UOS/CE/No. 2946
7-9-17

UNIVERSITY OF SARGODHA, SARGODHA

NOTIFICATION

No. UOS/Acad/762 Dated: 30.08.2017

On the recommendation of Academic Council made in its meeting dated 23.08.2016, the Syndicate in its 1/2017 meeting held on 15-16.05.2017 has approved the curricula of following programs to be implemented from the session mentioned against each:-

1. *Revised Scheme of Studies for BS, M.Sc, M.Phil & Ph.D Botany w.e.f 2016 and onward (annex-**'A', 'B', 'C'** & **'D'**).*
2. *Addition of Elective Courses in MS (CS) Curriculum w.e.f 2016 (annex-**'E'**).*
3. *Addition of courses in scheme of studies of Ph.D program of Computer Science (annex-**'F'**). (already included and notified vide No.UOS/Acad/573 dated 19.06.2017)*
4. *Revised curriculum of BS 4-Year Mathematics program w.e.f 2016 & onward (annex-**'G'**).*
5. *Revised curricula of M.Sc and M.Phil / Ph.D Mathematics w.e.f 2016 (annex-**'H', 'I'**)*
6. *Revised Scheme of Studies for BS, M.Sc, M.Phil and Ph.D Zoology w.e.f 2016 (annex-**'J', 'K', 'L', 'M'**)*
7. *Addition of Elective Courses in the Scheme of Studies of MS(CS) program (annex-**'N'**)*
8. *No. of credit hours for MS (CS) Thesis in Computer Science department (annex-**'O'**)*
9. *Addition of Elective Courses BS (CS) program in Computer Science w.e.f 2016 s(annex-**'P'**)*
10. *Revised curricula of BS & M.Sc program in Biotechnology w.e.f 2016-17 (annex- **'Q'** & **'R'**)*

30/8/17

(AMJAD HUSSAIN JANJUA)
Deputy Registrar (Acad)

Distribution:

- Chairman / Incharges of the concerned departments
- Controller of Examinations
- Directors Sub-Campuses
- Principals Affiliated Colleges (concerned)
- Web-Developer ***(for uploading on university web-site)***

C.C:

- Dean, Faculty of Sciences
- Secretary to the Vice-Chancellor
- P.A to Registrar

Annex-'J'

SCHEME OF STUDY FOR BS ZOOLOGY

(Revised 2016)

DEPARTMENT OF ZOOLOGY
UNIVERSITY OF SARGODHA
- SARGODHA - PAKISTAN

B.S. Zoology

CURRICULUM BS 4 YEARS (8 SEMESTERS) PROGRAM IN ZOOLOGY

SEMESTER I

Course codes	Course Title	Credits
ENG-101	English-I : INTRODUCTION TO COMMUNICATION LANGUAGE AND GRAMMAR	3(3+0)
PKS-101	Pakistan Studies	2(2+0)
BOT-101	Botany-I: Diversity of Plants	4(3+1)
CHEM-101	Chemistry-I: Physical Chemistry	4(3+1)
ZOL-101	Principles of Animal Life-I	4(3+1)
	Total Credits	17

SEMESTER II

Course codes	Course Title	Credits
ENG-102	English-II	3(3+0)
BIST-109	Islamic Studies	2(2+0)
BOT-102	Botany-II: Plant systematics, anatomy/development embryology	4(3+1)
CHEM-102	Chemistry-II: Inorganic Chemistry	4(3+1)
ZOL-102	Principles of Animal Life-II	4(3+1)
	Total Credits	17

SEMESTER III

Course codes	Course Title	Credits
ENG-201	English- III	3(3+0)
COMP-201	Introduction to Computer	3(2+1)
BOT-203	Botany –III: Cell biology, genetics and evolution	4(3+1)
CHEM-201	Chemistry-III: Organic Chemistry	4(3+1)
ZOL-201	Animal Diversity: Invertebrates	4(3+1)
	Total Credits	18

SEMESTER IV

Course codes	Course Title	Credits
PSY-201	Introduction to Psychology	3(3+0)
BOT-204	Botany-IV: Plant physiology and ecology	4(3+1)
ZOL-202	Animal Diversity: Chordates	4(3+1)
ZOL-203	Principles of Animal Physiology	4(3+1)
CHEM-202	Chemistry IV: Special Topics in chemistry	4(3+1)
	Total Credits	19

Semester- V:

Course code	Course Title	Credits
ZOL-501	Fisheries	3(2+1)
ZOL-502	General Biochemistry	4(3+1)
ZOL-503	Cell & Molecular Biology	4(3+1)
ZOL-504	Biostatistics	3(3+0)
ZOL-505	Wildlife	3(3+0)
	Total Credits	17

SEMESTER– VI:

Course Code	Course Title	Credits
ZOL-506	Environmental Biology	4(3+1)
ZOL-507	Animal Physiology	4(3+1)
ZOL-508	Developmental Biology	4(3+1)
ZOL-509	Genetics	4(3+1)
ZOL-510	Animal Behavior	3(2+1)
	Total Credits	19

Semester VII:

Course codes	Course Title	Credits
ZOL-601	Seminar	1(1+0)
ZOL-602	Biological Techniques	3(2+1)
ZOL-603	Principles and kinetics of toxicology	4(3+1)
Zol-604	Evolution & Principles of Systematics	4(3+1)
ZOL-605	Bioinformatics	3(2+1)
	Thesis/ Optional Paper*	4(0+4) / 4(3+1)
	Total Credits	19

SEMESTER-VIII:

Course Codes	Course Title	Credits
ZOL-606	Zoogeography & Paleontology	3(3+0)
ZOL-607	Synopsis & Research Methodology	2(2+0)
ZOL-608	Biotechnology	4(3+1)
	Thesis/ Optional Paper*	4(0+4) / 4(3+1)
	Total Credits	13

*In lieu of thesis optional courses will be offered from the list attached.

17+17+18+19+17+19+19+13 = 139

LIST OF OPTIONAL COURSES		
Course Codes	**Course Title**	**Credits**
ZOL-609	AQUACULTURE	4(3+1)
ZOL-610	BASIC HUMAN GENETICS	4(3+1)
ZOL-611	BIODIVERSITY OF INLAND AND TERRESTRIAL MOLLUSCS	4(3+1)
ZOL-612	BIODIVERSITY AND WILDLIFE	4(3+1)
ZOL-613	BIOLOGY AND CONTROL OF VERTEBRATE PESTS	4(3+1)
ZOL-614	BIOLOGY OF SPIDERS	4(3+1)
ZOL-615	BASIC MEDICAL ENTOMOLOGY	4(3+1)
ZOL-616	CONSERVATION BIOLOGY	4(3+1)
ZOL-617	ENDOCRINOLOGY	4(3+1)
ZOL-618	ENTOMOLOGY (CLASSIFICATION OF INSECTS AND PEST MANAGEMENT)	4(3+1)
ZOL-619	ENTOMOLOGY-I	4(3+1)
ZOL-620	ENTOMOLOGY-II	4(3+1)
ZOL-621	ENVIRONMENTAL ISSUES	4(3+1)
ZOL-622	FISH CULTURE	4(3+1)
ZOL-623	FISH ECOLOGY	4(3+1)
ZOL-624	FISH FEEDING MANAGEMENT	4(3+1)
ZOL-625	FISH PHYSIOLOGY & BREEDING	4(3+1)
ZOL-626	FUNDAMENTALS OF MICROBIOLOGY	4(3+1)
ZOL-627	GENERAL AND COMPARATIVE ENDOCRINOLOGY	4(3+1)
ZOL-628	GENERAL MICROBIOLOGY	4(3+1)
ZOL-629	HELMINTHOLOGY AND HOST-PARASITE RELATIONSHIP	4(3+1)
ZOL-630	HEMATOLOGY	4(3+1)

ZOL-631	ICHTHYOLOGY	4(3+1)
ZOL-632	IMMUNOLOGY	4(3+1)
ZOL-633	INSECTS OF VETERINARY AND MEDICAL IMPORTANCE	4(3+1)
ZOL-634	INTEGRATED PEST MANAGEMENT	4(3+1)
ZOL-635	INTRODUCTION TO ENVIRONMENT	4(3+1)
ZOL-636	LIMNOLOGY	4(3+1)
ZOL-637	MAMMALOGY	4(3+1)
ZOL-638	MICROBIOLGY AND BIOTECHNOLOGY	4(3+1)
ZOL-639	MICROBIOLOGY-I	4(3+1)
ZOL-640	MICROBIOLOGY-II	4(3+1)
ZOL-641	MOLECULAR AND CLINICAL ENDOCRINOLOGY	4(3+1)
ZOL-642	MOLECULAR BIOLOGY	4(3+1)
ZOL-643	MOLECULAR GENETICS	4(3+1)
ZOL-644	ORNITHOLOGY I	4(3+1)
ZOL-645	PARASITOLOGY	4(3+1)
ZOL-646	PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS	4(3+1)
ZOL-647	PHYSIOLOGY OF COORDINATION	4(3+1)
ZOL-648	PHYSIOLOGY OF REPRODUCTION	4(3+1)
ZOL-649	PRINCIPLE OF FISH BIOLOGY	4(3+1)
ZOL-650	PRINCIPLES OF PARASITOLOGY	4(3+1)
ZOL-651	PROTOZOLOGY	4(3+1)
ZOL-652	RESTORATION ECOLOGY AND SUSTAINABLE DEVELOPMENT	4(3+1)
ZOL-653	STATISTICAL ECOLOGY	4(3+1)
ZOL-654	WILDLIFE PARASITOLOGY	4(3+1)

