DEPARTMENT OF ZOOLOGY

CURRICULUM BS (4YEARS) PROGRAM

SESSION: 2016-2020, 2017-2021, 2018-2022

(EX POST FECTO APPROVAL)

Submitted by
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SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

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INTRODUCTION

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

Eligibility Criteria:

BS (4years): F.Sc. Pre medical/ A-level.

M.Sc. (2years): B.sc

Vision Statement of Department

The department aims to be among the leading departments of zoology country wide and to be a cradle of quality, up-to-date source of education and research which has relevance to local, regional and national needs. The department looks forward to launch post graduate, M.Phil. /Ph.D. programs in future as well.

Mission Statement of Department

The mission of the department of zoology is to utilize our knowledge and expertise in order to train students in zoological science and to equip them with professional skills and ethical practices relevant to zoology to apply them meaningfully in those areas/fields requiring zoological expertise. We aim to awaken an awareness of the need to explore, understand and conserve animal diversity. To create an attractive and research based innovative department where students want to come for study and contributes their role in the welfare of humanity by finding ways to increase the food production, to preserve rare animal species by improving their habitat and to find different zoonotic and other disorders and their solution.

Mission Statement of Program

The mission of the program is to educate and prepare graduate students to understand the scope and limitations of the subject along with practical application requiring zoological expertise for the development of human resource in the various disciplines of zoology.

State Program Objectives

The program objectives are;

- ✓ To impart knowledge about various disciplines of Zoology.
- ✓ To enhance students presentation skills.
- ✓ To impart knowledge in IT sector.
- ✓ To equip the students with professional skills.
- ✓ To establish culture of scientific research.
- ✓ To educate students about animal diseases, their causes, vectors, life cycles and treatment
- ✓ To improve the quality and quantity of animal based food through research
- ✓ To train students for better planning and management of animal resources and environment.

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CURRICULUM OF ZOOLOGY

SCHEME OF STUDIES BS (4YEARS) ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	Practical	CREDIT HOURS
1.	1st	English-I	ENG-301	3	0	3
2.		Pakistan Studies	PST-323	2	0	2
3.		Mathematics-I	MTH-307	3	0	3
4.		Functional Biology-I	ZOL -314	3	0	3
5.		Organic Chemistry	CHM-401	2	1	3
6.		Principles of Animal Life-I	ZOL-315	3	1	4
					Total Credit Hours	**18**
S.NO	**SEMESTER**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
7.	2nd	English-II	ENG -302	3	0	3
8.		Islamic Studies	ISL-320	2	0	2
9.		Biostatistics	STAT-301	2	1	3
10.		Functional Biology-II	ZOL -324	3	0	3
11.		Inorganic Chemistry	CHM-301	2	1	3
12.		Principles of Animal Life-II	ZOL-325	3	1	4
					Total Credit Hours	**18**
S.NO	**SEMESTER**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
13.	3rd	English-III	ENG -410	3	0	3
14.		Introduction to Computer	CSC-301	2	1	3
15.		Plant Systematic, Anatomy and Development	BOT-403	2	1	3
16.		Environmental Chemistry	CHM-402	3	0	3
17.		Animal Diversity-I	ZOL -435	3	1	4
					Total Credit Hours	**16**
S.NO	**SEMESTER**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
18.	4th	Introduction to Statistics	STAT -401	3	0	3
19.		Biodiversity and Conservation	ZOL -442	2	1	3
20.		Animal Diversity-II	ZOL -443	3	1	4
21.		Animal Form and Function-I	ZOL -444	3	1	4
22.		Animal Form and Function-II	ZOL -445	3	1	4
					Total Credit Hours	**18**

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SCHEME OF STUDIES BS (4YEARS) ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

S.NO	SEMESTER	COURSE TITLE	COURSE CODE	Theory	Practical	CREDIT HOURS
25.	5th	Introduction to Psychology	PSY-301	2	0	2
26.		Developmental Biology	ZOL -552	3	1	4
27.		Cell and Molecular Biology	ZOL -553	3	1	4
28.		Animal Behavior	ZOL -554	2	0	2
29.		Physiology	ZOL -555	3	1	4
				Total Credit Hours		**16**
S.NO	**SEMESTER**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
30.	6th	Biological Techniques	ZOL -561	1	2	3
31.		Evolution and Principles of Systematics	ZOL -562	4	0	4
32.		Biochemistry	BCHM-	3	0	3
33.		Ecology	ZOL -563	3	0	3
34.		Wildlife	ZOL -564	0	3	3
				Total Credit Hours		**16**
S.NO	**SEMESTER**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
36.	7th	Genetics	ZOL – 624	3	0	3
37.		Bioinformatics	BI – 409	3	0	3
38.		Zoogeography and Paleontology	ZOL – 625	3	0	3
39.		Principles of Parasitology	ZOL – 626	1	2	3
40.		Biotechnology	ZOL – 627	3	0	3
				Total Credit Hours		**15**
S.NO	**SEMESTER**	**COURSE TITLE**	**COURSE CODE**	**Theory**	**Practical**	**CREDIT HOURS**
41.	8th	Physiology of Coordination	ZOL – 631	2	1	3
42.		Cancer Biology	ZOL – 632	3	0	3
43.		Clinical Biochemistry	ZOL – 633	2	1	3
44.		Environmental Pollution	ZOL – 634	3	0	3
45.		Research Project OR	ZOL – 699	0	6	6
46.		Two Optional Courses from the list given below with its Course Code	ZOL- ZOL-	3 3	0	3 3
			Total Credit Hours			**18**

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ZOOLOGY CURRICULUM

SCHEME OF STUDIES OF BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

LIST OF OPTIONAL COURSES

S.NO	COURSE TITLE	COURSE CODE	CREDIT HOURS
1.	Agriculture Biotechnology	ZOL-636	3
2.	Analysis of Development	ZOL-637	3
3.	Animal Adaptations	ZOL-638	3
4.	Animal Behavior	ZOL-639	3
5.	Animal Communication	ZOL-640	3
6.	Animal Pests and Pathogens	ZOL-641	3
7.	Applied Microbiology	ZOL-642	3
8.	**Aquaculture and Fisheries**	ZOL-643	3
9.	Arachnology	ZOL-644	3
10.	Behavioral Ecology	ZOL-645	3
11.	Biochemistry of Drugs Action	ZOL-646	3
12.	Biology and Control of Vertebrate Pests	ZOL-647	3
13.	Biomedical Technology	ZOL-648	3
14.	Biotechnology in Aquaculture	ZOL-649	3
15.	Ecological Genetics	ZOL-650	3
16.	Elements of Stratigraphy and Structural Geology	ZOL-651	3
17.	**Endocrinology**	ZOL-652	3
18.	Environmental Physiology	ZOL-653	3
19.	Fish Bioenergetics	ZOL-654	3
20.	Fish Culture	ZOL-655	3
21.	Fish Ecology	ZOL-656	3
22.	Fish Endocrinology	ZOL-657	3
23.	Fish health Management	ZOL-658	3
24.	Fish Feeding Management	ZOL-659	3
25.	Hematology	ZOL-660	3
26.	Herpetology	ZOL-661	3
27.	Histology	ZOL-662	3
28.	Human Genetics	ZOL-663	3
29.	**Ichthyology**	ZOL-664	3
30.	Immunology	ZOL-666	3
31.	Insect Bioacoustics	ZOL-665	3

32.	Insect Biochemistry and Physiology	ZOL-666	3
33.	Insect Pathology	ZOL-667	3
34.	Insects of Veterinary and Medical Importance	ZOL-668	3
35.	Invertebrata	ZOL-669	3
36.	Invertebrate Palaeontology	ZOL-670	3
37.	Limnology	ZOL-671	3
38.	Mammalogy	ZOL-672	3
39.	Microbiology	ZOL-673	3
40.	Medical Biotechnology	ZOL-674	3
41.	Medical Microbiology	ZOL-675	3
42.	Molecular Biology	ZOL-676	3
43.	Microbiology of Extreme Environment	ZOL-677	3
44.	Neurobiology	ZOL-678	3
45.	Ornithology	ZOL-679	3
46.	Pharmacological and Pathological Endocrinology	ZOL-680	3
47.	Physiology of Functional Systems	ZOL-681	3
48.	Population Biology	ZOL-682	3
49.	Principles of Genetics	ZOL-683	3
50.	Quantitative Zoology	ZOL-684	3
51.	Radiation Biology	ZOL-685	3
52.	**Reproductive Biology**	ZOL-686	3
53.	Teratology	ZOL-687	3
54.	Techniques in Fisheries Research	ZOL-688	3
55.	Vector Biology	ZOL-689	3
56.	Vertebrate Palaeontology	ZOL-690	3
57.	Veterinary and Wildlife Parasitology	ZOL-691	3
58.	**Wildlife Management and Conservation**	ZOL-692	3
59.	Zoological Microtechniques	ZOL-693	3

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DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE BS ZOOLOGY SESSION: (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-I

COURSE NAME: English – I	**COURSE CODE:** ENG-301
COURSE STRUCTURE: Lectures: 3, Labs: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives
Enhance language skills and develop critical thinking.

Course Outline
Basics of Grammar, Parts of speech and use of articles, Sentence structure, active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling

Comprehension: Answers to questions on a given text

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

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

Translation skills: Urdu to English

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

Presentation skills: Introduction

Recommended Books

Functional English

a) Grammar
1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

COURSE NAME: Pakistan Studies	**COURSE CODE:** PST-323
COURSE STRUCTURE: Lectures: 2, Labs: 0	**CREDIT HOURS:** 2
PREREQUISITES: None	

Course Objectives

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

Course Outline

1. **Historical Perspective**

a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.

b. Factors leading to Muslim separatism

c. People and Land

i. Indus Civilization

ii. Muslim advent

iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**

Political and Constitutional phases:

a. 1947-58

b. 1958-71

c. 1971-77

d. 1977-88

e. 1988-99

f. 1999 onward

3. **Contemporary Pakistan**

a. Economic institutions and issues

b. Society and social structure

c. Ethnicity

d. Foreign policy of Pakistan and challenges

e. Futuristic outlook of Pakistan

Recommended Books

1. Burki, Shahid Javed. *State & Society in Pakistan*, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press,

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

COURSE NAME: Mathematics-I	**COURSE CODE:** MTH-307
COURSE STRUCTURE: Lectures: 3, Lab: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

This is a deficiency course for students who have not studied mathematics at the intermediate level. The basic concepts of trigonometry, linear algebra and vectors are introduced in this c ourse.

Course Outline

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

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

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

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

Binomial Theorem: Introduction to mathematical induction, binomial theorem with rational and irrational indices.

Trigonometry: Fundamentals of trigonometry, trigonometric identities.

Recommended Books

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, Algebra 2 and Trigonometry, 1978, Houghton & Mifflin,Boston (suggested text)
2. Kaufmann JE, College Algebra and Trigonometry, 1987, PWS-Kent Company, Boston
3. Swokowski EW, Fundamentals of Algebra and Trigonometry (6th edition), 1986, PWS-Kent Company, Boston

COURSE NAME: Functional Biology – I	**COURSE CODE:** ZOL – 314
COURSE STRUCTURE: Lectures: 3, Labs: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

To provide students with a biological foundation on which they can build a graduate degree in natural and physical science.

Course Outline

Biological Methods

Principles of Cellular Life

- Chemical Basis
- Structure and Function
- Principles of Metabolism
- Energy Acquisition

Principles of Inheritance

- Mitosis and Meiosis
- Chromosomes
- Observable Inheritance Patterns
- DNA Structure and Function
- RNA and Proteins
- Genes
- Genetic Engineering and Biotechnology

Biodiversity

- Fundamental Concept of Biodiversity
- One or two examples of each of the following from commonly found organism
- Prions
- Viruses
- Bacteria
- Protistans
- Algae
- Fungi
- Plants
- Crops
- Animals
- Invertebrates

- Vertebrates

Recommended Books

1. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

COURSE NAME: Organic Chemistry	**COURSE CODE:** CHM-401
COURSE STRUCTURE: Lectures: 2, Labs: 1	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

Familiarize students with basic principles, concepts and theories in organic chemistry.

(Theory and Practical)

Introduction to Organic Chemistry

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

Chemical Bonding and Properties of Organic Molecules

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

Classes and Nomenclature of Organic Compounds

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

Functional Group Chemistry

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

Recommended Books

(Latest available editions of the following books)

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

Concepts and Applications", Prentice-Hall, New Jersey.

Supplementary Literature

(Latest available editions of the following books)

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

COURSE NAME: Principles of Animal Life - I	**COURSE CODE:** ZOL– 315
COURSE STRUCTURE: Lectures: 3, Labs:1	**CREDIT HOURS:** 4
PREREQUISITES: None	

Course Objectives

The course aims to impart knowledge and understanding of:

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

Course Contents

1. **Place of Zoology in Science**

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

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

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

3. **Cells, Tissues, Organs, and Organ System of Animals**

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

4. **Energy and Enzymes: Life's Driving and Controlling Forces**

- Energy and the laws of energy transformation; activation energy; enzymes: structure, function and factors affecting their activity; cofactors and coenzymes; ATP: how cells convert energy? An overview.

5. **How Animals Harvest Energy Stored in Nutrients**

- Glycolysis: the first phase of nutrient metabolism; fermentation: "life without oxygen"; aerobic respiration: the major source of ATP; metabolism of fats and proteins; control of metabolism; the metabolic pool.

6. **Ecology I: Individuals and Populations**

- Animals and their abiotic environment; populations; interspecific interactions.

7. **Ecology II: Communities and Ecosystems**

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

Laboratory Work Outline

Practicals

1. Tests for different carbohydrates, proteins and lipids.

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

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

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

3. Plasmolysis and deplasmolysis in blood.
4. Protein digestion by pepsin.

5. Ecological notes on animals of a few model habitats.
6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 12th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 6th Edition (International), 2005. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 5th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES, 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.
7. Hickman, C.P. and Kats, H.L., LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.
8. Molles, M.C. ECOLOGY: CONCEPTS AND APPLICATIONS. 6th Edition. 2005. McGraw Hill, New York, USA.
9. Odum, E. P. FUNDAMENTALS OF ECOLOGY. 3rd Edition. 1994. W.B. Saunders.Philadelphia.
10. Slingby, D. and Cook, C., PRACTICAL ECOLOGY. 1986. McMillan Education Ltd. UK.

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DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-II

COURSE NAME: English – II	**COURSE CODE:** ENG-302
COURSE STRUCTURE: Lectures: 3, Labs: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

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

Recommended Books

Communication Skills

a. Grammar
   1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b. Writing
   1. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
   2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c. Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John

COURSE NAME: Islamic Studies	**COURSE CODE:** ISL– 320
COURSE STRUCTURE: Lectures: 2, Labs: 0	**CREDIT HOURS:** 2
PREREQUISITES: None	

Course Objectives

This course is aimed at:

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

Course Contents

Introduction to Quranic Studies

1. Basic Concepts of Quran
2. History of Quran
3. Uloom-ul -Quran

Study of Selected Text of Holy Quran

1. Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
2. Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3. Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4. Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5. Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

Study of Selected Text of Holy Quran

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

Seerat of Holy Prophet (S.A.W) I

1. Life of Muhammad Bin Abdullah (Before Prophet Hood)
2. Life of Holy Prophet (S.A.W) in Makkah
3. Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

1. Life of Holy Prophet (S.A.W) in Madina
2. Important Events of Life Holy Prophet in Madina
3. Important Lessons Derived from the life of Holy Prophet in Madina

Introduction To Sunnah

1. Basic Concepts of Hadith

2. History of Hadith
3. Kinds of Hadith
4. Uloom –ul-Hadith
5. Sunnah & Hadith
6. Legal Position of Sunnah

Selected Study from Text of Hadith

Introduction To Islamic Law & Jurisprudence

1. Basic Concepts of Islamic Law & Jurisprudence
2. History & Importance of Islamic Law & Jurisprudence
3. Sources of Islamic Law & Jurisprudence
4. Nature of Differences in Islamic Law
5. Islam and Sectarianism

Islamic Culture & Civilization

1. Basic Concepts of Islamic Culture & Civilization
2. Historical Development of Islamic Culture & Civilization
3. Characteristics of Islamic Culture & Civilization
4. Islamic Culture & Civilization and Contemporary Issues

Islam & Science

1. Basic Concepts of Islam & Science
2. Contributions of Muslims in the Development of Science
3. Quranic & Science

Islamic Economic System

1. Basic Concepts of Islamic Economic System
2. Means of Distribution of wealth in Islamic Economics
3. Islamic Concept of Riba
4. Islamic Ways of Trade & Commerce

Political System of Islam

1. Basic Concepts of Islamic Political System
2. Islamic Concept of Sovereignty
3. Basic Institutions of Govt. in Islam

Islamic History

1. Period of Khlaft-E-Rashida
2. Period of Ummayyads
3. Period of Abbasids

Social System of Islam

1. Basic Concepts Of Social System Of Islam
2. Elements Of Family
3. Ethical Values Of Islam

Recommended Books

1. Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad

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

COURSE NAME: Biostatistics	**COURSE CODE:** STAT– 301
COURSE STRUCTURE: Lectures: 2, Lab: 1	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

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

(Theory and Practical)

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

Recommended Books

1. Geoffery, R. Norman, David L. Streiner BIOSTATISTICS: THE BARE ESSENTIALS. 2000. B.C. Decke Inc.
2. Gerry, P. Quinn, Michael J. Keough, EXPERIMENTAL DESIGN AND DATA ANALYSIS FOR BIOLOGISTS. 2002. Cambridge University Press.
3. Campbell, R. C. STATISTICS FOR BIOLOGISTS. 1989. Cambridge University Press.

COURSE NAME: Functional Biology – II	**COURSE CODE:** ZOL – 324
COURSE STRUCTURE: Lectures: 3, Labs: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Outline

Myths and Realities of Evolution

- Microevolution
- Speciation
- Macroevolution

Level of Organization

- **Plants**
  Tissues
  Nutrition and Transport
  Reproduction
  Growth and Development
- **Animals**
  Tissue, Organ System and Homeostasis
  Information Flow and Neuron
  Nervous System
  Circulation and Immunity
  Nutrition and Respiration
  Reproduction and Development

- **Ecology and Behavior**
  Ecosystems
  Biosphere
  Social Interactions
  Community Interactions
  Human Impact on Biosphere
  Environment Conservation

Recommended Books

1. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

COURSE NAME: Inorganic Chemistry	**COURSE CODE:** CHM- 301
COURSE STRUCTURE: Lectures: 2, Labs: 1	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Outline

The program is aimed that the student should learn:

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

1. **The Periodic Law and Periodicity**
   Development of Periodic Table; Classification of elements based on s, p, d and f orbitals, group trends and periodic properties in s, p, d and f block elements, i.e., atomic radii, ionic radii, ionization potential, electron affinities, electronagetivities and redox potential.
2. **Principles of Chemical Bonding**
   Types of chemical bonding; ionic bonding; the localized bond approach: VB

theory, hybridization and resonance; the delocalized approach to bonding: molecular orbital theory as applied to diatomic and polyatomic molecules, three center bonds, bonding theory of metals and intermetallic compounds; conductors, insulators and semiconductors; bonding in electron deficient compounds; hydrogen bonding.

3. **Acids and Bases**
   Concepts of acids and bases including SHAB concept, relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions. Theory of Indicators, solubility, solubility product, common ion effect and their industrial applications.
4. **Chemistry of p-block Elements**
   Chemistry and structure of *p*-block elements; main emphasis on the chemistry and structure of noble gases and their compounds, chemistry and structure of interhalogens, pseudohalogens and polyhalides. Prediction of shapes of molecules using VSEPR model and hybridization.

Practical Work

1. Laboratory Ethics and safety measures

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

2. Qualitative analysis

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

3. Quantitative analysis

Laboratory work illustrating topics covered in the lecture of BT – 325

Recommended Books

1. Huheey, J. E., Keiter, E. A. and Keiter, R. L., "Inorganic Chemistry: Principles of Structure and Reactivity", 4th Ed., Harper and Row, New York, 2001
2. Cotton, F. A., Wilkinson, G. and Gaus, P. L., "Basic Inorganic Chemistry", 3rd Ed., Wiley, New York, 1995.
3. Clyde Day, M. & Selbin, J., "Theoretical Inorganic Chemistry", 2nd Ed., Van Nustrand Reinhold, 1969.
4. Lee, J.D., "Concise Inorganic Chemistry", Chapman and Hall, 5th Edition,1996.
5. Shriver, D. F., Atkins, P. W. and Langford, C. H., "Inorganic Chemistry", Oxford University Press, 2nd Edition, 1994.
6. Bassette, J., Denney, G. H. and Mendham, J., "Vogel's Textbook of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis" English Language Book Society, 4th Edition, 1981.
7. Vogel, A. I., "A Textbook of Micro and Semi-micro Qualitative Inorganic Analysis" Longman Green & Co. 1995.

COURSE NAME: Principles of Animal Life -II	**COURSE CODE:** ZOL– 325
COURSE STRUCTURE: Lectures: 3, Labs:1	**CREDIT HOURS:** 4
PREREQUISITES: None	

Course Objective

The course imparts knowledge and understanding of:

a. Cell division and its significance in cell cycle. Concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics

of genetics.

b. Animal behaviour and communication.
c. Theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

Course Outline

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

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

3. Chromosomes and Gene Linkage
Eukaryotic chromosomes; linkage relationships; changes in chromosome number and structure.

4. Molecular Genetics: Ultimate Cellular Control
DNA: the genetic material; DNA replication in eukaryotes; genes in action; control of gene expression in eukaryotes; mutations; applications of genetic technologies; recombinant DNA.

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

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

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

Lab Outline

1. Study of mitosis in onion root tip.

2. Study of meiosis in grasshopper testis (students should prepare the slide).

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

3. Problem based study of Mendelian ratio in animals.
4. Multiple alleles study in blood groups.
5. Survey study of a genetic factor in population and its frequency.
6. Study of karyotypes of *Drosophila*, mosquito.
7. Study of cytochemical detection of DNA in protozoa and avian blood cell.
8. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

Recommended Books
For Courses

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2000. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. Menlo Park, California: 2002. Benjamin/Cummings Publishing Company, Inc.

