. Surveys of microorganisms' activities based industries. Isolation and study of antibiotics producing bacteria. Isolation and study of cellulolytic bacteria. Isolation and identification of nitrogen fixing bacteria.

Books Recommended

1. Microbiology: A Human Perspective , 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education.
2. Microbiology Principles and Explorations, 2001. Jacquelyn, G.G. Wiley John & Sons Inc.
3. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., 1986. Mc-Graw Hill, London.
4. Environmental Microbiology, 2000. Alan H. Varnam and Malcolm G. Evans, Manson publishing London, NW11 7DL, UK.
5. Microbial Applications: Lab Manual in General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.

ES 48 ENVIRONMENTAL PHYSIOLOGY Cr. 3(2+1)

Course ContentsTo be provided by the Concerned Expertise

ES 49 ENVIRONMENTAL POLLUTION Cr. 3(2+1)

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 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. Acquirethe basic knowledge of pollutants nature
2. Understand the concepts of basic techniques and use them efficiently for control of pollutants with their nature

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3. Solve the problems of the environment by using different methods

Course outline:

1. Introduction

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

2. Water Quality Control:

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

3. Air Pollution:

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

4. Soil Pollution and Solid Waste:

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

5. Noise Pollution:

- Introduction, Noise and vibration, sources of noise pollution,
- Noise, health, permissible levels, sonic boom, impulsive noise
- Anechoic chamber reverberating sound, noise topography and regulations for control of noise

6. Thermal and light Pollution:

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

7. Status of Environmental Pollutions in Pakistan:

- Prevention and control of wastes and National program to control wastes
- 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

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.

ES 50 ENVIRONMENTAL TOXICOLOGY & CHEMISTRY-I Cr. 3(2+1)

Chemicals in Environment: Atmosphere, Soil, Water and everyday life; Environmental transport of chemicals; Abiotic Transformatics of Chemicals; Biotransformations by microorganisms; Biotransformations in animals and higher plants; Comparative metabolism; Quantitative toxicology; Toxicity measuring and endpoints; Intoxication, factors governing intoxication, toxic effects; Intoxication mechanism: Biochemical lesions, Animal-specific mechanism, microbe-specific mechanism;

Practicals

1. Study of effects of environmental pollutants some biochemical contents and liver function enzymes in experimental animals.
2. Study of normal microorganisms of the soil.
3. Effect of pesticides on the soil microorganisms.
4. Study of normal microorganisms of any waste water (pond) or freshwater body (canal).
5. Study of effects of pesticides and some toxic heavy metals on pond or canal microorganisms.

Textbook

1. Crosby, D.G. 1980. Environmental Toxicology and Chemistry, Oxford University Press, New York.

Additional Readings

1. Hayes, A.W. 1994, 3rd Ed. Principles and methods of toxicology, Raven Press, New York.
2. Klaassen, C.D. 1996. Casarett and Doull's Toxicology: The Basic Science of Poisons, McGraw-Hill, Health Professionals Division, New York.
3. Landis, W.G. and Yu, M.H., 1999. Introduction to environmental toxicology. Impact of chemicals upon ecological system. 2nd Ed. Lewis publishers, Boston, London.

ES 51 ENVIRONMENTAL TOXICOLOGY & CHEMISTRY-II Cr. 3(2+1)

Inorganic toxicants: Mettalloids, Heavy metals and others. Industrial chemicals i.e. petrochemicals, toxic byproducts and conversion products, Biotorum: refractory chemicals, chlorinated dioxins, Alicyclics, Polychlorainated Biphenyls; Phthalle esters Reactive Pollutants, Predicting environmental fate and effects.

Practicals

Studies on blood cells; Determination of lethal concentrations; Effects of Environmental chemicals on various organs; Liver function, Kidney function; Liver histopathology induced by environmental chemicals; Study on the role of bacteria in biodegradation of environmental chemicals.

Textbook

1. Crosby, D.G. 1980. Environmental Toxicology and Chemistry, Oxford University Press, New York.

Additional Readings

1. Hayes, A.W. 1994, 3rd Ed. Principles and methods of toxicology, Raven Press, New York.
2. Klaassen, C.D. 1996. Casarett and Doull's Toxicology: The Basic Science of Poisons, McGraw-Hill, Health Professionals Division, New York.
3. Landis, W.G. and Yu, M.H., 1999. Introduction to environmental toxicology. Impact of chemicals upon ecological system. 2nd Ed. Lewis publishers, Boston, London.

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ES 52 ENVIRONMENTAL TOXICOLOGY Cr. 3(2+1)

Objectives

This course will

1. Provide scientific basis to toxicology as it applies to the workplace and the environment. Cover the diverse chemical hazards encountered in the modern workplace and natural environment.
2. Provide a practical understanding of these hazards for those concerned with protecting the health of humans andecosystems.

Course Contents

Toxicology: History, Terms and Definitions; Principles of Toxicology; Development andpresent Scope of Environmental Toxicology; Frame Work of Environmental Toxicology; Toxicological Evaluations. Sources of Environmental Toxicants / Pollutants: Gaseous Chemicals and Heavy Metals. Toxicity Testing. Characteristics of Exposure: Spectrum of Toxic Effects, Indices of Toxicity. Toxico-dynamics. Toxico-Kinetics (Absorption, Distribution, and Elimination of Toxic Agents). Biotransformation,
Detoxification&Biodegradation.PollutionandRemediation.EcologicalRisk Assessment.

Practicals

1. Measurement of EnvironmentalToxicants.
2. Sampling of toxicants for ChemicalAnalysis.
3. RiskAssessment.

Books Recommended

1. Whitacre, D. M. (Editor) 2012. Reviews of Environmental Contamination and Toxicology. Vol. 223. Spriger, Switzerland.
2. Swarties, F. A. (Editor) 2011. Dealing with Contaminated Sites. From Theory towards Practical Application.1st Edition. 1104p.
3. Landus, W. G. and Yu, M.H. 2005. Introduction to Environmental Toxicology: Impact of Chemicals upon Ecological Systems.3rd Edition. LewisPublishers.
4. James, R. C. and Roberts, S. M. 2000. Principles of Toxicology: Environmental and Industrial Applications, 2nd Edition, Phillip L. Williams (Editor), John Wiley & Sons,Inc.
5. Hughes, W.W.(Editor)1996.Essentials of Environmental Toxicology. The effects of environmentally hazardous substances on human health.176 p. Taylor & FrancisLtd.

ES 53 EPIDEMIOLOGY AND PUBLIC HEALTH Cr. 3(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**

- Disease occurrence
- Mapping

- Causality

2. **Determinants of disease**
- Diagnostic testing
- Transmission and maintenance of infection
- Descriptive epidemiology
- Analytical epidemiology

3. **Case-control studies**
- Cohort studies

4. **Experimental epidemiology**
- Animal disease survey
- Types of sampling
- Surveillance,
- Prevention, Control and eradication,
- Outbreak investigation

5. **National and international disease reporting**
- Trans-boundary disease of veterinary importance
- TAD distribution
- Mapping
- Regulatory implications
- TAD control
- International trade framework

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. Beagleohole, T. KjellStrom, 2006. Basic Epidemiology.2nd Edition. WHO
4. Merrill, R. M., 2013. Introduction to epidemiology, 6th Edition.Jones and Barletta learning LLC.

ES 54 EPIDEMIOLOGY OF PARASITIC DISEASE Cr. 3(2+1)

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. Learnbasic 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-rela events in populations.

Course Outline:

1. **Introduction of Epidemiology**
- Significance
- Basis terminology
- general concepts

2. **Selection of epidemiological parameters**
- Surveillance study
- Host parasite associations;

3. **Population biology and genetics**

- Genetic variability and parasite transmission.
- Age- intensity and age prevalence profile of parasite infections

4. Ecological and evolutionary dynamics of parasites

- Parasite prevalence and seasons
- Epidemiological approaches for the control of parasites
- Application of molecular techniques in Epidemiology of parasitic infections.

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. Thrusfied, 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, lowa State University Press, Ames, lowa, USA.
6. Rollinson. D.R., Anderson, M., 1984. "Ecology and Genetics of Host- Parasite interations" Linnean Society Symposium Series No. 11, Academic press, New York. USA.

ES 55 EVOLUTION AND PRINCIPLES OF SYSTEMATIC ZOOLOGY Cr. 4(3+1)

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 integratingconcepts, 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 phonetic 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.
- **Sexualselection**: Theories of sexual selection; Darwin, Fisher and Zahavi.
- **Macroevolution: Evolutionary developmental biology**: allometery, 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 t ypes; Phenetic, Cladistic and evolutionary classification.
- Taxonomic collections and the process of identification.
- The rules of zoological nome nclature: 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. Phyylogeny Reconstruction using phenetic (Similarity and dissimilarity matrix and unweighted pair group method) and cladistic (compatibility method) analysis to a group of mock "organisms".

Text and Reference Books:

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.

ES 56 EXERCISE PHYSIOLOGY Cr. 3(2+1)

1. **Physiology in Exercise:** Exercise Metabolism, Hormonal Responses to Exercise; Circulatory Resonses to Exercise; Respiration during Exercise; Acid-Base Balance during Exercise; Temperature Regulation in Exercise.
2. **Physiology of Health and Fitness:** Patterns in health and disease; Body Composition and Nutrition for Health; Cardiorespiratory Fitness; Exercise Prescriptions for Health and Fitness; Exercise for Special Population.
3. **Physiology of Performance:** Factors Affecting Performance; Nutrition, Body Composition

and Performance; Evaluation of Performance; Training for Performance; Exercise and the Environment.

Practicals

Studies on responses of metabolite in exercise; Experiments on hormonal responses and sensitivity during exercise; Cardiac and Respiratory Indices and their adaptations in exercise; Work tests to evaluate cardiorespiratory fitness; Exercise prescription for health and fitness. Work tests to evaluate performance.

Textbook

1. McArdle, W.D., Katch, F.I. and Katch, V.L., 2001. Exercise Physiology, Nutrition and Human Performance, 5th edition. Lippincott, Williams and Wilkins Publishers, Philadelphia.

Additional Readings

2. Powers, S.K. and Howley, E.T., 1997. Exercise Physiology: Theory and application to fitness and performance. Brown & Benchmark Publishers, Madison.

ES 57 FISH BIOENERGETICS Cr. 3(2+1)

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

- Effects of biotic and abiotic factors on growth

Practical:

1. To study energy budge 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.

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, Melboune. Madras. First edition 1991.
4. Fish Energetics: New Perspectives. Peter Tytler& Peter Calow, Croom Helm London & Sydney. 1985.

ES 58 FISH CULTURE Cr. 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 fishculture
2. Selection offish species on the basis of theircharacteristics.
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:

- History of fish culture
- Aims of fish culture.
- Pond fish culture: Planning and construction of fish pond
- Water quality criteria
- Culturable fishes of Pakistan.
- Pond preparation: Fertilization of fish pond: Organic and inorganic fertilizers, fish seed stocking.
- Artificial feeding in fish culture: Fish feeding methods, different components of fish feed, composition of commonly available feed ingredients, preparation and feed storage methods.
- Integrated fish farming: Concepts and practices.
- Fish enemies. Fish diseases and remedial measures.
- Fish hatchery management.
- Fishing gears, pre- and post-harvesting care of fish,
- Fish handling and transportation,
- Fish storage and marketing.
- 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. Horvaph, 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.

ES 59: FISH DISEASE & HEALTH MANAGEMENT Cr. 3(2+1)

1. **Fish morphology and biology:** Brief account of Fish morphology and Biology; Warm water / cold water culturable fishes; Fish culture practices; Extensive/Semi intensive/intensive fish culture.
2. **Fish farm management:** Brief accounts of fish pond, fish stocking, water quality; maneuring/feeding/ harvesting.
3. **Fish health management:** Introduction to fish diseases; disease process; causes of disease. Effects of diseases.
4. **Fish diseases: A general account of infectious diseases;** (Viral; Bacterial fungal; parasitic diseases) Noninfectious diseases. (Nutritional; Genetics; Pollution; Environmental; Physical damage).
5. **Control of fish diseases:** Prevention; Therapy, management; Methods of disease control in fishes; Treatment of fish diseases. Diagnosis to action; Types of treatment; Methods of treatment; Strategies for treatment; Chemicals and drugs for fish health.