SEMESTER-I

ENG-101: ENGLISH-I: INTRODUCTION TO COMMUNICATION LANGUAGE AND GRAMMAR **Cr: 3(3+0)**

Course Contents

Serial No.	Course Contents	Description	No. of Hours (Approximately)
1.	Introduction to Communication Language and Grammar	Language	03
2.	Dictionary Skills	Language	03
3.	Parts of Speech, Tenses, Active Passive	Grammar	11
4.	New Year's Resolution,	Poetry	1
5.	Tartary	Poetry	1
6.	The Huntsman	Poetry	1
7.	Spoon Feeding	Essay	3
8.	Nagasaki	Essay	3
	Mid Term		
Serial No.	**Course Contents**	**Description**	
9.	Clause analysis and Synthesis (subject, predicate etc.)	Language	4
10.	One Art	Poetry	1
11	The Damned Human Race	Essay	3
12.	The Douches And The Jeweller	Short Story	3
13.	The Voice	Short Story	3
14.	A Passion In The Dessert	Short Story	3
15	My Tailor	Essay	3
16.	Death the Leveller	Poem	1
17.	The Character of A Happy Life	Poem	1

Books Recommended:

1) Pearl series English-I for BS-4 years

2) Mastering English Grammar by S.H.Burton

PKS-101: PAKISTAN STUDIES **Cr: 2(2+0)**

Course Contents:

1. **Two nation theory and ideology of Pakistan.**
   a. Historical background of creation of Pakistan.
   b. Two nation theory its historical context, definition and interpretation.
   c. Quaid -i- Azamand his political ideas.
2. **Political dynamics of Pakistan.**
   a. Constitutional Development in Pakistan (1947-73).
   b. Salient features of Constitution of Pakistan.
   c. Institutions of Pakistan, Political Parties: Bureaucracy, Army, Judiciary and Media.
   d. Problems of Pakistan as a Federal State.
3. **Socio-Economic issues of Pakistan.**
   a. Economic problems.
   b. Social and Demographic issues.
4. **Diplomatic dynamics of Pakistan.**
   a. Determinants and objectives of Pakistan's Foreign Policy.
   b. Pakistan's relations with its neighboring countries.
   c. Pakistan and the Muslim World.
   (A comprehensive review of Foreign Policy of Pakistan)

Recommended Books

1. Ahmad, Jamil Uddin, Early Phase of Muslim Political Movement, Publishers United Ltd., 1967.
2. Chaudhry, G.W., Constitutional Development in Pakistan, Longman, U.K., 1969
3. Hamid, Abdul, "Muslim Separatism in India".-
4. Hussain, J., An Illustrated History of Pakistan- Book 1 & 2", Oxford University Press, Karachi, 1983.
5. Ikram, Dr. S. M., Modern Muslim India and the Birth of Pakistan, Institute of Islamic Culture, Lahore, 1990.
6. Ikram, Dr. S. M., Muslim Rule in India and Pakistan, Students Books Aid, Karachi, 1991.
7. Kadri, Justice Syed Shameem Hussain, Creation of Pakistan, Wajidalis Ltd., Lahore, 1982.
8. Kazmi, Raza, Pakistan Studies, Karachi: Oxford University Press, 2012.
9. Kureshy, K. U., Geography of Pakistan, National Book Service, Lahore, 1986.
10. Mazhar-Ul-Haq, The 1973 Constitution of Pakistan, Bookland, Lahore, 1993.
11. Mehmood, Dr. Safdar, Pakistan Political Roots and Development, Vanguard, Lahore, 1990
12. Mehmood, Dr. Safdar, The Constitution of Pakistan 1973: Comments and Comparison, A. H Publisher, Lahore, 1994.
13. Nasir, M. Saeed; Hyder, Syed Kamal, Economics of Pakistan, Educon Publicabon, Lahore, 1993-94.
14. Qureshi, I. H., A Short History of Pakistan, University of Karachi, 1992.
15. Qureshi, I. H., Struggle for Pakistan, University of Karachi, 1965.
16. Saqib, Ahsan Ullah, History of Indo-Pakistan since 1526, Dogar Brothers, Lahore, 1992.
17. Sayeed, K. B., The Political System of Pakistan, National Book Service, Lahore.
18. Sayeed, Dr. Khalid Bin, "Pakistan: The Formative Phase".
19. Shaw, Isobel, Odyssey Illustrated Guide to Pakistan, the Guide Book Company Ltd., 1996.
20. Talbot, Ian, Pakistan: A Modern History, London: Oxford University Press, 2005.
21. Zining, Lawrance, Pakistan in Twentieth Century: A Political History, London: Oxford University Press, 2006.

BOT-101 : BOTANY-I: DIVERSITY OF PLANTS **Cr: 4(3+1)**

Course Outline:

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

a) **Viruses** (RNA and DNA types) with special reference to TMV;

b) **Bacteria and Cyanobacteria** (Nostoc, Anabaena, Oscillatoria) with specific reference to biofertilizers, pathogenicity and industrial importance;

c) **Algae** (Chlamydomonas, Spirogyra, Chara, Vaucheria, Pinnularia, Ectocarpus, Polysiphonia)

d) **Fungi** (Mucor, Penicillium, Phyllactinia, Ustilago, Puccinia, Agaricus), their implication on crop production and industrial applications.

e) **Lichens** (Physcia)

f) **Bryophytes**

i. Riccia ii.Anthoceros iii.Funaria

g) **Pteridophytes.**

i. Psilopsida(Psilotum) ii. Lycopsida (Selaginella) iii. Sphenopsida (Equisetum)

iv. **Pteropsida** (Marsilea)

h) **Gymnosperms**

i. Cycas ii. Pinus iii. Ephedra

i) Angiosperms

i.Monocot (Poaceae) ii.Dicot (Solanaceae)

Lab Outline:

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

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

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

Recommended Books:

1. Lee, R. E. 1999. Phycology. Cambridge University Press, UK
2. Prescott.L.M., Harley.J.P.and Klein.A.D.2004.Microbiology, 3rd Ed. WM.C. Brown Publishers.
3.Alexopoulos, C.J., Mims, C.W. and Blackwell,M.1996.Introductory Mycology. 4th Ed. John Wiley and Sons Publishers.
4. Agnos, G. N. 2004. Plant pathology.5th Ed. Academic Press London.
5.Vashishta, B. R. 1991. Botany for degree students (all volumes). S. Chand and Company Ltd. New Delhi.
6. Andrew, H. N. 1961. Studies in Paleobotany.John Willey and Sons.
7. Ingrouille , M. 1992. Diversity and Evolution of Land Plants. Chapman & Hall.
8 Mauseth, J. D. 2003. Botany: An Introduction to Plant Biology 3rd Ed., Jones and Bartlett Pub. UK
9. Marti, J. Ingrouille & Plant: Diversity and Evolution. 2006 CUP
10.Taylor, T. N. & Taylor, E. D. 2000. Biology and Evolution of Fossil Plants. Prentice Hall. N. Y.
11. Hussain, F. 2012. A Text Book of Botany and Biodiversity. Pak Book Empire.

Journals / Periodicals:

Pakistan Journal of Botany, American Journal of Botany, Canadian Journal of Botany, Annals of Botany.

CHEM-101: CHEMISTRY-I:PHYSICAL CHEMISTRY **Cr:4(3+1)**

Course contents:

Elementary Mathematics: i.e., function and their graphs. Equation of straight lines. Function and limits, continuous and discontinuous functions. Logarithm. Differentiation of elementary algebraic and trigonometry functions. Meaning of differentiation in term of rate of change. Simple method of integration and their physical significance.

Physical States of Mater.

Gases: deviation from ideal behavior of real gases. (van der Waal's equation, critical Phenomena, Critical values of T, P &V., liquification of gases, molecular collisions, collision diameter, mean free path)

Liquids : physical properties like viscosity, Parachor value, Refractive index, molar refraction Dipole moment, rheochor value and their applications.,

Solids : the classification of crystals. Unit cell. Braggg's method of crystal structure analysis. X-rays crystallography of sodium chloride. The powered method of crystal structure analysis.