For Lab

Recommended Books

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

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DETAILED COURSE OUTLINE OF BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-III

COURSE NAME: English-III	**COURSE CODE:** ENG-410
COURSE STRUCTURE: Lectures: 3, Labs: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

To enhance language skills and develop critical thinking

Course Contents

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

Note: Extensive reading is required for vocabulary building 15

Recommended Books

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

COURSE NAME: Introduction to Computer	**COURSE CODE:** CSC-301
COURSE STRUCTURE: Lectures: 2, Labs: 1	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

This course focuses on introducing computing environments, general application software, basic computing hardware, operating systems, desktop publishing, Internet, software applications and tools and computer usage concepts.

Course Outline

History, classification, computer and society, overview of numbering system with various Boolean functions, flow chart techniques, storage, programs & software, system software, application software, operating systems, office automation tools: word processing, graphics packages, databases and spreadsheets, various operating systems, current trends and research prospects. Legal and moral aspects of computing.

Lab Outline

Computation of Number system, Implementation of Boolean Functions, Basic machines organization including motherboard, memory, I/O cards, Networking devices, Use of flow charts, Introduction to office tools, overview of different browser including open source browsers, Introduction to various operating systems.

Recommended Books

1. "Introduction to Computer Science", P.K Sinha
2. "Computer Science- An Overview", Glenn Brooks.

COURSE NAME: Plant Systematic, Anatomy & Development	**COURSE CODE:** BOT-303
COURSE STRUCTURE: Lectures: 2, Labs: 1	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

To understand

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

Course outline:

a) Plant Systematics

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

5. Diagnostic characters, economic importance and distribution pattern of the following families:

i. Ranunculaceae

ii. Brassicaceae (Cruciferae)

iii. Fabaceae (Leguminosae)

iv. Rosaceae

v. Euphorbiaceae

vii Cucurbitaceae

vii. Solanaceae

viii. Lamiaceae (Labiatae)

ix. Apiaceae (Umbelliferae)

x. Asteraceae (Compositae)

xi. Liliaceae (Sen. Lato)

xii. Poaceae (Gramineae)

b) Anatomy

1. Cell wall: structure and chemical composition
2. Concept, structure and function of various tissues like:
   i. Parenchyma
   ii. Collenchyma
   iii. Sclerenchyma
   iv. Epidermis (including stomata and trichomes)
   v. Xylem
   vi. Phloem
3. Meristem: types, stem and root apices
4. Vascular cambium
5. Structure and development of root, stem and leaf.

Primary and secondary growth of dicot stem, periderm

6. Characteristics of wood: diffuse porous and

ring –porous, sap and heart wood, soft and hard wood, annual rings.

c) Development / Embryology

Early development of plant body:

1. Capsella bursa-pastoris
2. Structure and development of Anther Microsporogenesis Microgametophyte
3. Structure of Ovule Megasporogenesis Megagametophyte
4. Endosperm formation

5. Parthenocarpy
6. Polyembryony

Lab Outline:

Anatomy

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

Taxonomy

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

Recommended Books

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

Publishing Company, Limited New Delhi.

Journals / Periodicals: Pakistan Journal Of Botany, Taxon, Phyton.

COURSE NAME: Environmental Chemistry	**COURSE CODE:** CHM-402
COURSE STRUCTURE: Lectures: 3, Labs: 0	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objectives

From this course, the students should be able to:

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

Course Outlines

Atmospheric Chemiser

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

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

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

Green Revolution – pest control, pesticides, toxicity of pesticides, integrated pests management.

Energy Production and Environment – liquid and gaseous fuel, hydrogen economy.

Renewable Energy – nuclear energy, solar energy, geothermal and tidal energy.

Recommended Books

Recommended Text Books

Latest editions of the following books:

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

5. Staneley E. Manahan, Environmental Chemistry, Brooks, California.

Recommended Reference Books

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

Recommended Journals/Periodicals Journals related to:

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

Recommended World Web:
Web Sites related to:

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

COURSE NAME: Animal Diversity-I	**COURSE CODE:** ZOL-435
COURSE STRUCTURE: Lectures: 3, Labs: 1	**CREDIT HOURS:** 4
PREREQUISITES: None	

Aims and Objectives:
The course is designed to provide students with:
a. concepts of evolutionary relationship of animal kingdom.
b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

Course Contents

1. Introduction

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

2. Animal-Like Protists: The Protozoa

Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations.

3. Multicellular and Tissue Levels of Organization

Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations.

4. Triploblastics and Acoelomate Body Plan

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

5. Pseudocoelomate Body Plan: Aschelminths

Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations.

6. Molluscan Success

Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations.

7. Annelida: The Metameric Body Form

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

8. Arthropods: Blueprint for Success

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

9. Hexapods and Myriapods: Terrestrial Triumphs

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

Lab Outline

Practicals

1. Study of *Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, Paramecium* as representative of animal like protists. (Prepared slides).

2. Study of sponges and their various body forms.

3. Study of principal representative classes of phylum Coelenterata.

4. Study of principal representative classes of phylum Platyhelminthes.

5. Study of representative of phylum Rotifera, phylum Nematoda.

6. Study of principal representative classes of phylum Mollusca.

7. Study of principal representative classes of phylum Annelida.

8. Study of principal representative classes of groups of phylum Arthropoda.

9. Brief notes on medical/economic importance of the following:
Plasmodium, Entamoeba histolitica, Leishmania, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.

10. Preparation of permanent stained slides of the following: *Obelia, Daphnia*, Cestode, Parapodia of *Nereis.*

Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.

2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.

3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.

4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.

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

Books Recommended (Practicals)

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

2. Miller, S.A., GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.

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DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE OF BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-IV

Course Name: Introduction to Statistics	**Course Code:** ZG-401
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: None	

Course Objectives

The course aims at enabling the students to understand the basic statistical tools for research and economic models development.

The course covers basic concepts, descriptive statistics, probability, random variables, probability distributions, parameter estimation, hypothesis testing, linear correlation, linear regression, contingency tables, and analysis of variance. Applications are made to business, social sciences, and natural/physical sciences

Intended Learning Outcomes

a. **Knowledge and understanding:**
   i. Learn about early development of statistics.
   ii. ii. Upgrade students' knowledge about hypothesis and the use of parametric and non parametric tests.
   iii. Explain the role and importance of statistics in psychology.

b. **Intellectual skills**
   i. Understand the basic qualities of central tendency, dispersion, hypotheses etc.

c. **Professional and practical skills**
   i. Use of Statistics in psychological researches.
   ii. Use of z test, t test, ANOVA etc.
   iii. Interpret test scores.

d. **General and transferable skills**
   i. Apply and interpret various statistical methods.

Course Outline

Unit I. What is Statistics?

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

Unit 2. Presentation of Data

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

Unit 3. Measures of Central Tendency

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

Unit 4. Measures of Dispersion

Introduction, Absolute and relative measures, Range, The semi-Inter-quartile Range, The Mean Deviation, The Variance and standard deviation, Change of origin and scale, Interpretation of the standard Deviation, Coefficient of variation, Properties of variance and standard Deviation, Standardized variables, Moments and Moments ratios. Exercises.

Unit 5. Probability and Probability Distributions.

Discrete and continuous distributions: Binomial, Poisson and Normal Distribution. Exercises

Unit 6. Sampling and Sampling Distributions.

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

Unit 7. Hypothesis Testing

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

Unit 8. Testing of Hypothesis-Single Population

Introduction, Testing of hypothesis and confidence interval about the population mean and proportion for small and large samples, Exercises

Unit 9. Testing of Hypothesis-Two or more Populations

Introduction, Testing of hypothesis and confidence intervals about the difference of population means and proportions for small and large samples,

Analysis of Variance and ANOVA Table. Exercises

Unit 10. Testing of Hypothesis-Independence of Attributes

Introduction, Contingency Tables, Testing of hypothesis about the Independence of attributes. Exercises.

Unit 11. Regression and Correlation

Introduction, cause and effect relationships, examples, simple linear regression, estimation of parameters and their interpretation. r and R^2. Correlation. Coefficient of linear correlation, its estimation and interpretation. Multiple regression and interpretation of its parameters. Examples

Recommended Books

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

COURSE NAME: Biodiversity and Conservation	**COURSE CODE:** ZOL-442
COURSE STRUCTURE: Lectures: 2, Labs: 1	**CREDIT HOURS:** 3
PREREQUISITES: None	

Course Objective

To familiarize the students with the diversity of nature. Importance of biodiversity for survival and proper functioning of ecosystems.

Course Outline

1. Definition of biodiversity as defined in the convention of biological diversity (CBD).
2. Introduction of species on each other for their survival.
3. Extent of known and estimated biodiversity of earth.
4. Measuring biodiversity: Alpha, Beta, and Gamma diversity, Systematic diversity , functional diversity, taxic diversity.
5. Ecological services, indirect value of ecosystem by virtue of their ecological functions, direct value of ecosystem (i.e. Utility of living resources).
6. Sustainable and unsustainable use of ecosystem resources, consequences of unsustainable use, ecosystem degradation, extinct species, desertification and deforestation.
7. Biodiversity Hot spots of the world.
8. International treaties/agreements regarding Biodiversity and conservation; CBD, CITES, Ramsar.
9. IUCN categorised protected areas in Pakistan.
10. Environmental Impact Assessment.
11. Use of herbarium and Botanical Garden in biodiversity and conservation.

Lab Outline

1 Inventory of plant biodiversity in various habitats.
2 Field survey for baseline studies and Impact Assessment.
3 Identification of wild plant species used by local communities in different ecosystems.

Recommended Books

1. Heywood, V. (ed.). 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme. Cambridge University Press, Cambridge, UK.
2. Falk, D.A. & Holsinger, K.E. 1991. Genetics and Conservation of Rare Plants. Center for Plant Conservation. Oxford University Press, Oxford, UK.
3. Frankel, O.H., Brown, A.H.D. & Burdon, J.J. 1995. *The Conservation of Plant Biodiversity*. Cambridge University Press, Cambridge, UK.
4. IUCN. 1994. *IUCN Red List Categories.* As Approved by the IUCN Council. IUCN.
5. Leadlay, E. and Jury, S. 2006 Taxonomy and Plant Conservation. CUP.
6. Bush, M.B. 1997 Ecology of a changing Planet. Prentice hall. New Jersy.
7. French, H. 2000 Vanishing Borders- protecting the Planet in the age of globalization. W.W. Norton & Co
8. Swanson, T. 2005 Global Action for Biodiversity. Earth Scan Publication Ltd.
9. Taylor, P. 2005 Beyond Conservation. Earth Scan Publication Ltd.

Course Name: Animal Diversity-II	**Course Code:** ZOL-443
Course Structure: Lectures: 3, Lab:1	**Credit Hours:** 4
Prerequisites: None	

Aims and Objectives:

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

Course Contents

1. Echinoderms

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

2. Hemichordates and Invertebrate Chordates

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

3. Fishes: Vertebrate Success in Water

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

4. Amphibians: The First Terrestrial Vertebrates

Evolutionary perspective: phylogenetic relationships; survey of order caudata,

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

5. Reptiles: The First Amniotes

Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhynchocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.

6. Birds: Feathers, Flight, and Endothermy

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

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

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

Lab Outline

Practicals

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

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

Recommended Books

Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF

ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.

2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International) 2002. Singapore: McGraw Hill.

3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.

4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.

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

Books Recommended (Practical)

1. Hickman, C.P. and Kats, H.L. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. 2000. Singapore: McGraw Hill.

2. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition (International), 2002. Singapore: McGraw Hill.

Course Name: Animal Form and Function-I	**Course Code:** ZOL-444
Course Structure: Lectures: 3, Lab:1	**Credit Hours:** 4
Prerequisites: None	

Aims and Objectives*:*

The course aims to teach the students about:

a. Animals diversity adapted in different ways for their functions through modifications in body parts.
b. The diversity in integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory, respiratory, nutritive, excretory, osmoregulatory and reproductive systems according to strategies to survive in their specific conditions.
c. Organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
d. The basic structure of each system that determines its particular function.

Course Contents

1. Protection, Support, and Movement

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

2. Communication I: Nerves

Neurons: structure and function; neuron communication: introductory accounts of

resting membrane potential, action potential (nerve impulse) and transmission of the action potential between cells; invertebrate and vertebrate nervous systems: the spinal cord, spinal nerves, the brain, cranial nerves and the autonomic nervous system.

3. Communication II: Senses

Sensory reception: baroreceptors, chemoreceptors, georeceptors, 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, hearing and equilibrium in water, skin sensors of damaging stimuli, skin sensors of heat and cold, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates.

4. Communication III: The Endocrine System and Chemical Messengers

Chemical messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action; some hormones of porifera, cnidarians, platyhelminthes, 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, Immunity, and Gas Exchange

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

Lab Outline

Practicals

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.

2. Study and notes of skeleton of *Labeo, Rana tigrina, Varanus,* fowl and rabbit.

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

3. Earthworm or leech; cockroach, freshwater mussel, *Channa* or *Catla catla* or *Labeo* or any other local fish, frog, pigeon and rat or mouse and rabbits are representative animals for study in dissections.

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

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

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

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

8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of

representative fish/mammals).

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

Recommended Books

Books recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Books Recommended (Practicals)

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

Course Name: Animal Form and Function-II	**Course Code:** ZOL-445
Course Structure: Lectures: 3, Lab:1	**Credit Hours:** 4
Prerequisites: None	

Aims and Objectives:

The course deals with the:

. Basis of structure and functions of animal nutrition, digestion, homeostasis and temperature regulation.

. It introduces the basic concepts in reproduction and development in animal kingdom.

. Provides knowledge about the development of chordate body plan and fate of germinal layers.

Course Contents

1. Nutrition and Digestion

Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion; animal strategies for getting and using food, diversity in digestive structures of invertebrates and vertebrates; the mammalian digestive system: gastrointestinal motility and its control, oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion.

2. Temperature and Body Fluid Regulation

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

3. Reproduction and Development

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

4. Descriptive Embryology

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

Lab Outline

Practicals

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

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

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

Recommended Books

Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2001. New York: McGraw Hill.
5. Campbell, N.A. BIOLOGY, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Books Recommended (Practicals)

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

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY
PESHAWAR
DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE OF BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-V

Course Name: Introduction to Psychology	**Course Code:** PSY-301
Course Structure: Lectures: 2, Labs: 0	**Credit Hours:** 2
Prerequisites: None	

Course Objectives:

- To describe psychology with major areas in the field,
- To identify the parameters of this discipline. Distinguish between the major perspectives on human thought and behavior. Appreciate the variety of ways psychological data are gathered and evaluated.

To gain insight into human behavior and into one's own personality or personal relationships. Explore the ways that psychological theories are used to describe, understand, predict, and control or modify behavior.

Course Outline:

1. Introduction to Psychology:
    a. Nature and Application of Psychology with special reference to Pakistan.
    b. Historical Background and Schools of Psychology (A Brief Survey)

2. Methods of Psychology
    a. Observation
    b. Case History Method Experimental Method
    c. Survey Method
    d. Interviewing Techniques

3. Biological Basis of Behavior
    a. Neuron: Structure and Functions
    b. Central Nervous System and Peripheral Nervous System
    c. Endocrine Glands

4. Sensation, Perception and Attention
    a. Sensation
        i. Characteristics and Major Functions of Different Sensations

ii. Vision: Structure and function of the Eye.
iii. Audition: Structure and functions of the Ear.

b. Perception
   i. Nature of Perception
   ii. Factors of Perception: Subjective, Objective and Social
   iii. Kinds of Perception
   iv. Spatial Perception
   v. Temporal Perception; Auditory Perception

c. Attention
   i. Factors, Subjective and Objective
   ii. Span of Attention
   iii. Fluctuation of Attention
   iv. Distraction of Attention (Causes and Control)

5. Motives
   a. Definition and Nature
   b. Classification

   Primary (Biogenic) Motives: Hunger, Thirst, Defection and Urination, Fatigue, Sleep, Pain, Temperature, Regulation, Maternal Behavior, Sex

   Secondary (Sociogenic) Motives: Play and Manipulation, Exploration and Curiosity, Affiliation, Achievement and Power, Competition, Cooperation, Social Approval and Self Actualization.

6. Emotions
   a. Definition and Nature
   b. Physiological changes during Emotions (Neural, Cardial, Visceral, Glandular), Galvanic Skin Response; Pupilliometrics
   c. Theories of Emotion
   d. James Lange Theory; Canon-Brad Theory
   e. Schechter-Singer Theory

7. Learning
   a. Definition of Learning
   b. Types of Learning: Classical Operant Conditioning, Methods of Learning: Trial

and Error; Learning by Insight; Observational Learning

8. Memory
   a. Definition and Nature
   b. Memory Processes: Retention, Recall and Recognition
   c. Forgetting: Nature and Causes

9. Thinking
   a. Definition and Nature
   b. Tools of Thinking: Imagery, Language, Concepts
   c. Kinds of Thinking
   d. Problem Solving, Decision Making, Reasoning

10. Individual References
   a. Definition concepts
      Intelligence, Personality, aptitude, achievement

Recommended Books

1. Atkinson R. C., & Smith E. E. (2000). *Introduction to psychology* (13th ed.). Harcourt Brace College Publishers.
2. Fernald, L. D., & Fernald, P. S. (2005). *Introduction to psychology*. USA: WMC Brown Publishers.
3. Glassman, W. E. (2000). *Approaches to psychology*. Open University Press. Hayes, N. (2000). *Foundation of psychology* (3rd ed.). Thomson Learning. Lahey, B. B. (2004). *Psychology: An introduction* (8th ed.). McGraw-Hill Companies, Inc.
4. Leahey, T. H. (1992). *A history of psychology: Main currents in psychological thought*. New Jersey: Prentice-Hall International, Inc.
5. Myers, D. G. (1992). *Psychology*. (3rd ed.). New York: Wadsworth Publishers
6. Ormord, J. E. (1995). *Educational psychology*: *Developing learners*. Prentice- Hall, Inc

Course Name: Developmental Biology	**Course Code:** ZOL-552
Course Structure: Lectures: 3, Labs:1	**Credit Hours:** 4
Prerequisites: None	

Course Objectives:

The course will provide detailed knowledge about the principal features of development, cellular basis of morphogenesis, mechanisms of cellular differentiation and concepts of induction in development. It will provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. The concept related to the theory in Developmental Biology will be practically demonstrated in this course. In the continuity of the animals during reproduction following the union of the traits from the

parents in their gametes, the zygote proceeds through enormous phenomena of development up to their emergence resembling to the parents. The concepts of all these developmental mechanisms will be communicated to the students in this course.

Course Outline:

Introduction: Principal features of development, origin of sexual reproduction, developmental patterns; Spermatogenesis; Oogenesis.

Fertilization: Recognition of sperm and egg, fusion of gametes, activation of egg metabolism, rearrangement of egg cytoplasm.

Cleavage: Patterns of embryonic cleavage, mechanism of cleavage.

Gastrulation: Fate maps, gastrulation in sea urchin, amphibians, birds and mammals.

Early Vertebrate Development: Neurulation, ectoderm, mesoderm and endoderm.

Cellular Basis of Morphogenesis: Differential cell affinity, cell adhesion molecules.

Mechanism of Cellular Differentiation: RNA processing, translational regulation of developmental process, cell-fate by progressive determinants, autonomous cell specification by cytoplasmic determinants, establishment of body axes and mechanism of teratogenesis; Secondary Induction.

Organogenesis: A brief account; Origin and migration of germ cells in vertebrates.

Factors controlling growth and oncogenesis.
Hormones as mediators of development; Regeneration in vertebrates.

Recommended Books

1. Gilbert, S. F. DEVELOPMENTAL BIOLOGY, 2006.Sinauer Associates, Sunderland, MA.
2. Balinsky, B. I. AN INTRODUCTION TO EMBRYOLOGY, 1985. Saunders.
3. Saunders, J. W. DEVELOPMENTAL BIOLOGY, 1982. McMillan and company.
4. Oppenheimer, S.S. INTRODUCTION TO EMBRYONIC DEVELOPMENT, 1984. Allen and Bacon.
5. Ham, R. G. and Veomett, M. J. MECHANISM OF DEVELOPMENT. 1980. C. V. Mosby Co.
6. Klaus, K. BIOLOGICAL DEVELOPMENT. 2nd Edition, 2001.McGraw Hill.

Lab Outline:

Practicals Study of structure of gametes in some representative cases, i.e., frog, fish, fowl

and mammal. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc. Study of fertilization, early development of frog through induced spawning under laboratory conditions. Preparation and study of serial sections of frog or chick embryos. Application of microsurgical techniques on chick embryos in vitro. Preparation and staining of histological slides.

Course Name: Cell and Molecular Biology	**Course Code:** ZOL-553
Course Structure: Lectures: 3, Labs:1	**Credit Hours:** 4
Prerequisites: None	

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

Course Contents:

Introduction to prokaryotic and eukaryotic cells: Plasma membrane**,** its chemical composition structure and functions: of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.

Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments.

Cytoplasmic Organelles: Membrane system (structural and functional commonalities). Ultrastructure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus (with reference to its role in synthesis of glycoprotein), Mitochondria (with reference to its role in cellular respiration, and its significance as semi-autonomous organelle), Lysosome (with reference to its diverse roles due to hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glycoxysome (with reference to glyoxylic acid cycle).

Nucleus, chromatin, heterochromatin, euchromatin, chromosome structure with reference to coiling and nucleosome during different phases of cell cycle, Replication (mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with special reference to DNA polymerases, concept of Replicons etc.), Transcription (variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes, involved, RNA splicing, split genes, concept of Ribozymes and posttranscriptional processing), RNA transduction, Genetic code, point mutations, Translation (with reference to the specific role of Ribosomes, various factors, and posttranslational processing).Control of Gene expression in Prokaryotes.

Recommended Books

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. MOLECULAR BIOLOGY OF THE CELL, 1989. Garland Publishing Inc., New

York.
2. Damell Jr. J., Lodisch, H. and Balimore, D. MOLECULAR CELL BIOLOGY, 1990. Scientific American Inc. N.Y.
3. De Robertis, E. D. P. and De Robertis Jr. E. N. F. CELL AND MOLECULAR BIOLOGY, 1987. Lea & Febiger, New York.
4. Karp, J. CELL AND MOLECULAR BIOLOGY, CONCEPTS AND EXPERIMENTS, 2005. Jhon Wiley and Sons, INC.
5. Geoffrey M.C., Robert E.H. THE CELL: A MOLECULAR APPROACH, 2007. Sinauer Associates, INC.