Practicals

Dissection of culturable carp; sampling of fish for diagnostic purpose; Study of fish for parasitic, fungal and bacterial diseases; Preparation of slides of parasites; Visit to a fish farm; Preparing a diagnostic report of diseased fish sample.

Textbook

1. Post, G.W. 1988. Textbook of fish health. T.F.H. publications Inc. USA.

Additional Readings

1. Bauer, O.N., Musselius, V.A. and Strelkov, Yu.A. 1973. Diseases of pond fishes. Keter press, Jerusalem.
2. Kabata, Z. 1985. Parasites and diseases of fish cultured in tropics. Taylor and Francis, London.
3. Legler, K.E., Bardach, J.E., Miller, R.R. and Maypassino, D.R. 1977. Ichthyology (2nd Ed.) John Wiley, UK.
4. M. Huet, 1986. Text book of Fish culture, breeding and cultivation. Fishing book news Ltd.
5. Noga, E.J. 2010. Fish Diseases. Diagnosis and treatment. 2nd Ed. Wiley and Blackwell, USA.
6. Treves, B.K.M. 2008. Applied fish pharmacology. Springer, India.
7. Boyd and Tucker, 1998. Pond Aquaculture and water quality management. Springer, India.

ES 60 FISH ECOLOGY Cr. 4(3+1)

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**
   - Introduction
   - Properties of water
   - Diversity of fishes
   - Relationship
2. **Effects of Abiotic Environmental Identities on Distribution**
   - Introduction
   - Effects of abiotic identities
   - Abiotic factors and the distribution of fishes in rivers and lakes
   - Abiotic factors and the distribution of fishes in estuaries
   - Abiotic factors and the distribution of fishes in littoral and sub-littoral marine waters.
   - Effect of abiotic factors on the distribution of open-sea species.
   - Adaptations of fish to abiotic environmental factors
3. **Biotic Factors and the Structure of Fish Communities**
   - Introduction
   - Classification of the interactions
   - Role of biotic factors and community structure
   - Biotic interactions and community structure in rivers and lakes
   - Biotic interactions and community structure in thesea
   - Competition and predation in freshwater communities
4. **Migration, Territoriality and Shoaling in Fishes**
   - Introduction
   - Swimming capacity and energy coasts
   - Patterns and site attachment and social interactions
   - Migration and colonization in fishes
   - Over-wintering migrations
   - Movement of water and modes of fish movements.
   - Diadromy
   - Homing
   - Implications for exploitation
5. **Feeding and Growth**
   - Introduction
   - Feeding ecology in freshwater environments
   - Feeding ecology in estuaries

- Ecology of feeding of marine fishes
- Detection and selection of food
- Ecomorphology of feeding
- Trophic categories of fishes
- Utilization of food
- Rate of food consumption
- Growth

6. Life-Histories and Population Dynamics

- Introduction
- Life-history traits and the concept of trade-offs
- Breeding pattern of fishes
- Population characteristics
- Dynamics of fish populations
- Production

7. Applied Ecology of Fishes

- Introduction
- A classification of problems in applied ecology
- Applied fish ecology of rivers
- Applied ecology of lacustrine fishes
- 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

Text and Reference Books:

1. Fish Ecology. R.J. Wootton, Blackie Academic & professional an imprint of Chapman &Hall, London, Weinheium. 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, Melboune. Madras. First edition 1990, reprinted with revisions 1991.
4. Environmental Biology of Fishes. Malcolm Jobling. Tokyo, Melboune. Madras. First edition 1995.
5. Ecology and Conservation of Fishes. Harold M. Tyus, CRC Press, Taylor and Francis Group, USA, 2011.

ES 61 FISH ENDOCRINOLOGY Cr. 3(2+1)

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 ofendocrine system of different fishes of Pakistan.
3. To conveythe 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. **AQUIRE**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**
- Differentiate between exocrine and endocrine system
- Fish endocrine system and mechanism
- The evolution of fish endocrinology

2. **Pituitary gland**
- Origin
- Functions
- Neurohypophysis and its hormones
- Adenohypophysis and its hormones

3. **Thyroid gland**
- Introduction of thyroid gland
- Functions in fish

4. **Pancreas**
- Introduction to pancreas of fishes
- Types in fish
- Pancreatic glands
- Pancreatic hormones

5. **Gastro-intestinal hormones**
- Introduction
- Types
- Function

6. **Adrenal cortex (internal tissue), chromaffin tissues and corpuscles stannous**
- Brief introduction
- Important functions in fish

7. **Sex hormones**
- Gonadal hormones in fish;
- 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**
- Brief introduction
- Pheromones
- 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 textbo of Endocrinology. 13th ed. Elsevier Inc, USA.

(12)

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., Zaccone, 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.

ES 62 FISH FEEDING MANAGEMENT Cr. 3(2+1)

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

- Need of supplementary/ artificial feeding of fish.
- Scope of artificial feeding infish.
- Metabolism of feed nutrients (Protein, Lipid, Carbohydrate) in fish.
- Feeding practices, Different types of feeders.
- Diet preparation andprocessing techniques.
- Estimation of apparent nutrient digestibility.
- FCRand FCE indices.
- Feed ration and frequency, judging fish feeding response.
- Food acquisition and patterns of estimation of food requirements.
- Feed processing and manufacturing: floating and sinking feed.
- 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 lengthetc.
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.

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.

ES 63 FISH HEALTH MANAGEMENT Cr. 3(2+1)

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:

- Introduction to fish health management.
- Elements of fish health management
- General husbandry procedures, feeding, fish handling.
- Facility and equipment management: overview of facility, layout plan, management of facility, management of equipment.
- Bio-security and mitigation measures: equipment maintenance and disinfection, mitigation disease spread from infected or diseased fish.
- Disease emergencies: fish disease outbreaks, fish health emergency procedures, determining the cause of outbreaks.
- Monitoring and record keeping: fish health records, feeding, fish monitoring, water quality monitoring, fish production records, treatment records.
- Common signs of diseased fish, modern techniques for investigation of disease.
- Kinds of diseases: non-infectious diseases, infectious diseases, virus borne diseases, bacterial diseases, fungal diseases, fish vaccination.
- Preventive measures, control of fish disease, disease resistance.
- 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.

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.HS. 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.

ES 64 FISH PHYSIOLOGY AND BREEDING Cr. 3(2+1)

Course Objectives

The objectives of the course are:-

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

Learning Outcomes

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

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

Course Contents:

1. **Fish nutrition**
   - Digestive system;
   - Stomach less fishes;
   - Stomach fishes;
   - Digestion and absorption;
   - Food; Plant origin; Animal origin;
   - Feeding; Fresh food; Dry concentrates; Pelleted food.
2. **Transportation:**
   - Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma);
   - Circulation; Arterial system; Venous system; Capillaries;
   - Transport of food material.
3. **Respiration:**
   - Gills;
   - Lungs;
   - Skin;
   - Swimbladder;
   - Homeostasis.
4. **Excretion:**
   - Kidneys;
   - Hypo-osmotic urine;
   - Hyper-osmotic urine;
   - Osmoregulation.
5. **Reproduction:**

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

6. **Breeding:**
   - Natural (seasonal); Artificial;
   - Hormonal induced breeding;
   - Temperature & photoperiod;
   - control induced breeding.
7. **Growth:**
   - Extensive culture (due to the consumption of natural food);
   - Semi-intensive culture (due to natural & artificial food);
   - Intensive culture (due to only dry concentrates).
8. **Fish health:**
   - Water quality;
   - Hygiene of fish culture facilities;
   - Hygiene of equipments used in fish culture.
9. **Diseases and their control:**
   - Viral;
   - Bacterial;
   - Fungal;
   - Parasitic;
   - Protozoan;
   - Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera);
   - Annelids (leeches); Arthropods (water ticks, water flea, water mites).
10. **Fish migration:**
    - To nursery ground;
    - To maturation grounds;
    - Freshwater to marine water;
    - Marine water to freshwater.
11. **Fish behaviour:**
    - Learning and memory;
    - Light response for maturation;
    - Courtship behaviour;
    - 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, NH_3, 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

ES 65 FISHERIES MANAGEMENT Cr. 3(2+1)

Road to management, natural populations, protection against hazards, improvement of habitat, age and growth, managing natural populations, the significance of fishes in the life of mankind and biological basis of natural fishery.

Books Recommended

1. Templeton, R. G. 1995. Freshwater Fisheries Management (2nd Ed.) Fishing News Books, Blackwell Science, USA.
2. Jacques, A. 1999. Management of Freshwater Fisheries. Technique et Documentation, Lavoisier, Paris.
3. Rounsefell, G.A. and Everhart, W.H. 1963.Fishery Science its Methods and Application. John Wiley & Sons, Inc., New York.
4. Arrignon, J. 1999. Management of Freshwater Fisheries. Oxford & IBH Publishing Co. N. Delhi.

ES 66 FRESHWATER FISH PARASITOLOGY Cr. 3(2+1)

Introduction to Freshwater fish Parasitology: Fish health and diseases: Diagnosis of diseases. Collection and preservation of parasitic / fish specimens. Parasitic protozoans,Platyhelminths, Acanthocephala, Nematoda, Hirudinea and Crustacean in fishes, their lifecycle and pathogenesity. Methods of control of parasitic diseases in culturable fish. External treatment of fish and disinfection of fish culture facilities.

Practicals

Study, identification and preservation of various freshwater fish parasites. Preparation of slides of fish parasites. Visit to fisheries facility farm / hatchery etc.

Textbook

1. Baue Musselius and strelkor. 1973. Diseases of pond fishes. Keter press. Jeruslam.

Additional Readings

1. Kabata, Z 1985. Parasite and diseases of fish cultured in the tropics Taylor and Francis. London.
2. Post .G. 1987. Textbook of fish health. T.F.H. Publication's. USA.
3. Robert R J. 2002. Fish Pathology (3rd Ed.) Bailliere Tindal. London.
4. Woo.P.T.K.1995 Fish diseases and disorder. vol. 1. Protozoan and metazoan infection. CAB International University press Cambridge. UK.

ES 67 FUNDAMENTALS OF FISHERIES Cr. 3(2+1)

Major Fish groups (Freshwater fishes), Criteria for the selection of cultureable fish species. Fish Pond construction; (site selection, soil and water quality, types of ponds, shape and depth of

ponds). Aquaculture (the concept aquaculture in freshwater only). General classification of fish, size, shape and external feature. Basic types of fish culture. Study of various Physico-chemical characteristics of inland water.

Practicals

Survey of inland waters, collection and preservation of fishes, study and comparison of morphological classification of freshwater fishes, dissection of a fish to expose various system. .

Books Recommended

1. Moyle, P.B. and Joseph, J.C. 2004. Fisheries: An Introduction to Ichthyology, Prentice Hall, London.
2. Parker R. O., 2004. Aquaculture Science (4th ed.). Delmar Learning, London.