Quantum theory and Atomic Structure i.e., wave and particle nature of matter De Brogile equation. Schrodinge wave equation. solution for particle in 1D box. quantization concept, Heisenberg Uncertainty Principle. Puali Excusion Principle, Hund's Rule of maximum multiplicity.

Chemical Thermodynamics i.e., system and surrounding. First law of thermodynamics and its state functions, enthalpy change in physical and chemical system. Work done and the change in internal energy during the isothermal and adiabatic processes in ideal gases. Heat capacity at constant volume and pressure. Concept of reversible and irreversible processes. Spontaneous and non spontaneous processes. The second law of thermodynamics. Comot cycle, change of entropy with change in temperature, pressure and volume .

Chemical Equilibrium i.e.,: the concept of equilibrium. Law of Mass Action, equilibrium constant, relationship between K_c, K_p, K_x and K_a and LeChaterlier's Principle and the effect of variables e.g. temperature, concentration and pressure on equilibrium constant.

Solutions i.e., solution and concept of concentration units such as molarity, molality, ppb and ppm. The ideal and non ideal solutions. Raoult's law colligative properties such as lowering of vapor pressure, elevation in boiling point ebullioscopy, cryoscopy, osmotic pressure, distillation and concept of azeotrops **Chemical Kinetics i.e.,** Order of reaction. Zero, first and second order reaction. Various method for determining the order of reaction. Depression of rate constant on temperature. Arrhenius equation, activation energy and its determination, brief account of Lindermmann's mechanism for unimolecular reactions, brief account of collision theory and transition state theory of bimolecular reactions. **Electrochemical Sciences i.e.,** equivalent and molar conductance , dependence of conductance on the nature of solvent and temperature, Kohlrausch's law and its applications, measurement of conductance strong and weak electrolytes, degree of dissociation. Oslwald dilution law. Dissociation constant. Calculation of pH for a typical waek acid.

Practicals

1. Determination of surface tension and Parachor value by stalagmometer.
2. Determination of percent composition of liquid solutions from surface tension measurement.
3. Determination of viscosity and Rhechor value of liquids from viscosity measurement.
4. Determination of percent composition of liquid solutions viscometrically.
5. Determination of refractive index and molar refractivity by refractometer.
6. Determination of percent composition of liquid solutions by refractive index measurements.
7. Determination of heat of solution by solubility method.
8. Determination of heat of neutralization of an acid with a base.
9. A kinetic study of acid hydrolysis of ethyl acetate.
10. Kinetic study of saponification of ethyl acetate.
11. Determination of molecular weight of a compound by elevation in boiling point. (Ebullioscopic method).
12. Determination of molecular weight of a compound by lowering of freezing point (The Cryoscopic methods).
13. Determination of equilibrium constant of KI + I2 KI3
14. Conductometirc titration of strong acid and strong base.

Recommended Books

1. Chaudhry, G.R., *Text Book of Physical Biological Sciences*, 2nd Edition. New Kitab Markaz, Aminpur Bazar, Faisalabad, Pakistan. (2001).
2. Maron S. H. and Jerome, B. *"Fundamentals of Physical Biological Sciences"* Macruthan Publishing co. Inc. New York, (1995).
3. Atkins P.W. and Clugston, M.J. *"Principles of Physical Biological Sciences"* Pitam Publishing Company. NY (1998)
4. Moore. W.J., *"Physical Biological Sciences"*, 5th Ed. Longmans Publishers, NY (1972)
5. Jones, M., *"Elements of Physical Biological Sciences"* 3rd Ed. Benjamin Cummings Publishing Company Inc., NY (1993).
6. Adamson, A. W. *"Understanding Physical Biological Sciences"* 3rd Ed. Benjamin Cummings Publishing Company Inc. NY (1973)
7. Heald, C. and Smith, A.C.K. *Applied Physical Biological Sciences* MacMillan UK (1973).
8. Akhtar, M.N. & Ghulam Nabi, *"Text Book of Physical Biological Sciences"* Ilmi Kitab Khawna, Lahore (2006)
9. Bhatti, H.N. and K. Hussain, *"Principles of Physical Biological Sciences"*; Carwan Book House, Lahore (2005).
10. Levitt, B.P., *"Findlay's Practical Physical Biological Sciences"*. 9th Ed. Longman, London (1973).
11. Das, R.C. and B. Behera, *"Experimental Physical Biological Sciences"*, Tata McGraw Hill, Delhi (2003).
12. Crocleford, H.D., H.W. Biard, F.W. Getzen & J.W. Nowell, *"Laboratory Manual of Physical Biological Sciences"*, 2nd Ed., John Wiley & Sons. London (1975).

ZOL-101 : PRINCIPLES OF ANIMAL LIFE – I Cr: 4(3+1)

Objectives

The course aims to impart knowledge and understanding of:

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

Course Contents

Scope of Zoology: Introduction; significance and applications of zoology; animal diversity; the scientific method; environment and world resources. The Chemical Basis of Animal Life: Brief introduction to biomolecules;
carbohydrates, lipids, proteins, and nucleic acids.

Cellular Organization: Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, vacuoles;the nucleus: nuclear envelope, chromosomes and nucleolus.

Animal tissues: Types: epithelial, connective, muscle and nervous tissue; organs and organ systems.

Enzymes: Structure, types; function and factors affecting their activity; cofactors and coenzymes.

Energy Harvesting: Aerobic and anaerobic respiration: glycolysis, citric acid cycle and electron transport chain; fermentation, the major source of ATP.

Reproduction and Development: Types: asexual and sexual, gametogenesis, fertilization, metamorphosis, zygote and early development.

Ecological Concepts: Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles, and limiting factors, populations and communities, human population growth, pollution, resource depletion and biodiversity.

Practicals

1. Tests for different carbohydrates, proteins and lipids.
   Note: *Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.*
2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), 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 anddeplasmolysis in blood. Preparation of blood smears.
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).

Books Recommended

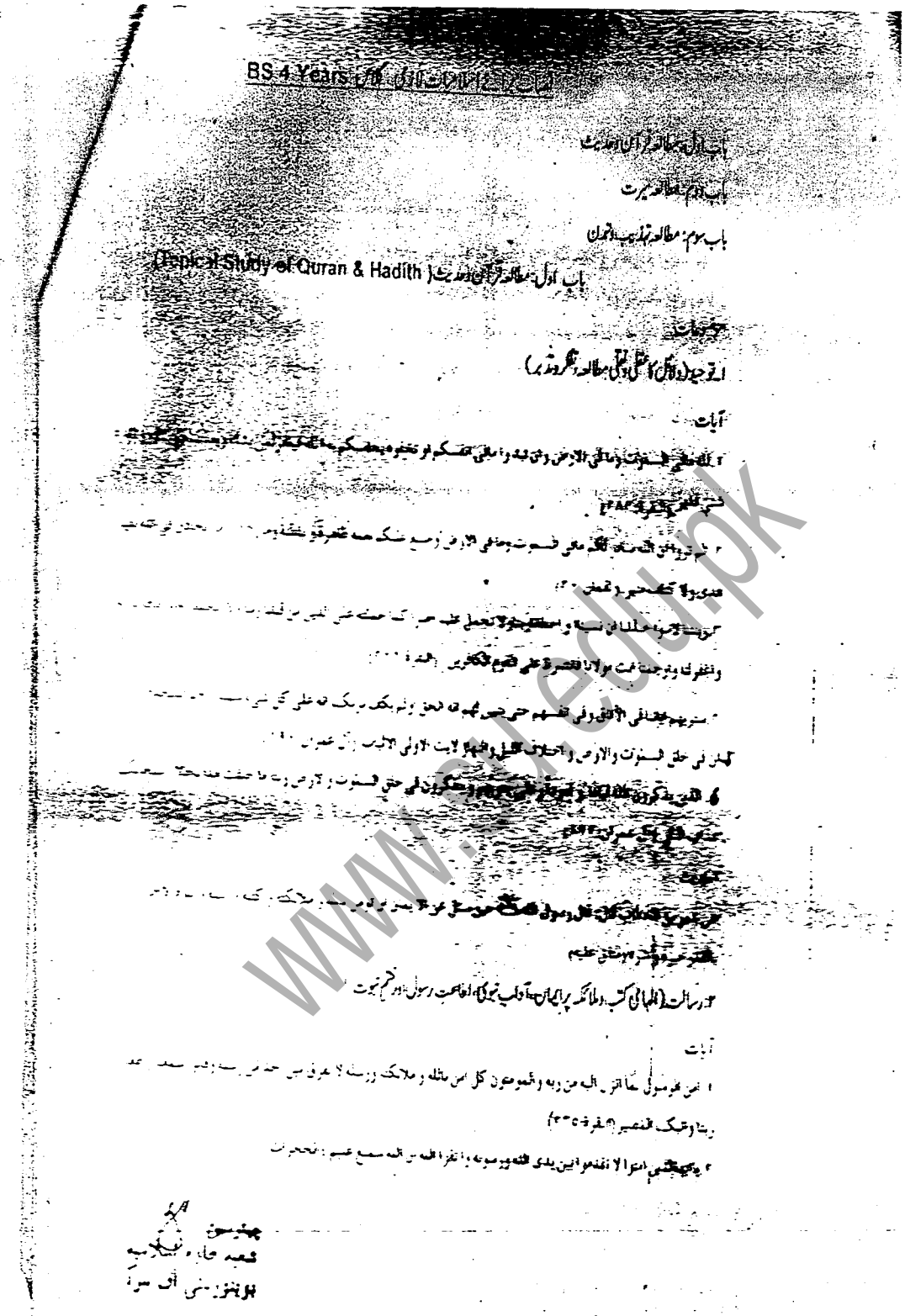
1. Miller, S.A. and Harley, J.B. 2005. Zoology, 6th Ed. (International), Singapore: McGraw-Hill.
2. Molles, M.C. 2005. Ecology: Concepts and Applications. 6th Ed. McGraw Hill, New York, USA.
3. Hickman, C.P., Roberts, L.S. and Larson, A. 2004. Integrated Principles of Zoology, 12th Ed. (International), Singapore: McGraw Hill.
4. Campbell, N.A. 2002. Biology. 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
5. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
6. Hickman, C.P. and Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.
7. Odum, E. P. 1994. Fundamentals of Ecology. 3rd Ed. W.B. Saunders. Philadelphia.