Practicals

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

Course Name: Animal Behavior	**Course Code:** ZOL-554
Course Structure: Lectures: 2, Labs:0	**Credit Hours:** 2
Prerequisites: None	
Course Contents: **Mechanism of behavior:** Nervous system and behavior, hormones and behavior, biological rhythm, development of behavior, learning behavior, communication. **Social organization**: conflict, sexual reproduction, parental care, social system.	
Recommended Books 1. Goodenough, J., McGuire, B. and Wallace, R.A. PERSPECTIVE ON ANIMAL BEHAVIOUR. 2001.John Wiley & Sons, New York. 2. Scott, G. ESSENTIAL ANIMAL BEHAVIOUR. 2005.Blackwell Pub. New York 3. Dngatkin, L. A. PRINCIPLES OF ANIMAL BEHAVIOUR. 2006.W.W. Nortan and Co.New York.	

Course Name: Physiology	**Course Code:** ZOL-555
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4
Prerequisites: None	
Course Objectives: The basic functional expression in animals is the membrane irritability understood in the form of nerve impulse. This course particularly imparts the concepts and mechanisms of integration in the different functional systems of the animals. These mainly constitute the mechanisms of nervous system and the hormonal system for the coordination. The motility and locomotion also contributes in the integration of the animal to its environment, therefore, also included in this section.	

Course Contents:

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

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

Receptors Physiology: Transduction; Sensory coding; Range fractionation; Sensory adaptations; Mechanoreception: Hair cell mechanism particularly in acoustico-lateralis system of vertebrates; Cutaneous receptors; Cellular and molecular mechanisms in taste and olfactory reception; Photoreception: Ultrasttructure of photoreceptors, Photochemistry, Phototransduction and physiological basis of color vision; Physiological mechanisms in electroreception.

Chemical Messenger and Regulators/Endocrine Physiology: Types and functions of secretions. An overview of invertebrate endocrine structures, their hormones and physiological roles. An overview of hormones, their chemistry and physiological roles of Hypothalamus, Pituitary, Thyroid, Parathyroid and associated structures, Endocrine pancreas, Gastropancreatic system, Adrenal medulla (Chromaffin Tissue), Adrenal cortex, Ovary, Testis and Placenta. A generalized model account of hormone synthesis, storage and secretion (a peptide hormone model and steroid hormones); Hormonal interactions in metabolic and developmental function; Water and electrolyte balance and reproduction. Integrated endocrine and neural responses in glycemia and calcium homeostasis and reproductive cycles; General account of hormonal regulations, hormonal turnover, recognition; Mechanisms of action in hormones involving membrane receptors and nuclear modulated gene expression; Endocrine functions of kidneys, heart and pineal gland.

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

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

Exchange of Gases: Transport of O_2 and CO_2 between respiratory surface (the lungs) and body cells. Regulation of lungs respiration; Gas transfer in water (gills) and its regulation. Respiratory responses in extreme conditions as hypoxia; Hypercapnia in air breathing divers.

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

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

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

PRACTICALS

Practicals Muscle and Neuromuscular Activity: Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of
stimulus strength, effect of stimulus frequency (tetany), effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human.

Excitability, Sensation and Behaviour: Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology.

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

Respiration and Exercise: Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure glycemia altered by exercise.

Endocrine and Reproductive Mechanisms: Effect of insulin on glycemia, study of stages in estrous cycle.

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald, R. ECKERT ANIMAL PHYSIOLOGY: MECHANISMS AND ADAPTATIONS, 5th Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. PHYSIOLOGY, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. PRINCIPLES OF PHYSIOLOGY, 3rd Edition. 2000. St. Lious, Mosby.
4. Guyton, A.C. and Hall, J.E. TEXTBOOK OF MEDICAL PHYSIOLOGY, 10th Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. COMPARATIVE ANIMAL PHYSIOLOGY. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. ANIMAL PHYSIOLOGY, ADAPTATION AND ENVIRONMENT, 5th Edition. 1997. Cambridge University Press, Cambridge.
7. Bullock, J., Boyle, J. and Wang, M.B. PHYSIOLOGY, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.

Books Recommended for Practicals

1. Tharp, G. and Woodman, D. EXPERIMENTS IN PHYSIOLOGY, 8th Edition. 2002. Prentice Hall, London.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-VI

Course Name: Biological Techniques	**Course Code:** ZOL-561
Course Structure: Lectures: 1, Lab:2	**Credit Hours:** 3
Prerequisites: None	

Course Outline:
(Theory and Practical)

Microscopy: Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, Phase Contrast Dark field Interference microscope, Electron microscope.

Micrometery and Morphometry: Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter).

Specimen preparation for optical microscopy.
Standard system for weight, length and volume. Preparation of stock solutions of various strengths.

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

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

Separation Techniques: Chromatography: Principle, applications, types, thin layer, paper, column, gas, ion exchange chromatography. Electrophoresis: principle, applications, types.

Spectrophotometery: Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.

Basic principles of Sampling and Preservation: Sampling soil organisms, Invertebrates, Aquatic animals, Mammals, Estimation of population size, Preservation of dry and wet specimens.

Books Recommended

1. Dean, J. R. EXTRACTION METHODS FOR ENVIRONMENTAL ANALYSIS. 1999. John Wiley and Sons Ltd. UK.
2. Curos, M. ENVIRONMENTAL SAMPLING AND ANALYSIS: LAB MANUAL. 1997. CRC Press LLC. USA.

3. Curos, M. ENVIRONMENTAL SAMPLING AND ANALYSIS: FOR TECHNICIAN. 1997. CRC Press LLC. USA.
4. Cheesbrough, M. DISTRICT LABORATORY PRACTICE IN TROPICAL COUNTRIES. Part I. 1998. University Press Cambridge, UK.
5. Cheesbrough, M. DISTRICT LABORATORY PRACTICE IN TROPICAL COUNTRIES. Part II. 1998. University Press Cambridge, UK.
6. Slingsby, D. and Cock, C.

Course Name: Evolution and Principles of Systematics	**Course Code:** ZOL-562
Course Structure: Lectures: 4, Lab: 0	**Credit Hours:** 4
Prerequisites: None	

Course Objectives:

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

Course Contents

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

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

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

Systematic Zoology: Contribution of systematics to Biology: History of Taxonomy (Downward classification, upward classification, impact of the origin of species, population systematics, current trends); Microtaxonomy, phenon, Taxon; Taxonomic categories: specific category, infraspecific category, higher categories; species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept), species mate recognition concept; non-dimensional species concept; Multidimenstional species concept; Cohesion species concept; Difficulties in the application of biological species concepts; polytypic species, subspecies, super species, sibling species; study of major type of variation within a single population. Speciation and taxonomic decision, various types of characters, cladistic analysis, Macrotaxonomy; different kinds of taxonomic characters; Taxonomic collection and identification; definitions of Synonym, Homonym, Keys; Evolution of the theory of Nomenclature; interpretation and application of the code (stability, priority, first revisor principle) range of authority of code; concept of availability, type method formation of specific names.

Books Recommended

Evolution

1. Ridley, M. EVOLUTION. 1993. Blackwell Scientific Publications.
2. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. EVOLUTION. 1973. W.H. Freeman and Company.
3. Dobzhansky, T. GENETICS AND THE ORIGIN OF SPECIES, 1951. Columbia University Press, New York.
4. Mayr, E. POPULATIONS, SPECIES AND EVOLUTION, 1965. Harvard University Press.
5. Moody, P.A. INTRODUCTION TO EVOLUTION, 1989. Harper and Row Publishers, New York.
6. Strickberger. M.W. EVOLUTION. 2000. Jones & Barrett Publishers

Systematic Zoology

1. Mayer, E. PRINCIPLES OF SYSTEMATIC ZOOLOGY. 1994. McGraw Hill, New York.
2. Mayer, E. and Asblock, P.D. PRINCIPLES OF SYSTEMATIC ZOOLOGY. 1991. McGraw Hill, New York
3. Mayr, E. ANIMAL SPECIES AND EVOLUTION, 1985. Harvard University Press.
4. Heywood, V.H. TAXONOMY AND ECOLOGY. 1975. Academic Press, London.
5. Whili, M.J.D. MODES OF SPECIATION, 1978. W.H. Freeman and Co., San Francisco.

Course Name: Biochemistry	**Course Code:** BCHM-
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives:

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

Course Contents

Amino acids, peptides and proteins: standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; natural modifications of amino acids in proteins; non-standard amino acids, their structure and role; peptides, their ionic behavior and amino acid composition, cytochrome c; Macromolecular separation techniques in biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation.

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

Carbohydrates: classification, types, important characteristics and structure of

carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin formation; disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides.

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

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

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

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

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

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

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

Books Recommended

1. Nelson, D. L. and Cox, M.M. LEHNINGER PRINCIPLES OF BIOCHEMISTRY, 3rd Edition, 2000. McMillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. HARPER'S BIOCHEMISTRY, 25th Edition, 2000. McGraw Hill, New York.

3. Voet. D., Voet, J.G., and Pratt, C.W. FUNDAMENTALS OF BIOCHEMISTRY, 1999. John Wiley and Sons, Inc., New York.
4. Zubay, G. BIOCHEMISTRY, 4th Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
5. Lubert, S. BIOCHEMISTRY, 4th Edition, 1995. W.H. Freeman & Company, New York.
6. McKee, T. and McKee, J.R. BIOCHEMISTRY, THE MOLECULAR BASIS OF LIFE. 3rd Edition, 2003. McGraw Hill.

Books Recommended (Practicals)

1. Plummer, David T. AN INTRODUCTION TO PRACTICAL BIOCHEMISTRY, 1990. 4th Edition McGraw-Hill Book Company, London.
2. Wilson, K & Walker, J. PRACTICAL BIOCHEMISTRY: PRINCIPLES AND TECHNIQUES, 4th Edition, 1994. Cambridge University Press.

Course Name: Ecology	**Course Code:** ZOL-563
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives:

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

Course Contents:

An overview of concepts of ecosystem with emphasis on interaction and homeostasis. Basic global ecosystems (atmosphere, hydrosphere, lithosphere, ecosphere). Biogeochemical cycle: nitrogen, phosphorus, sulpher, water, carbon, nutrient. Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire. Energy: laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. Population ecology: basic population characters, growth and growth curves, population dynamics and regulations. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions. Ecological niche: basic concepts and types. An overview of major biomes of the world. Applied Ecology: Resources and their ecological management (mineral, agricultural and forest, range management, desalination and weather modification, landscape and land use); Pollution (definition, types, cost, origin and management); water (sources, domestic and industrial pollution, heavy metals, water purification, waste water treatment); air (sulpher dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE & CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution. Radiation. Space biology. Contemporary environmental themes: (ozone depletion, acid rain, green house effect and global warming, desertification, deforestation, exotic and invasive species, radioactivity

leakage, environmental laws).

Books Recommended

1. Odum, E. P. 1994. FUNDAMENTALS OF ECOLOGY. 3rd Edition W.B. Saunders.Philadelphia.
2. Molles, M.C. 2005 Ecology: CONCEPTS AND APPLICATIONS. 6th Edition, McGraw Hill, New York, USA.
3. Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E. and Turner, M.G., 1998. ECOLOGY. Oxford Univ. Press, UK.
4. Slingsby, D. and Cook, C., 1986. PRACTICAL ECOLOGY. McMillan Education Ltd. UK.
5. Chapman, J.L. and Reiss, M.J.1997. ECOLOGY: PRINCIPLES AND APPLICATIONS. Cambridge Univ. Press, UK.
6. Smith, R.L. 1980. ECOLOGY AND FIELD BIOLOGY, Harper and Row.
7. Newman, I. 1993. APPLIED ECOLOGY. Black Well Scientific Publications Oxford. UK.
8. Cox, C.B and Morre, D. 2000. BIOGEOGRAPHY: AN ECOLOGICAL AND EVOLUTIONARY APPROACH, 6th Edition. Life Sciences King's College, London, UK.

Course Name: Wildlife	**Course Code:** ZOL-564
Course Structure: Lectures: 0, Lab: 3	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives:

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

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

Books Recommended

9. Bailey, J.A. PRINCIPLES OF WILDLIFE MANAGEMENT, 1986. John Wiley and Sons.
10. Ali S. and Ripley S.D. A HANDBOOK OF BIRDS OF INDIA & PAKISTAN, 1973.

Oxford University Press, London.
11. Roberts, T. J. THE BIRDS OF PAKISTAN, (Vol. I). 1992. Oxford University Press.
12. Roberts, T. J. THE BIRDS OF PAKISTAN, (Vol. II), 1998. Oxford University Press.
13. Roberts, T.J. MAMMALS OF PAKISTAN. 1977. Ernest Benon Ltd, London.
14. Robinson, W.L. and Bolen, E.G. WILDLIFE ECOLOGY AND MANAGEMENT. 1984. McMillan, Cambridge.
15. Magon, C.F. BIOLOGY OF FRESHWATER POLLUTION. 1988. Longman and Scientific Publication.
16. Boyd, C.E. and Tucker, C. S. POND AQUACULTURE AND WATER QUALITY MANAGEMENT. 1998. Boston, Kluwer Publishers Alabama.
17. Ali, S.S. PALEONTOLOGY, ZOOGEOGRAPHY & WILD-LIFE MANAGEMENT. 1999. Nasim Book Depot. Hyderabad, India.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY
PESHAWAR
DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-VII

Course Name: Genetics	**Course Code:** ZOL-624
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives

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

Course Contents

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

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

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

Books Recommended

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

Course Name: Bioinformatics	**Course Code:** BI-409
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	
Aims and Objectives	

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

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

Course Contents

(THEORY AND PRACTICAL)

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

Computer operating systems, software downloading and installation, Database management.

Books Recommended

1. Gibas, C. and Jambeck, P. DEVELOPING BIOINFORMATICS COMPUTER SKILLS. 2001. O'Reilly publishers.
2. Westhead, D.R., Parish, J.H. and Twyman, R.M. INSTANT NOTES ON BIOINFORMATICS. 2003.Viva Books Private Limited.
3. Lest, A.M. INTRODUCTION TO BIOINFORMATICS. 2002. Oxford University Press.
4. Baxevanic, A.D. and Ouellette, B.F.F. BIOINFORMATICS: 2004. A PRACTICAL GUIDE TO THE ANALYSIS OF GENES AND PROTEINS, 3rd Edition. O'Reilly publishers.
5. Krane, D.E. and Raymer, M.L. FUNDAMENTAL CONCEPTS OF BIOINFORMATICS. 2002. Benjamin Cummings.
6. Moody, G. DIGITAL CODE OF LIFE: HOW BIOINFORMATICS IS REVOLUTIONIZING SCIENCE, MEDICINE AND BUSINESS. 2004. John Wiley and Sons.
7. Orengo, C. A., Jones, D.T. and Thornton, J.M. BIOINFORMATICS: GENES, PROTEINS AND COMPUTERS (Advanced Text) 2003. Roultledge.
8. http://www.ncbi.nlm.nih.gov
9. http://www.ebi.ac.uk
10. http://foldoc.doc.ic.ac.uk/foldoc/index.html
11. http://wit.integratedgenomics.com/GOLD/

Course Name: Zoogeography & Paleontology	**Course Code:** ZOL-625
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives

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

Course Contents

Zoogeography: Branches of zoogeography (descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography). Animal distribution (cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution) Barriers and dispersal. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaearctic, Nearctic regions), Oriental, Ethiopian, Australian, and New tropical Regions. Palaeogeography (Theories of Continental drift and Plate tectonics).

Principles of Paleontology: Earth, Shells of earth; (atmosphere, hydrosphere, biosphere

and lithosphere). Rock, types of rocks (lgneous rocks, sedimentary rocks and metamorphic rocks) Fossil, types and uses of fossils, nature of fossils. Processes of fossilization. Geological time scale. Pre-Cambrian life. Post Cambrian life (Palaeozoic life, Mesozoic life, Cenozoic life). Geochronometry (Uranium/Lead dating, radiocarbon dating, methods), evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

Books Recommended

Zoogeography:

1. Darlington, P. J. Jr. ZOOGEOGRAPHY, 1963. John Wiley and Sons.
2. DeBeaufort, L. F. ZOOGEOGRAPHY OF THE LAND AND INLAND WATERS. 1951. Sidgwick and Jackson.
3. Ali, S.S. PALAEONTOLOGY, ZOOGEOGRAPHY AND WILDLIFE MANAGEMENT. 1999. Nasim Book Depot, Hyderabad, India

Paleontology:

1. Dunbar C.O. HISTORICAL GEOLOGY, 1969. John Wiley and Sons Inc. New York.
2. Brouwer, A. GENERAL PALAEONTOLOGY, 1977. Oliver and Boyed, London.
3. Gilbert, L. I. and Colbert, E.H. EVOLUTION OF VERTEBRATES, 1980. John Wiley and Sons Inc. New York.
4. Ali, S.S. PALAEONTOLOGY, ZOOGEOGRAPHY AND WILDLIFE MANAGEMENT. 1999. Nasim Book Depot, Hyderabad, India.

Course Name: Principles of Parasitology	**Course Code:** ZOL-626
Course Structure: Lectures: 1, Lab: 2	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives

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

Course Contents

Introduction to parasitology. Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals. Camers in parasitology. Some basic definitions. Basic principles and concepts. Parasite ecology and evolution. Basic principles and concepts. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms. Acquired immune response in vertebrates. Immunity in invertebrates. Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship.

Parasitic protozoa, form, function and classification: Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae. Other flagellated protozoa, order Retortamonadita, order Diplomonadida, order Trichomonadida, order Opalinida. The Amoebas. Order Amoebida, order Schizopyrenida. Phylum Apicomplexa, Gregarines, Coccidia and related organisms. The apical complex, class Gregarinea, class Coccidea. Phylum Apicomplexa, Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida. Phylum ciliophora, ciliated protistan parasites, class Spirotoichea, class Litostomitea, class Oligohymenophorea. Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa. The Mesozoa, pioneers or

Degenerates. Class Rhombozoa, class orthonectida, Phylogenetic position, physiology and Host parasite relationship. Classification of Phylum Mesozoa.

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

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

Practicals

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

Books Recommended

1. Roberts, L.S. and Janovy, J. FOUNDATION OF PARASITOLOGY, 6th Edition. 2000. McGraw Hill Book Co.
2. Hausman, K. and Hulsmann, N. T. PROTOZOOLOGY, 2nd Edition. 1996. Medical Publishers, Inc. New York.
3. Noble, E.R. and Noble, G.A. PARASITOLOGY. THE BIOLOGY OF ANIMAL PARASITES. 5th Edition. 1982. Lea and Febiger Publisher.
4. Beck, J.W. and Davies, J.E. MEDICAL PARASITOLOGY. 3rd Edition. 1981. C.V. Mosby Company, Toronto, London.
5. Cheesbrough, M. MEDICAL LABORATORY MANUAL FOR TROPICAL MEDICINE. Vol.I. 1987. University Press Cambridge.
6. Smyth, J.D. INTRODUCTION TO ANIMAL PARASITOLOGY. 1994. Cambridge University Press.
7. Roberts, L.S. and Janovy, J. Jr. FOUNDATIONS OF PARASITOLOGY. 7th Edition. 2005. W.M. Brown Publishers, Chicago, London, Tokyo, Toronto.
8. Beck, J.W. and Davies, J.E. MEDICAL PARASITOLOGY. 3rd Edition. 1981. C.V. Mosby Company, Toronto, London.
9. Cheesbrough, M. MEDICAL LABORATORY MANUAL FOR TROPICAL MEDICINE. Vol.I. 1987. University Press Cambridge.
10. Smyth, J.D. INTRODUCTION TO ANIMAL PARASITOLOGY. 1994. Cambridge University Press.
11. Roberts, L.S. and Janovy, J. Jr. FOUNDATIONS OF PARASITOLOGY. 7th Edition. 2005. Wm Brown Publishers, USA.
12. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W. VETERINARY PARASITOLOGY. 2000. Longman Scientific and Technical publications, Longman Group, UK.

Course Name: Biotechnology	**Course Code:** ZOL-627
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3

Prerequisites: None

Course Objectives

To acquaint students with the basic concepts and significance of biotechnology as it stands today.

Course Contents

Biotechnology- definition and history; foundations of biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture (fod, livestock, fisheries, algae, fungi, etc.); protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world.

Books Recommended

1. Daugherty E, 2012. Biotechnology: Science for the New Milenium. 1st Editon, Revised; Paradigm Publication.
2. Smith JE, 209. Biotechnology. 5th Editon; Cambridge University Pres.
3. Nichol TSD, 204. An Introduction to Genetic Enginering. 2nd Editon; Cambridge University Pres, UK.
4. Purohit SS, 205. Biotechnology Fundamentals & Aplication. 4th Editon; Agro Bios, India.
5. Ratlegde C and Kristiansen B, 206. Basic Biotechnology. 2nd Editon; Cambridge University Pres, UK.
6. Thomas JA and Fuchs RL, 202. Biotechnology and Safety Asesment. 3rd Editon; Academic Pres, UK.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEPARTMENT OF ZOOLOGY

DETAILED COURSE OUTLINE BS ZOOLOGY (SESSION: 2016-2020, 2017-2021, 2018-2022)

SEMESTER-VIII

Course Name: Physiology of Coordination	**Course Code:** ZOL-631
Course Structure: Lectures: 2, Lab: 1	**Credit Hours:** 3
Prerequisites: None	

Aims and Objectives:

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

Course Contents

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

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

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

Endocrine System: General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretary 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.

Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R. ECKERT ANIMAL PHYSIOLOGY: Mechanisms and Adaptations, 5th Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. PHYSIOLOGY, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. PRINCIPLES OF PHYSIOLOGY, 3rd Edition. 2000. St. Lious, Mosby.
4. Guyton, A.C. and Hall, J.E. TEXTBOOK OF MEDICAL PHYSIOLOGY, 10th Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. COMPARATIVE ANIMAL PHYSIOLOGY. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. ANIMAL PHYSIOLOGY: ADAPTATION AND ENVIRONMENT, 5th Edition. 1997. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D. EXPERIMENTS IN PHYSIOLOGY, 8th Edition. 2002. Prentice Hall, London.