ES 68: FUNDAMENTALS OF HUMAN GENETICS Cr. 4(3+1)

Course Contents To be provided by the Concerned Expertise

ES 69 FUNDAMENTALS OF MICROBIOLOGY Cr. 4(3+1)

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**
   - History of microbiology
   - Microbes influencing our lives
   - Characterization and identification of microorganisms
2. **Virology**
   - Structure of virus, Characteristics of virus, Virus-host cell interaction
   - Viral replication, Transformation,Transmission oftransforming viruses
   - Mechanism of pathogenicity; virus cultivation and propagation
3. **Morphology and fine structure of bacteria**
   - Size, Shape and arrangement of bacterial cells, motility, Capsules
   - Structure and composition of cell wall, Cytoplasmic membrane, Protoplasts, Endospore, pili
4. **Cultivation of Bacteria, Pure culture and growth characteristics**
   - Nutritional requirements, Nutritional types of bacteria
   - Bacteriological media, Physical conditions required for growth
   - Pure culture, Methods of isolating pure culture, maintenance and preservation of pure cultu Cultural characteristics
5. **Growth and Metabolism**
   - Growth of microbial population, measurement of microbial growth, growth rate, growth curv
   - Determination of number of cells by direct microscopic count, Plate count method, membrane filter count, Turbidimetric method

- Determination of cell mass by measurement of growth

6. Food and Medical Microbiology

- Microbial spoilage of foods, Food poisoning, Food infection
- Factors effecting the spoilage of food (water, pH, oxygen, nutrients, physical structure of food), Botulism food poisoning, Mycotoxins
- Food preservation (drying, refrigeration, irradiation, canning, pasteurization).
- Sources and communicability of diseases, Communicable diseases,Non-communicable diseases
- Chain of infection, Etiological agents, Specificity, Source and reservoirs of etiological agents, Methods of transmission

7. Normal Microbial Flora and Microbial Ecology

- Significance of normal microbial flora, Origin of normal Microbial flora, Microbial flora of skin, Microbial flora of gastrointestinal tract, Microbial flora of genito-urinary tract
- Sterile sides of human body, Mechanism of bacterial pathogenicity
- Distribution and activities of microorganisms in natural systems, Role of bacteria in elemental cycles
- Plant interaction of microbial communities with their biotic and abiotic environment microbial role in global carbon cycle

8. Soil, Air and Water Microbiology

- Soil environment, Microbial flora of soil, Bacteria, Fungi, Algae, Rhizosphere, Biogeochemical activities of microorganisms in soil
- Microbial content of air, Indoor air, Outdoor air
- 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

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. McKerrow, Jeffery A. Hobden, Judy A. Sakanari, Karen
5. C. Carroll, Stephen A. Morse, Steve Miller, Thomas G. Mitchell and Timothy A. Mietzner.
6. Laboratory Experiments in Microbiology, 11th ed. (2015) by Ted R. Johnson and Christine L. Case.
7. 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.
8. Alcamo's Fundamentals of Microbiology, 9th Ed., (2012) by Jeffrey C Pommerville.
9. Bergey's Manual of Systematic Bacteriology(2012).
10. Microbiology Principles and Explorations (2001) by Jacquelyn, G.G.

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ES 70 GENERAL AND COMPARATIVE ENDOCRINOLOGY Cr. 3(2+1)

Course Objectives:

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

Course Contents:

1. **An overview of general concepts and principles of endocrinology**: The endocrine system: Type of hormones; Endocrine and nervous system relationship; General principles in function interaction, nature, synthesis, transport of hormones; General concept of feedback, biorhythms pathology and assessment of endocrine function; Evolution of endocrine system.
2. **Hypothalamus and pituitary: Hypothalamic hormones:** Origin, chemistry and actions.

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

3. **Thyroid gland:** Anatomy and histology of gland; Formation and secretion of thyroid hormones; Thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function.
4. **Calciotrophic and mineral metabolism hormones:** Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.
5. **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.
6. **Adrenal medulla and catecholamines:** Chromaffin cell and organization; Structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors.
7. **Adrenal cortex:** Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoids, mineralocorticoids and adrenal sex steroids.
8. **Hypothalamic-Hypophysical-Gonadal axis in Reproduction:** Hormonal and neuronal factors nd their interactions in ovarian, testicular and other reproductive targets functions.
9. **Testes: Androgenic tissue:** Structure and chemistry; Transport, metabolism and mechanism of action.
10. **Ovaries: Ovarian hormones:** Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action. The interactions in developments in estrous and menstrual cycles.
11. **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.
12. **Endocirnology of lactation:** Hormones in lactation.
13. **Endocrinology of heart, kidney, immune system:** Growth and pineal gland.
14. **Functional diversity of hormones in vertebrates**
15. **Overview of endocrine mechanisms in invertebrates.** Study of hormones of invertebrates in concepts of growth, metamorphosis, reproduction and pheromones.

Practicals

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.

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)

8. (relevant for some general background info on reproduction pitched for undergraduate students).
9. Chandra S. Negi, introduction to endocrinology
10. Charles Brook, Nicholas Marshall, essential endocrinology
11. 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
3. Edition. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.
6. Knobil, E. and Neill, J.D., *et al.*, 1995. The Physiology of Reproduction, Vol.1&2; 2nd Edition, Raven Press, New York.
7. Evert, B.J. and Johnson, M.H., 2000. Essential Reproduction, 5th Edition. Blackwell Science Inc., Oxford.

ES 71 GENERAL MICROBIOLOGY Cr. 3(2+1)

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**
   - Discovery of the microbial world
   - Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods
   - The scope of microbiology
   - Microbial evolution, systematics and taxonomy
   - Characterization and identification of microorganisms
   - Nomenclature and Bergey's manual
2. **Viruses**
   - Bacteriophages and phages of other protists
   - Replication of bacteriophages
   - Viruses of animals and plants
   - History, structure and composition
   - Classification and cultivation of animal viruses
   - Effects of virus infection on cells
   - Cancer and viruses
3. **Morphology and fine structure of bacteria**

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

4. Cultivation of bacteria

- Nutritional requirements and nutritional types of bacteria
- Physical conditions required for growth
- Bacteriological media
- Choice of media and conditions of incubation

5. Reproduction and growth of bacteria

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

6. Pure cultures and cultural characteristics

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

7. Eukaryotic microorganisms

- Algae: Biological and economic importance of algae
- Characteristics of algae; Lichens. Fungi: Importance of fungi
- Morphology; Physiology and reproduction, Cultivation of fungi
- Economic importance of protozoa

8. Prokaryotic diversity

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

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.

ES 72 GENERAL PARASITOLOGY Cr. 3(2+1)
Course ContentsTo be provided by the concerned expertise

ES 73 GENES AND DISEASE Cr. 3(2+1)

Introduction to Genes and Disease, Blood and Lymph Diseases, Cancers, The Digestive System, Ear, Nose, and Throat, Diseases of the Eye, Female-Specific Diseases, Glands and Hormones, The Heart and Blood Vessels, Diseases of the Immune System, Male-Specific Diseases, Muscle and Bone, Neonatal Diseases, The Nervous System, Nutritional and Metabolic Diseases, Respiratory Diseases, Skin and Connective Tissue, Chromosome Map.

Textbooks
1. Genes and Disease, National Center for Biotechnology Information (US). Bethesda (MD): National Center for Biotechnology Information (US), 1998.
2. Liwin, B. 2007. Genes. 9th Ed. Jones & Bartlett Publishers.

ES 74 GENETIC COUNSELING Cr. 3(2+1)

What is genetic counseling? Timing of genetic counseling. What are genetic counselors? What is genetic Testing? What disorders can genetic test predict? Does genetic counseling always involve genetic tests? Creating a family health history. Organization of genetic counseling services. Genetic counseling as a profession. What to expect during a visit with a genetic counselor. Role of genetic counseling. The field of genetic counseling. Birth defects. How genetic disorders occur? Genetic testing procedure. Limitation of genetic testing. Benefits of genetic counseling, disadvantages.

Practicals
1. Genetic testing.
2. Types of genetic testing.
3. Laboratory automation.
4. Diagnostic techniques.
5. ELISA.
6. Karyotyping.

ES 75 HEMATOLOGY Cr. 3(3+0)

Course Objectives
The objectives of the course are:-
1. To impart knowledgeabout 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 a hypersensitivity.

Course Learning Outcomes:

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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**
   - Introduction to Hematology and techniques of hematology.
   - Anticoagulants EDTA , heparin, balanced oxalate, calcium citrate and low molecular weight heparin
   - Phelbotomy tray and phlebotomy procedure.
2. **Hemopoiesis**
   - Normocytic erythropoiesis.
   - Megaloctic erythropoiesis andsubstances required for erythopoiesis.
   - Life span of RBC, Structure of RBC and composition of hemoglobin.
   - Synthesis of hemoglobin.
   - Leukopoiesis, maturation of neutrophils.
   - Maturation of basophils and maturation of eosinophils.
   - Maturation of lymphocytes AND maturation of monocytes.
   - Maturation of plasmacytes and their proliferation.
   - kinship between neutrophils and monocytes.
   - Maturation of thrombocytes and thrombocytopenia.
   - Erythrocyte indices and CBC.
3. **Anemias**
   - Hypoproliferative anemia and bone marrow damage.
   - Spur cell anemia and Sickle cell anemia.
   - Hemolytic anemia and mechanism involved in hemolysis of RBC.
   - Sideroblastic and nonsideroblastic anemia.
   - Macrocytic anemia.
   - Coagulation factors.
4. **Immunity**
   - Phagocytosis, microphages, macrophages ,mast cells and grades of immunity.
   - Measurement of immunity.
   - Antigens and immune tolerance.
   - Major histocompatibility complex I and II.
   - Characteristics of antigens.Acquired immunity. Passive acquired immunity.
   - Consequences of antigen and antibody binding.
   - Humoral immunity and cell mediated immunity.
5. **Allergy and hypersenstivity**
   - Atopic allergy and anaphylactic hypersensitivity.
   - Immune complex dependent hypersensitivity and hypersensitive response.
   - Sensitization of cells.Adaptive immunity.
   - Immediate hypersensitivity. Delayed hypersensitivity
   - .Adjuvants and their types.Complement system and hypersensitivity reactions.
   - Cellular basis of cell mediated hypersensitivity.
   - Complement.Antibodies.
   - Synthesis of antibodies and stimulatory hypersensitivity.
   - Interferones and serum sickness.

- Autoimmune disorders

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. Elesvier
3. O'Hehir, R.E., *Holgate*, S. T. and Sheikh, A., 2016: Middleton's Allergy Essentails. 2nd Ed. Elesvier
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.

ES 76 HELMINTHOLOGY Cr. 3(2+1)

Systematics, biology, pathology, host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance.

Systematics, morphology and biology of Arthropods causing disease or those responsible for transmission of disease. Chemical and non-chemical control of Arthropods of Medical and Veterinary importance.

Practicals

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

Books Recommended

1. Noble and Noble, 1982. Parasitology. The Biology of animal parasites. 5th edition. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical parasitology. 3rd edition. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge, London.
4. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press, UK.
5. Roberts, L.S. and Janovy, J. Jr., 2005. Foundations of Parasitology. 7th Edition. McGraw Hills Boston.

ES 77 HELMINTHOLOGY AND HOST-PARASITE RELATIONSHIP Cr. 3(2+1)

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 the

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:

ES 78 HERPETOLOGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 79: HISTOLOGY Cr. 3(2+1)

Methods of study of cell. Different types of tissue: Epithelium, connective, muscle, nervous, microanatomy of different body organs.

Practicals

Study of prepared slides of different tissues, preparation of sections and differential staining of sections of different tissues.

Textbook

1. Rhodein. Histology, 5th Ed.

Additional Readings

1. Copenharer, W.M. Bailey's textbook of Histology. 17th Ed.

ES 80 HUMAN EMBRYOLOGY & TERATOLOGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 81 HUMAN GENETICS Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 82 ICHTHYOLOGY (Bs Specialized Course) Cr. 3(2+1)

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**
   - Systematic position of fish in animal kingdom
   - Distribution of various commercial and noncommercial fishes of Pakistan

2. **Morphology of fishes**
   - External features of fishes
3. **Coordination of fishes**
   - Fish muscular system, locomotion and energetics of swimming.
   - Physiology of respiration and air breathing among fishes.
   - Cardiovascular system,
   - blood and its circulation and hydromineral balance: Osmoregulation, ionic regulation, stress responses, freezing resistance and acid-base balance.
   - 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.
   - Gas in the gas bladder: Loss, retention and secretion of gas.
   - Process of aestivation in fish.
   - Control of kidney function in fish. Sensory system and communication in fish: Acousticolateralis system, sound reception and production.