SEMESTER II

ENG-102: ENGLISH-II **Cr. 3(3+0)**

Course Contents

Month	Contents	Description	No. of Hours (Approximately)
March	Narration/Direct indirect	Grammar	04
	Paragraph Writing	Grammar	06
	The Divine Image	Poem	01
	Sonnet Composed upon Westminster Bridge	Poem	01
March/April	Youth and Age	Poem	01
	The New constitution	Short Story	03
	The Bear	One-Act Play	05
	Quaid-e-Azam's Adress to the Constituent Assembly	Essay	03
	Mid Term		
April/May	Note-Taking	Grammar	01
	Punctuation	Grammar	02
	Oral Presentation Skills	Language	02
	To Wordsworth	Poem	01
	Patriot into Traitor	Poem	01
	When You Are Old	Poem	01
	Smoke Screens	One-Act Play	04
June	Mayhew	Short Story	03
	Breakfast	Short Story	02
	Seeing Life	Essay	02
	The Last Lesson	Essay	02
	Oral Presentation		03



BS 4 Years

باب اول: مطالعہ قرآن و حدیث

باب دوم: مطالعہ سیرت

باب سوم: مطالعہ مذاہب عالم

(Topical Study of Quran & Hadith) باب اول: مطالعہ قرآن و حدیث

تمہیدات

۱۔ توحید (دلائل عقلی و نقلی مطالعہ و تفکر و تدبر)

آیات

۱۔ [illegible]

۲۔ [illegible]

۳۔ [illegible]

۴۔ [illegible]

۵۔ [illegible]

۶۔ [illegible]

۷۔ [illegible]

احادیث

۱۔ [illegible]

۲۔ [illegible]

۳۔ رسالت (الٰہامی کتب، ملائکہ پر ایمان، آداب نبوی، اطاعت رسول اور ختم نبوت

آیات

۱۔ [illegible]

۲۔ [illegible]

۳۔ [illegible]

٢ يايها الذين امنوا لا ترفعوا اصواتكم فوق صوت النبي ولا تجهروا له بالقول كجهر بعضكم لبعض ان تحبط اعمالكم وانتم لا تشعرون (الحجرات: ٢)

٣ ان الذين يغضون اصواتهم عند رسول الله اولئك الذين امتحن الله قلوبهم للتقوى لهم مغفرة واجر عظيم (الحجرات: ٣)

٤ ولو انهم صبروا حتى تخرج اليهم لكان خيرا لهم والله غفور رحيم (الحجرات: ٥)

٥ ان الذين ينادونك من وراء الحجرات اكثرهم لا يعقلون (الحجرات: ٤)

٦ يايها الذين امنوا ان جاءكم فاسق بنبا فتبينوا ان تصيبوا قوما بجهالة فتصبحوا على ما فعلتم نادمين (الحجرات: ٦)

٧ واعلموا ان فيكم رسول الله لو يطيعكم في كثير من الامر لعنتم ولكن الله حبب اليكم الايمان وزينه في قلوبكم وكره اليكم الكفر والفسوق والعصيان اولئك هم الراشدون (الحجرات: ٧)

٨ فضلا من الله ونعمة والله عليم حكيم (الحجرات: ٨)

٩ النبي اولى بالمؤمنين من انفسهم وازواجه امهتهم واولوا الارحام بعضهم اولى ببعض في كتاب الله من المؤمنين والمهجرين الا ان تفعلوا الى اوليائكم معروفا كان ذلك في الكتاب مسطورا (الاحزاب: ٦)

١٠ ان الله وملائكته يصلون على النبي يايها الذين امنوا صلوا عليه وسلموا تسليما (الاحزاب: ٥٦)

١١ ان الذين يؤذون الله ورسوله لعنهم الله في الدنيا والاخرة واعد لهم عذابا مهينا (الاحزاب: ٥٧)

١٢ لقد كان لكم في رسول الله اسوة حسنة لمن كان يرجو الله واليوم الاخر وذكر الله كثيرا (الاحزاب: ٢١)

١٣ ما كان محمد ابا احد من رجالكم ولكن رسول الله وخاتم النبيين وكان الله بكل شيء عليما (الاحزاب: ٤٠)

حديث

عن العباس بن عبد المطلب انه قال يا رسول الله هل نفعت ابا طالب بشيء فانه كان يحوطك ويغضب لك قال نعم هو في ضحضاح من نار ولولا انا لكان في الدرك الاسفل من النار (متفق عليه)

قرآن

آيات

١ هو الذي اخرج الذين كفروا من اهل الكتاب من ديارهم لاول الحشر ما ظننتم ان يخرجوا وظنوا انهم مانعتهم حصونهم من الله فاتاهم الله من حيث لم يحتسبوا (الحشر: ٢)

٢ ولا تكونوا كالذين نسوا الله فانساهم انفسهم اولئك هم الفاسقون (الحشر: ١٩)

حديث

عن ابن مسعود عن النبي ﷺ قال لا يزال الرجل يصدق حتى يكتب عند الله صديقا وان الكذب يهدي الى الفجور وان الفجور يهدي الى النار وما يزال الرجل يكذب حتى يكتب عند الله كذابا (متفق عليه)

[illegible]