Course Name: Cancer Biology	**Course Code:** ZOL-632
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	

Course Objectives

This course will teach the students to be conversant on issues related to cancer, its etiology, development, carcinogenic agents, treatment and prevention. The main aim and objective of this course is to educate the students on various genetic and molecular changes in normal cells that undergo during transformation into malignant cells.

Course Outlines

Cell cycle, Check Points, M.Phase Kinase, Regulatory activities in S and M. Phase (Heterokaryon experiments), Oncogenes: Growth factors, Receptors, Signal Transducer, Transcriptional Factors and Cell Cycle Genes. Tumor Suppressing genes: (Rb and P53 etc.), Tumor inducing DNA Virus, Tumor inducing RNA Virus, Human Colon Cancer, Breast Cancer, cervical Cancer, Lung cancer, Hepatic carcinoma, Cancer Epidemiology and Prevention, Risk factors and Carcinogenic agent: Chemicals and Radiations, Tumor Invasion and Metastasis, Role of Nutrients, Hormones and Gene Interaction in Carcinogenesis, Cancer Therapy.

PRACTICAL (if lab facilities available)

Heterokaryon experiments; study of DNA damage by physical and chemical methods; Ames test for identification of mutagenic agent; case study of chromosomal abnormalities in human and agricultural specimen.

NOTE: The course has been taken from "CURRICULUM OF BIOCHEMISTRY (BS/MS) (Revised 2013)", Higher Education Commission, H-9, Islamabad.

Books Recommended

1. The Biology of Cancer by Robert A Weinberg.
2. Cancer Biology by Raymond W. Rudon, latest editon, Oxford University Press.
3. Wintrobe's Clinical Haematology by Maxwel, M. Wintrobe, G. Richard Le, Wiliams and Wilking Publishers, New York.

Course Name: Clinical Biochemistry	**Course Code:** ZOL-633

Course Structure: Lectures: 2, Lab: 1	**Credit Hours:** 3
Prerequisites: None	

Course Objectives

Provide students with advanced understanding and applied knowledge in the theory and practice of Clinical Biochemistry and equip them with a critical understanding of how biochemical investigations are employed to develop a clinical diagnosis. Emphasis will also be placed on understanding the biochemical basis of human disease.

Course Contents

Diagnostically important Plasma Enzymes & Proteins: Identification and treatment of enzyme deficiencies, Assessment of cell damage, Factors affecting results of plasma enzyme assays. Abnormal plasma enzymes activities: isoenzymes in plasma (lactate dehydrogenase, creatine kinase, Amylase): Abnormalities of proteins in plasma: immunoglobins deficiencies, Disorders of carbohydrate metabolisms and Clinical correlations: Diabetes mellitus, Fructose intolerance, Lactic acidosis, Hypoglycemia, Galactosaemia; Glycogen storage Diseases (enzyme defect in different forms of glycogen storage diseases); Disorders of Lipid Metabolism (lipoproteins, classification of lipoproteins, hyperlipidemia, cholesterol and cardiovascular diseases); Disorders of purine and pyrimidine metabolism (Gout, Arthrits); Metabolic Bone Diseases (Calcium balance, Biological functions of calcium, phosphate and magnesium metabolism); Liver Diseases (cirrhosis', specific liver diseases); Hemoglobinopathies, Disorders of Iron and porphyrin metabolism. Cancer and its consequences- tumor progresion, tumor markers, oncogenes, local efects of tumor, cancer cachexia, Ectopic hormone production, consequences of cancer treatment.

PRACTICAL

Phelobotmy (blood sampling), serum/plasma isolation procedure, Complete blood count, isolation of tissues samples and storage; Total protein determination in serum and plasma; Blod glucose test, Glucose tolerance test for diabetes mellitus, Glycation (HbA1c); Liver function tests, Renal Function tests, Cardiac enzymes, Albumin determination; Determination of lipid profile, serum and urine electrolytes.

NOTE: The course has been taken from "CURRICULUM OF BIOCHEMISTRY (BS/MS) (Revised 2013)", Higher Education Commission, H-9, Islamabad.

Books Recommended

1. Clinical Chemistry: Principles, Procedures, Corelations by Michael L. Bishop, Edward P. Fody, Lary E. Schoef Publisher: Lipincot Wiliams & Wilkins; 5th Edition (July 6, 2004)
2. Tietz Fundamentals of Clinical Chemistry by Carl A. Burtis, Edward R. Ashwod. Publisher: W.B. Saunders Company; 5th Edition (January 15, 2001).
3. Lecture Notes on Clinical Biochemistry, Alistaire F Smith, Geofrey Becket, Simon Walker, Peter Rae 6th Edition, John Wiley & Sons, 1998.

Course Name: Environmental Pollution	**Course Code:** ZOL-634
Course Structure: Lectures: 3, Lab: 0	**Credit Hours:** 3
Prerequisites: None	
Course Objectives	

The course is focused on introducing environmental pollution and its sources. It will also cover the existing laws related to pollutants in Pakistan and the conventions ratified internationally.

Course Outline

Environmental Pollution, sources, types and causes. Types of pollutants: Physical, chemical and biological; Characteristics of domestic & industrial effluents; Effects of Pollutants on human & other living organisms; Industrial and Municipal Solid Waste. Principles of Waste Management & Disposal; Fate of pollutants; Factors affecting movement of pollutants in soil, air and water. Monitoring of Environmental Pollution; Pollution Control Strategies; Environmental Laws: Pollutants Guidelines; International Protocols; Case Studies.

NOTE: The course has been taken from "CURRICULUM OF ENVIRONMENTAL SCIENCE BS/MS (Revised 2013)", Higher Education Commission, H-9, Islamabad.

Books Recommended

1. Understanding Environmental Pollution, Hil, M.K., 2nd Edition. Cambridge University Press, Cambridge UK, 2005.
2. Environment Pollution: Types, Sources & Management. Ghafoor, A., G. Murtaza, M.Z. Rehman, M. Sabir, H.R. Ahmad and Saifulah. Allied Book Centre, Lahore, Pakistan. 2012.

DETAILS OF OPTIONAL COURSES OFFERED BY DEPARTMRNT OF ZOOLOGY BS (SESSION: 2016-2020, 2017-2021, 2018-2022)

AGRICULTURE BIOTECHNOLOGY	ZOL-636	3(3+0)

Course Objectives

- To introduce biotechnology and its principles
- To familiarize the students about the modern concepts of different techniques
- To impart knowledge about the effect of biotechnology on productivity

Course learning outcomes

The students will learn about;

- The modern concepts of biotechnology and its principles
- The effect of biotechnology on productivity

Course contents

Role of biotechnology in aquaculture, use of effective microorganisms in technology; fish as an experimental animal, technical details and possibilities. Use of hormones for sex manipulation and growth promotion in cultivable fishes: hormonal manipulation of sex, gonadal sex manipulation, masculinization and sterilization by androgens, femisnizaton by estrogens, duration and timing and method of administration of steroid hormones. Hormonal enhancement of growth.Genetic in enhancing productivity; phenotypic sex reversal, heterospecific insemination long-term preservation of gametes, selection of high directional growth rate, production of polyploids.

Books Recommended

1. Sinha, C.R.P. and Srivastava, 1991. Biotechnology and Aquaculture Engineering.
1. Session Oxford and IBH Publishing Co. (Pvt.) Ltd., New Delhi.
2. Pimtani, M., 1992. Aquaculture Research Needs for 2000 AD. Oxford and IBH Publishing Co. (Pvt.) Ltd., New Delhi.
3. Gall, G.A. and Chen, H., 1994. Fish Bioenergetics. Chapman and Hall, London.
4. Schreck, C.B. and Moyle, P.B., 1990. Methods for fish Biology. American Fisheries Soc. Bethesda Maryland, USA.
5. Matty, A.J., 1985. Fish Endocrinology. Timber Press, USA.
6. Pakin, J. and Lensen, E.B. [eds], 1993. Fish Ecophysiology. Chapman and Hall, London.

ANALYSIS OF DEVELOPMENT	ZOL-637	3(3+0)

Course Objectives

1. To provide knowledge of Principal features of development and cellular basis of morphogenesis

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

Course Outcome

Students who successfully complete this course will be able to:

1. Identify the events that lead up to and comprise the process of fertilization.
2. Discuss the critical contributions of sperm and egg to the zygote and how structure informs function.
3. Describe in general terms how vertebrates gastrulate (frog, chick and mammal).
4. Identify embryonic structures in preparations, photographs and diagrams.
5. Indicate the derivatives of embryonic structures.

Course Contents

1. Introduction: Historical review of embryology. Uses of modern molecular techniques in Developmental biology. Developmental patterns; Sexual reproduction Spermatogenesis, Oogenesis and Fertilization Cleavage Patterns of embryonic cleavage, Mechanism of cleavage Gastrulation: Fate map Neurulation, ectoderm, mesoderm and endoderm Morphogenesis: Cellular Basis of Morphogenesis: Differential cell affinity, Cell adhesion molecules; Mechanism of Cellular Differentiation: RNA processing, Translational regulation of developmental process, Cell-fate by progressive determinants, Autonomous cell specification by cytoplasmic determinants, Axis Development Establishment of body axes and Mechanism of teratogenesis; Secondary Induction; Organogenesis: A brief account; Origin and Migration of Germ Cells in Vertebrates; Factors controlling Growth. Factors controlling Growth and Oncogenesis Hormones as Mediators of Development;
   Regeneration in Vertebrates.

Books Recommended

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

ANIMAL ADAPTATIONS	ZOL-638	3(3+0)

Course objectives

- To know about Requirement of animal habitat
- To know about adaptation and its types
- Specific examples of animals of different environment and their adaptation

Learning outcomes

- Requirement of habitat
- Learn about adaptation
- Specific examples of animals of different environment and their level of adaptation

Course contents

Introduction to habitat and niche, detail account of requirement of habitat and types of habitat, adaptation; its definition components and factors affecting adaptation; role of environment in adaptation; genetic, embryonic, physical anatomical morphological and physiological adaptations or changes; types of adaptations with their characteristic animals;

Recommended Books

1. Animal Adaptations (Life Science Library) Library Binding – August 30, 2006 by Elizabeth Rose

2. birds and climatic change: impact and conservation responses James W. Pearce-Higgins: Cambridge University;

3. Animals and Temperature: Phenotypic and Evolutionary Adaptation: Part of Society for Experimental Biology Seminar Series: Ian A. Johnston, University of St Andrews, Scotland Albert F. Bennett, February 2008

ANIMAL BEHAVIOR	ZOL-639	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. 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 behavioural; displays.
5. Integrate the animal behavior as balanced mechanism to develop animal personality.

Course Contents

Introduction to Behaviour and its types.Development of behavior and impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses. Physiology of behavior in changed environments.Hormones and behavior in animals. Innate behavior of three spined stickle back fish. Learned behavior and its mechanisms; quick learners' vs slow learners.Concept of animal cognition; key to understand and develop multiple behavioural choices.Ecological and genetics to maintain animal behavior.Concept of territoriality and defense in animals.Circadian rhythms and concept of bio-rhythmicity in animals. Costs and benefit ratios in behavior; Competition for resources; survival of the most suitable individuals; evolutionary arms races in behavior. Social organization in animals and concept of group living Communication in animals: Visual, Bioacoustic, electrical, chemical and tactile.Various types of chemical signals in animals' behavior and their importance in ecosystems.

Text and Reference Books

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

ANIMAL COMMUNICATION	ZOL-640	**3(3+0)**

Course Objectives

The objectives of this course are to…

1. Examine how animals communicate with each other: The physical adaptations and constraints on generating and receiving signals in different sensory modalities
2. Investigate the evolutionary processes that influence communication in animals.
3. Examine why animals communicate with each other: ultimate questions about communication.
4. Integrate this information and these concepts in a look at human communication Text

Course Learning Outcomes

- The students will learn animal communication its evolution and its role in survival of animal species

Course content

Introduction to animal communication; evolution of communication; Visual Communication. Visual communication for animals: badges and displays. Auditory Communication. Barking, growling, hissing and purring. Tactile Communication.Chemical Communication. Importance of animal communication in survival of species communication in invertebrates:

Book and Resources Text book:

1-Bradbury, JW and Vehrencamp, SL (2012)

2- Principles of Animal Communication, 2nd ed. Sinauer Associates; Sunderland, Massachusetts. http://sites.sinauer.com/animalcommunication2e/index.html

3- (http://www.dartmouth.edu/~library/reserves/).

ANIMAL PESTS AND PATHOGENS	ZOL-641	**3(3+0)**

Course objectives:

The course objectives are to;

- Give knowledge of animal pest
- To explains relationship of pest and animals diseases

Learning Outcomes:

The student should be able to identify, collect and management of different insects of household, man and animals.

Course content:

Introduction; identification, biology and control of different insect pests like ants, termites, cockroaches, silver-fish, cricket, powder-post beetle, carpet beetle, cloth-moths, psocids, lice, bed-bugs, fleas, mosquitoes, house flies, wasps, sand flies, stable flies, flesh flies, blow flies, tsetse flies, black flies and midges.

Recommended Books:

1. Agarual, S. 2009. Insect Pests of Cereals and their Management.Oxford Book Co. India. 2. Aldridge, B. 2004. Medical Entomology.Text book of Public Health and Veterinary Sciences. Chapman and Hall, London.

3. Atwal, A.S. and Dhaliwal, 2005. Agricultural Pests of Southeast Asia and their Management.Kalyani Publishers, Ludhiana.

4. Bishop, F. C. 1916. Fleas as Pests to Man and Animals, with Suggestions for Their Control. Harvard Uni Press, USA

5. Edmen, H. F. 2013, Handbook of Agricultural Entomology published by John Wiley & Sons 312 pp.

6. Fernald, H.T. 2008. Applied Entomology, An Introductory Textbook of Insects in their Relation to Man. Kessinger Publishing (Amazon).
7. Gold, R. E. and John, S. C. 2010, Hand book of Household & Structural Insect pest published by Entomological Society of America 160 pp
8. James, M.T. and Harwood, R.F. 1969. Herm's Medical Entomology. The Macmillan Company Canada.
9. Jarau, S. and Hrucir, M. 2009, Food exploitation by social insects CRC press 360 pages.

APPLIED MICROBIOLOGY	ZOL-642	**3(3+0)**

Course Objectives:
This course will provide:
- Information about the applications of microbiology in the different fields of life.
- Understanding of its applications in agricultural, industrial and/or environmental microbiology.
- Information on the role of microorganisms in biotechnology

Course Learning Outcomes
The students will learn;
- applications of microbiology in different fields
- applications in agricultural, industrial and/or environmental microbiology.
- the role of microorganisms in biotechnology

Course Contents

Control of microorganisms: Fundamentals of control by physical and chemical agents, antibiotics and other chemotherapeutic agents. Microorganisms and diseases: Host-microbe interactions. Resistance and immunity.Air, food and water-borne human infections.Human contact diseases.Infectious diseases of animals. Environmental microbiology: Microbiology of air. Aquatic microbiology.Soil microbiology.Microbiology of domestic water and sewage.Microbiology of food, milk and milk products. Industrial Microbiology: Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts. Microbial Ecology: Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

Books Recommended

1. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. Microbiology: A Human Perspective, 2001. McGraw Hill Higher Education.
2. Jacquelyn, G.G. Microbiology Principles And Explorations, 2001. John Wiley & Sons Inc.
3. Benson, H.J. MICROBIAL APPLICATIONS: LAB MANUAL IN GENERAL MICROBIOLOGY, 1994. WMC Brown Publishers, UK.
4. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., MICROBIOLOGY, 1986. McGraw Hill, London.

AQUACULTURE AND FISHERIES	ZOL-643	**3(3+0)**

Course Objectives:

The course aims to;

- Impart knowledge about history, needs and importance of fisheries and Aquaculture.
- Describe the culture able fish species and their biology.
- Elaborate the basics of fish culture and aquaculture facilities.
- Provide knowledge about fishing gears and post-harvest techniques.

Learning outcomes:

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

- Acquire knowledge about history, needs and importance of fisheries and aquaculture.
- Discuss various fish species characteristics and understand their culture requirements.
- Understand basics of pond fish culture and other advanced culture practices.
- Define various types of fishing gears, capturing methods and post-harvest technology.

2.

Course Contents

Introduction to fisheries and aquaculture, national and international trends.Fish morphology and diversity in size and shape.Distribution of fishes in Pakistan, commercial fishes, marine and freshwater.Types of ponds, planning construction and pond preparation. Pond fertilization, dosage and methods of application Food and feeding habits of fishes, feed types, artificial and natural fish feeds, feeding strategies of artificial fish feeds. Aquatic habitats, ecology and extant of distribution, Water quality parameters (abiotic: temperature, light, salinity, pH, turbidity etc.) and their effects on fish health and production. Biotic parameters (plankton, insects, aquatic vegetation etc.) of ponds, lakes, rivers, and impacts on fish growth.Induced breeding techniques.Fish diseases and their control.Fishing gears, fishing techniques, fishing communities.Fisheries co-management.Fish preservation, processing, transportation and marketing.

3. **Recommended Books:**

1. Stickney R.R. 2016. Aquaculture an introductory text, CABI. Publishing, London, UK.
2. Fitzsimmons, K., R.S.N. Janjua and M. Ashraf, 2015. **Aquaculture Handbook—Fish Farming and Nutrition in Pakistan.**
3. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture.Agrotech Publishing Academy, Udaipur, New Delhi, India.

4. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABIPublishing, London, UK.
5. Pillay, T.V.R. and M.N. Kutty 2005. Aquaculture: Principles andPractices. Blackwell Science Limited. New York.
6. Ali, S.S. 1999. An Introduction to Freshwater Fishery Biology.University Grants Commission, H-9 Islamabad.

ARACHNOLOGY	ZOL-644	**3 (3,0)**

Course Objectives:

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

Course learning outcomes:

On completion of this course, the students should be able to:
1. Study the history and importance of Arachnids.
2. Demonstrate about identifications of Arachnids.
3. Impart in-depth knowledge of Arachnids.

Course Contents:

Importance and applications of Arachnology.Importance and its future perspectives.History of arachnology, Introduction of arachnology according to history.Structure of the Arachnids Characters of Arachnids.classification position of class Arachnid. External and internal anatomy

Life history of Arachnids.Defense mechanisms.Arachnid with relationship to man.Role of Arachnids as a biological control.Arachnids families' identification.

Recommended Books:

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

BEHAVIORAL ECOLOGY	ZOL-645	**3 (3,0)**

Course objectives:

The course aims to:

- Give information about Natural selection ecology and behavior, testing hypothesis in behavioral ecology, economic decisions and the individual, predator versus prey evolutionary armed races.
- Give information about competing for resources, living in groups, fighting and assessment, sexual conflict and sexual selection, parental care and mating systems.
- Give information about alternative breeding strategies, on selfishness and altruism.
- Give information about cooperation and helping in mammal, fish and birds, altruism in insects, design of signal and its evolution.

Course learning outcomes:

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

- Understand about Natural selection ecology and behavior, testing hypothesis in behavioral ecology, economic decisions and the individual, predator versus prey evolutionary armed races.
- Understand about competing for resources, living in groups, fighting and assessment, sexual conflict and sexual selection, parental care and mating systems.
- Understand about alternative breeding strategies, on selfishness and altruism.
- Understand about cooperation and helping in mammal, fish and birds, altruism in insects, design of signal and its evolution.

Course Contents:

Natural selection ecology and behaviour, testing hypothesis in behavioural ecology, economic decisions and the individual, predator versus prey evolutionary armed races, competing for resources, living in groups, fighting and assessment, sexual conflict and sexual selection, parental care and mating systems, alternative breeding strategies, on selfishness and altruism, cooperation and helping in mammal's fish and birds, altruism in insects, design of signal and its evolution.

Recommended Books:

1. Bonnett, R., H. Fordd., 1993 Behavioural ecology of fishes - Nature
2. Krebs. 1997 - Behavioural Ecology: An Evolutionary Approach by - Science
3. Krebs 1993 - An Introduction to Behavioural Ecology - Science

BIOCHEMISTRY OF DRUGS ACTION	ZOL-646	**3 (3,0)**

Course objectives:

The course aims to:

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

Course outcomes:

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

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

Course Contents:

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

Recommended Books:

1. Cumings, J. N and Kremer, M. (1973). Biochemical aspects of Neurological disorders.
2. Hoffman, W. S. (1977). Biochemistry of Clinical Medicine, 4th Ed

BIOLOGY AND CONTROL OF VERTEBRATE PESTS	ZOL-647	**3 (3,0)**

Course Objectives:

The objectives of the course are: -

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

Course Outcomes:

Upon successful completion of the course, the student will be able to:
1. CLASSIFY the insects at different hierarchical levels.
2. RECOGNISE the insect pests of major crops.
3. DESIGN the pest management plan for insect pests of crops.

Course contents

general characteristics of insects. Relationship with other Arthropods, splitting up intodifferent evolutionary lines, Reasons for success of the insects in diverse environments. Population dynamics: factors regulating insect population. Life history and life tables.Predation and competition.Insect defenses and adaptations.Insect communication. Brief account of different insect pest management strategies as: Cultural Control; Physical and Mechanical Control; Host Plant Resistance; Biological Control; Chemical Control; Other approaches.

Recommended 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.
4. 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.

BIOMEDICAL TECHNOLOGY	ZOL-648	**3 (3,0)**

Course Objectives:

The objectives of the course are: -
1. To provide expertise in microbiology, with a particular focus on medical virology.
2. To achieve in-depth knowledge and understanding of medical virology.
3. Develop an understanding of the scientific basis of concepts, as well as practical skills in medical virology.

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:
1. Understand differences between the lifecycles of major groups of viruses, in particular how different viruses exploit the molecular and cell biology of their hosts.

2. Understand the innate and adaptive defenses of mammals against viruses, and the strategies that viruses have evolved to evade these host defenses.
3. Understand strategies to prevent (vaccination) and to treat (antiviral therapy) viral infections.