Practical:

1. Collection and identificationof 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.

ES 83 IMMUNOCHEMISTRY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 84 IMMUNOLOGY Cr. 3(2+1)

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 immunologic 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 usingimmunological 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**
   - Introduction to immunity.
   - Immune response

- Infectious agents

2. **Innate Immunity and Inflammation**
- Sentinel cells and circulating leukocytes
- Inflammatory events and signaling
- The formation of pus

3. **Microbial Recognition and Responses in Innate Immunity**
- Pattern recognition receptors
- Innate immune signaling
- The complement system

4. **Antibodies**
- Blymphocytes
- Antibody structure and function

5. **Lymphocyte Development and Diversity**
- Lymphocyte development
- Clonal selection and expansion
- Differences between B and T lymphocytes
- The generation of lymphocyte receptor diversity

6. **T Cell Activation by Antigens**
- The role of dendritic cells
- The lymphatic system and delivery of antigen to lymph nodes
- Adaptive immune activation in secondary lymphoid tissues
- Antigen presentation

7. **T Cell-Dependent B Cell Responses**
- T Cell activation of B cells
- Isotype switching and affinity maturation

8. **Helper T Cells**
- Helper T cell functions
- The role of helper T cells in disease

9. **Cytotoxic T Cells**
- Cytotoxic T cell functions
- Selection and expansion of cytotoxic T cells
- Therapies that target cytotoxic T cell functions

10. **Failures of the Immune System**
- Immunodeficiencies
- Autoimmune diseases
- Allergic diseases

11. **Immunology-Based Therapy of Diseases**
- Transplantation and transfusion

Practical:

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

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: 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.

ES 85 INSECT BIOACCOUSTICS Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 86 INSECT BIOCHEMISTRY AND PHYSIOLOGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 87 INSECT PATHOLOGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 88 INSECT STRUCTURE AND FUNCTION Cr. 3(2+1)

General characteristics of insects. Relationship with other Arthropoda.
Hard Parts: General segmentation, Cuticle: Detailed structure. Epidermal layer; its structure and function. Basement membrane. Colours of insects. Cuticular outgrowths and appendages, sclerotization. Metamorphosis.
Head: Cephalization, Sclerites, Modifications. Antennae: Different modes of ingestion and types of mouth parts.
Thorax; legs, their different modifications and functions.
Wings: Different regions. Development. Basal attachments. Main veins and their branches (generalized insects). Wing coupling apparatus.
Abdomen: Secondary appendages and external genitalia. Endoskeleton: Head, thorax and abdomen.
Comparative structure of all the systems, e.g., digestive, excretory, respiratory, circulatory, and nervous system and their physiology. Sense organs: sound and light producing organs. Exocrine and Endocrine glands including pheromones and their functions.
Reproduction: Reproductive organs and different types of reproduction in insects. Types of larvae and pupae.

Practicals

Preparation of permanent slides. All the hard parts (terminal segments, wings, antennae, legs, mouth parts). Different systems, especially digestive, reproductive of the following insects. American cockroach, grasshopper, housefly, mosquito, any common beetle. Sympathetic nervous system of cockroach.

Books Recommended

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

ES 89 INSECTS OF VETERINARY AND MEDICAL IMPORTANCE Cr .3(3+0)

Course Objectives:

The objectives of the course are:-
1. To provide knowledge about insect vectors, disease borne pests of veterinary and hu

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 importantinsect vectors and disease borne pests of veterinary and human importance.
2. Understandtheir life cycles during transmission of diseases for control.
3. Analyze about their control

Course Outline:

1. **Introduction**
   - General introduction to medical and veterinary entomology
2. **Phylum arthropoda**
   - Salient features of insects
   - Classification
   - General morphology and physiology of insects
   - Modifications in mouthparts and appendages of insects
   - Metamorphosis and its types
3. **Insects of medical and veterinary importance**
   - Mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks
   - Life cycles
   - Diseases and their control
4. **Insect venoms**
   - Bees, wasps, ants.
   - Insect toxins
   - Arthropod allergens
5. **Insect pest management**
   - Definition
   - Principles and methods of insects control
   - Components of pest management
   - Techniques
   - General measures to control insects
   - Economics of pest management

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 ConlJ19l.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.

ES 90 INTEGRATED PEST MANAGEMENT Cr. 3(2+1)

Brief account of integrated pest management: common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Pest management Theory; Biological control, ecological management of crop environment, Insecticide and its application, managing insect with resistant plant and sterile technique: Managing ecological black lash.

Practicals

Collection, preservation and identification of insect pests upto families (except for the

identification upto species of a few pests of great economic importance), with the help of keys/literature. Pollution estimation of insect using different sampling methods. Effect of insecticides on predators and insect pest (Mortality and behaviour).

Textbook

1. Pedigo, L.P., 1991. Entomology and Pest Management. Maxwell MacMillan.

Additional Readings:

2. Richards, O.W. and Davies, R.J., 1977. *Imm's General Textbook of Entomology*. Vol-2.
3. Metcalf, C.L. and Flint, W.P., 1962. *Destructive and Useful Insects*, McGraw-Hill.

ES 91 INTRODUCTION TO ENVIRONMENT Cr. 3(2+1)

Course Objectives:

The course objectives are:

1. To enable students to understand interrelationship between variousComponents of the environment.
2. To provide knowledge about basic concepts of matter, energy, birth ofUniverse, solar system and origin of earth.
3. To provide knowledge about environmental geology and environmentand life and human activity are considered for understanding ofenvironment and its trans disciplinary integration.

Course Learning Outcomes:

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

1. Discover interrelationship between variousComponents of the environment.
2. Interpret basic concepts of matter, energy, birth ofUniverse, solar system and origin of earth.
3. Assess environmental geology and environmentand life and human activity for understanding of environment and its trans disciplinary integration.

ES 91 INTRODUCTION OF ENVIRONMENT Cr. 3(2+1)

Course Outline:

1. Introduction and definitions.

- Environmental systems; Atmosphere, Lithosphere, Hydrosphere, Biosphere, Origin and their interrelationships

2. Environmental factors

- Physical, chemical and biological factors.

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

4. Environnent and human interactions.

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

5. Environmental issues and challenges

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

6. Environment and sustainable development

7. Issues of social environment

- Population growth, urbanization
- Migration and poverty
- Lifestyle and environment.

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.

ES 93 INTRODUCTION TO APPLIED FISHERIES Cr. 3(2+1)

Introduction to basic principles of fish farming/fish culture. Cultureable fish species of Pakistan, Construction of commercial fish farm. Natural and Artificial fish feed. Carp hatchery and artificial breeding. Fish rearing and growth. Fish enemies, disease and their control.

Books Recommended

1. M. Huet, 1986. Textbook of fish culture breeding and cultivation. Fishing Book News Ltd.
2. Jhingran, Pullin 1986. A hatchery manual on Chinese and Indian major carps. ADB, Manila.
3. R. Santhana, N. Sukumayan and P. Natarajan 1990. A manual of fresh water aquaculture. Oxford and IBH publishing co. Pvt. Ltd. Bombay.
4. Larzlo Harvath, Gizella Tamas, Chris SeaGrave 1992. Corp and Pond fish culture. Fishing News Books. Conwall.

Practicals

Identification of culterable corps fish species, study of Gut contents of these fishes.

Textbook

1. L. Santhana, N. Sukumaran, P. Natarajan 1990. A manual of fresh water aquaculture. Oxford and IBH publishing Co. Pvt. Ltd. New Delhi.

ES 94 INTRODUCTION TO FISH BIOLOGY Cr. 3(2+1)

Introduction to fish. Various groups of fishes. Fish habitat. (Fresh water, Brakish water and marine water). Fish morphology (scales and its types, fins and its types, fin rays, operculum, barbles, head and mouth).

Fish Anatomy, (Skull, vertebral column, brain, spinal cord, gills, heart in fishes, liver and kidney, swim bladder, spleen, pancreas, intestine, stomach and reproductive organs).

Textbook:

1. Legler, Bardach, Miller & Passino 2003. Ichthyology, 2nd Edition, John Willey & Sons.

Additional Readings

1. M. Huet, 1986. Text book of Fish culture, breeding and cultivation. Fishing book news Ltd.
2. Jhingram & Pullin, 1985. A hatchery manual for Chinese and major carps. ADB Manila.
3. Woo, 1995. Fishes diseases and disorders, Protozoan and Metazoan infections. Pak Book corporation.

Practicals

Identification of some fresh water fishers of Pakistan. Study and survey of fish collection in Punjab University Museum.

Textbook:

1. Key to fishes of Punjab by Mirza and Sharif 1996. Ilmi Kitab Khana Lahore.

ES 94 INVERTEBRATE PALEONTOLOGY Cr. 3(2+1)

Course Objectives:

The objectives of the course are:-

1. Toprovide 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. Tounderstand 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**

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

2. **Siwalik Hills**

- Siwalik Hills: A brief account of the Siwalik Hills.
- Division of Siwalik Group:Upper Siwaliks, Middle Siwaliks and Lower Siwaliks.
- Formations of Siwalik Group:Kamlial, ChinjiNagri, Dhok Pathan andSoan.

3. **Siwaliks Invertebrate fauna**

- A detailed classification of invertebrate microfossils and macrofossils.
- Study of the structure, affinities, distribution of the Protozoa, Coelenterata, Bryozoa, Brachiopoda, Mollusca, Arthropoda and Echinodermata.
- Biostratigraphical importance and lithostratigraphic correlations of the Invertebrate fossils.
- Morphological trends, phylogenetic characteristics and evolutionary trends in the major invertebrate phyla.
- Paleoecology & 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.

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 a Evolutionary Discipline. University of Chicago Press.
3. Michael, J.B., David, A, and Haper, T., 2009. Paleobiology and the fossil record. 3rd Ed. Wil Black, UK.
4. Foote, M. and Millar, A.I., 2007. Principles of paleontology. 3rdEd. W.H. Freeman & Co. US
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. Blackwe

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.

ES 95 LABORATORY TECHNIQUE Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 96 LIMNOLOGY Cr. 3(2+1)

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

Course Learning Outcomes:.
Upon successful completion of the course, the student will be able to:
1. **Recall**the basic knowledge ofphysico-chemical properties of lentic and lotic environment.
2. **Describe** thermal stratification, management and conservation of lakes.
3. **Relate**the inland water quality with the production of aquatic fauna.
4. **Illustrate** the basin morphometry and eutrophication of lakes.
5. **DETERMINE**the values of various physico-chemical and biological parameters of lotic and lentic water bodies.

Course Contents:
1. **Introduction and scope of Limnology**
- Introduction, History and scope
- Structure of aquatic ecosystems
- Origin of lotic and lentic waters, and estuaries
- Zonation
- Thermal stratification
- Eutrophication

2. **Properties of freshwater**
- Physical properties of water (temprature, light, color, turbidity, conductivity); chemical properties of water (pH, oxygen, CO_2, salinity, dissolved solids, trace elements, nitrogen, phosphorous and sulphur cycles)
- Biological properties, plankton (phytoplankton, zooplankton)
- Methodology for collection
- Preservation and identification;
- Planktonic adaptations and diurnal migration;
- Factors affecting planktonic productivity

3. **Lake formation**
- Lake formation and basin morphometry
- Processes of Lake Eutrophication
- Sedimentation and acidification
- Biological productivity in lakes
- Lakes of Pakistan
- 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.

ES 97 MAMMALOGY Cr. 3(2+1)

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 o 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 mammologists in the conservation and management of mammals.

Course Outlines:

- **Introduction and history** ofmammalogy; basic characteristics of mammals; diversified habitats for mammals in Pakistan and various continents.
- **Mammalian phylogeny**; dentition and dental formulae, cranial characteristics, evolution of mammals. Concepts of viviparity and ovo- viviparity.
- **Concept of biogeography**; mammalian radiations, biogeography of mammals of Pakistan occurrence, habits and varied habitats, importance to ecosystems and negative values.
- **Food and feeding strategies; preferred food sources**of mammals, foraging habits, diurnal

and

- nocturnal feeding regimes of mammals; ecological constraints and mammalian adaptations. Concepts
- of stenophagy and euryphagy.
- **Population dynamics of mammals; rates of natality, mortality, immigration and emigration**
- **Population modeling concepts** in mammals; mammalian crowding and scuffles with respect to various environments.
- **Communication and social organization**; chemical signaling in mammals, types and causes of occurrence, communication skills and emergence of mammalian call notes.
- **Mammalian Adaptations**;concept of torpor formation, aestivation, hibernation, acoustic laterlis systems in mammals. Concept of molecular basis of mammalian adaptations.
- **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. Vaghuan, 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

ES 98 MECHANISMS OF DEVELOPMENT Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 99 MEDICAL ENTOMOLOGY Cr. 3(2+1)

Introduction to Medical Entomology. Arhtropods as a cause and cause and carrier of disease. Development and Classification of insets and arachnids. Mouth parts and their importance in the transmission of disease. Insecticidal and acaricidal practices. Morphology, life cycle, medical importance and control of the following insects and arachnids.