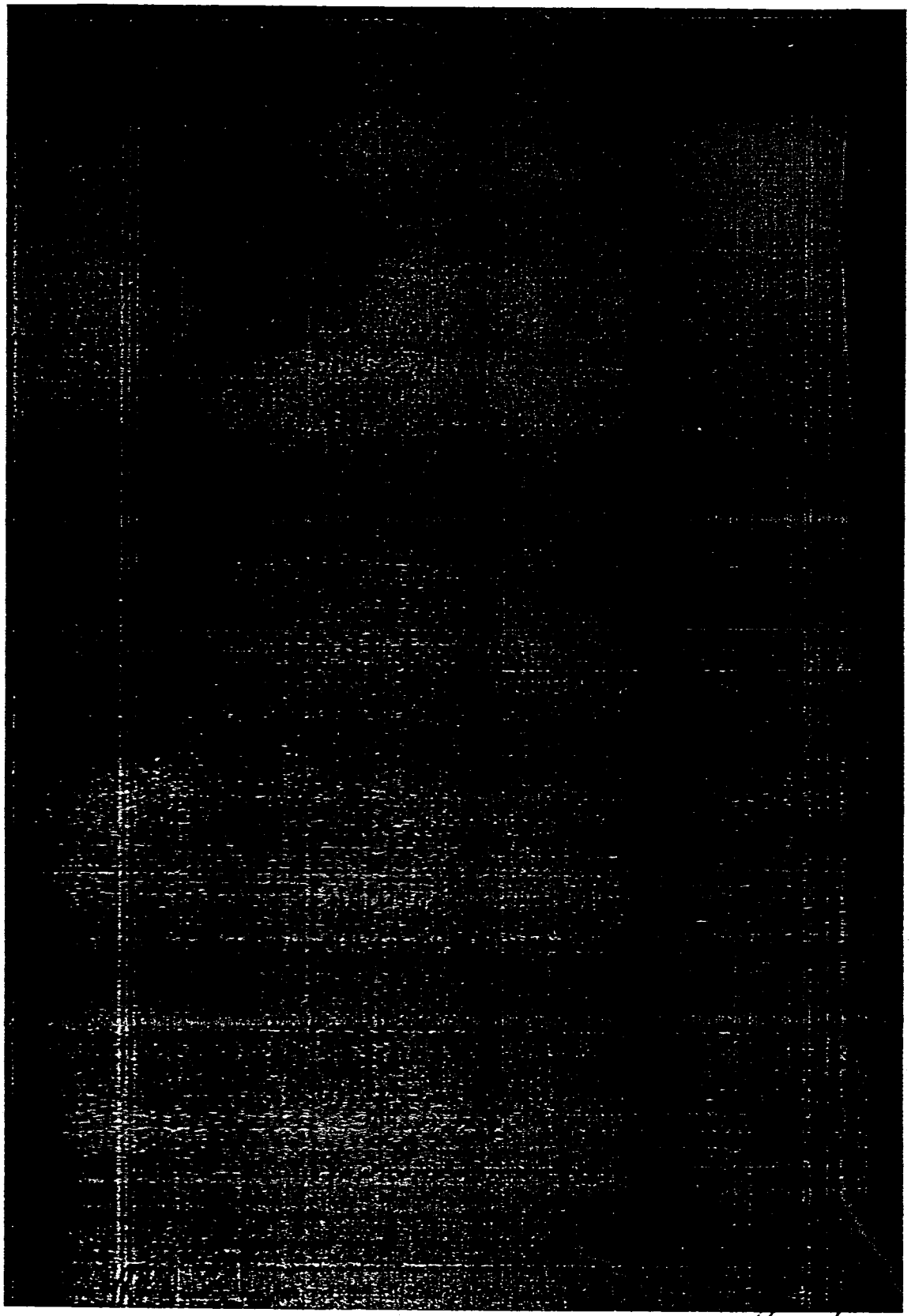
١ قد افلح المؤمنون الذين هم في صلاتهم خاشعون (المؤمنون: ١)

٣ والذين هم للزكوة فاعلون (المؤمنون: ٣)

٤ يايها الذين امنوا هل ادلكم على تجارة تنجيكم من عذاب اليم (الصف: ١٠)

٥ تؤمنون بالله ورسوله وتجاهدون في سبيل الله باموالكم وانفسكم ذلكم خير لكم ان كنتم تعلمون (الصف: ١١)

يغفر لكم ذنوبكم ويدخلكم جنات تجري من تحتها الانهار ومساكن طيبة في جنات عدن ذلك الفوز العظيم (الصف: ١٢)



3

۶. والذين هم على صلوتهم يحافظون (المومنون:۹)

۷. اولئک هم الوارثون (المومنون:۱۰)

۸. الذين يرثون الفردوس (المومنون:۱۱)

۹. هم فيها خلدون (المومنون:۱۱)

احادیث

۱. عن انس قال: قال رسول الله ﷺ والذی نفسی بیده لا یؤمن عبد حتی یحب لاخیه ما یحب لنفسه (متفق علیه)

۲. عن النعمان بن بشیر قال: قال رسول الله ﷺ تری المؤمنین فی تراحمهم و توادهم وتعاطفهم کمثل الجسد اذا اشتکی عضوا تداعی له سائر الجسد بالسهر والحمی (متفق علیه)

۶. آداب معاشرت

۱. وان طائفتان من المومنین اقتتلوا فاصلحوا بینهما فان بغت احداهما علی الاخری فقاتلوا التی تبغی حتی تفیء الی امر الله فان فاءت فاصلحوا بینهما بالعدل واقسطوا ان الله یحب المقسطین (الحجرات:۹)

۲. انما المومنون اخوة فاصلحوا بین اخویکم واتقوا الله لعلکم ترحمون (الحجرات:۱۰)

۳. یایها الذین امنوا لا یسخر قوم من قوم عسی ان یکونوا خیرا منهم ولا نساء من نساء عسی ان یکن خیرا منهن [illegible] ولا تلمزوا انفسکم ولا تنابزوا بالالقاب بئس الاسم الفسوق بعد الایمان ومن لم یتب فاولئک هم الظلمون (الحجرات:۱۱)

۴. یایها الذین امنوا اجتنبوا کثیرا من الظن ان بعض الظن اثم ولا تجسسوا ولا یغتب بعضکم بعضا [illegible] میتا فکرهتموه واتقوا الله ان الله تواب رحیم (الحجرات:۱۲)

۵. یایها الناس انا خلقنکم من ذکر وانثی وجعلنکم شعوبا وقبائل لتعارفوا ان اکرمکم عند الله اتقکم ان الله علیم خبیر (الحجرات:۱۳)

احادیث

عن ابی هریرة ان رسول الله ﷺ قال: ان المفلس من امتی من یاتی یوم القیمة بصلاة [illegible] قذف هذا واکل مال هذا وسفک دم هذا وضرب هذا فیعطی هذا من حسناته وهذا من حسناته [illegible] ان یقضی ما علیه اخذ من خطایاهم فطرحت علیه ثم طرح فی النار

۷. [illegible]

۱. ومن اظلم ممن افتری علی الله الکذب وهو یدعی الی الاسلام [illegible]

۲. یریدون لیطفئوا نور الله بافواههم والله متم نوره ولو کره الکفرون (الصف [illegible])

۳. هو الذی ارسل رسوله بالهدی ودین الحق لیظهره علی الدین کله ولو کره المشرکون [illegible]

احادیث

۱. عن ابی سعید ن الخدری عن رسول الله ﷺ قال من رای منکم منکرا فلیغیره بیده فان لم یستطع فبلسانه فان لم یستطع فبقلبه وذالک اضعف الایمان (مسلم)

۲. عن عبدالله بن عمر قال قال رسول الله ﷺ الا کلکم راع وکلکم مسئول عن رعیته فالامام الذی علی الناس راع وهو مسئول عن رعیته والرجل راع علی اهل بیته وهو مسئول عن رعیته والمرأة راعیة علی بیت زوجها وولده وهی مسئولة عنهم [illegible]

Objectives

This course aims to:

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

Course Contents

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

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

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

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

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

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

Selected Study from Text of Hadith

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

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

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

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

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

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

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

Books Recommended

1. Hameedullah M, "Emergence of Islam" , IRI, Islamabad
2. Hameedullah M, "Muslim Conduct of State"
3. Hameedullah M. 'Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,"

5. Hussain Hamid Hassan. "An Introduction to the Study of Islamic Law" leaf Publication Islamabad. Pakistan.
6. Hasan A.1993. Principles of Islamic Jurisprudence. Islamic Research Institute, International Islamic University, Islamabad.
7. Waliullah, M.1982. Muslim Jurisprudence and the Quranic Law of Crimes. Islamic Book Service.
8. Bhatia, H.S.1989. Studies in Islamic Law, Religion and Society. Deep & Deep Publications New Delhi
9. Zia-ul-Haq M.2001. Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad.

BOT-102: BOTANY-II: PLANT SYSTEMATICS, ANATOMY/DEVELOPMENT, EMBRYOLOGY
Cr: 4(3+1)

Course contents:

a) Plant systematic

1. **Introduction to Plant Systematic:** aims, objectives and importance.
2. **Classification:** brief history of various systems of classification with emphasis on Takhtajan.
3. Brief introduction to nomenclature, importance of Latin names and binomial system with an introduction to International Code of Botanical Nomenclature (ICBN).Vienna code.
4. **Morphology:** a detailed account of various morphological 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 vi Cucurbitaceae
vii. Lamiaceae (Labiatae) viii. Apiaceae (Umbelliferae)
ix.Asteraceae (Compositae) x. Liliaceae

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. Phloem Epidermis (including stomata and trichomes) v. Xylem

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

1. Early development of plant body
2. Capsella bursa-pastoris
3. Structure and development of Anther Microsporogenesis, Microgametophyte
4. Structure of Ovule Megasporogenesis Megagametophyte
5. Endosperm formation
6. Parthenocarpy
7. Polyembryony

Lab Outline:

Plant Systematics

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

Anatomy and Embryology

1. Study of stomata and 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.
5. Anatomy of germinating seeds
6. Study of pollens

Recommended Books:

1. Mauseth, J. D. 1998. An Introduction to Plant Biology: Multimedia Enhanced. Jones and Bartlett Pub. UK
2. Moore, R. C., W. D. Clarke and Vodopich, D. S. 1998. Botany. McGraw Hill Company, U.S.A.
3. Raven, P. H., Evert, R. E. and Eichhorn, S. E. 1999. Biology of Plants. W. H.Freeman and Company Worth Publishers.
4 Stuessy, T. F. 1990. Plant Taxonomy. Columbia University Press, USA.
5. Lawrence, G. H. M. 1951 Taxonomy of Vascular Plants. MacMillan & Co. New York.
6. Panday, B. P. 2004. A textbook of Botany (Angiosperms). S. Chand and Co. New Delhi.
7 Raymond E, S. E. Eichhorn. 2005. Esau's Plant Anatomy. Meristems cells and tissues of the plant body, 3rd Ed. John Wiley & Sons. Inc.
8. Fahn, A. 1990. Plant Anatomy.Pergamon Press, Oxford.
9. Esau, K. 1960. Anatomy of Seed Plants. John Wiley, New York.
10. Maheshwari, P. 1971. Embryology of Angiosperms. McGraw-Hill. New York.
11. Eames A. J. and L. H Mac Daniels. 2002. An introduction to Plant Anatomy. Tata-Mac Graw-Hill Publishing Company, Limited, New Delhi.
12. Pullaiah, T. 2007. Taxonomy of Angiosperms. 3rd Edition, Regency Publications, New Delhi.
13. Naik, V. N. 2005 Taxonomy of Angiosperms. 20th Reprint TataMacGraw-Hill Publishing Company, Limited New Delhi.
14 Rajput. M. T., S. S. Hassney and K. M. Khan. 1996. Plant Taxonomy. New Trends Computer Service, Hyderabad, Sindh. Pakistan.Journals / Periodicals:
Pakistan Journal of Botany, Taxon, Phyton.

CHEM-102: CHEMISTRY-II: INORGANIC CHEMISTRY **Cr: 4 (3+1)**

Course Contents:

Periodic Classification of Elements and Periodic Table i.e., Modern Periodic Table: Classification of elements based on s, p, d, and f orbitals: placement of element on the basis of electronic configuration in periodic table. Group trends and periodic properties, ionization potentials, electron affinities and electronegativities; Redox potential, electrochemical series and its applications.

Chemical Bonding i.e., Nature of a bond, ionic, covalent and coordinate covalent bond Valence Bond Theory (VBT), Molecular Orbital Theory (MOT), Valence Shell Electron Pair Repulsion (VSEPR) theory and hybridization.

Acid Base Equilibria i.e.: general concept of Acids and bases including soft and hard acid base concept, relative strengths of acids, significance of pH, pKa, pKb and buffers, Indicators: (Acid-base, Redox, Adsorption), solubility product, common ion effect and co-precipitation.

Chemistry of p-block elements i.e., chemistry of Boron, Aluminium, Carbon, Silicon, Nitrogen, Phosphorus, Oxygen, Sulphur, Halogens and Noble Gases; their structure, properties and application.

chemistry of d-Block Elements i.e., Electronic configuration. General characteristics of d-block elements Werne's theory. of coordination compounds nomenclature. nature of coordinate covalent bond. Applications of VBT, MOT and CFT of coordination compounds, introduction of chelates, Isomerism in coordination compounds.

Practicals

1. Qualitative Analysis; four radicals (cations and anions) for salt mixture.
2. Chromatographic separation of cations
3. Determination of total hardness of water using EDTA.
4. Estimation of manganese (II) using EDTA
5. Estimation of copper (iodometrically).
6. Determination of thiosulphate ion (Iodometrically).
7. Determination of ferricyanide using KI solution.
8. Determination of chloride by Volhard's and Mohr's methods.
9. Estimation of chloride ions using adsorption (Fluorescein) indicator.
10. Estimation of bromide ions using adsorption (Eosin) indicator.
11. Estimation of percentage of ferrous ions in the Mohr's salt using KMnO4.
12. Percentage determination of ferric ions in ferric alum using KMnO4 solution.
13. Determination of purity of commercial potassium oxalate using KMnO4 solution.
14. Estimation of ferrous ions using K2Cr2O7 solution.

Recommended Books

1. Iqbal, M.Z. '*Text Book of Inorganic Biological Sciences*', Ilmi Kitab Khana. Revised Edition (1998).
2. Chaudhry, G. R., '*Text Book of Inorganic Biological Sciences*, 2nd Edition; New Kitab Markaz, Faisalabad, Pakistan (2001).
3. Bhatti, H.N. and Nasir, B.A. *Modern Inorganic Biological Sciences*, 1st Edition, The Carvan Book House, Lahore, (2000).
4. Albert, C.F., Wilkinson G. and Gaus, P.L. *Basic Inorganic Biological Sciences*, 3rd Edition, John Wiley & Sons, Inc. NY (1995).

5. Lee. J.D.. '*Concise Inorganic Biological Sciences*'. 5th Edition. Chapman & Hall, UK (1996).
6. Jolly. W.L. '*Modern Inorganic Biological Sciences*', *Biological Sciences*', 2nd Edition McGraw Hill. NY (1991).
7. Shriver, D.F., Atkins P.W. and Langord, C.H. '*Inorganic Biological Sciences*', 2nd Edition, Oxford Press, UK (1994).
8. Housecroft, C.E. and Sharpe, A.G., '*Inorganic Biological Sciences*', 3rd Edition, Longman, NY (1992).
9. Rayner-Canham, G. '*Descriptive Inorganic Biological Sciences*', W.H. Freeman & Co. UK (1995).
10. Jeffery, G.H., Bassett, J., Mendham, J. and Denney, R.C. '*Vogel's Textbooks of Quantitative Chemical Analysis*', 5thy Edition, Benjamin-Cummings, NY (1989).
11. Vogel, A.I, '*A Text Book of Macro and Semimicro Qualitative Inorganic Analysis*', Longman Green & Co. NY (1995).
12. Skoog, D.A., West, D.M and Holler, F.J. *Analytical Biological Sciences*, 6th Edition Saunders College Publications, UK (1994).
13. Graham, H and Man, H. *Biological Sciences in Context* 5th Edition, Thomas Nelson Ltd. U.K. (2000).
14. Philp M. *Advance Biological Sciences*, Cambridge Low Price Edition, U.K. (1996).
15. David H. *Modern Analytical Biological Sciences*, McGraw Hill, NY (2000).

ZOL-102: PRINCIPLES OF ANIMAL LIFE–II

Cr: 4(3+1)

Objectives

- The course will impart knowledge and understanding of:
- Cell division and its significance in cell cycle.
- Concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
- Animal behaviour and communication.
- Theories of evolution, gene flow and mechanism of evolution with reference to animal diversity.

Course Contents

Cell Division: Cell cycles: Mitosis and meiosis; control of the cell cycle.

Inheritance Patterns: Mendelian genetics; inheritance patterns; gene, structure, chemical composition and types.
Chromosomes and Gene Linkage: Eukaryotic chromosomes; linkage and crossing over; chromosomal aberrations.

Cellular Control: DNA: the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA technologies and their applications.

Animal Behavior: Behaviour and its types, proximate and ultimate causes; anthropomorphism; development of behavior; learning; factors controlling
animal behavior; communication; behavioral ecology; social behavior.

Evolution: A Historical Perspective: Theories of evolution: Natural selection Lamarckism and neo lamarckism, Darwinism and neo Darwinian.
Evolution and Gene Frequencies: Hardy-Weinberg principle; evolutionary
mechanisms: population size, genetic drift, gene flow, de Vries mutation theory and rates of evolution, polymorphism; species and speciation; molecular evolution; mosaic evolution.

Practicals

1. Study of mitosis in onion root tip.
2. Study of meiosis in grasshopper testis (students should prepare the slide).
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).

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

Books Recommended

1. Pechenik, J.A. 2012. Biology of Invertebrates. 4th Edition (International), Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Miller, S.A., Harley, J.B. 2002. Zoology, 5th Edition (International), Singapore: McGraw Hill.

4. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International). Singapore: McGraw Hill.
5. Campbell, N.A. 2002. Biology. 6th Edition. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
6. Kent, G.C., Miller, S. 2000. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
7. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

SEMESTER III

ENG-201: ENGLISH-III

Cr: 3(3+0)

Course Objective

Month	Contents	Description	No. of Hours (Approximately)
	Listening Skills	Language	3
	Reading Skills	Language	2
	Letter Writing	Poetry	3
	All the world' A Stage	Poetry	1
	On His Blindness	Poetry	1
	To Autumn	Poetry	2
	One Vote for this age of Anxiety	Essay	3
	On Babies	Essay	3
	Islamic Culture	Essay	4
	Mid Break		
	Essay Writing		3
	No Buyers	Poetry	1
	Prayer Before Birth	Poetry	1
	The Owl Critic	Poetry	3
	Take Piety	Short Story	3
	The Necklace	Short Story	3
	The Happy Prince	Short Story	3
	Even Exchange	One Act Play	4
	The Master of The House	One Act Play	4

COMP-201: INTRODUCTION TO COMPUTER **Cr: 3(2+1)**

Course contents

Course Syllabus: Introduction to Computers, The Internet and World Wide Web, Application Software, The System Unit, Input Devices, Output Devices, Storage, System Software, Communications, Databases, Computer Security and Safety, Ethics, and Privacy.