Course contents:

Detection and prevention: Eradication of viral diseases. Laboratory methods for detecting and classifying.Techniques for developing viral vaccines.Antiviral therapies. Gene modification & application of recombinant DNA Technology, Mutagenesis-Deletion mutagenesis, Oligonucleotide derived mutagenesis, Site directed mutagenesis, Applications of rDNA technology in Diagnostics; Pathogenesis, Genetic diversity; Therapeutic proteins-vaccines.Molecular probes (Production, labelling and uses).

Recommended Books:

1. Christopher Burrell Colin Howard Frederick Murphy. 2016. Fenner and White's Medical Virology, 5th Edition. Imprint: Academic Press. University of Texas Medical Branch, Galveston, TX, USA.
2. Dorothy H. Crawford. 2011. Viruses: A Very Short Introduction. Publisher Oxford University Press.
3. James H. Jorgensen, Michael A. Pfaller. 2015. Manual of Clinical Microbiology.11th Edition Publisher American Society for Microbiology. Washington DC, United States.
4. Nicholl, D. S. T. 2008. An Introduction to Genetic Engineering; 3rd Edition. Cambridge University Press, Singapore.

BIOTECHNOLOGY IN AQUACULTURE	ZOL-649	**3 (3,0)**

Course objectives:

The course aims to:

- Provide information about the role of biotechnology in aquaculture,
- Provide information about the use of effective microorganisms in technology; fish as an experimental animal, technical details and possibilities.
- Provide information about the use of hormones for sex manipulation and growth promotion in cultivable fishes.
- Provide information about the Hormonal enhancement of growth.

Course learning outcomes:

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

- Understand about the role of biotechnology in aquaculture,
- Understand information about the use of effective microorganisms in technology; fish as an experimental animal, technical details and possibilities.
- Understand about the use of hormones for sex manipulation and growth promotion in cultivable fishes.
- Understand about the Hormonal enhancement of growth.

Course contents:

Role of biotechnology in aquaculture, use of effective microorganisms in technology; fish as an experimental animal, technical details and possibilities. Use of hormones for sex manipulation and growth promotion in cultivable fishes: hormonal manipulation of sex, gonadal sex manipulation, masculinization and sterilization by androgens, femisnizaton by estrogens, duration and timing and method of administration of steroid hormones. Hormonal enhancement of growth.Genetic in enhancing productivity; phenotypic sex reversal, heterospecific insemination long-term preservation of gametes, selection of high directional growth rate, production of polyploids.chromosomes and DNA., sex hormones, Artificial fecundity and induced breeding of cultivable fish.

Recommended books:

1. Sinha, C.R.P. and Srivastava, 1991. Biotechnology and Aquaculture Engineering. Session Oxford and IBH Publishing Co. (Pvt.) Ltd., New Delhi.
2. Pimtani, M., 1992. Aquaculture Research Needs for 2000 AD. Oxford and IBH Publishing Co. (Pvt.) Ltd., New Delhi.
3. Gall, G.A. and Chen, H., 1994. Fish Bioenergetics. Chapman and Hall, London.
4. Schreck, C.B. and Moyle, P.B., 1990. Methods for fish Biology.American Fisheries Soc. Bethesda Maryland, USA.
5. Matty, A.J., 1985. Fish Endocrinology. Timber Press, USA.
6. Pakin, J. and Lensen, E.B. [eds], 1993. Fish Ecophysiology. Chapman and Hall, London.
7. Dunham R A. 2004. Aquaculture and Fisheries Biotechnology CABI.

ECOLOGICAL GENETICS	ZOL-650	**3 (3,0)**

Course objectives:

The course aims to:

- Provide information about the ecological Genetics: numerical fluctuations in animal population. Polygenic characters evolving in isolation.
- Provide information about the theory of genetic polymorphism; balanced polymorphism.

Course learning outcomes:

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

- Understand about the ecological Genetics: numerical fluctuations in animal population. Polygenic characters evolving in isolation.
- Understand about the theory of genetic polymorphism; balanced polymorphism.

Course contents:

Ecological Genetics: numerical fluctuations in animal population. Polygenic characters evolving in isolation.Selection for a balanced gene complex.Transition between stabilization (Sympatric evolution).The theory of genetic polymorphism; balanced polymorphism.The evolution of heterozygous advantage.The formation of supergenes. Genetics: general principles; gene structure; mutations; mutations and their chemical basis; detection and

isolation of mutants. Study of estimation of gene frequencies in natural population. Artificial selection of quantitative characters; protective coloration and frequency dependent selection (a) artificial prey (b) natural prey.

Recommended books:

1. Prescott, LM., Harley JP., and Klein, DA. 1999. Microbiology (4th edition). WC Brown / McGraw Hill. Publishers, USA.
2. Lewis, R. 1997. Human Genetics – concepts and applications. WCB-McGraw Hill Publishers, USA.
3. Pelczar, Jr., MJ. Chan, ECS. And Kreig. NR. 1997. Microbiology: Concepts and Applications, International Edition.McGraw Hill Publishers. USA.
4. Snustad, DP, Simmons, MJ and Jenkins JB. 1997. Principles of Genetics. John Wiley & Sons, Inc. New York. USA.
5. Tamarin RH. 1996. Principles of Genetics. 5th edition. WmC Brown Publishers USA.
6. Talaro, K. and Talaro. A. 1996. Foundations in Microbiology. WC Brown Publishers USA.
7. Levitan, M. 1988. Textbook of Human Genetics. Oxford University Press. UK.

ELEMENTS OF STRATIGRAPHY AND STRUCTURAL GEOLOGY	ZOL-651	**3 (3,0)**

Course Objectives

The objectives of the course are: -

1. To provide information on the distribution of animals and them 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 provides 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. DEVELOP the understanding of speciation, dispersal isolation and extinction process through biogeography and fossils record.
2. ILLUSTRATE the ability to locate, characterize and differentiate various biomes and fossils of animals over time.
3. EXPLAIN the distribution of animals on the basis of fossils record.
4. DEVELOP understanding regarding process of fossilization and its importance in evolutionary history of an animal and its distribution.

Course Outline:

Paleo geography, Theories of continental drift and plate tectonics, Pangea Zoogeographical regions: Zoogeographic Division and Boundaries; Geographic Ranges, Physical Features: Climates, Faunas and Affinities of Palearctic, Nearctic Regions, Oriental, Ethiopian, Australian, And Neotropical Regions, Insular Fauna. Paleontology:The Planet Earth, History, age, shells of earth, atmosphere, hydrosphere, biosphere and lithosphere.
Rocks: Types; lgneous rocks, sedimentary rocks and metamorphic rocks. Biostratigraphy, Paleontologically important areas of Pakistan.Geo-chronometry: Uranium/Lead dating, radiocarbon dating, methods, index fossils, evolutionary history of man, elephant, horse and camel, Paleoecology, Paleo magnetism.

Books Recomended:

1. Beddard, F. E. 2008. A text book of zoogeography.Bibliobazar, LLC. Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup & Sons. Delhi.
2. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
3. Darlington, P. J. Jr. 1963. Zoogeography, John Wiley and Sons. Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
4. Foote, M and Millar, A. I. 2007. Principles of paleontology 85rdEd. W. H.Freeman & Co. USA.
5. Ali, S.S. 1999.Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
6. Brouwer, A. 1977. General Palaeontology, Oliver and Boyed, London.

ENDOCRINOLOGY	ZOL-652	**3 (3,0)**

Course objectives:

The course aims to:

- Provide information about the Recent advancements in the field of endocrinology with specific reference to clinical aspects.
- Provide information about the Diseases of the endocrine system.
- Provide information about the Mechanism of the hypothalamic releasing factors – neurotransmitters; growth hormones; adrenocorticotropins (ACTH); gonadotrophins (FSH, LH, LTH); thyroid stimulating hormone (TSH); oxytocin; vasopressin; thyroid hormones; insulin and glucagons; adrenal hormones.
- Provide information about the gastrointestinal hormones.

Course learning outcomes:

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

- Understand about the Recent advancements in the field of endocrinology with specific reference to clinical aspects.
- Understand about the Diseases of the endocrine system.

- Understand about the Mechanism of the hypothalamic releasing factors – neurotransmitters; growth hormones; adrenocorticotropins (ACTH); gonadotrophins (FSH, LH, LTH); thyroid stimulating hormone (TSH); oxytocin; vasopressin; thyroid hormones; insulin and glucagons; adrenal hormones.
- Understand about the gastrointestinal hormones.

Course contents:

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; Nature, synthesis, transport of hormones;General concept of feedback, biorhythms, pathology and assessment of endocrine function; 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;posterior pituitary: Release, regulation and actions of vasopressin and oxytocin.Causes and effect of over and under production of hypothalamic and pituitary hormonesHypothalamic, pituitary and thyroid, adrenocortical, gonadal and other axis. Thyroid gland; Calciotrophic and Mineral Metabolism Hormones; Adrenal Medulla and Catecholamines; Adrenal Cortex; Testes: Androgenic tissue: Anatomy, structure, chemistry, synthesis and transport of hormone, Metabolism, action and mechanism of action.Testicular disorder. Ovaries: Ovarian Anatomy, hormones: Steroid biochemistry and biosynthesis;Cyclic changes, menopause

Ovarian disorder; Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and Adaptation in pregnancy and parturition.

Recommended books:

1. Neischalg, E. And Behre, H.M. 1997. Andrology. Springer Publications. USA.
2. DeGroot, I.J. (Eds). 1995. Endocrinology (3 volumes). W.B. Saunders Publications. USA.
3. Turner, C.D. and Bagnara, J.T. 1976. General Endocrinology. W.B. Saunders Publications. USA.

ENVIRONMENTAL PHYSIOLOGY	ZOL-653	**3 (3,0)**

Course Objectives:

Studying the proposed course, students should be able to:

1. Understand the conceptual mechanisms of ecology
2. Utilize the subject tools qualitatively and quantitatively in relation to environment.
3. Able to conduct independent research in diverse disciplines of ecology.

Course Learning Outcomes:

1. Acquire knowledge and apply advanced methods for studying ecosystem patterns and processes.
2.Understand the integrated understanding of the different concepts and theories for the community assembly and how they impact ecosystem functions.
3. Solve some basic and critical ecological issues related to present day ecology and community structures of animals.
4. Analyze sophisticated ecological issues and explain their role for environmental sustainability and fluctuations.
5. Understanding the complex interactions for the nutritional fluxes in ecosystems and predicted environmental disturbances to faunal distribution.

Course Outlines:

Basic themes of ecology; types of ecology, ecosystem classification, terrestrial, freshwater, desert and marine.Organismal ecology including the protists and invertebrates with their classification and characteristics.Aquatic Environment: water cycle and its properties, role of light in aquatic environments; water as solvent; dissolved oxygen contents, acidity and water movements and water balance. Terrestrial ecosystems: biogeo-chemical cycles in environment, role of forest plantations, types of forests; tropical, tropical-rain forests and coniferous forests to house animal's fauna. Animal adaptations: Animal adaptations to the environment role of temperature in maintenance of animals, life history patterns, nutritional constraints and animal development. Climate changes: global wind circulation, precipitation, ocean currents, regional climates, microclimates and their effects on animals. Animal survival values and adaptations to climate changes in various environments.Population trends: animals surviving in various environments, factors affecting growth rates, causes of mortality, natality and logistic equations to explain their sustainability. Concepts of animal tussles; intra and interspecific competitions.Community Dynamics: primary and secondary succession; landscape ecology and its importance. Ecosystem energetics and concept of bioenergetics in ecology.Habitat Loss; fragmentation ecology, biodiversity values and loss, conservation strategies in environments in response to restoration ecology.determine animal community populations.

Books Recommended:

1. Molles, M.M. 2015. Ecology; Concepts and Applications.McGraw-Hill Books; Inc., New Mexico, USA.
2. Bonan, G. 2015. Ecological Climatology. Cambridge Univ. Press,Cambridge, UK.
3. Dodds, W.K., M.R. Whiles. 2010. Freshwater Ecology. Acad. Press, Netherlands.
4. Nordell, S., T. Valone. 2017. Animal Behaviour. Freeman Press, New York, USA.
5. Speight, M.R., M.D. Hunter, A.D. Watt. 2008. Ecology of Insects. WileyBlackwell Co., USA

FISH BIOENERGETICS	ZOL-654	**3 (3,0)**

Course Objectives:

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

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:
1. SYNTHESIZE the scope and components of bioenergetics.
2. COMPARE and analyze energy budgets for different fish species.
3. DESCRIBE nutrient balances and imbalances and their impacts on fish.
4. DETERMINE energy utilization by fish and factors affecting it.
5. DESCRIBE how fishes utilize various feed ingredients in feeds.
6. DESCRIBE uses of energy in metabolism and food as nutrient sources.
7. DETERMINE energy requirements of fish.

Course Outline:

Introduction to Energetics and Energy Budget: Energetics Energy budget, Adaptive aspects of energy allocation Fish feed and their nutrition value Introduction to fish food and nutrition 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.Metabolism Carbohydrates Metabolism Amino acids metabolism Lipid Metabolism Regulation of metabolism by hormones Effects of biotic and abiotic factors on metabolism. Growth Regulation of growth by hormones, Thyroid hormones, Growth hormone, Effects of biotic and abiotic factors on growth

Recommended 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.

FISH CULTURE	ZOL-655	**3 (3,0)**

Course Objectives:

The objectives of this course are:
1. Identify the importance of fish culture.

2. Describe basic components of Aquaculture.
3. To enable the students the necessary basic information about fishery and aquaculture
5.

Course outcomes:

6. Upon successful completion of this course the students will be able to:
7.
1. Understand requirement for fish and seafood in the world is increasing.
2. The students will be able to understand the factors which are important for a sustainable growth in the industry.
3. Discuss advantages and disadvantages with the two aquatic food primary production systems, fishery and aquaculture
4. Discuss important factors for performing a sustainable fishery and a sustainable aquaculture
8.
9. Course contents:
10. Basic concept and principles of aquaculture (fish and prawn), selection of species for culture, site selection types of farms, contraction of ponds, soil qualities), Mariculture: substrate system, seawater ponds, cages, enclosures, tanks; aquaculture in fresh and brackish waters. Aquaculture in practice. General characteristics of fish: size, shape and external features. Freshwater fishes of Pakistan. Freshwater fishing methods.
11. Food and feeding habits of fish: feeding types. Pond fish culture: types of fish ponds, planning and construction of fish ponds, water quality variables. Requisite conditions suitable for fish culture. Cultureable species of fish , procurement of stocking material, preparation and management of rearing fish ponds. Mono-poly-and composite fish culture systems. Fertilization of fish ponds: their application and impact on fish growth an water quality. Fish feed and feeding: Feed ingredients and feed conversion efficiency. Fish diseases and their control.

12. Books Recommended:

1. Pillay, T.V.R., 1999. Aquaculture: Principles and Practices. Fishing News Books, U.K.
2. Ali, S.S., 1993. An Introduction to Freshwater Fishery Biology. University Grants Commission, Islamabad.
3. Parker, R., 1994. Aquaculture Sciences. Delmar Publishers, Washington DC.
4. Bardach, I.E., 1977. Sustainable Aquaculture.
5. Mareel, H., 1971. Text Book of Fish Culture-Breeding and Cultivation of Fish.
6. Purdom, C.E., 1995. Genetics and Fish Breeding.
7. Schorperclaus, W., 1991. Fish Diseases. Oxonian Press Pvt. Ltd. New Delhi, India.

FISH ECOLOGY	ZOL-656	**3 (3,0)**

Course Objectives:

The objectives of this course are**:**

1. Identify the importance of fish ecology.
2. Describe basic components of ecology.
3. To give the students the necessary basic information about fish ecology.
13.
14. <u>Course outcomes:</u>
15. Upon successful completion of this course the students will be able to:
16.
1. Practical and theoretical knowledge of aquatic systems, with emphasis of central topics in the management of freshwater
2. Basic limnology and water quality.
3. Understanding the role of eutrophication.
4. Predation and the significance of predation in water.
5. Cascade effects and regulation of freshwater systems
6. Basic fish ecology (growth and energetics in fish, fish parasites and population regulation in fish)

Course contents:

Properties of water, the significance of water for the formation of animals on individual and community level.Composition of fish biotic and abiotic components, Fish growth, processes, energetics, parasites and populations regulations. The natural and artificial (aquaculture) ecosystems, the most important Fish groups, community structures, and control of communities through top control (predator control), or bottom control (available food), eutrophication and its significance on fish growth, limnology and its importance.

BooksRecommended:

1. Fish EcologyWootton, R.J. (1992)
2. Fisheries Acoustics.Authors: MacLennan, David, Simmonds, E.J.
3. Fish Ecology (Tertiary Level Biology), 1991 by Robert J. Wootton .
4. Fisheries Ecology and Management by Carl Walters and Steven J. D. Martell
17.
18.

FISH ENDOCRINOLOGY	ZOL-657	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. Identify the importance of fish.
2. Describe basic hormone functions of Fishes.
19.

Course outcomes:s

20. Upon successful completion of this course the students will be able to:
21.

1. Understand requirement for fish and seafood in the world is increasing.
2. The students will be able to understand the factors which are important for a sustainable growth.

22.

Course contents:

Introduction to hormones & endocrine glands – hypothalamus, pituitary (master gland), Ultimobranchial gland, thyroid, parathyroid,Pineal gland, adrenal cortex and medulla, pancreas, ovary and testes – their morphology and hormones released – target organs and effect; positive and negative feedback mechanism;Comparison of endocrine glands of Fishes; the development of glands from pisces; hypothalamus, pituitary, pineal, thyroid, pancrease and adrenal glands. Pheromones – their secretion and action.

Books Recommended:

1. Neischalg, E. and Behre, HM. 1997. Andrology. Springer Publications. USA.
2. DeGroot, I.J. (Eds) 1995. Endocrinology (3 volumes). WB Saunders Publications, USA.
3. Nelson, RJ. 1995. An introduction to Behavioral Endocrinology. Sinauer Associates, NY USA.
4. Turner, CD and Bagnara, JT. 1976. General Endocrinology. WB Saunders Publications, USA.
5. Purdom, C.E., 1995. Genetics and Fish Breeding.

FISH HEALTH MANAGEMENT	ZOL-658	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. Recognize the importance of fish health.
2. Illustrate basic mechanism of fish health.

23.

Course outcomes:

24. Upon successful completion of this course the students will be able to:
25.

1. Identify requirements for healthy fish.
2. The students will be able to understand the factors which are important for a sustainable growth.
3. Evaluate important factors for a sustainable fishery and aquaculture

26.

Course contents:

27. Criteria for healthy Fish, physiology and anatomy of fish, body composition (water, protein, fats, carbohydrates and minerals in freshwater and marine fishes), nutrition and growth (dietary requirement, measurement of growth, factors affecting growth rates) reproductive physiology & endocrinology (types, reproductive system, development of ovary and testes, sex differences, sexual maturity, fecundity, fish migration), Fish diseases and their control.

28.

Books Recommended:

1. Najaa, LR, Lie, O and Jauncey, K. 1997. Aquaculture Nutrition. Blackwell Sciences Ltd., Oxney Mead Oxford UK.
2. Noga, EJ, 1996. Fish disease: Diagnosis and treatments. Osney Mead Oxford UK.
3. Halver, JE. 1995. Fish Nutrition. John Wiley, UK.
4. Woo, PTK. 1995. Fish disease and disorders: protozoan and metazoan infections. Voi. 1. Mc Millan & Co. USA.
5. Hirshchhorn, H. 1989. Hand book of fish diseases. Osney Mead Oxford UK.

FISH FEEDING MANAGEMENT	ZOL-659	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. Understand the importance of fish.
2. Enable basic components of fish food.

29.

Course outcomes:

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

30.

1. Acquire food requirement of fish.
2. Discuss important factors for performing a sustainable fishery and a sustainable aquaculture.
3. The students will be able to understand the factors which are important for a sustainable growth.

31.

Course contents:

32. Digestive physiology and anatomy of fish (food, feeding habits, factor affecting food consumption, digestion, absorption, conservation). Nutritional biochemistry and metabolism and amino acids, proteins.Fatty acids and lipids, carbohydrates, vitamins and minerals.Nutritional bioenergetics; feed stuff, feed ingredients, unconventional feed ingredients. Storages problems of feed and feed stuff, stability of ingredients in fish feeds, fish feed formulation. Fish feed manufacturing in developing countries with special emphasis on Pakistan.

33.

Books Recommended:

1. Najaa, LR, Lie, O and Jauncey, K. 1997. Aquaculture Nutrition. Blackwell Sciences Ltd., Oxney Mead Oxford UK.
2. Noga, EJ, 1996. Fish disease: Diagnosis and treatments. Osney Mead Oxford UK.
3. Halver, JE. 1995. Fish Nutrition. John Wiley, UK.
4. Woo, PTK. 1995. Fish disease and disorders: protozoan and metazoan infections. Voi. 1. Mc Millan & Co. USA.
5. Hirshchhorn, H. 1989. Hand book of fish diseases. Osney Mead Oxford UK.
6. Parker, R., 1994. Aquaculture Sciences. Delmar Publishers, Washington DC.
7. Bardach, I.E., 1977. Sustainable Aquaculture.

HEMATOLOGY	ZOL-660	**3 (3,0)**

Course objective:

The objectives of this course are:

1. To understand the blood cells in normal and abnormal conditions.
2. To illustrate the theory application of hematology procedures.

Course Outcomes:

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

1. Apply principles of safety, quality assurance and quality control in Hematology
2. Compare and contrast hematology values under normal and abnormal conditions
3. Evaluate normal and abnormal cell morphology with associated diseases.

Course contents:

34. Hematology: Hematopoiesis, Erythrocytes: Erythropoiesis, Maturation, Membrane Characteristics, Erythrocytes, Hemoglobin. Morphology and Inclusions Leukocytes: The Granulocytic and Monocytic Series, Lymphocytes and Plasma Cells.Anemia: Acute and Chronic Blood Loss Anemia and Anemias associated with Systemic , Disorders, Bone Marrow Failure Syndromes, Disorders of Iron Metabolism and Heme Synthesis, Macrocytic and Megaloblastic Anemias, Hemolytic Anemias, Hemoglobinopathies and Thalassemias, Disorders of Granulocytes and Monocytes, disorders of Lymphocytes, Characteristics of Leukemias, Lymphomas, and Myelomas, Acute Leukemias, Lymphoid and Plasma Cell Neoplasms, Myeloproliferative Neoplasms Myelodysplastic Syndromesand Myelodysplastic/Myeloproliferative Neoplasms

BooksRecommended:

1. Wintrobe's Clinical Hematology Text Book

2. Practical haematology. Book by Barbara Bain, Barbara J. Bain, Imelda Bates, Mike A Laffan, DM FrcpFrcpath, Mike A. Laffan, and S. Mitchell Lewis.
3. Hematology Board Review: Blueprint Study Guide and Q&A
4. HemattologiaClinica. Teoria y Procedimientos. Book by Mary Turgeon
5. Hematology: Clinical Principles and Applications Book
6. Clinical Hematology and Fundamentals of Hemostasis Book by Denise M. Harmening.
7. Bethesda Handbook of Clinical Hematology Book by Neal S. Young.