Cockraches and beetles; Bed bugs, conenose and other bugs, Sucking and biting Lice; Simulid Gnats, Phlebotomus flies and Mosquitoes; Horse flies, Deer flies, Snipe flies, Syrphid flies, Musoeoid flies, Louse fly, House fly and its relatives. Tsetse flies, Stomoxys flies, Horn flies, Myiasis causing flies, Fleas and Ticks. Mites and Pentasomids, Venomous and Urticarial Arthropods.

Practicals

Collection, preservation and pinning of adult insects and arachnids of medical importance.
Mouth parts of insets and arachnids. Wing venation of insects.
Mounting of stigmal plates and their identification.
Demonstration of life cycle stages of typical insect and arachnids.
Methods of preparation and examination of skin scrapings for mites.
Methods for dissecting arthropod vectors to determine infection rates.
Identification of various species of cockroaches, bettles, bugs, lice, flies, fleas ticks and mites.

Books Recommended

1. Wall, R. and Shearer, D. 2001. "Veterinary Ectoparasites: Biology Pathology and Control" 2nd Ed. Blackwell Science Publication, UK.
2. Geogri, J.R., Georgi M.C. and Theodorides, V.J. 1999. "Parasitology for Veterinarian." 7th Ed. W.B. Sunders Co., London.
3. Wall, R. and Shearer, D. 1997. "Veterinary Entomology" Chapman and Hall, London.
4. Herms, W.B. and James, M.T. 1996. Medical Entomology. The Mc Millian Co. New York, USA.
5. Kettle, D.S. 1995. "Medical and Veterinary Entomology" CAB International, Wallingford, Oxan. U.K.
6. Service M.W. 1980. A guide to Medical Entomology. The McMillan Press Ltd. London.

ES 100 MEDICAL PARASITOLOGY Cr. 3(2+1)

Introduction, classification of medically important protoza and helminthes. Their general characteristics, habitat, transmission & epidemiology and control measures.
Amoeba, flagellates, coccidian, protozoa from body site, tissues and blood.
General morphology, life cycle, epidemiology and control measure of trematodes, cestodes and nematodes, intestinal & tissue nematodes.

Practicals

Qualitative and quantitative analysis of stool for the presence of protozoa & helminthes. Examination of blood for protozoa & helminthes. Differential identification of important parasites. (from prepared slides) Collection, preservation, identification & staining of helminthes of medical importance.

Books Recommended

1. Berger, S.A., May 2005. Human Parasitic Diseases. Jones and Bartlett Publishers.
2. Bogitsh, B.J., Carter, C.E. and Oeltmann, T.N., 2004. Academic Press.
3. Ruth, Ph.D., Leventhal, Cheadle, R.F., 2003. Medical Parasitology.
4. Roberts, L.S. and Janovy, J. Jr., 2005. Foundations of Parasitology.7th Edition. McGraw Hill, Boston.
5. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge.
6. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press, UK.
7. Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M. and Jennings, F.W., 2001. Veterinary Parasitology. ELBS, Langman, U.K. (265 pages).
8. Schmidt, G.D. and Roberts, L.S., 2005. Foundations of Parasitology. 17th Edition. McGraw Hill, Canada.

ES 101 MEDICAL VIROLOGY Cr. 3(2+1)

Introduction, DNA Virus, RNA Virus, Viral diseases e.g. Adenoviruses, Choronoviruses Paramyxoviruses, Orthomyxoviruses, Gastroenteroitis viruses, Parvovirus, Poxvirus, Hepatitis virus,, Retrovirus and HIV, Viral infection and special syndromes.

Practicals

Lab diagnosis of viral infections, sample collection, handling, Rapid diagnostic methods, Virus isolation and cell culture, detection of antiviral antibodies, Immunization, Antiviral chemotherapy points of action in the virus life cycle, use of antivirals; general consideration.

Text Books

1. Leslie Collier and John Oxford, Human Virology, Ed 4th , Oxford University Press Inc., New York. ISBN 13: 978-0-19-856660-1.
2. Bruce A Voyles (2000) The biology of viruses. Ed. 2nd McGrew Hill companies Inc. New York. NY10020.

ES 102 MICROBIAL CONTROL OF INFECTIOUS DISEASE Cr. 3(2+1)

Control of microorganisms: Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic agents. Microorganisms and diseases: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals.

Practicals

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

Textbooks

1. Pelczar, M.J. Jr., Chan, E.C.S. and Krieg, N.R. 1986. Microbiology– McGraw Hill Inc., New York.
2. Benson, H.J., 1994. Microbiological applications. WmC Brown Publishers, Dubuque, USA.

Additional Readings

1. Alcamo, E. 1994. Fundamentals of Microbiology. The Bengamin/Cummings Publishing Co. Inc. Redwood city, CA 94065.
2. Pelczar, M.J. Jr., Chan, E.C.S. and Krieg, N.R. 1993. Microbiology concepts and applications – McGraw Hill Inc., New York.

ES 103 MICROBIOLGY AND BIOTECHNOLOGY Cr. 3(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**

- History and scope
- Techniques and examples (e.g. biofertilizers,Bio-pesticides, Bio- herbicides, bacterial and fungal Bioinsecticides, Virus-based bioinsecticides)

1. **Microbial Diversity**

- Microbial classification (Morphological classification, Nutritional classification, Biochemical classification, Serological/ antigenic classification, Staining reaction)
- Morphological diversity
- Metabolic diversity
- Structural diversity
- Genetic diversity
- Ecosystem and Biomes

2. **Biomass:**
- Major components of plant biomass (Cellulose, Hemicelluloses, Lignin)
- Architecture and composition of the wood cell wall
- Biomass degradation

3. **Production of Proteins in Bacteria and Yeast**
- Production of proteins in bacteria
- Production of proteins in yeast

4. **Plant–Microbe Interactions**
- Use of symbionts
- Use of nitrogen-fixing bacteria to improve crop yields
- Production of transgenic plants
- Insect-resistant plants

5. **Recombinant and Synthetic Vaccines**
- Problems with traditional vaccines
- Impact of biotechnology on vaccine development
- Mechanisms for producing immunity
- DNA vaccines

6. **Primary Metabolites: Organic Acids and Amino Acids**
- Citric Acid
- Microbial production of Amino Acids (Lysine, Glutamic acid)
- Enzymatic production of amino acids

7. **Secondary Metabolites**
- Antibiotics
- Other biologically active microbial metabolites;

8. **Ethanol:**
- Stage I - from feedstock to fermentable sugars
- Stage II- from sugars to alcohol

9. **Environmental Applications**
- Degradative capabilities of microorganisms
- Origins of organic compounds
- Microbiological degradation of xenobiotics
- Microorganisms in mineral recovery
- Microorganisms in the removal of heavy metals from aqueous effluent

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

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 Glaze 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.

ES 104 MICROBIOLOGY OF EXTREME ENVIRONMENT Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 105 MOLECULAR & CLINICAL ENDOCRINOLOGY Cr. 3(2+1)

1. **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, immunoradiometeric, immunochemiluminometeric and radioreceptor assays and their statistical procedures.

2. **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.
3. **Functional Pathology in Endocrine Glands:** Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, cortiophin regulation; Pituitary Disorders: Prolactinomas, acromegaly, Cushing's syndrome. Diabetes inspidus, hypo- and hyper-tonic syndromes; Thyroid Diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function; Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and Hormonal Therapy; Abnormalities of Testicular Functions and Hormonal Therapy.
4. **Fuel Homeostasis:** Glucose Homeostasis and Hypoglycemia; Diabetes Mellitus; Disorders of Lipoprotein Metabolism; Eating Disorders: Obesity, anroxia nervosa and bulimia nervosa.
5. **Development and Growth:** Disorders of growth and puberty.
6. **Endocrine Hypertension.**
7. **Polyendocrine Syndromes.**
8. **Hormones and Cancers:** Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy.
9. **Geriatric Endocrinology:** Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis.

Practicals

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

Textbook

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

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.

ES 106 MOLECULAR & CLINICAL PHYSIOLOGY Cr. 3(2+1)

Molecular mechanisms in neuronal integration and behavior and the basis of neuronal behavioral diseases. Hormonal and other chemical communications and transductions and the bases of the diseases. 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. Molecular mechanisms in

functional systems and the molecular basis of their diseases.

Practicals

Experimental and clinical case studies to understand the concepts in theory course.

Textbooks

1. Karp, G., 2005. Cell and Molecular Biology: Concepts and Experiments. 4th edition. John Willey and Sons, New York.
2. Textbook of Medical Physiology. Guyton, A. C. and Hall, J. E., 11th Edition 2005. W. B. Saunders Company, U. S. A.

Additional Readings

1. Williams Textbook of Endocrinology. Wilson, J. D., Foster, D. W., Larsen, P. R. and Kronenberg, H. 2003 10th Edition. W. B. Saunders, Philadelphia.
2. Endocrinology Vol. I, II & III. Edited by DeGroot, L. J. et al. 2002 Edition. W. B. Saunders, Philadelphia.

ES 107 MOLECULAR & CLINICAL ENDOCRIONOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 108 MOLECULAR BIOLOGY OF CANCER Cr. 3(2+1)

Course outline

DNA mutation and cancer, Role of telomerase in carcinogenesis, Role of male and female sex hormone in cancer induction, Molecular basis of conversion of proto-oncogenes into oncogenes, Cancer Epigenetics, DNA methylation and cancer, Histone acetylation/ deacetylation and cancer

Practicals

1. Identification of cancer cells from prepared slides of various human cancer tissues.
2. Determination of IC50 values of various drugs against cancer cells using MTT assay.
3. Quantification of Live and dead cells using Trypan blue assay and Live/Dead assay.
4. Assessment of Nuclear morphological changes using PI and H33258 staining from prepared slides
5. Identification of apoptosis and necrosis

Books Recommended:

1. Margaret A. Knowles, 2005. Introduction to the cellular and Molecular Biology of Cancer. Oxford University Press,
2. Leonard Maurice Franks, Natalie M. Teich, 1997. Introduction to the Cellular and Molecular Biology of Cancer. Oxford University Press
3. Cancer Epigenetics, Edited by Trygve Tollefsbol, 2009. CRC Press Taylor & Francis Group
4. Culture of Animal Cells: A manual of Basic Technique and Specialized Applications, Freshney, R. I. 5th edition, WILEY BLACKWELL
5. Tollefsbol T. (2019) Cancer Epigenetics. CRC Press, 1st Edition

ES 109 MOLECULAR BIOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 110 MOLECULAR GENETICS Cr. 3(2+1)

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**
- Genome organization of various organisms
- DNA and RNA viruses.
- Transposable Elements.

2. **Gene Regulation**
- Gene regulation in Prokaryotes
- Gene regulation in Eukaryotes

3. **Post Transcriptional Modifications**
- Capping and Poly A tail addition
- RNA splicing
- RNA editing.

4. **DNA Damage**
- Single strand break
- Double strand breal
- Oxidative damage
- Pyrimdine dimer formation

5. **DNA Repair Mechanisim**
- BER
- NER
- Photoreactivation

6. **Study of Molecular Techniques**
- Southern blotting
- Western blotting
- Northern blotting
- RFLP
- RAPDS
- 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.

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.