Course Outline:

1. **Introduction to Computers:** Data and Information, Information Processing Cycle, the Components of a Computer, Advantages and Disadvantages of Using Computers. Networks and the Internet. Computer Software, Categories of Computers, Elements of an Information System, Examples of Computer Usage, Computer Applications in Society [Ch. 1].

2. **The Internet and World Wide Web**: Key Concepts of the Internet, Evolution of the Internet, The World Wide Web, E-Commerce, Other Internet Services, Netiquette [Ch. 2].

3. **Application Software:** Business Software, Graphics and Multimedia Software, Software for Home, Personal, and Educational Use. Web Applications, Application Software for Communications. [Ch. 3]

4. **The System Unit:** Processor, Data Representation, Memory, Expansion Slots and Adapter Cards, Ports and Connectors, Buses, Bays, Power Supply. [Ch. 4]

5. **Input Devices:** What Is Input? What Are Input Devices? The Keyboard, Pointing Devices, Mouse, Other Pointing Devices, Touch Screens And Touch-Sensitive Pads. Pen Input. Other Input For Smart Phones. Game Controllers. Digital Cameras. Voice Input. Video Input. Scanners And Reading Devices. Biometric Input. Terminals. Putting It All Together, Input Devices For Physically Challenged Users. [Ch. 5]

6. **Output Devices:** What is Output? Display Devices. Printers. Speakers, Headphones, and Earbuds, Other Output Devices. [Ch. 6]

7. **Storage:** Hard Disks, Flash Memory Storage. Cloud Storage, Optical Discs. Other Types of Storage. [Ch. 7]

8. **System Software:** Operating Systems, Operating System Functions, Types Of Operating Systems, Stand-Alone Operating Systems, Server Operating Systems. Embedded Operating Systems, Utility Programs [Ch. 8]

9. **Communications:** Uses of Computer Communications, Networks, Network Communications Standards, Communications Software, Communications over the Telephone Network, Communications Devices, Home Networks, Communications Channel, Physical Transmission Media, Wireless Transmission Media. [Ch. 9]

10. **Databases:** Data and Information. The Hierarchy of Data, Maintaining Data. File Processing Versus Databases, Database Management Systems,

Labs: Lab work should be carried out to develop students' Computer Skills, Operating Systems and Utility Software Skills, E-Mail Skills, Word Processing Skills, Spreadsheet Skills, Electronic Presentation Skills, Web Surfing Skills.

Books Recommended:

Discovering Computers by Gary B. Shelly & Misty E. Vermaat, Course Technology; 1st Edition (January 25, 2011).

Recommended Books:

1. Hoelzel, A. R. 2001. Conservation Genetics. Kluwer Academic Publishers.
2. Dyonsager, V. R. (1986). Cytology and Genetics. Tata and McGraw-Hill Publication Co. Ltd,, New Delhi.
3. Lodish. H. 2001. Molecular Cell Biology. W. H. Freeman and Co.
4. Sinha, U. and Sinha, S. (1988). Cytogenesis Plant Breeding and Evolution, Vini Educational Books, New Delhi.
5. Strickberger, M. V. (1988), Genetics, MacMillan Press Ltd., London.
6. Carroll, S. B., Grenier, J. K. and Welnerbee, S. D. 2001.From DNA to Diversity -Molecular Genetics and the Evolution of Animal Design. Blackwell Science.
7. Lewin, R, 1997. Principles of Human Evolution. Blackwell Science.
8. Strickberger, M. W. 2000 Evolution. Jones &Bartlet Publishers Canada
9. Ingrouille M. J. & B. Eddie. 2006. Plant Diversity and Evolution. Cambridge University Press.
10. Bruce Albert et al. 2009. Essential cell biology. Garland Sciences Publishers.

Journals/Periodicals:

Theoretical & Applied Genetics. the Cell. Heredity.

CHEM-201: CHEMISTRY-III: ORGANIC CHEMISTRY Cr:4(3+1)

Nomenclature:

Common & IUPAC names and rules of IUPAC.

Basic Concepts in Organic chemistry:

Localized and delocalized bonding, concept of hybridization leading to bond angles, bond energies, and geometry of simple organic molecules, dipole moment, inductive effect; resonance energy, rule of resonsance. Resonsance effect steric inhibition, hyperconjugation; tautomerism, hydrogen bonding, Hydrocarbons (open, closed and aromatic),

Isomerism:

(Z, E convention, cis; trans, Geometrical, optical isomerism and chirality), optical activity.chirality and optical activity, racemasation, and resolution of racemic mixtures, R,S notation,diasterioisomers, conformational isomerism ;Brief introduction to conformation of ethane, n-butane and cyclohexane.

Alkyl Halides

Preparation and reaction of alkyl halides with special reference to nucleophilic substitution

And elimination reactions ,Grignard reagent;preparation ,structure and application in the synthesis in the synthesis of alcohol and carboxylic acid.

Chemistry of Hydroxyl Group and ethers.

Bnef review of physical properties ,preparation and reaction of alcohols. phenols.:acidity.preparation and reaction of phenols. preparation and reaction ethers.

Carbonyl Compounds

Structure, reactivity and preparation reactions of aldehydes and ketones

Chemistry of Carboxylic Acids and their Derivatives

Physical properties of carboxylic acid . effects of substitution and structure on the strength of acidity of carboxylic acid ,preparation , properties and reaction of carboxylic acids and their derivatives like esters, amides, acid halides and acid annyonides

Chemistry of amino group.

Structure of aliphatic and aromatic primary , secondary, tertiary amines.physical properties of amines, basicity and nucleophilicity of amines .preparation and reaction of mines diazonium salts and preparation and application.

Practicals

Qualitative Organic Analysis
Systematic identification of organic compounds containing groups
Containing groups like COOH, OH, NH2 and C=O.
Purification techniques viz solvent extraction distillation and recrystallisation etc.
Preparation of simple organic compounds viz, Ethyl benzoate, benzoic acid, tribromophenol, aspirin and nitrobenzene.

Recommended Books

1. Younas, M. *Text Book of Organic Biological Sciences,* Ilmi Kutab Khana, Lahore (2006).
2. Rehman, A. *Text Book of Organic Biological Sciences,* Caravan Book House Lahore (2006).
3. Smith M.B. and March, J. *March's Advanced Organic Biological Sciences,* 5th Edition, John Wiley, NY. (2001).
4. Pine, S. H. *Organic Biological Sciences*, (5th Edition) McGraw-Hill, NY. (1987).
5. Sykes, P., *A Guide Book to Mechanism in Organic Biological Sciences,* Longman, London (1999).
6. Younas, M. *Organic Spectroscopy,* A. H. Publisher, Lahore (2006).
7. Solomons, T.W.G., *Fundamentals of Organic Biological Sciences,* Wiley, NY (2003).
8. Kemp, W., *Organic Spectroscopy*, Macmillan, London (1990).
9. Vogel, A.I. *A Text Book of Practical Organic Biological Sciences,* Longman, London (1968).
10. Mann, F.G and Saunders B.C. *Practical Organic Biological Sciences,* Longman, London (1978).
11. Shriner, R.L., Curtin, D.Y. Fuson, R.C. and Morrill, T.C. *The Systematic Identification of Organic Compounds,* Wiley, NY (1997).
12. Rehman, A. *Experimental Organic Biological Sciences,* The Caravan Book House, Lahore (2006).
13. Morrison, R.T. and Boyd, R.N. *Organic Biological Sciences*, Allyn & Bacon, Boston (1987).

ZOL-201: ANIMAL DIVERSITY: INVERTEBRATES **Cr: 4(3+1)**

(CLASSIFICATION, PHYLOGENY AND ORGANIZATION)

Objectives

The course is designed to provide students with:

- Taxonomic characteristics and classification of each phylum
- Concepts of evolutionary relationship of animal kingdom
- Knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life

Course Contents

Introduction: Architectural pattern of an animal, taxonomy and phylogeny, major subdivisions of animal kingdom with evolutionary perspective. **Animal-Like Protists**: The Protozoa; 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.

Multicellular and Tissue Levels of Organization: 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 andnematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum Ctenophora; further phylogenetic considerations.

Triploblastics and Acoelomate Body Plan: Phylum Platyhelminthes: classification up to class; the free-living flatworms and the tapeworms: Phylum Nemertea: Phylum Gastrotricha: further phylogenetic considerations.

Pseudocoelomate Body Plan: Aschelminths: 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.

Molluscan Success: 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.

Annelida: The Metameric Body Form: relationship to other animals, metamerism and tagmatization; External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development in different classes; further phylogenetic considerations.