35.
36.

HERPETOLOGY	ZOL-661	**3 (3,0)**

37.

Course objective:

The objectives of this course are:

1. To understand the amphibians and reptiles.
2. To illustrate the behavior of amphibians and reptiles.

38.
39.

Course Outcomes:

40. Upon successful completion of this course the students will be able to**:**

41.

1. Understand diversityof amphibian and reptiles.
2. The students will be able to know the factors which are essential for a sustainable growth of amphibian and reptiles.

42.

Course contents:

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

Books Recommended:

1. Easa and K.K. Ramachandran. 2004, Peechi, Kerala Forest Research Institute Biodiversity Documentation for Kerala, Part 10: Reptiles. P.S., 57 p.
2. D.R. Khanna and P.R. Yadav. New Delhi 2005, Biology of Amphibia, Discovery Pub.394 p.
3. D.R. Khanna and P.R. Yadav. New Delhi 2004, Biology of Reptiles, Discovery Pub. 414 p.
4. J. C. Daniel. Delhi. 2002, The Book of Indian Reptiles and Amphibians/ Bombay Natural History Society and Oxford University Press.

5. F. H. Pough, Robin M. Andrews, John E. Cadle, Martha L. Crump, Alan H. Savitsky, Kentwood D. Wells 2003, Herpetology, Third Edition. 736 Publisher: Prentice Hall.

HISTOLOGY	ZOL-662	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. Identify different types of tissues.
2. Describe different organs of vertebrates.

43.

44.

45. Course outcomes:

46. Upon successful completion of this course the students will be able to:
    1. Understand the structures of vertebratestissues.
    2. The students will be able to understand different organs of vertebrates.

Course Contents:

Detailed study of types, structure and function of vertebrate tissues,selected glands and organs, Principles of Histology , Four Basic Types of Tissues (a.Epithelial b. Connective c.Muscle Tissue d. Nervous Tissue), Organs a.Integumentaryb.Digestivec.Respiratoryd.Cardiovascular e. Urinary f.Endocrine g. Male Reproductive System h.Female Reproductive System

BooksRecommended:

1. Junquiera, L.C. et al. BasicHistology, latest ed.
2. Eroschenko, V.P. diFiore's Atlas of Histology with Functional Correlations. 2012
3. Bloom & Fawcett. A Textbook of Histology.

47.

HUMAN GENETICS	ZOL-663	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. Understand the Phenomenon of Inheritance.
2. Describe the genetic disorder and gene therapy.

48.

49. Course outcomes:

50. Upon successful completion of this course the students will be able to:
    1. Know the the Phenomenon of Inheritance.
    2. Illustrate the genetic disorder and gene therapy.

    51.

Course contents:

Simples autosomal, sex-linked inheritance, lethal genes, chromosomal abnormalities, multiple alleles an blood groups, linkage an crossing over, variation in expression of genes, study of twins as a special method of genetic inference, congenital malformation and prenatal interaction, genetic aspects of race and race mixture. Cancer as a genetic disorder; Gene therapy and its types; inherited immune deficiencies, eugenics; Human Genome Project – in – depth analysis.

Books Recommended:

1. Lewis, R. 1997. Human Genetics – concepts and applications. WCB-McGraw Hill Publishers, USA.
2. Snustad, DP, Simmons, MJ and Jenkins JB. 1997. Principles of Genetics. John Wiley & Sons, Inc. New YorkUSA.
3. tamarin RH. 1996. Principles of Genetics. 5th edition. WmC Brown Publishers USA.
4. Levitan, M. 1988. Textbook of Human Genetics. Oxford University Press. UK.

ICHTHYOLOGY	ZOL-664	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. Identify the different types of fish nutrition.
2. Describe body composition of fishes.

52.

53. **Course outcomes:**

54. Upon successful completion of this course the students will be able to:

55.

56. 1: Understand the different nutrients of fishes

57. 2: The students will be able to understand body composition of fishes.

58.

Course Contents:

Biology of commercial food fishes of Pakistan, their morphology, anatomy, systematic, ecology and distribution. Physiology of digestion (food, feeding habits, factor affecting food consumption, digestion, absorption, conservation) body composition (water, protein, fats, carbohydrates and minerals in freshwater and marine fishes), nutrition and growth (dietary requirement, measurement of growth, factors affecting growth rates) reproductive physiology & endocrinology (types, reproductive system, development of ovary and testes, sex differences, sexual maturity, fecundity, fish migration.

Books Recommended:

1. Lagler, K.F. *et al*. 1977. Icthyology (Second Edition).

2. Norman, J.R. & Greenwood, P.H. 1975. A history of fishes (Third Ed).
3. Hoar, W.S. *et al*. 1979. Fish Physiology. Vol-VIII.
4. Mirza, M.R. 1975. Freshwater fishes and Zoogeography of Pakistan. Bijdr. Dierk. (Amsterdam), 45: 143-180.
5. Weatherly, A.H. 1972. Growth and Ecology of Fish Populations.
6. Nikolsky, G.V. 1978. The Ecology of Fishes.
7. Wootton, R.J. 1990. Ecology of Teleost Fishes. Chapman & Hall, London.
8. Jobling, M. 1995. Environmental Biology of Fishes. Chapman & Hall, U.K.
9. Weatherly, A.H. and Gill, H.S. 1987. The Biology of Fish growth. Chapman & Hall, U.K.
10. Talwar, P.K. and Jhingran, A.G. 1991. Inland Fishes of India & Adjacent Countries. Vol. I & 11. Oxford & IBH Publishing Co., Pvt. Ltd., New Delhi.
11. Mirza, M.R. and Bhatti, M.N. 1993. Pakistan Ki Machlianaur Mahi Parwari Part-I. Ferozesons (Pvt.) Ltd., Lahore, Pakistan.
12. Evans, D.H. 1998. The physiology of fishes.

IMMUNOLOGY	ZOL-666	**03(3,0)**

Course Objectives:

The objectives of this course are:

1) To promote critical thinking among students.
2) to provide students with a foundation in immunological processes
3) to provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology

Course Outcomes:

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

1) clearly state the role of the immune system
2) compare and contrast the innate versus adaptive immune systems

Course Outline: The immune system: organs constituting the immune system, their location in the human body and basic architecture, principles and techniques of seriology. The immunnocompetent cells; their origin, surface makers, populations and subpopulations, immuniological characterization and function. Anibody induction and production: antigen and antibody metabolism, cells involved in cellular sequence of events, kinetics of antibody synthesis, Antibody diversity. The role of T-cells and immunoglobulins in the immune response. Immunologic memory: positive and negative phenomena of natural tolerance.Manifestations of antigens antibody reactions including precipitation, agglutination, omplement fixation and neutralization. Basic and applications of ELISA, RIA, Immunoflorescence and Immunoblotting.Role of MHC in antigen presentation. Immunological disorders: Autoimmunity, Immunnodeficiency, Tissue rejection. Nature of tumor transplantation and immunology and immunogenetics.Resistance and immunonization to infectious diseases.

Books Recommended:

1. Abbas, K. Lichtman and Jordan, S. Pober (Latest Edition) Cellular and Molecular Immunology". W.B. Saunders.
2. Janeway-Travers. (Latest Edition) Immunobiology. Current Biology Ltd. UK.
3. Riott, IM, Delves, PJ (2001). Roitt's Essential Immunology. Blackwell Scientific Pub, London.
4. Geo f. brooks, Stephen A. Morse, Janet Butel, Janet S. Butel (2001). Jawetz, Melnick and Adelberg's Medical Microbiology McGraw-Hill Companies.
5. Kuby, J. (1996). Immunology Immunology 2nd Ed. W.H. Freeman & Co. USA. Benjamini, E. Immunology. (2001).

INSECT BIOACOUSTICS	ZOL-665	**03(3,0)**

Course Objectives:

The Main Objectives of this Course are

1. To understand the basic mechanism of production of sound in insects
2. To know the basic purpose of sound production in insects

Course Outcomes:

The students will be able to explain production and mechanism of sound.

Course Outline:

Introduction to insect bioacoustics, why insects listen:Predator detection and avoidance, reproduction and host localization. Being small yet loud: Resonance, Baffles. Enhancing sound reception: Resonance, Katydid ear trumpets, active mechanics. Sound localization: Pressure Gradient Ears of Crickets, Mechanically Coupled Fly Ears.

Books Recommended:

Arthur W. Ewing, Arthropod Bioacoustics: Neurobiology and Behavior

INSECT BIOCHEMISTRY AND PHYSIOLOGY	ZOL-666	**3(3,0)**

Course Objectives:

The objectives of this course are

1. To familiarize the students with the physiological systems in insects.
2. Identify the influence that neural and hormonal controls have within each system.
3. Develop a sense of how physiology can infuse in major research topics in entomology.

Course Outcomes:

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

1.Become familiar with insect biochemistry and physiological systems such as the endocrine system, the digestive system, the excretory system, the respiratory system, etc.

Course Outline:

1. Endocrine system (Ch. 1) : Hormones & signal transduction system o G-coupled protein o Secondary messengers (cAMP, Ca2+ , IP3, DG, nitric oxide) ,Insect hormones- [name, synthesis origin, overview of function] o Prothoracicotropic hormone (PTTH) o Ecdysteroids (ecdysone & 20-hydroxyecdysone) o Juvenile hormone (JH) o Adipokinetic hormone (AKH) o Eclosion hormone (EH) o Pheromone-biosynthesis-activating neuropeptides (PBANs) o Others: Mas-ETH, egg-development neurohormone (EDNH)

2. Integumental system (Ch. 2) : Structure, function & formation o sclerotization , Growth & Molting o Metamorphic development o Molting process o Endocrinology of molting & metamorphosis

3. Digestive/Metabolic system (Ch. 3) :Digestive system (alimentary tract) , Energy metabolism o Carbohydrate metabolism (glycolysis, Kreb's & oxidative phosphorylation) ,Glucose, PGAL, pyruvate, acetyl CoA, CO2, trehalose o Other metabolites- lipids, proteins o Transport and regulation ,Fat body (not from the book) o Structure o metabolism

4. Circulatory system (Ch. 4) : Systemo Hemolymph &Hemocytes ,Immunity ,Thermoregulation

5. Excretory system (Ch. 5) : System o Malpighian tubules & hindgut , Osmoregulation o Water o Salts

6. Respiratory system (Ch. 6) : Tracheal system , Physiology of gas exchange

7. Muscular system (Ch. 7) : Insect muscle tissue o types (tubular, close-packed, fibrillar) , muscle contraction o flight o synchronous vs. asynchronous o metabolism strategies

8. Nervous system (Ch. 8) : Components of the nervous system o Nerve potentials , Sensing the environment vision

9. Reproductive systems (Ch. 9) : Female reproductive systems , Male reproductive systems Reproduction

10. Developmental systems. (Ch. 10) Insect eggs &oogenesis , embryology

Recommended Books:

1.Physiological Systems in Insects. 3 rd edition Marc J. Klowden.Academic Press 2013.2.Insect Physiology and Biochemistry. James L. Nation. 2015
3.The Insect: Structure and Function. R. F. Chapman. 2013
4.Ecological and Environmental Physiology of Insects. Jon Harrison. 2012

INSECT PATHOLOGY	ZOL-667	03(3,0)

Course Objectives:

The objectives of this course are:

1)to provide knowledge about major insect pathogens including bacteria, fungi, viruses, protozoa and nematodes.

Course Outcomes:

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

1. Clearly understand the life cycles and pathobiology (pathology, transmission, effects) of the major groups of invertebrate pathogens (viruses, bacteria, fungi, protozoa, and nematodes) 2.Know The physiology and ecology of disease in insects, including the role of disease in the population dynamics of the hosts

Course Outline:

Insects Get Sick, Too: An Introduction to Insect Diseases : Insect Immunity; Resisting Parasites and Pathogens: Characteristics of Pathogens; Bacterial Disease Agents and Opportunists : Viva la Viruses: Microsporidian Misfits and other Protists : Fungal Pathogens: Mortality from Mycelia : Entomopathogenic Nematodes: Disease-Causing Worms : Dealing with Disease: Ecology, Epizootiology and Elimination.

Books Recommended:

1. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
2. Rozendael, J. A. 1999. Vector ConlJ19l. A I. T. B. S. publishers, New Delhi.
3. 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.

INSECTS OF VETERINARY AND MEDICAL IMPORTANCE	ZOL-668	03(3,0)

Course Objectives:

The Objectives of this course are:

1.to provide knowledge about insect vectors, disease borne pests of veterinary and human importance 2. to understand their life cycles as they carry viruses and other 108 organisms during transmission of diseases

3. to impart knowledge about their control.

Course Outcomes:

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

1.Identify the major pests of veterinary entomology and provide pest management solutions. 2. Learn to recognize the diversity of arthropods of medical and veterinary importance. 3. Learn the biology and ecology of the primary pests of importance

4. Compare and contrast the life-history strategies used by major vector and pest species of medical and veterinary importance

Course Outline:

General introduction to medical and veterinary entomology: phylum arthropoda, salient features of insects, classification, general morphology and physiology of insects, modifications in mouthparts and appendages of insects, metamorphosis and its types. Insects of medical and veterinary importance: mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks: life cycles, diseases and their control. Insect venoms; bees, wasps, ants.Insect toxins, arthropod allergens. Insect pest management: definition, principles and methods of insects control, components of pest management, techniques, general measures to control insects, economics of pest management.

Books Recommended:

4. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
5. Rozendael, J. A. 1999. Vector ConlJ19l. A I. T. B. S. publishers, New Delhi.
6. 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.
59.

INVERTEBRATA	ZOL-669	**03(3,0)**

Course Objectives:

The Objectives of this course are:

(1) to introduce how invertebrate animals are organized, how they work, and how they reproduce

(2)to provide students with a basic understanding of invertebrate diversity

Course Outcomes:

Upon successful completion of this course, the students will be able to:
1)Describe how different body designs solve (or create) biological problems related to physiological and environmental challenges
2)Contrast major animal groups with regard to how the body works in movement, growth, nutrition, respiration, water balance, excretion, defense, & reproduction

Course Outline:

A comparative approach in the study of structure with emphasis on function.Major groups of invertebrates and relationship.Living systems and organization relative to life. Adaptation for movements: Protozoa to Echinodermata: Pseudopodia, cilia, muscles and appendages. Nutrition in Protozoa, lower metazoan, filter feeding, intra and extra cellular digestion. Respiration and excretion.Nervous system; primitive and advanced.Reproduction and larval forms.

Books Recommended:

1. Brusca, R. C. and Brusca, G. J. (2002). Invertebrates. 2nd Ed. Sinauer Associates. Inc., Publishers.
2. Pechenik, J.A., 2000. Biology of invertebrates, 4th Edition (International). Singapore: McGraw Hill.
3. Hickman, Jr. C. P; Roberts, L. S and Larson, A. (1998). Biology of Animals. McGraw Hill Co, Inc.
4. Hickman, C.P., Roberts, L.S. and Larson, A., 2001. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
5. Barrington E. J. W. (1977). Invertebrate structure and function.
6. Rupppert, E, D and Barnes, R. D. (1994). Invertebrate zoology. 6th Ed. Saunders College Publishing.
7. Dorit, R. L., Walker, Jr. W. F and Barnes, R. D. (1991). Zoology. Saunders College Publishing, Inc.
8. Miller, A.S. and Harley, J.B., 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
9. Campbell, N.A., 2002. Biology, 6th Edition. Menlo Park, California: The Benjamin/Cummings Publishing Company, Inc.
10. Miller, S.A., 2002. Genral Zoology Laboratory Manual. 5th Edition (International) Singapore: McGraw Hill;
11. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.
12. Marshall, A.J. and Williams, W.D., 1972. *A Textbook of Zoology*,Volume I, Invertebrata. McMillan Co., New York.

INVERTEBRATE PALAEONTOLOGY	ZOL-670	**03(3,0)**

Course Objectives:

The main Objectives of this course are:

1)To increase the basic knowledge of the diversity of life forms that evolved during billions of years of Earth's history.

2) To increase the knowledge of students about division of invertebrate palaeontology.

Course Outcomes:

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

1. Become familiar with the major invertebrates history.
2. Familiar with divisions of invertebrate paleontology and taxonomy.
3. To learn the Hard and soft part preservation .

Course Outline:

Principles of palaeontology,Introduction, Occurrence of invertebrate fossils in Phanerozoic rocks, Hard-part preservation, Soft-part preservation, Divisions of invertebrate palaeontology, Taxonomy, The species concept, Nomenclature and identification of fossil species, Taxonomic

hierarchy, Use ofstatistical methods, Palaeobiology, Palaeoecology, Functional morphology, growth and form, Stratigraphy, Lithostratigraphy, Biostratigraphy and Chronostratigraphy.

Recommended Books:

Invertebrate Palaeontology and Evolution E.N.K. Clarkson Professor of Palaeontology Department of Geology University of Edinburgh Scotland Fourth edition

LIMNOLOGY	ZOL-671	**03(3,0)**

Course Objectives :

1.To impart the knowledge about the diversity of aquatic ecosystems.
2. To elaborate the chemical properties of water.
3. To teach about the adaptations and characteristics of aquatic life.

Course Outcomes:

Upon successful completion of this course, the students will be able to:
1.analyse and evaluate abiotic and biotic conditions in aquatic systems
2.account for structure and dynamics in biogeochemical cycles and organism communities

Course Outlines:

Diversity of aquatic ecosystems.Comparison of fresh, brackish and marine ecosystems. Unusual and extreme habitats, hydrology, physiography and physical properties like temperature, light, turbidity, currents, density, their interactions and relations with aquatic life. Chemical properties like dissolved oxygen, carbon dioxide, pH, alkalinity, hardness, inorganic and organic substances, their distribution, dynamics and influence on aquatic ecosystem. Status and forms of nutrients like nitrogen, sulphur, phosphorus 99 and carbon in natural waters; nutrients use and remineralization with special reference to processes controlling the levels of nitrogen, phosphorus and sulpher in aquatic ecosystem. Stichiometry of autographs and heterotrophs; concepts of trophic state, aquatic productivity & eutrophication.Managing eutrophication in freshwater habitats.Biodiversity of fresh waters.Ecological classification of aquatic biota.Limnological importance of biota.Adaptations and characteristics of aquatic life.Quantitative and qualitative changes in spatial and temporal distribution of aquatic biota.

Books Recommended:

1.Moss, B. R. 2010. Ecology of Fresh Waters.John Wiley & Sons Inc., New York, USA.
2. Dodds, W. K. 2006. Fresh Water Ecology: Concept and Environmental Applications. Academic Press, New York, USA.
3. Wetzel, R. G. 2001. Limnology: Lake and River Ecosystem. 3rd Ed. Academic Press, New York, USA.
4. Munshi, J. D. and J. S. D. Munshi. 1995. Fundamentals of Freshwater Biology. Narendra Publishing House, New Delhi, India.

5. Ward, H. B. and G.C. Whipple. 1989. Freshwater Biology. John Wiley & Sons Inc., New York, USA. 6. Welch, P. S. 1988. Limnology.4th Ed. McGraw Hill, New York, USA.

MAMMOLOGY	ZOL-672	**03(3,0)**

60.

Course Objectives :

1.To teach the students about phylogenetic relationships of the primitive and present mammals, based on taxonomic and modern approaches

2.To study the feeding and foraging periodicities of different mammalian groups and impact of environment on feeding behavior

3.To ascertain different mammalian population patterns viz. concept of natality, mortality, modeling signaling and effective communication in various mammals

Course Outcomes:

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

1.Identify the internal and external anatomical characteristics of the major orders and families of mammals.

2.Give examples of strategies mammals use to survive, find mates and reproduce.

Course Outline:

Introduction to mammalogy.History of mammalogy.Mammalian phylogeny.Dental and cranial characteristics.Evolution of viviparity. Biogeography: Mammalian radiation, biogeography of mammals of Pakistan. Food and 95 feeding: Stenophagy and euryphagy. Population regulation: Natality, mortality, immigration, emigration, population size, mean crowding, population modeling, Signaling: Types and evolution, communication and social organization. Mammalian Adaptations: Molecular basis of torpor, aestivation, hibernation, acoustic orientation (echolocation). Home range and territoriality. Predation: Predator-prey co-evolutionary race.

Books Recommended:

1.Vaghuan, T. A., J. M. Ryan and N. J. Czaplewski. 2010. Mammalogy. 5 th 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 York, USA.

MICROBIOLOGY	ZOL-673	**03(3,0)**

Course Objectives:

The main objectives of this course:

1)To give the students with basic knowledge about the diversity of microorganisms.

2) To impart knowledge about morphology and microbial activities

Course Outcomes:

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

1.to describe diversity, morphology and other life activities of microorganisms.
2. Identify the microorganisms and the diseases caused by microorganisms.

Course Outline:

History of Microbiology.Methods of Microbiology, microscopy, Culturing, Identification.Morphology and fine structure of viruses, Bacteria, fungi and Protozoan. Growth of microorganisms: Microbial cultivation (Viruses, Bacteria, Fungi). Microbial nutrition, Microbial reproduction, Growth control.Classification of microorganisms.Bacteria, Fungi, Viruses.Symbiotic relationships of Bacteria and fungi.Microbiology of soil, water and air.Microorganisms and diseases.

Books Recommended:

1.Kathleen, PT, Arthur, T (2010). Foundations in Microbilology, Basic Principles. McGraw Hill Companies.
2.Gerard, JJ, Tortora, Funke, Berbell, R, Funke, Christine, L Case (2006). Microbiology and introduction study guide. Benjamin Cummings Publishing Company.
3.Pelezar Jr. MJ Cham, E.C.S. Krieg, NR (1993). Microbiology, concepts and applications.McGraw hill, Inc. N.Y.