ES 111 MOLECULAR PHYSIOLOGY Cr. 3(2+1)

Overview of resting membrane, action potential and synaptic transmission; Structure and mechanisms in ion channels; Biosynthesis of neurotransmitters; Neurotransmitters actions at synaptic receptors. Neurosecretions and neurotransmitters in higher nervous system activity.
Molecular mechanisms in transduction of sensory stimuli into impulse; photochemistrry and transduction of photoreceptor; Color vision.
Overview of endocrine glands, their hormones and roles; Chemistry and biosynthesis of hormones of adenohypophysis, thyroid, parathyroid, endocrine pancreas, adrenal medulla and steriodogenic tissues; Metabolism of thyroid and steriodogenic tissues; Structure of hormone receptors; Mechanisms of action of a protein/peptide, a steroid and thyroid hormone; Hormonal regulation of metabolism; Molecular basis of muscular contraction; Molecular interaction at neuromuscular level; Molecular structure of cilia and flagella and mechanisms in movements.
Automicity and rythmicity of myogenic heart; Regulation of cardiac activity; Humoral regulation of circulation: Vasoconstriction and vasodilation. Exchange of respiratory gases; Chemical regulation of respiration. Nature and formation of various nitrogenous waste products; Glomerular filteration, reabsorption, and secretion mechanisms; Concentration of urine. Regulation of digestive secretions; Digestion and absorption of nutrients.
Molecular mechanisms in adaptation to temperature extremes.

Practicals
Study of post synaptic receptor mechanisms in neuromuscular preparation of frogs; Experiments to study the molecular responses to hormones. Study of hormones receptors in differing hormonal circulation levels; Ultra-structure study of muscle structure for muscle contraction. Effect of chemicals and drugs on cardiac activity of prepared frogs; Study of drugs on reflexes and local circulation models. Respiratory function and oxygen consumption in acidosis and alkalosis in mouse. Study of nature of nitrogenous wastes of animals inhabiting different environment. Urine analysis in different physiological states. Absorption of glucose in inverted intestinal sac, effect of drugs on intestinal movements. Muscular responses to Pyrexia.

Textbooks

1. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Edition. W.B. Saunders Company, Philadelphia.
2. Karp, G., 2005. Cell and Molecular Biology: Concepts and Experiments. 4th edition. John Willey and Sons, New York.
3. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 101th Edition. Prentice Hall, London.

Additional Readings

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 4th ed. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd edition. St. Lious, Mosby.
4. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.

ES 112 NATURAL PHOTOGRAPHY Cr.3(3+1)
Course outline to be provided by the concerned expertise

ES 113 NEUROBIOLOGY Cr.3(3+1)

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**
- The organization of the nervous system; neurons, types of neurons, nerves
2. **Electrical signals of nerve cells**
- Membrane permeability; Channels and transporters; Nerve Impulse
3. **Synaptic Transmission;**
- Neurotransmitters; their receptors and effects; Intracellular signal transduction;
4. **Sensory somatic system:**
- The somatic sensory system; Pain;
5. **Vision**
- 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**
- 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;**
- Taste system, Olfactory system
8. **Motor Neurons/system**
- Lower motor neuron circuits and motor control;
- Upper motor neuron control of the brainstem and spinal cord;
- Modulation of movement by the basal ganglia and the cerebellum;
- Eye movements and sensory motor integration; the visceral motor system;
9. **Brain development**
- brain development; construction of neural circuits;modification of brain circuits as result of experience;plasticity of mature synapses and circuits;
10. **Association Cortices**
- 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

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., Augstine, 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.

ES 114 ORNITHOLOGY Cr.3(2+1)

Objectives of the proposed course are aimed to:

1. Impart knowledge to identify birds and understand their behavior and relationships in their natural habitat.
2. Provide vision to understand the factors that cause bird populations to change, and to assess certain bird habitats in relation to climate changes.
3. Address both the theoretical and practical knowledge regarding widespread bird diversity in the diversified environments.

Course Learning Outcomes:

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

1. **ACQUIRE** the basic knowledge of the birds in the diversified habitats.
2. **UNDERSTAND** theirbehavior and possible their relationships to the natural habitats.
3. **SOLVE**the issues to detect minute morphological variations by using different high powe spotting scopes in the field study for various habitats.
4. **ANALYZE** the likely impacts of changing climatic conditions on variety of birds in differe

ecosystems to sift in roosting, nesting and behavioural mechanisms.

Course Outlines (contents):

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

ES 115 PHARMACOLOGICAL AND PATHOLOGICAL ENDOCRINOLOGY Cr.3(2+1)

Course outline to be provided by the concerned expertise

ES 116 PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS Cr. 3(2+1)

Course Contects:

1. **Cardiovascular System:** Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output; Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.
2. **Respiratory System:** Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbondioxide; Regulation of ventilation; Respiratory responses in extreme conditions.
3. **Renal System:** Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostais; Role of kidney in acid-base balance.
4. **Gastrointestinal System:** Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in

various segments.

5. **Osmoregulation:** Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aquous and terrestrial environments.
6. **Environmental Challenges:** Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetic; Energy, environment and evolution.

Practicals

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

Textbooks

7. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Edition. W.B. Saunders Company, Philadelphia.
8. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 101th Edition. Prentice Hall, London.

Additional Readings

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

ES 117 PHYSIOLOGY OF COORDINATION Cr. 3(2+1)

Course Contects:

1. **Physiological Mechanisms at Cell:**
   Cellular membrane and transmembrane transport; resting membrane potentials; Generation and conduction of action potentials; synaptic transmission; Membrane receptors, Second messenger and signal-transduction pathways.
2. **Nervous System:**
   Organization of nervous system; General sensory system; Visual, Auditory, Vestibular and Chemical sensory system; Motor system with brainstem, Cortical, Cerebellar and basal ganglia control of posture and movements; Autonomic system and its control; Higher functions of nervous system including state of consciousness, learning, memory.
3. **Muscle and Movements:**
   Molecular basis of contraction; Muscles activity on skeleton; Adaptation of muscles for various activities; Muscles in the walls of hollow organs.
4. **Endocrine System:**
   General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones

action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroid at different stage of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

Practicals

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

Textbooks

1. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Edition. W.B. Saunders Company, Philadelphia.
2. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 101th Edition. Prentice Hall, London.

Additional Readings

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

ES 118 PHYSIOLOGY OF ENDOCRIONOLGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 119 PHYSIOLOGY OF FUNCTIONAL SYSTEMS Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 120 PHYSIOLOGY OF NEURONAL INTEGRATION & BEHAVIOR Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 121 PHYSIOLOGY OF REPRODUCTION Cr. 3(2+1)

Course Contects:

1. **Introduction:** Overview of structure, at different levels, of reproductive systems and developments in gametes formation.
2. **Sex Determination and Differentiation:** Molecular aspects and chemical messengers in differentiation.
3. **Hypothalamic-Hypophysical-Gonadal axis in Reproduction:** Hormonal and neuronal

factors and their interactions in ovarian, testicular and other reproductive targets functions; The interactions in developments in estrous and menstrual cycles; The interactions in transitions from childhood to reproductive and post-reproductive states.

4. **Reproductive Behaviors:** Physiological basis of male and female sexual behavior and maternal behavior; Endocrine basis of communication in reproduction and aggression; Pheromones in mammalian reproduction; Rhythms in Reproduction.
5. **Pregnancy:** Hormonal mechanism in fertilization, zygote transport and implantation. Placental steroid and polypeptide hormones; Recognition and maintenance of pregnancy; Maternal metabolism in gestation, Hormonal mechanism in parturition.
6. **Lactation:** Hormonal mechanism in lactation; Lactogenesis, Galactopoeisis, Milk ejection.
7. **Reproductive Senescence:** Hormonal and metabolic aspects in menopause; Mechanisms in males.
8. **Fertility Control Mechanisms:** Hormonal contraceptives; Rhythmic methods, Immunologic techniques and other fertility control procedures in women; complications in their uses; Fertility control in men and search for male contraceptive.

Practicals

Study of male and female reproductive tract; physiological histology of segments of male and female reproductive tracts; Recognition of spermatogonial cells, ovarian follicles and corpus luteum in gonads; study of hormonal mechanisms in superovulation and implantation; Tests for pregnancy recognition; Experiments on role of gonads in maintenance of acessory sex gland in males and target structures in females; Study of fertility control procedures in populations. Study of the female cycle. Effects of hormones on cyclic activity. Influences of goadoectomy on the targets. Metabolism pattern in different reproductive ststes.

Textbooks

1. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 2003. William's Textbook of Endocrinology, 10th Edition. W.B. Saunders Company, Philadelphia.
2. Endocrinology Vol. III. Edited by DeGroot, L. J. 2002 Edition. W. B. Saunders, Philadelphia.

Additional Readings

1. Knobil, E. and Neill, J.D., *et al.*, 1995. The Physiology of Reproduction, Vol.1&2; 2nd Edition, Raven Press, New York.
2. Evert, B.J. and Johnson, M.H., 2000. Essential Reproduction, 5th Edition. Blackwell Science Inc., Oxford.

ES 122 POPULATION BIOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 123 PRINCIPLES & METHODS IN PHYSIOLOGY Cr. 3(2+1)

Status of physiology in life sciences. Significance of animal physiology. Central theme in anim physiology: Structure function relationship; adaptation, acclimatization and acclimati homeostasis; feedback control systems; and conformity and regulation.

Levels of organization in functions. Integration of functions from molecular level to the high level of organization. Bases of diversity of functions. Experimental methods for exploring physiology: Formulating and testing hypothesis. Molecular and Cellular techniques: Light and the electron microscopy; Cell culture and fractionation; Isolation, purification and fractionation of proteins and nucleic acids; X-ray diffraction analysis; Spectrophotometry; Ultracentrifugation; Hybridization; Recombinant DNA technology. Use of monoclonal antibodies. Biochemical analyses; Experiments with isolated organs and organ systems. Observing and measuring animal behaviour. Importance of physiological state in research. Animal experimentation in physiology. Literature and information of physiological sciences.

Practicals

Preparations of flow charts, schematic figures for concepts in physiology. Use of information

technology in update information in physiological sciences. Studies of model experiments for central themes in physiology. A few model experiments of molecular and cellular techniques.

Textbook

1. Karp, G., 2005. Cell and Molecular Biology: Concepts and Experiments. 4th edition. John Willey and Sons, New York.

Additional Readings

1. Eckert Animal Physiology, Mechanism and adaptations. Randall, D., Burggren, W. and French, K. 2002 5th Edition. W. H. Freeman and Company, New York.
2. Pinciples of Physiology. Berne, R. M. and Levy, M. N. Mosby Inc. 2000 Edition. St Louis.

ES 124 PRINCIPLES AND KINETICS OF TOXICOLOGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 125 PRINCIPLES FISH BIOLOGY Cr. 3(2+1)
Course outline to be provided by the concerned expertise

ES 126 PRINCIPLES OF PARASITOLOGY Cr. 3(2+1)

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**
- Classification of relationships between two individuals
- Symbiosis, commensalisms, parasitism, myiasis, zoonosis
- Infection and infestation.

2. **Evolutionary aspects related to parasites**
- Geographical distribution
- Epidemiology: Incidences of occurrence and prevalence.

3. **Classification of parasites**
- Ectoparasites, endoparasite, temporary parasites, permanent parasites, facultative parasites, accidental parasites, wandering parasites (brief account and examples)
- Classification of hosts: Definitive, intermediate and paratenic hosts.

4. **Host susceptibility and specificity**
- Various types of susceptibilities
- Host-parasite relationships
- Morphology and physiology of parasites
- Adaptations to parasitic mode of life
- Effects of parasitism on parasites.

5. **Effcets of parasites on hosts**
- Influence of parasites on host populations.
- Pathological responses
- Immunoparasitology: immunity and immune responses of host.

6. **Diagnosis, prevention, control treatment**

- Common drugs and anthelmintics
- Vector control methods.

7. **Protozoology**

- Protozoan parasites of man and other animals
- Classification, life cycle, habitat, morphology, epedimiology and immunopathology of infections e.g., *Entamoeba spp. Pathogenic amoeba, Giardia spp. Trichomonas, Trypanosoma, Leshmania, Plasmodium and Toxoplasma gondii.*

8. **Helminthology**

- Helminth parasites of man and other animals
- General account, classification, biology, life cycle, pathology and symptology and immunology. Platyhelmenthes: e.g. Trematodes (Fisccciola and Schistosoma) Cestodes: *Taenia. Nematodes: Trichuris, Strongyloides, Toxocara and Filaria worms.*

9. **Medical and Veterinary Entomology**

- Biology and classification of arthropods of veterinary and medical importance.
- Biology and life cycles e.g. lice, Ticks, mites, mosquitoes, fleas, flies, bugs etc.
- Arthropods as disease transmitters/vectors.

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 hulsmann, 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

ES 127 PRINCIPLES OF TOXICOLOGY-I Cr. 3(2+1)

History and General Introduction of Toxicology, Classification of Toxic agents; Characteristics of Exposure; Spectrum of undesirable effects; Interaction of Chemicals; Dose Response relationship; Variation in Toxic responses; Descriptive animal Toxicity Tests; Mechanism of Toxicity;. Delivery of Toxicant from exposure site to Target; Reaction and Effect of Toxicant with the Target molecule; Cellular Dysfunction and resultant toxicities; Repair or Disrepair.

Practicals

Preparation of various doses of a pyrethroid insecticide, cypermethrin for determination of LD50 value against mice and a stored grain beetle, *Tribolium castaneum.*

Determination of LD_{50} dose of organophosphate insecticide, malathion against insect and chick models.

Study of change in responses and behaviour of animals following toxicant administration at sublethal and acute levels.

Study of changes in food consumption of mice or chicks after administering sublethal doses of any toxicant.

Effect of sublethal dose of any toxicant on changes in body weight of the mice.

Study of tissue pathology following toxic exposure such as Liver, kidney through histological slides.

Textbook

1. Kalassan, C. D., Amdur, M. O. and Doull, J., 1996. Casarett and Doull's Toxicology, The Basic Science of Poisons, 5th Edition, McGraw-Hill Health Professions Division, New York.

Additional Readings

2. Williams, P. L., James, R. C. and Roberts, S. M., 2000. Principles of Toxicology, Environmental and Industrial Applications, 2nd Edition, John Wiley & Sons, Inc., New York.

3. Hayes, A. W., 2001. Principles and Methods in Toxicology, 4th Edition, Raven Press Ltd. New York.

ES 128 PRINCIPLES OF TOXICOLOGY-II Cr. 3(2+1)

Disposition of Toxicants: Absorption, Distribution and Excretion of Toxicants: Absorption of Toxicants by Gastrointestinal Tract, Lungs, Skin and by Special Routes; Distribution of Chemicals: Tissue storage of Toxicants; Blood-Brain Barrier; Placental passage of Toxicants; Excretion of Toxicants: Urinary and Fecal excretion; Exhalation and other minor routes; Biotransformation of Toxicants: Phase-I and Phase-II biotransformation Reactions.

Practicals

1. Determination of Lowest Observed Adverse Effect Level (LOAEL) of cypermethrin (a pyrethroid insecticide) against any insect model.
2. Determination of No Observed Adverse Effect Level (NOAEL) of cypermethrin (a pyrethroid insecticide) against any insect model. Determination of LD 50 value of pesticide malathion against mammalian model (mice).
4. Effect of toxicant on the relative organ weights of mice or chicks.
5. Effect of sublethal doses of any toxicant on the gross organ pathology in mice.
6. Effect of sublethal dose of any toxicant on total erythrocytic count in mice blood.
7. Effect of sublethal dose of any toxicant on total leukocytic count in mice blood.

Textbook

1. Kalassan, C. D., Amdur, M. O. and Doull, J., 1996. Casarett and Doull's Toxicology, The Basic Science of Poisons, 5th Edition, McGraw-Hill Health Professions Division, New York.

Additional Readings

1. Williams, P. L., James, R. C. and Roberts, S. M., 2000. Principles of Toxicology, Environmental and Industrial Applications, @nd Edition, John Wiley & Sons, Inc., New York.
2. Hayes, A. W., 2001. Principles and Methods in Toxicology, 4th Edition, Raven Press Ltd. New York.

ES 129 PROTEOMICS Cr. 3(2+1)

Molecular Biology of Proteins (types, structure, synthesis, translation), Posttranslational modifications (glycosylation, phosphorylation, methylation, etc.), Molecular mechanisms of cellular communication/signaling pathways, Bioinformatic tools (genomics, proteomics, metabonomics). Protein-Protein Interactions, receptor identification and characterization, Integral Membrane Proteins and Ion Channels, Peptide Models of Transmembrane, Domains, Membrane Fusion and Membrane Binding Proteins, Apolipoproteins. Advance techniques used in proteomics including, 2D Gel Electrophoresis, Mass Spectrometry, Maldi TOF, MS/MS, LC/MSMS, iTRAQ, Protein arrays etc.

Textbook

1. Principles of Proteomics by R. M. Twyman (2004).BIOS Scientific Publishers

Additional Readings

1. Proteomics in Practice: A Guide to Successful Experimental Design (2008) 2nd Edition by R. Westermeier, T. Naven, and Hans-Rudolf. J.Wiley &Sons.
2. Molecular Biology of the Cell, (2008) 5th Editon .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter 5th Edition Garland Sciences, Taylor and Francis.
3. Biochemistry (2007) 6th edition by J.M. Berg, J.L. Tymoczko & L. Stryer W.H. Freeman & Co.
4. Introduction to Proteomics: Tools for the New Biology(2001) by Daniel C. Liebler.

ES 130 PROTOPARASITOLOGY Cr. 3(2+1)

History, Systematic, Biology, Pathology, control of protozoa of medical/ veterinary/ economic

importance. Host parasite relationship, immunity & resistance.
Morphology life cycle, diagnosis & prevention (control) of following; Amoeba, Plasmodium, Leishmania/Trypanosoma, Giardia, Babesia, Theileira, Balantidium, Toxoplasma, Sarcocysts etc.

Practicals

1. Methods of collections, preservation , transpatation of parasitic material.
2. Qualitative & quantitative methods of faecal examinations.
3. Blood examination for protozoa.
4. Microscopic measurements of protozoas.

Textbooks

1. Ruth, Ph.D., Leventhal, Cheadle, R.F., 2003. Medical Parasitology 5th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
2. Roberts, L.S. and Janovy, J. Jr., 2001. Foundations of Parasitology 5th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.

Additional Readings

1. Berger, S.A., May 2005. Human Parasitic Diseases. Jones and Bartlett Publishers.
2. Bogitsh, B.J., Carter, C.E. and Oeltmann, T.N., 2004. Academic Press, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press, London.
4. Smyth, J.D., 1994. Introduction to Animal Parasitology. Cambridge University Press.
5. Urquhart, G.M., Armour, J., Duncan, J.L., Dunn, A.M. and Jennings, F.W., 2001. Veterinary Parasitology. Ed ELBS, Langman, U.K.
6. Schmidt, G.D. and Roberts, L.S., 2005. Foundations of Parasitology. 17th Edition. McGraw Hill, Canada.

ES 131 PROTOZOOLOGY I Cr. 3(2+1)

History of protozoology, Introduction to parasitology, basic terminology, types of parasitism, parasitic life cycle; basic principles and concepts in parasitic ecology and evolution. Anatomy of protozoa nutrition, locomotion, excretion, reproduction, encystment and excystment, Osmoregulation and energy metabolism in protozoa, Basic concepts of immunity, immune responses against parasites, evasion of immune response by parasites (mechanism), theoretical backgrounds of Immunodiagnostic techniques used for identification of parasites. (Aggutination, precepitation, ELISA, RIA).

Practicals

Preparation of solutions used for culturing of protozoa, Methods of collection, culturing, purification and preservation of protozoa. Quantificaiton of protozoa, comparison of leukocytes of infected and uninfected animals, Observation of intestine and other organs for Lesion scoring, Blood examination for protozoa. Microscopic measurement of protozoa.

Textbooks

1. Protozoology (latest edition). Grell, K.G. Springer-Verlag Berlin, Heidelberg, New York.
2. Foundations Of Parasitology, 2000. Robert, L.S. and Janovy, J.Jr. Wm. C. Brown Publishers London.
3. Practical Exercise In Parasitology, 2001. Hatton, D.W., Behinke, M. and Marshal, I. Cambridge University Press, BSP.

Additional Readings

1. General Parasitology (latest edition). Chang, T.C. Academic Press, New York, London.
2. Veterinary Parasitology, 2000. Urquhart, G.M., Duncan, J.L., Qunn, A.M. and Jenniry, F.W. Longman Scientific and Technology, U.K.
3. Parasitic Diagnosis, 1999. Hayate, S. and Akhtar, M. UGC Govt. of Pakistan.
4. Foundations of Parasitology, 2000. 5th ed. Robert, L.S. and Janovy, J.Jr. W.C.B. Company U.K.
5. Introduction to Animal Parasitology, 1994. Smyth, J.D. Cambridge Univ. Press.

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ES 132 PROTOZOOLOGY II Cr. 3(2+1)

Classification of protista, biology, pathology and control of parasitic protozoa with particular reference to parasites of medical and veterinary importance. Morphology, life cycle, diagnosis, epidemiology, immunity and resistance and control of species of following general protozoon parasites, *Trypanosoma rhodesiense, T. gambiense, T. bruci, T. cruzi,* (Trypanosomiasis). *Leishmania donovani, L. tropica, L. braziliensis, L. maxicana,* (Leishmaniasis). Flagellated protozoa; *Chilomastix, Giardia*. Trichomonas. Subphyllum Sarcodina, Amebas; (Amoebiasis). Phylum Apicomplexa. *Gregarines, Coccidia, Toxoplasma, Sarcocystis, Cryptosporidium*. Phylum Apicomplexa, *Plasmodium falciparum, P. ovale, P. malariae, P. vivax,* Malaria. Phylum, Ciliophora, ciliated protistan parasites; *Balantidium* and *Anaplasma*. Phylum Microspora *Babesia, Theileria.*

Practicals

Preparation of stains and solutions required for processing of slides of protozoon parasites, Isolation of protozoan from the intestine of cockroach, grasshopper, termites and frogs. Induction of parasitic infection in chicks (Coccidia). Scoring of health status of birds, re-isolation of pathogens, comparison of Hemoglobin level in chicks (Coccidia). Study of prepared slides of a number of protozoan parasites.

Textbooks

1. Protozoology (latest edition). Grell, K.G. Springer-Verlag Berlin, Heidelberg, New York.
2. Foundations of Parasitology, 2000. Robert, L.S. and Janovy, J.Jr. Wm. C. Brown Publishers, London.

Additional Readings

1. General Parasitology (latest edition). Chang, T.C. Academic Press, New York, London.

ES 133 QUANTITATIVE ZOOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 134 RADIATION BIOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 135 REPRODUCTIVE BIOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

ES 136 REPRODUCTIVE ENDOCRINOLOGY Cr. 3(2+1)

Fertility control and its complications. Sexual dysfunctions. Endocrine changes of pregnancy. Endocrinology of developing fetus. Sexual differentiation. Puberty and its disorders. Infertibility in both genders.

Practicals

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

Textbook

1. Moore and Persand, 2001. The developing human. 6th Ed. Harcourt Asia.

Additional Readings

2. De Groot, 2001. Endocrinology Vol. III W.B. Sundres.

ES 137 RESTORATION ECOLOGY Cr. 3(2+1)

Introduction to Restoration Ecology, Degradation of Ecosystems, Global Warming, Energy Consumption, Ecosystem Management Models, Value of Ecosystem Services, Outlook for Ecological Restoration, Different Restoration Approaches, Varying Scales of Restoration, Future of Restoration, Habitat Fragmentation, Theories of Succession, Successional Processes and Restoration, Primary Succession, Secondary Succession, Animals in Succession, Management of Succession, Monitoring Succession, Equilibrium Theory of Island Biogeography, Matrix Restoration, Corridors, Stepping Stones, Metapopulation Networks, Metapopulation Dynamics, Metapopulation Restoration Projects, Landscape Restoration,Passive Restoration, Forest Restoration, Regeneration Niche.