MEDICAL BIOTECHNOLOGY	ZOL-674	**3 (3,0)**

Course Objectives:

To acquaint students with biotechnology in healthcare including diagnostic tools, immunization and therapeutics.

Course Outcomes:

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

1. Develop an understanding of the various aspects of medical biotechnology.
2.Get the knowledge regarding various chemotherapeutic agents.
3.Develop an understanding of vaccination process.

Course Contents:

Introduction to medical biotechnology; social acceptance of medical biotechnology; molecular basis of disease; molecular and genetic markers; detection of mutations and infectious agents; active and passive immunization; vaccines (live, killed, recombinant DNA vaccines, subunit vaccines, DNA vaccines, edible vaccines); organ transplantation; applications of transgenic animals (animal models of diseases, farming and enhancement of farm animals); drug delivery systems; blood transfusion and grafting techniques; pharmacogenetics; gene therapy; biopharmaceuticals from plants; stem cell technology

Books Recommended:

1. Pongracz J. and Keen M. 2009. Medical Biotechnology.1st Edition; Elsevier Health Sciences. 2. Schacter B. Z. 2005. Biotechnology and Your Health: Pharmaceutical Applications. Chelsea House Publishers, 3.Chetan DM and Dinesh KP, 2006.Health and Pharmaceutical Biotechnology. Firewall Media. 4. Bustillo LGT and Pena IG, 2012. Biotechnology: Health, Food, Energy and Environment Applications (Biotechnology in Agriculture, Industry and Medicine).Nova Science Publication. 5. Dogramatzis, 2010. Health care Biotechnology. 1st Edition; CRC Press

MEDICAL MICROBIOLOGY	ZOL-675	**3 (3,0)**

Course Objectives:

1.To identify common infectious agents and the diseases caused by them.

2. To recall microbial physiology including metabolism, regulation and replication.

Course Outcomes:

By the end of the course the students will be able to:

1. Explain general and specific mechanisms by which an infectious agent causes disease.

2. Describe the epidemiology of infectious agents including how infectious diseases are transmitted.

Course Contents:

Microbiology and Medicine, antimicrobial agents, mode of action.Bacterial pathogenicity, sources and spread of infection in the community. Immunological principles: antigens, antibodies, and antigen- antibody reactions. Bacterial pathogens and associated diseases.Staphylococcus, skin and wound infections.Streptococcus, sore throat, scarlet fever, glomerulo nephritis.Pneumococcus, respiratory infections.Corynebacterium. Erysipelothrix: Listerial, Diphtheria. Mycobacterium tuberculosis: pulmonary and other tuberculosis infections. Actinomyces. Neisseria: Meningitis, Gonorrhoea. Salmonella, Shigella.Escherichia coli, Klesbsiella, Proteus, Providencia.Anthrax bacillus.Clostridum tetani.Poxiviruses.Herpes viruses.Herpes simplex.Cytomega-lovirus infections.Adenoviruses.Influenza viruses. Miscellaneous viruses: Rubella Corona, Areana viruses. Hepatisis viruses.Arboviruses.Rickettsia.Pathogenetic Fungi.Protozoa.Infective Syndromes and diagnostic procedures. Stratagy of antimicrobial Microbiology and Medicine, antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of infection in the community. Immunological principles: antigens, antibodies, and antigen- antibody reactions.Bacterial pathogens and associated diseases. Staphylococcus, skin and wound infections.Streptococcus, sore throat, scarlet fever, glomerulo nephritis.Pnemococcus, respiratory infections.Cornyebacterium. Erysipelothrix: Listerial, Diphtheria. Mycobacterium tuberculosis: pulmonary and other tuberculosis infections. Actinomyces. Neisseria: Meningitis, Gonorrhoea. Salmonella, Shigella.Escherichia coli, Klesbsiella, Proteus, Providencia.Anthrax bacillus.Clostridum tetani.Poxiviruses.Herpes viruses.Herpes simplex.Cytomega-lovirus

infections.Adenoviruses.Influenza viruses. Miscellaneous viruses: Rubella Corona, Areana viruses. Hepatisis viruses.Arboviruses.Rickettsia.Pathogenetic Fungi.Protozoa.Infective Syndromes and diagnostic procedures. Stratagy of antimicrobial therapy. Prophylactic immunization.

Books Recommended:

1. Boyd. R. F. (1995). Basic Medical Microbiology. 5th Ed. Little Brown and Co.
2. Ingles, T. S. S. (2003). Microbiology and Infection. 2nd Ed. Churchill livingstone.
3. Wester, E. W., Anderson, D. G., Pearsall, N. (2004). Microbiology: A human perspective. McGraw Hill.
4. Cruickshank, R, Duguid, J.P., Hermion, B.P. and Swain, R.H.A., (1975). *Medical Microbiology*, (Vol. 1 & Vol. 2), Churchill Livingstone, N.Y.
5. Turk, D.C. and Poster, I.A., (1978). *A Short Textbook of Medical Microbiology*, Hodder and Stoughton.
6. Vollum, R.L., Jamison, and Cummins C.S. (1970). *Fairbrother's Textbook of Bacteriology*, William Heinemann, London.Collins, C.H. and Lyne P.M. *Microbiological Methods*.

Molecular Biology	ZOL-676	**3 (3,0)**

Course Objectives:

The course will provide

1. An understanding of how molecular mechanisms are constructed and regulated
2. Knowledge about different molecular biological techniques

Course Outcomes:

By the end of the course the students will be able to:

1.Explain the fundamental structure, properties and processes in which nucleic acids play a role.

2.Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms.

Course Contents:

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

gene, mutation gene structure and function. DNA replication: prokaryotic and eukaryotic, viral, DNA repair, recombination, transonses their insertion sequence, gene expression: and translation: transcription, pro and eukarotic biosynthesis of RNA ad its regulation, initiation, elongation, and termination, RNA polymerase function and modulation of its activity: promoters, operators repressor, terminator, regulation, post transcriptional processing of rtRNA, mRNA, rRNA, Bacterial protein synthesis and regulation; Eukaryotic protein synthesis and regulation, post translational modification, organelles genome.

Books Recommended:

1. Darnell Jr. J., Lodisch, H. and Balimore, D., (2004). Molecular Cell Biology, Scientific American Inc. N.Y.
2. Zubay, G.L., (1995). Biochemistry, W.H. Freeman & Co., New York.
3. Griffiths, Anthony J. f., Et. Al. (2002). Modern genetic analysis: Integrating genes and genomes Edition 2nd W.H. Freeman, New York.
4. Lehninger, A.L., Nelson, D.L. and Co. N.M., (2000). Principles of Biochemistry. Worth Publishers, N.Y.
5. Lehninger, A.L., Nelson, D.L. and Co. N.M., (2000). Principles of Biochemsitry. Worth Publishers, N.Y.
6. Karp, G., (2002). Cell and Molecular Biology: Concepts & Experiments. 3rd Edition. John Wiley Sons, Inc., N.Y.
7. Weaver, Robert F. (1999). Molecular Biology McGraw-Hill, Boston.

Microbiology of Extreme Environment	ZOL-677	**3 (3,0)**

Course objectives:

The objectives of this course are:

1. To Understand basic knowledge of extremophiles.
2. To describe the remarkable survival abilities of microorganisms in a variety of extreme environments.

Course outcomes:

1: Understanding processes and changes in the environment.

2: Elaborate general competences in extreme microbial ecology.

Course contents:

Basic principles in microbiology and microbial ecology, Basic in cell structure and function, Newest methods in microbial ecology, Microbial biodiversity, Metabolisms, growth and regulation, Microbes in soil , water and sediments, Basics of underground microbiology, Aero-microbiology, Microenvironments and biofilms, Microbiology and extreme environments such as high and low temperature and desiccation, geographical poles, arid desert , volcanoes, salanity. Microbial life in permanently cold soil, lake ice microbial communities in alpine and Antarctic lake, Physiology of cold adapted microorganisms, genes and enzymes involve in

adapting extreme environment, microorganisms of cold desert, ice sheets and glaceries, cold sediments and geographical poles. Microbial life in permanently dry soil, desert microbial communities , Physiology of desert adapted microorganisms, , microorganisms of arid desert, , microorganisms of dry sediments.Microorganisms and their adaptation in saturating salt concentrations and Volcanoes.

Books recommended:

1: M. T. Madigan, J. M. Martinko, D. A. Stahl, D. P. Clark: Brock Biology of microorganisms – 13. izdaja (2012), Pearson Education, Inc., publishing as Benjamin Cummings, San Francisco

2: I. L. Pepper, C. P. Gerba, T. J. Gentry: Environmental Microbiology – 3. izdaja (2015), Academic Press, Elsevier

3: Vincent W.F. Microbial Ecosystems of Antarctica.Cambridge University Press, ; 1988

4: Brock T.D. Thermophilic Microorganisms and Life at High Temperatures**.** Springer-Verlag, ; 1978.

5: Brock T.D. Thermophiles: General, Molecular and Applied Microbiology. John Wiley & Sons, ; 1986.

6: Herbert R.A. Codd G.A. Microbes in Extreme Environments.Academic Press, ; 1986.

7: Kushner D.J. Microbial Life in Extreme Environments. Academic Press, ; 1978.

8: Shilo M. Strategies of Microbial Life in Extreme Environments. Dahlem Konferenzen. Verlag Chemie, ; 1979

NEUROBIOLOGY	ZOL-678	**3 (3,0)**

Course Objectives:

The course will provide :

1.an understanding of basic neuroanatomy and nervous system function on a molecular, cellular, systems level.

2. an understanding about behaviors that are control by nervous system.

Course Outcomes:

By the end of the course the students will be able to:

1.Explain function of nervous system.

2.Explain working principle of nerve cells.

Course Contents:

The organization of the nervous system; Electrical signals of nerve cells; Membrane permeability; Channels and transporters; Synaptic Transmission; Neurotransmitters; their receptors and effects; Intracellular signal transduction; The somatic sensory system; Pain; Vision; central visual pathways; the auditory system; the vestibular system; the chemical

senses; lower motor neuron circuits and motor control; upper motor neuron control of the brainstem and spinal cord; modulation of movement by the basal ganglia and the cerebellum; eye movements and sensory motor integration; the visceral motor system; brain development; construction of neural circuits; modification of brain circuits as result of experience; plasticity of mature synapses and circuits; The association cortices; Language and lateralization; sleep and wakefulness; emotions; sex, sexuality and brain; human memory.

Books Recommended:

1. Haines, D, E. (1997). Fundamental Neuroscience. Churchill Livingstone. Inc.
2. Purves, D., Augstine, G. J., Fitzpatrick, D., Katz, L. C., LaManta, A-S., McNamara, J. O., Williams, S. M. (2001). Neuroscience. Sinauer Associates, Inc.
3. Shepherd, G. M. (1994). Neurobiology. Oxford University Press, Inc.
4. Levitan, I. B. and Kaczmarek, L. K. (1997). The neuron: cell and molecular biology. Oxford University Press. Inc.
5. Matthews, G. G. (1998). Neurobiology. Blackwell Science.
6. Conn, P. M. (1995). Neuroscience in medicine. J. B. Lippincott Co.
7. Beatty, J. (2001). The human brain. Sage Publications, Inc.
8. Revest, P. and Longstaff. (1998). Molecular neurosciences. BIOS Scientific Publishers. Ltd.
9. FitzGerald,M.J.T and Jean Folan- Curran (2002).Clinical neuroanatomy and related neuroscience.Harcourt Publishers Limited.

Rafael Yuste and Arthur Konnerth (2005).Imaging in neuroscience and development a laboratory manual.Cold spring Laboratory press.

ORNITHOLOGY	ZOL-679	**3 (3,0)**

Course Objectives:

The objectives of this course are:

1. to provide students with knowledge to identify birds and understand their behavior and relationships in their natural habitats.

Course Outcomes:

By the end of the course the students will be able to:

1. Understand the diversity of birds.
2. develop an understanding about morphology and internal anatomy of birds.

Course Contents:

Introduction to ornithology, class Aves, taxonomy of birds up to orders, families and major species; evolution of birds; biology of fossil birds; archaeopteryx, archaeornithes, neoornithes; morphology and surface anatomy of bird, and development structure of feathers, plumage; structure of bones; basic embryology of birds; internal anatomy of birds; systems physiology; blood circulatory, cardiovascular physiology, heart, blood cells and hemodynamics; respiratory

system, air sacs, ventilation of lungs, metabolic rates, oxygen consumption; urinary system, kidney physiology and production of solid or semisolid excreta, brain physiology and anatomy, special senses, olfaction, vision, taste; digestive system, anatomy, guts and feeding strategies; morphological and physiological adaptations of birds to flying, kinds of flight, mechanisms of aerodynamics; reproductive organs anatomy and physiology, egg laying and breeding seasons; bird migration, song production, bird behavior, courtship, mating, egg incubation strategies, brood parasitisim; predator-prey relationship; homing behavior; learning, imprinting; nest building; bird parasite; endangered species of birds; bird conservation and sanctuaries.

Books Recommended:

1. Kaiser, G. W. (2008). The Inner Bird: Anatomy and Evolution. Amazon Co.
2. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
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. A J Urfi (2009). Birds of India: A Literary Companion, OUP.
5. Frank B. Gill. (2004). Ornithology.2nd Ed. W. H. Freeman & Co.
5. Handbook of Bird Biology by Cornell Lab of Ornithology. Princeton University Press. New Jersey. 2004
7. Rank B. Gill. (2004). Ornithology: Ecology and Evolution of Darwin's Finches 99 ed. (rev). Princeton. W. H. Freeman.
8. David Allen Sibley and Alfred A. Knopf (2003).The Sibley Field Guide to Birds of Eastern North America. New York Press
9. David Allen Sibley and Alfred A. Knopf (2002).Sibley's Birding Basics New York Press.
10. Salim Ali and S. Dillon Ripley (2001). Handbook of the Birds of India and Pakistan : Together with Those of Bangladesh, Nepal, Bhutan and Sri Lanka/. Reprint. New Delhi, Oxford University Press, 10 Vols.
11. Noble S. Proctor, Patrick Lynch, Patrick J. Lynch, Patrick J. Lynch (1998). Manual of Ornithology: Avian Structure and Function. Yale University Press.
12. Audubon Handbook: How to Identify Birds? 88th ed. Mcgraw-Hill Publishing Company.

PHARMACOLOGICAL AND PATHOLOGICAL ENDOCRINOLOGY	ZOL-680	**3 (3,0)**

Course Objectives:

1. To provide an understanding of endocrinological disorders and basic concepts.
2. To develop a plan for the diagnosis, treatment and prevention of the endocrinological disorders.

Course Outcomes:

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

1.Understand different disorders of Endocrine system.

2.Know about diagnosis and treatment of diseases of endocrine glands.

Course Contents:

Pharmacology, and toxicology of the endocrine system. Disorders of the Endocrine System: Hyperfunction & hypofunction of the glands; altered tissue response, tumors & other causes of endocrine disorders. Disorders of the Pituitary Gland: Anterior Pituitary: Developmental, circulatory & inflammatory disorders of the pituitary gland,Pituitary Adenomas: Classification, prevalence and the disorders related to tumors; Disorders due to abnormal secretion of anterior pituitary hormones: hypopituitarism; hyperpituitarism: Acromegaly & giantism, hyperprolactinemia Posterior Pituitary: Diabetes insipidus, syndrome of inappropriate secretion of ADH. Disorders of Growth: Endocrine and non–endocrine causes of abnormal growth. Disorders of the Thyroid Gland: Approach to a patient with thyroid disease; Adverse effects of Iodide, Goitrogens; Euthyroidism, Nontoxic goiter. Hyperthyroidism; Effects of thyrotoxicosis,Grave's disease, Hypothyroidism: Myxedema and cretinism, thyroiditis, thyroid cancer; thyroid hormone resistance syndromes. Endocrine Disorders of Bone and Mineral Metabolism: Clinical evaluation of metabolic bone disease, biochemical markers of bone metabolism Hypercalcemic disorders: parathyroid dependent & independent. Hypocalcemic Disorders: hypoparathyroidism & other causes of hypocalcaemia; disorders of phosphate & magnesium metabolism. Disorders of Endocrine Pancreas: Classification, signs, symptoms and pathogenesis of Diabetes mellitus: Secondary forms of diabetes mellitus, impaired glucose tolerance, Diagnosis, control & management of Diabetes Mellitus. Syndromes of extreme insulin resistance & Metabolic X syndrome.A brief account of Diabetic complications. Obesity: Prevalence, methods of determination of obesity, causes, endocrine & metabolic consequences of obesity. Disorders of Adrenal Gland: Adrenocortical disorders: Cushing's Syndrome, adrenal insufficiency, congenital Adrenal Hyperplasia. corticosteroid therapy: Glucocorticoids as pharmacologic agents and their adverse effects. Disorders of minearalcorticoid excess and deficiency, Endocrine hypertension, Pheochromocytoma and others.

Books Recommended:

1. Basic & Clinical Endocrinology, 7th Edition. Green Span & Strewter, Prentice Hall Intern, 2004.(Recommended Textbook).

2. Principles & Practice of Endocrinology & Metabolism, 3rd Ed. Kenneth L. Becker. Lippincot, Williams & Wilkins 2001.

3. Williams Textbook of Endocrinology; 10th edition. Larson, Kronenberg, Melmed & Polonsky. Saunders.2003

4. Endocrine Physiology 3rd Ed. Kacsoh. B., McGraw-Hill Boston, 2003

5. Essential Endocrinology, 3rd Ed. Charles G. D Brook & Nicholas, J. Marshall. Blackwell Science.Intern Edition.

6. Textbook of Endocrinology, 5th Ed., Mac E. Hadley, Pearson Education, 2005

7. Molecular Endocrinology, 3rd Ed., Franklyn F. Bolander, Elsevier Publication, 2004

8. Fundamentals of Clinical Endocrinology, 4th Ed, Reginald Hall & Michael Bessser. Churchill Living Stone,1989

9. Endocrinology, 2nd Ed. William Jubiz, McGraw-Hill International Editions, 1987.

PHYSIOLOGY OF FUNCTIONAL SYSTEMS	ZOL-681	3 (3,0)

Course Objectives:

1. To study the details of physiological systems maintaining the homeostasis.
2. Interrelations of the systems.
3. Regulatory features of the each system's function.
4. To study the details of nervous and hormonal coordination at molecular and cellular level in animal.
5. Bio synthetics, secretary and regulatory aspects of coordination.

Course Outcomes:

By the end of the course the students will be able to:

1.Explain structural and functional features of different organ systems.

2.Develop an understanding regarding regulations of these systems.

Course Contents:

Digestive System:Structure,Function,Mechanism of digestion in animals.

Excretory system: System organization, Kidneys, Urine formation, Glomerular filtration, Processes of tubular reabsorptions and secretion. Endocrine System: Cellular secretions and their types, Structure and function of endocrine glands, Basic mechanism of hormone action, Control of hormone secretion by Hypothalamo-pituitary axis, Secretions of non-endocrine glands of body. Reproductive System: Female reproductive system, Oogenesis and its hormonal regulation, Menstrual cycle: Phases of menstruation, hormonal regulation, Overview of secondary sex characteristics, external genitalia and mammary glands, Male reproductive system, Testes and Spermatogenesis, Male sex hormones and their role in spermatogenesis, Accessory sex glands and composition of semen. Musculo-skeletal System: Structure and function of muscle, Neuromuscular junction. Nervous System: Structure and function of neuron, Membrane potential and nerve impulse, Synaptic transmission, Sensory and motor system. Spinal Cord: Nerve Pathways, Sensory and motor tracts and Spinal nerves, Reflexes and reflex arc. Brain: Functional areas of brain and cranial nerves, Formation and regulation of cerebrospinal fluid, Cerebral blood flow and blood brain barrier, Receptors and their classification.

Books Recommended:

1. Shier, D., Butler, J., Lewis, R., 2003. Hole's Essentials of Human Anatomy and Physiology, 8th ed; McGraw-Hill.

2. Tortora, G. J. J., and Grabowski, S.R., 2000. Principles of Anatomy and Physiology, 9th ed; John Wiley and Sons,

3. Guyton, A. C. and Hall, J. E. 2005. Textbook of Medical Physiology, 12th ed; W. B Saunders.

4. Waugh, A., Grant, (2002). A., Ross and Wilson Anatomy and Physiology in Health and Illness, 9th ed; Churchill Livingstone,
5. Marieb, E.N., 1997. Human Anatomy and Physiology, 4th ed; Benjamin/Cummings Science Publishing, 6. Hall, J. E and Guyton, A. C., 2005. Guyton and Hall Physiology Review Elsevier Health Sciences
7. Seifter, J., 2005. Concepts in Medical Physiology Lippincott Williams & Wilkins. 8. Martini, F. H. and Ober, W. C., 2005. Fundamentals of Anatomy and Physiology, 2005.Pearson Education.
9. Marieb, E. N., 2005. Human Anatomy and Physiology Laboratory Manual: Fetal Pig Version, Update, Pearson. 10. Martini, F. H. 2005. Fundamentals of Anatomy and Physiology-Study Guide, Pearson. 11. Wood, M., 2005. Laboratory Manual for Anatomy and Physiology, Cat Version Pearson. 12. Wood,M. G., 2005. Anatomy and Physiology: Main Version. Pearson Education 13.Moore, K, L., Dalley, A. F. and Dalley, A. F., 2005.Clinically Oriented Anatomy.Lippincott Williams and Wilkins.

POPULATION BIOLOGY	ZOL-682	**3 (3,0)**

Course Objectives:

To understandthe interactions of organisms and their environments and the consequences of these interactions for population and community.

Course Outcomes:

Upon successful completion of this course,the students will be able to:
1.Know about basic characteristics of population.
2.Understand pattern of population growth and variation in population size.

Course Contents:

Introduction to population biology, basic population characters, growth and growth curves, growth and regulation of population size, population genetics, population dynamics and regulations.
Populations: distribution and abundance, population dynamics and distribution limits.
Population composition: Urban and rural character, biological characteristics, cultural characteristics.
Components of population growth: World patterns and trends of fertility, world patterns and trends of mortality, causes and consequences of migration and regional variations.
Community ecology: basic concepts, community analysis, ecotones, inter-population interactions.
Community: organization and various concepts, community dynamics.