Practicals

Restoration of Primary Sites, Management of Restoration Projects, Setting Goals, Planning, Action Plan, Adaptive Management, Monitoring, Aftercare and Final Assessment, Legal Framework and International Agreements, Environmental Legislation, Recovery of Forested Ecosystems.

Text books

1. Greipsson, S. 2011. Restoration Ecology, Biology and Physics Department, Kennesaw State University, Kennesaw, Georgia
2. Parikh, J. and Dattye, H. 2003. Sustainable Management of Wetlands Biodiversity and beyond. Sage Publications New Delhi Thousand Oaks London. Pp.444.

Book Recommended

1. 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.

ES 138 RESTORATION ECOLOGY AND SUSTAINABLE DEVELOPMENT Cr. 3(2+1)

Objectives

1. to enable the students to identify the main candidates (wetlands, lakes, rivers,forests, etc) forconservation.
2. to train the students to develop approaches for conservation such as designingand management of protectedareas.
3. to make the students able to play the role of an active conservation biologist.

Course Contents

Conservation at the community level: Protected Areas: Existing protected areas, the effectivenes. of protected areas, Establishment priorities for protection, International agreements. Designing protected Areas: Reserve size, minimizing edge and fragmentation effects, Habitat corridors,Land scape ecology and Park design. Managingprotectedareas: Habitat management, Park management and people. Outside protected.

areas: Wildlife outside parks, Strategies for success, Ecosystem management. Restoration ecology: Restoration ecology in practice. Main candidates for ecological restoration: Wet lands, Lakes urban areas, Prairies, Tropical dry forests. Restoration ecology and the future of conservation Government action: local legislation, national legislation.

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

Practicals

1. To study the principles of reservedesign.

2. To study the classification of protected areas (IUCN1994).
3. Visits to the national parks of Pakistan and reportwriting.
4. The Ramsar convention on wetlands for Pakistan.
5. To review and study the measures of protecting precious biodiversity in Pakistan with particular reference to national and international conservationprogrammes.
6. To study and review the threats to biodiversity of Himalayanforests.
7. To study different types of Ex*situ* conservationstrategies.

Books Recommended

1. Primack, R. B. 2000. *A* Primer of Conservation Biology. 2nd ed. Sinauer Associates Inc. Publishers Sunderland,USA.
2. Cox, C. B. and Morre, P. D. 2000. Biogeography: An ecological and evolutionary approach.6th ed. Life Sciences King's College London, UK.
3. Mirza, Z. B. 1998. Illustrated Handbook of Biodiversity of Pakistan. Printopack. Rawalpindi,Pakistan.
4. Gaston, K. J. and Spicer, J. I. 1998. Biodiversity An Introduction.15t ed. Blackwell Science Ltd.UK.
5. McKinny, M.L.andSchoch, M. R. 1998. Environmentalscience:System and solution. 1st ed. Jones and Bartlett Publications,USA.
6. Hussain, S.S. 1992. Pakistan Manual of Plant Ecology.1 st ed. National Book Foundation,Pakistan.
7. Bradbury, I. K. 1998. The Biosphere. 1st ed. John Wiley and Sons Inc.UK

ES 139 SEMINAR Cr. (2)

ES 140 SIGNAL TRANSDUCTION AND BIOMEMBRANES Cr. 3(2+1)

Introduction, surfaces and interfaces, chemical compositions. Structure of membranes. Isolation of membrane bound proteins, morphology and function of different biological membranes (plasma membrane, mitochondrion, chloroplast, mesosome, endoplasmic reticulum, Golgi apparatus, lysosomes, tonoplast, nucleus). Membrane transport: active and passive transport. Membrane receptor-ligand interactions and pathways.

Textbook

1. Molecular Cell Biology (2007) 6th Edition. H. Lodish, C.A. Kaiser, M.Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H. Freeman.

Additional Readings

1. Biochemistry (2007) 6th edition by J.M. Berg, J.L. Tymoczko & L. Stryer W.H. Freeman & Co.
2. Molecular Biology of the Cell, (2008) 5th Editon .B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts & P. Walter 5th Edition Garland Sciences, Taylor and Francis.
3. Molecular Cell Biology (2007) 6th Edition. H. Lodish, C.A. Kaiser, M.Krieger. M.P. Scott, A. Bretscher, H. Ploegh, & P. Matsudaira, W.H. Freeman.
4. G. Karp, 2008. Cell and Molecular Biology: Concepts and Experiments, by John Wiley & Sons.

ES 141 TAXIDARMY Cr. 3(2+1)

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
- Definition
- scope and importance; daily life, hobby, zoos, wildlife, sport hunting and science (natural history museums)

2. Materials and equipment
- Chemicals and solutions
- Skinning and mounting tools

3. Techniques
- Skinning
- Dehydration
- Tanning
- preparing and mounting of reptiles, birds and mammals
- mounting of heads of mammals (deer, markhoretc)
- mounting of skeletons
- resin embedding
- preparation of head casts.

4. Transportation and status
- Laws of transportation of skins across the continents
- Status of taxidermy in the modern time today
- Alternatives of taxidermy.

5. Wet preservation
- Materials and methods
- Pinning
- Curation of stuffing
- Mountings
- 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 Bird
4. Wagstaffe, R. and Fidler, J.H. (1968). The preservation of natural history specimens Volu Vertebrates. Witherby. Video presentations from youtube can be helpful.

ES 142 TECHNIQUES IN FISHERIES RESEARCH Cr. 3(2+1)

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:

1. **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.
2. **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.
3. **Microtomy:**
   Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections.
4. **Extraction techniques:**
   Centrifugation, Ultracentrifugation, Distillation, Use of Soxhalet 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.
5. **Separation Techniques:**
   Chromatography: Principle, applications, types, thin layer, column, gas, ion exchange chromatography. Electrophoresis.
6. **Spectrophotometery:**
   Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.
7. **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 Electrophorosis
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 micropittes
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.

ES 143 TERATOLOGY Cr. 3(2+1)

Course Objectives

The course aims to:

1. **Provide information on** understanding the basis of possible drugs, infections and environmental effects on the developing human embryo and fetus
2. Impart detailed knowledge about cellular basis of teratogenesis
3. 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 regardi teratology risks for drug, chemical, and infection exposures during pregnancy.

Course Outline:

1. **Introduction to teratology**
- Teratology: an overview
- Impact of Planned and Unplanned Pregnancy on teratological development
- Mechanism of teratogenesis

2. **Effect of Ionizing radiations**
- Atomic bomb survivors in Japan
- Impact of radiation before or immediately after implantation of the embryo into the uterine wall
- Higher doses of radiation during all stages of intrauterine development

3. **Hypoxia, hyperthermia and industrial exposure**
- Activation of stress protein
- *Hypoxic exposure* impact on during chorio-vitalline membrane development

4. **Teratogenic effects of substances of abuse**

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- Ethanol
- Heroin
- Cocaine and heavy smoking

5. **Effects of maternal infections in pregnancy**

- Zika virus
- Rubella
- 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**

- Antiepileptic drugs
- Anticancer drugs
- Antithyroid medicines
- Psychoactive medication

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 EditionISBN-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

ES 144 VECTOR BIOLOGY Cr. 3(2+1)

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. Discoverthe 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**

- Key aspects of vector taxonomy
- Evolution
- Biology and Behavior.

2. **An introduction to the life-cycles of vectors**

- Ecology
- Role in transmission of various diseases

3. **Major groups of arthropod-borne pathogens and vectors**

- Basic components of arbopathogen disease cycles
- Principles of pathogen transmission dynamics

4. **Emergent pathogens**
- Vector genetics
- Vaccines for vector-borne disease
- Traditional and modern disease control strategies
- Venomous Arthropods.

5. **Biology and Ecology of some vectors of medical importance (order Diptera)**
- Mosquitoes (*Anopheles culicine*), Black flies sand flies, biting midges, horse flies, deer flies and clegs, tsetse flies, house flies, myiasia producing flies (blow flies, blue bottles, green bottles, flesh flies, warable flies and bot flies).
- Morphology, anatomy, distribution, breeding habits, life-cycle and seasonal prevalence of the species
- Brief account of diseases spread by these vectors
- Methods of control
- Modern trends in their biological and chemical control.

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.

ES 145 VERTEBRATE PALAEONTOLOGY Cr. 3(2+1)

A detailed study of the structure, classification, affinities and distribution of the various important fossil groups of fishes, amphibians, reptiles, aves and mammals. A brief account of the Siwalik Hills and its fauna.

Practicals

Collection of fossil vertebrates in the field; their preparation; identification and study. A general survey of the fossil vertebrates in various museums of Pakistan.

Books Recommended

1. D.R. Prothero, 2004. Bringing fossils to life: An introduction to Palaeontology (2nd) McGraw Hill, New York.
2. K.N. Prasad, 2001. An introduction to the mammalian fauna of the Siwaliks system. Prasad publication, New Delhi, India.
3. J.J. Thomson, 1997. Functional Morphology in vertebrate Palaeontology, Cambridge University Press, Cambridge.
4. Romer, A.S., 1964. Vertebrate Palaeontology. The University of Chicago Press, Chicago and London.
5. Young. J.Z., 1981. The life of vertebrates. (7th Ed.) Oxford University Press, New York, U.S.A.
6. Colbert, E.H., 1980. Evolution of vertebrates, John Wilay and Sons. Inc. New York.

ES 146 VETERINARY AND WILDLIFE PARASITOLOGY Cr. 3(2+1)

Course outline to be provided by the concerned expertise

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ES 147 VIROLOGY Cr. 3(2+1)

Fundamental of virology, History of Virology, structure of viruses, characteristic of virus host interaction, virat replication and expression (bacteriophages, RNA viruses DNA viruses), Transmission of viruses, classification of viruses , mechanism of pathogenicity viruses of medical importance, HIV, retrovirus, Hepatitis viruses, prisons, virus cultivation and propagation, viral ontogenesis.

Practicals

1 Isolation of bacteriophages.
2 Enumeration of bacteriophages by serial dilution.
3 Extraction of viral nucleic acids.
4 Assays for detection of vial nucleic acids.
5 Assays for detection of antiviral antibodies.
6 Staining of viral inclusion bodies.

Books Recommended

1. Leslie Collier and John Oxford, Human Virology, Ed 4th , Oxford University Press Inc., New York. ISBN 13: 978-0-19-856660-1
2. Murray et al., Microbiology, 6th Ed.,
3. Bruce A Voyles (2000) The biology of viruses. Ed. 2nd McGrew Hill companies Inc. New York. NY10020
4. Flint S.J., Enquist L.W., Krug RM, Racaniello, V.R. and Skalka, Ainciples of Virology. Molecular biology pathogenesis and control. ASM press Washington D.C.

ES 148 WETLANDS MANAGEMENT Cr. 3(2+1)

Aquatic Ecosystems: Wetlands Hydrology, biogeochemistry, classification, Human Impacts and management of wetlands, climate change and wetlands, values and valuation of wetlands. Lakes, and Rivers, Degradation of Aquatic Ecosystems, Restoration of Wetlands, Passive Restoration, Active Restoration. The Ramsar Strategic Plans.

Practicals

Preparation of a conservation project for wetlands:

1. Wetlands without outlets.
2. Wetlands with outlets.
3. River and marsh lands.
4. Coastal wetlands.

Books Recommended

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.

ES 149 WILD LIFE PARASITOLOGY Cr. 3(2+1)

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. Examineabout host parasite relationship and control measure

Course Outline:

- An overview of Wildlife in Pakistan
- Parasites of wild animals and birds
- Role of wild animals and birds in dissemination of parasitic disease of domestic animals and man
- Pathogenesis
- Diagnosis and control of ecto and endo-parasites of wild animals and birds.

Text and Reference Books:

1. Fowler, M.E., 1990. Zoo and Wild Animal Medicine Current Theraphy Saunders, W.B. Company, Philadelphia, USA.
2. Levine, N.D., 1990. Veterinary Protozoology. The lowa State University press. Ames, Lowa, 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 lowa State University Press, Amess, USA.

ES 150 **WILD LIFE PARASITOLOGY** **Cr. 3(2+1)**

Course outline to be provided by the concerned expertise