Books Recommended:

1.A Primer of Population Biology1st Editionby Edward O. Wilson (Author), William H. Bossert (Author)

2.Population Biology: Concepts and Models Paperback– December 13, 1996by Alan Hastings (Author, Editor)

PRINCIPLES OF GENETICS	ZOL-683	3 (3,0)

Course Objectives:

1.To familiarize students with basic knowledge of gene and inheritance.
2. To understand transmission of DNA.
3.To describe applications and techniques of modern genetic technology.

Course Outcomes:

By the end of the course, the students will be able:

1. Describe the fundamental molecular principles of genetics.
2. Understand the relationship between phenotype and genotype in human genetic traits.
3. Describe the basics of genetic mapping.
4. Understand how gene expression is regulated.

Course Contents:

Mendelian principles.Sex determination and sex linkage. Gene interaction (Epistasis) and modifications of mendelian ratios. Multiple alleles and blood group systems.Quantitative inheritance.Linkage and recombination.Chemical nature of genetic material (DNA and chromosome organization), replication of DNA. Mapping the genom (linkage, crossing over and chromosome mapping, chromosome walking). Recombination in fungi, bacteria and viruses. Mutations: induced and spontaneous. Gene expression (in Prokayates, the operon system e.g., Lace and trp operon).Regulation of gene expression and development.Extra chromosomal inheritance including material effect. Transposable elements in bacteria, yeast and plants. Mutation and hereditary diseases in human, chromosomal aberrations, variations in chromosome number.Population genetics, gene frequencies and equilibrium, inbreeding and heterosis, Hardy-Weinberg Law.Genetics of behaviour.DNA transformation in bacteria.Plasmids in bacteria.Restriction endoucleases, cutting and joining of DNA, recombinant DNA and gene cloning.Restrictss.ion mapping and sequencing. Application: Genetic counseling, applications of principles of genetics in animal and plant breeding.

Books Recommended:

1. Lewis, R. 1997. Human Genetics – concepts and applications. WCB-McGraw Hill Publications, USA.
2. Snustad, DP, Simmons, MJ and Jenkins JB. 1997. Principles of Genetics. John Wiley & Sons, Inc. New York,
   USA
3. Tamarin RH. 1996. Principles of Genetics. 5th edition. WmC Brown Publishers USA
4. Lewin, B. 1990. Gene IV, Cell Press. Cambridge, M.A.

5. Mays, L.L., 1989. Genetics. A Molecular Approach. MacMillan and Co., N.Y.
6. Levitan, M. 1988. Textbook of Human Genetics. Oxford University Press. U.K.

QUANTITATIVE ZOOLOGY	ZOL-684	**3 (3,0)**

Course Objectives

1. The course will provide knowledge about the importance and use of quantitative data in zoology.
2. To help the students to understand the methods to analyse data pertaining to their research work and to assess the significance of their experimental designs.

Course Learning Outcomes

Students who successfully complete this course will be able to:

- DESCRIBE the roles quantitative data serves in Zoology and biomedicalresearch.
- EXPLAIN general principles of study design and its implications for valid inference.
- ASSESS data sources and data quality for selecting appropriate data for specific research questions.
- TRANSLATE research objectives into clear, testable statistical hypotheses.
- DESCRIBE basic principles and the practical importance of key concepts.
- APPLY numerical, tabular, and graphical descriptive techniques commonly used to characterize and summarize data.
- IDENTIFY appropriate statistical methods to be applied in each research setting.
- DIFFERENTIATE between quantitative problems that can be addressed with standard, commonly used statistical methods and those requiring input from a professional biostatistician.

Course Contents:

1. Introduction:

a. Types and properties of numerical data
b. Population and sample, variable, categorical and non-categorical data,
c. Scales of measurements, errors of measurements
d. Mensuration studies of animals

2. Measure of central tendency

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

3. Frequencies distributions and grouping

a. Empirical FD, relative FD, Cumulative FD, class frequency, class limits, class boundaries, class mark, class interval, midpoints.

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

4. Population and sampling

a. Inference in finite and infinite populations.
b. Inference based on sampling design.
c. Simple random sampling with and without replacement.

5. Probability and probability distribution

a. Definition, properties, experiment and random experiment, event, outcome, trial, multiplication rule, b. sample space and sample point, mutually exclusive event
c. combinations and permutations d. probability distribution
e. binomial experiment

6. Confidence interval

7. Correlation and regression

8. The analysis of variance and Tests of frequencies

a. ANOVA, its uses and LSD
b. Hypothesis testing
c. Steps of hypothesis testing
d. Z-test
e. t-test, types,
f. Chi-square

<u>Books Recommended:</u>

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.

RADIATION BIOLOGY	ZOL-685	**3 (3,0)**

Course Objectives:
1. To impart concepts about the ionizing Radiations.
2. To incorporate the Characteristics and genetic effects of radiations on biological systems.
3. To know about Hazards, protection and usefulness of radiations.

Course Learning Outcomes:
1.**Acquire**basic knowledge about the Radiations
2. **Understand**: the characteristics and effects of radiation on biological systems at molecular, subcellular, cellular and tissue levels.
3. **KNOW** about the usefulness of radiotracer in biological research.

Course Contents:
1. Introduction,
2. Ionizing radiations
3. Characteristic types and nature of radioactive emission.
4. Law of radioactive decay, carbon and uranium dating, effects of radiation on biological systems at molecular, subcellular, cellular and tissue levels.
5. The genetic effects of ionizing radiation.
6. Radiation hazards and principles of protection.
7. Radio-tracers as a useful instrument for biological research.

Books Recommended

1. Meredith, W.J. and J.B. Massey, 1978, Fundamental Physics of Radiology. Bristol. John Wiley and Sons, Ltd. U.K.
2. Lawrence, C.W. 1975: Cellular Radiobilogy, Edward Arnold (Publishers) Ltd, London.
3. Coggle, J.E. 1973: Biological Effects of Radiation. Wykehem Publications (London) Ltd.
4. Alper, T. 1981: Cellular Radiobiology. Cambridge University Press, London.
5. Margan, K. 1978: Principles of Radiations Protection, John Wiley & Sons, N.Y.
6. Granier, R. and Devis, J. (1999). Applied radiation biology and protection. Ellis Hawood Ltd. England.
7. Farshier, S. (2001). Essentials of radiation biology and protection. Blackwell publisher UK.
8. Bodri, W. (2000). How to neutralize the harmful effects of radiation or radioactive exposure. Blackwell publishers, UK.
9. Davidovits, P. (2001). Physics in biology and medicine, Edition 2nd Harcourt Science and Technology Company, San Diego.

REPRODUCTIVE BIOLOGY	ZOL-686	**3 (3,0)**

Course Objectives:

The objectives of the course are:-
1. To introduce the field of Reproductive Biology, its history and significance
2. To impart knowledge about anatomy and physiology of reproduction
3. To demonstrate the socio-economic issues of reproductive biology.

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:
1. **UNDERSTAND** the fundamental anatomy of male and female reproductive systems in various mammalian species
2. **ACQUIRE** knowledge about histology and physiology of the male and female reproductive systems
3. **COMPREHEND** the basic patterns and periodicity of reproductive processes in mammals
4. **ELABORATE** the socio-economic problems related to reproductive biology

Course Contents:

1. Introduction

a. Reproductive Biology Around Us – Overview
b. Anatomy of female reproductive system
c. Anatomy of male reproductive system
d. Reproductive Endocrinology
e. Pituitary and hypothalamus

2. Reproductive cycles

a. Puberty and seasonality of breeding
b. Estrous cycle and menstrual cycle
c. Disorders of sexual development
d.Folliculogenesis
e.Spermatogenesis
f. Fertilization and early embryonic development
g. Implantation and placentation
h. Parturition & Post-Partum recovery
i. Obesity & Reproduction
j. Regulation of Fertility in Humans
k. Reproductive Aging
l. Lactation
m. Addictions & Reproduction
n. Endocrinology of Stress in Reproduction

Books Recommended:

1. Pathways to Pregnancy and Parturition by P. L. Senger. 3rd edition (2012). Published by Current Conceptions Incorporated USA.
2. Andrology by E. Nieschlag, H. M. Behre and S. Nieschlag. 3 rd edition (2010).Published by Springer, USA.

3. Knobil & Neill's Physiology of Reproduction by T. M. Plant and A. J. Zeleznik. 4th edition (2014).Published by Springer, USA.
4. Endocrinology: Adult and Pediatric (Vol II) by J. L. Jameson and L. J. De Groot. 7th edition (2015).Published by Elsevier - Health Sciences Division.

TERATOLOGY	ZOL-687	**3 (3,0)**

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 regarding teratology risks for drug, chemical, and infection exposures during pregnancy.

Course Contents:

1. Introduction to teratology

a.Teratology: an overview

b. Impact of Planned and Unplanned Pregnancy on teratological development

c. Mechanism of teratogenesis

2. **Effect of Ionizing radiations**

a. Atomic bomb survivors in Japan

b. Impact of radiation before or immediately after implantation of the embryo into the uterine wall

c. Higher doses of radiation during all stages of intrauterine development

3. Hypoxia, hyperthermia and industrial exposure

a. Activation of stress protein

b. Hypoxic exposure impact on during chorio-vitalline membrane development

4. Teratogenic effects of substances of abuse

a. Ethanol

b. Heroin
c. Cocaine and heavy smoking

5. Effects of maternal infections in pregnancy

a. Zika virus
b. Rubella
c. Toxoplasmosis

6. Effects of maternal diabetes on the developing embryo and fetus

7. Effects of systemic lupus erythematosus (SLE) and other autoimmune diseases and effects of anemia during pregnancy

8. Impact of various medications on development

a. Antiepileptic drugs
b. Anticancer drugs
c. Antithyroid medicines
d. Psychoactive medication

Books Recommended:

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 3 rd 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

TECHNIQUES IN FISHERIES RESEARCH	ZOL-688	**3 (3,0)**

Course Objectives:

The course aims to;

1. Equip students with basic and advanced techniques used in fisheries & aquaculture research.
2. Develop critical thinking, technical expertise and work habits.
3. Expose students to the equipment, field situations, collecting techniques, laboratory procedures, data analyses, writing styles, research expectations, and frustrations of fishery science..
4. Reproductive capacity and success, recruitment, food habits, migrations, population estimates, and other aspects of fishery science and management.

Course Learning Outcomes:

After completing this course students will be able to;

1**. Understand** basic and advanced techniques used in fisheries research.

2. **Solved** problems by using technical expertise to design and devise strategies.

3. **Practically** using equipment and software to formulate, analyze and elaborate results.

4. **Demonstrate** advanced equipment and techniques used for analysis.

Course Contents:

Identification and growth indices:

Fish sampling, Fish morphometric measurements, stock assessment, age and growth studies, length weight relationship, Condition factor; Daily Growth Coefficient, Hatchery operations and fish breeding techniques.

Feed formulation and Proximate Analysis:

Definition, Categories**:** Moisture, Ash, Crude protein, Crude lipid, Crude fibre, Nitrogen-free extracts (digestible carbohydrates). Genetic and hormonal manipulation for increased fish production.Food Conversion Efficiency, Fish Health & Safety.

Microtomy:

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

Extraction techniques:

Centrifugation, Ultracentrifugation, Distillation, Use of 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.

Separation Techniques:

Chromatography: Principle, applications, types, thin layer, column, gas, ion exchange chromatography. Electrophoresis.

Spectrophotometery:

Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.

Basic principles of Sampling and Preservation:

Sampling soil organisms, Invertebrates, Aquatic animals, Mammals, Preservation of dry and wet specimens.

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.

VECTOR BIOLOGY	ZOL-689	**3 (3,0)**

Course Objectives:

The objectives of the course are:-

1. To provide in-depth appreciation of diseases transmitted by invertebrate vectors.
2. To impart knowledge about control of vector-borne disease.

Course Learning Outcomes:

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

1. 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 Contents:

1. Vector Biology and Control

a. Key aspects of vector taxonomy
b. Evolution
c. Biology and Behavior.

2. An introduction to the life-cycles of vectors

a. Ecology
b. Role in transmission of various diseases

3. Major groups of arthropod-borne pathogens and vectors

a. Basic components of disease cycles
b. Principles of pathogen transmission dynamics

4. Emergent pathogens

a. Vector genetics
b. Vaccines for vector-borne disease
c. Traditional and modern disease control strategies
d. Venomous Arthropods.

5. Biology and Ecology of some vectors of medical importance (order Diptera)

a. Mosquitoes (Anopheles culicine), Black flies 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).

b. Morphology, anatomy, distribution, breeding habits, life-cycle and seasonal prevalence of the species
c. Brief account of diseases spread by these vectors
d. Methods of control
e. Modern trends in their biological and chemical control.

Books Recommended:

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. 4 th 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.

Vertebrate Palaeontology	ZOL-690	**3 (3,0)**

Course Objectives:

The objectives of this course are
1. To discuss the history and evolution of the vertebrates.
2. The phylogenetic relationships and evolutionary patterns of the major groups.
3. The laboratory component focuses on comparative vertebrate osteology and fossil representation of major groups.

Course Learning Outcomes:

On completion of the course, the students will be able to;
1. Acquire theoretical knowledge about prehistoric life form of fishes, amphibians, reptiles, birds and mammals at different stages of Geological Time Scale.
2. Compare different oesteology of vertebrate groups.
3. Collect the fossils from field
4. Evaluate the palaeocology and palaeoenvironment associated with different faunal elements.

Course Contents:

1. **Introduction to vertebratePalaeontoloy and vertebrate origions**.
2. **Fishes**
a. Early Fishes and Acquiring Jaws

b. Post-DevonianFish Evolution:
c. Sharks, rays, and bony fishes
d. Sarcopterygii and the oldest tetrapods (fishes with legs)
3. Carboniferous Tetrapodsand amphibians
4. Reptiles
a. Origin of Amniotesand early Amniotes
b. Synapsidsof the Permian
c. Basal Archosaurs and Origin of Crocodiles
d. Early Crocodilians, Testudines, and Lepidosaurs
e. Mesozoic Marine Reptiles
f. Origin of Dinosaurs
i. Saurischia
ii. Ornithischia
iii. Pterosaurs
5. Birds and Feathered Dinosaurs
6. Cretaceous–Tertiary Boundary Extinction
7. Origin of Mammals; Mesozoic Mammals
8. Dawn of the Age of Mammals; Early Cenozoic Mammals
9. Major Groups of Cenozoic Placentals

Books Recommended:

1. Vertebrate Palaeontology 3rd Edition (2005), by Michael J. Benton
2. Vertebrate Paleontology and Evolution, by Robert L. Carroll (1988), published by W. H. Freeman and Company.
3. Mammals from the Age of Dinosaurs, by Z. Kielan-Jaworowska, R. Cifelli, and Z. Luo (2004), published by Columbia University Press.
4. Gaining Ground: The Origin and Evolution of Tetrapods, by Jennifer A. Clack (2002), published by Indiana University Press.
5. The Beginning of the Age of Mammals, by Ken D. Rose (2006), published by The Johns Hopkins University Press.
6. The Rise of Placental Mammals, edited by Ken D. Rose and J. David Archibald (2005), The Johns Hopkins University Press.

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Veterinary and Wildlife Parasitology	ZOL-691	**3 (3,0)**

Course Objectives:

1. Provide knowledge regarding different modes of transmission of wildlife parasites along with their pathology, life cycles and host parasite relationship
2. Impart advance knowledge on various important wildlife parasites. 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. **Describe** the nomenclature used in parasitology and classify parasites.
2. **Acquire** knowledge regarding different modes of transmission of wildlife parasites along with their pathology life cycles and host parasite relationship.
3. **Examine** about host parasite relationship and control measure.

Course Contents:

1.Introduction to parasitology

a. Effect of parasites on their hosts and their economic importance;
b. Basic terminology
c. Parasite relationship
d. Types of parasitism
e. Organ specificity, Ecology of parasites
f. Types of hosts
g. Modes of infection of parasites
h. Nomenclature and classification of parasites
i. Parasitic Zoonosis
j. Immunity against parasites General concepts on Parasite control strategies

1. An overview of Wildlife in Pakistan

a. Parasites of wild animals and birds
b. Role of wild animals and birds in dissemination of parasitic disease of domestic animals and man
c. Pathogenesis
d. Diagnosis and control of ecto and endo-parasites of wild animals and birds.

Books Recommended:

1. Schmidt G.D. and L.S. Roberts, 2013. Foundations of Parasitology. 9th Edition, W.C.B. Company, U.K.
2. Akhtar, M., M.A. Hafeez and C.S. Hayat, 2003. General Parasitology and Protozoology.The Elite Scientific Publications, Faisalabad-Pakistan.Bowman D. D. (2013): Georgis' Parasitology for Veterinarians. 10th Ed. Saunders Elsevier.
3. Urquhart G.M., J. Armour, J.L. Duncan, A.M. Dunn, F.W. Jennings, 2000. Veterinary Parasitology.Longman Scientific and Technical, U.K.
4. Foreyt, W.J., 2001. Veterinary Parasitology, Reference Manual Iowa State Press, Blackwell Publishing Company.
5. Zajac A.M. and G.A. Conboy, 2006. Veterinary Clinical Parasitology 7th Edition.Blackwell Publishing AAVP.
6. Iqbal, Z., M.S. Sajid, A. Jabbar, R.Z. Abbas and M.N. Khan, 2006. Techniques in Parasitology.Higher Education Commission, Islamabad-Pakistan.
7. Hayat, C.S. andM. Akhtar. 1999. Parasitic Diagnosis. University Grants Commission, Islamabad, Pakistan.

8. Fowler, M.E., 1990. Zoo and Wild Animal Medicine Current Theraphy Saunders, W.B. Company, Philadelphia, USA.
9. Levine, N.D., 1990. Veterinary Protozoology.The lowa State University press.Ames, Lowa, USA.
10. Soulsby, E.J.L., 1986 Helminths. Arthropods.And Protozoa of Domesticated Animals.7th Ed. Bailliere and Tindall, London.
11. Davis, J.W. and R.C. Anderson. 1971. Parasitic Disease of wild Mammals, The lowa State University Press, Amess, USA.

Wildlife Management and Conservation	ZOL-692	**3 (3,0)**

Course Objectives:

The objective of this course is
1. To enable the student to understand values and objectives of wildlife conservation
2. To understand the wildlife management rules and regulations in Pakistan 3. To understand how National and International agencies involved in conservation and management of wildlife.

Course Learning Outcomes:

Upon successful completion of this course, the student will be able to:
1. **ACQUIRE** theoretical knowledge about the identification, distribution, status, conservation and management (population estimate technology) of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan.
2. **UNDERSTAND** the zoo rules, protected area system Game Reserves, Wildlife Sanctuaries and National Parks,
3. **SOLVE** the threats to wildlife by applying the scientific principles and modern technologies.
4. **ANALYSE**,interpreting and synthesize data and other information about the population of wildlife
5. **EVALUATE** the conservation management by government department, National and International organizations
6. **DEMONSTRATE** the ecological assessment, International conventions and importance of wildlife to certain area.

Course Contents:

1. Wildlife of Pakistan

a. Introduction
b. Important Definitions
c. Identification
d. Distribution
e. Status
f. Wildlife values
g. Conservation and Management (population estimate technology) of fishes, amphibians, reptiles, birds and mammals of major importance in Pakistan

2. Objectives of wildlife conservation
3. Problems in wildlife conservation
4. Wildlife rules and regulations in Pakistan
a. Principles of Reintroduction
b. IUCN categories of Wildlife
c. Zoo rules
5. National and International agencies involved in conservation and management of wildlife
a. National Organizations
b. International Organizations
6. Protected Areas in Pakistan
a. Sanctuaries
b. Game Reserves
c. National Parks
7. Threatened species of Pakistan.
a. Vulnerable
b. Endangered
c. Critically Endangered
8. Modern Techniques for Control of Environmental Pollution in Wildlife Areas
9. Endangered Species Causes and Measures for the Conservation
10. International Conventions

Course Contents:

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

Books Recommended

1. Primack, RB. 1998. Essentails of Conservation Biology. 2nd edition. Sinauer Associates, NY. USA.
2. Meffe, GK. And Carroll, CR. 1997. Principles of Conservation Biology. Sinauer Associates, NY. USA.
3. Primack, RB. 1995. A Primer of Conservation Biology. Sinauer Associates, NY. USA.
4. Giles, RH. Jr. 1989. Wildlife Management Techniques. Wildlife Society – Washington. DC. USA
5. Bailey, JA. 1986. Principles of Wildlife Management. John Wiley & Sons. Inc. USA.
6. Dasma, RF. 1979. Wildlife Biology, John Wiley & Sons, Inc. USA.

Zoological Microtechniques	ZOL-693	**3 (3,0)**

Course Objectives:

This course aim to;

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

Course Learning Outcome:

After successfully completion of this course,

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

Course Contents:

1. Microscopy:

a. Principles of light microscopy. Magnification, Resolution,

b. Types of microscopy (Bright field, Dark field, Phase Contrast)

c. Confocal Microscopy

d. Electron microscope: Scanning electron microscope and Transmission electron microscope (SEM and TEM).

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

a. Diferent Measurement systems (length; surface; weight, volume, temperature), Calculations and related conversions

b. Concentrations- percent volume; ppt; ppm - molarity, normality, molality

c. Preparation of stock solutions of various strengths

d. Use of stage and ocular micrometers

e. Calibration of ocular micrometer and measurement of size animal and plant cell and nuclei.

3. Specimen preparation for optical microscopy:

a. Introduction to Microtomy and its types

b. Tissue Fixation, dehydration, clearing, embedding, Section cutting (transverse, longitudinal section)

c. Tissue mounting (dry mount, wet mount)

d. Staining: Hematoxylin and Eosin staining

4. Separation and purification techniques:

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

5. Chromatography:

a. Chromatography: Principle, applications, types,

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

6.Spectrophotometry:

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

7. Basic principles of Sampling and Preservation:

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

8. DNA sequencing:

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

Books Recommended

1. Dean, J. R. 1999. Extraction Methods for Environmental Analysis.John Wiley and Sons Ltd. UK. 45
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.

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