Arthropods: Blueprint for Success: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations; phylogeny and adaptive diversification.

Echinoderms: relationships to other animals, echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development; further phylogenetic considerations.

Lesser Invertebrates: The lophophorates, entoprocts, cycliophores, and chaetognaths

Practicals

Museum study of representative Phyla. Permanent slide preparations

1. Study of *Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma.*
2. *Paramecium* as representative of animal like protists. (Prepared slides).
3. Study of sponges and their various body forms.
4. Study of principal representative classes of Phylum Cnidaria.
5. Study of principal representative classes of Phylum Platyhelminthes.
6. Study of representative of Phylum Rotifera, Phylum Nematoda.
7. Study of principal representative classes of Phylum Mollusca.
8. Study of principal representative classes of Phylum Annelida.
9. Study of principal representative classes of groups of Phylum Arthropoda.
10. Brief notes on medical/economic importance of the following:
11. *Plasmodium,Entamoeba histolitica, Leishmania*, Liverfluke, Tapeworm, Earthworm,
12. Silkworm, Citrus butterfly.

Books Recommended

1. Hickman, C.P., Roberts, L.S., Larson, A. 2011. Integrated Principles of Zoology, 15th Ed. (International). Singapore: McGraw Hill.
2. Miller, S.A., Harley, J.B. 2011. Zoology, 8th Ed. (International), Singapore: McGraw Hill.
3. Pechenik J.A. 2010. Biology of Invertebrates, 4th Ed. (International). Singapore: McGraw Hill.
4. Campbell. N.A. 2002. Biology. 5th Ed. Menlo Park. California: Benjamin/Cummings Publishing Company, Inc.
5. Miller. S.A.. 2002. General Zoology Laboratory Manual. 5th Ed. (International). Singapore: McGraw Hill.
6. Hickman. C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

SEMESTER IV

PSY-201: INTRODUCTION TO PSYCHOLOGY **Cr: 3(3+0)**

Course Objectives:

- To ensure an effective orientation of students towards the discipline of psychology so that they may come to appreciate the diversity of the subject and its pragmatic significance.
- To make students familiar with the essentials features of research enterprise in Psychology.
- To inculcate a sense of personal relevance of Psychology as a subject with the potential of gaining better insight into one's own self

1. **Introduction to Psychology**
   Nature and Application of Psychology with special reference to Pakistan
2. **Research Enterprise in Psychology (A brief sketch)**
   a. Goals of Scientific Enterprise and Steps in Scientific Investigation
   b. Advantages of Scientific Approach
   c. Experimental Research, Descriptive / Correlational Research
      i) Naturalistic Observation
      ii) Case History Method
      iii) Survey Method
   d. Statistics and Research
      i) Descriptive Statistics
      ii) Inferential Statistics
   e. Evaluating Research
      i) Sampling Bias
      ii) Placebo Effects
      iii) Distortion in Self Report Data
      iv) Experimenter Bias
   f. Research Ethics
      i) The Question of Deception
      ii) The Question of Animal Research
3. **Biological Basis of Behavior**
   a. Communication and Organization of the Nervous System
   b. The Brain and Behavior
   c. Right Brain / Left Brain: Cerebral Laterality
   d. The Endocrine System
   e. Heredity and Behavior (Nature & Nurture)
   f. The Evolutionary bases of Behavior
4. **Sensation and Perception**
   a. Psychophysics: Basic Concepts and Issues
   b. Our senses of Sight: The Visual System
   c. Our Senses of Hearing: The Auditory System
   d. Our Chemical Senses: The Taste and Smell
   e. Our Senses of Touch: Sensory Systems in the Skin
   f. The other Senses
      i) The Kinesthetic System
      ii) The Vestibular System
5. **Motivation and Emotion**
   a. The Motivation of Hunger and Eating
   b. Affiliation: In Search of Belongingness
   c. Achievement: In search of Excellence
   d. The Elements of Emotional Experience
   e. Theories of Emotion
      i) James Lange Theory

ii) Cannon-Bard Theory
iii) Schachter's Two Factor Theory
iv) Evolutionary Theories of Emotion

6. **Learning & Memory**
   a. Definition of Learning and memory
   b. Types of Learning
   c. (i Classical Conditioning
   d. (ii.Operant Conditioning)
   e. Changing Directions in Study of Conditioning; Observational Learning
   f. Types and process of memory (Encoding, Storage, Retrieval, Forgetting)
   g. In Search of Memory Trace: The Physiology of Memory
   h. Are There Multiple Memory Systems?
7. **Language & Thinking**
   a. The Cognitive Revolution in Psychology
   b. Language: Turning Thoughts into Words
   c. Problem Solving: In Search of Solutions
   d. Decision Making: Choices and Chances

Personality: Theory, Research and Assessment

   e. The Nature of Personality
   f. Psychodynamic Perspectives
   g. Behavioral Perspectives
   h. Humanistic Perspectives
   i. Biological Perspectives
   j. Contemporary Empirical Approaches to Personality Traits
   k. Culture and Personality

8. **Nutrition Psychology: Food Choice and Eating Habits**
   a. Introduction to food psychology
   b. Theoretical models of food choice
      i. Why are models important?
      ii. The Furst model of food choice
      iii. The influence of factors such as Life course; Influences; Personal systems; Value negotiations; Strategies
   c. **Models in health**
      i. Commonly used models in health initiatives
      ii. 1. Theory of Planned Behavior (TPB)
      iii. 2. Health Belief Model (HBM)
      iv. Other models
      v. Public health strategies
   d. **Influence on eating habits and physiology**
      i. Eating as an automatic behavior
      ii. Inhibition of the desire to overeat
      iii. The effect of effort on food intake
      iv. The effect of repetition of food and variety
   e. **Eating, personality and motivational states**
      i. Emotional influences on food choice
      ii. Impulse, inhibition, eating restraint and intake
      iii. The influence of stress and coping
      iv. Decision-making styles
      v. The example of health campaigns
      vi. Personal factors in weight control
      vii. The Big 5; Personality and weight
      viii. Why weight loss efforts falling short

f. **Motivation and weight control**
   i. The relevance of Locus of Control (LOC)
   ii. Emotional response to experiences by locus of control
   iii. How to develop an internal locus of control

Recommended Books:

Weiten, W. 2012. Psychology: Themes and Variations (9th ed.). Woods worth Ltd.
Kalat, J.W. 2011. Introduction to Psychology (9th Edition). Wadsworth Cengage learning Publishing inc.
Atkinson, R. C. and Smith, E. E. 2000. Introduction to Psychology (13thed.). Harcourt Brace College Publishers.
Fernald, L.D. and Ferbnald, P. S. 2005. Introduction to Psychology. USA: WMC Brown Publishers.
Glassman, W. E. (2000). Approaches to Psychology. Open University Press.
Odgen, J. (2010). Psychology of eating (2nd edition). Blackwell Publishing.

BOT-204: BOTANY- IV: Plant Physiology and Ecology **Cr: 4(3+1)**

Course Contents

a) Plant Physiology

1. **Water relations** (water potential, osmotic potential, pressure potential,matric potential). Absorption and translocation of water. Stomataregulation.

2. **Mineral nutrition:** Soil as a source of minerals. Passive and active transport of nutrients. Essential mineral elements, role and deficiency symptoms of macronutrients.

3. **Photosynthesis**: Introduction, Oxygenic and non-oxygenic photosynthesis Mechanism: light reactions (electron transport and photophosphorylation) and dark reactions (Calvin cycle). Differences between C3 and C4plants.Factors affecting this process, Products of photosynthesis.

4.**Respiration**:Definitionand respiratory substrates. Mechanism of Glycolysis,Krebscycle. Electron transport and oxidative phosphorylation.anaerobicrespiration. Energy balance in aerobic and anaerobic respiration, Respiratory quotients.

b)Ecology

1. **Introduction** aims and applications of ecology.
2. **Soil:** Physical and Chemical properties of soil (soil formation, texture. pH. EC, organism and organic matter etc.) and their relationships to plants.
3. **Light and Temperature.** Quality of light diurnal and seasonal variations.Ecophysiologicalresponses.
4. **Water:** Field capacity and soil water holding capacity. Characteristics of xerophytes and hydrophytes. Effect of precipitation on distribution of plants.
5. **Wind**: Wind as an ecological factor and its importance.
6. **Population Ecology:** Introduction. A brief description of seed dispersal and seed bank.
7. **Community Ecology**

i.Ecological characteristics of plant community

ii. Methods of sampling vegetation (Quadrate and line intercept)

iii. Major vegetation types of the local area.

8. **Ecosystem Ecology**

i.Definition. types and components of ecosystem.

ii. Food chain and Food web.

9. **Applied Ecology:** Causes, effects and control of water logging and salinity with respect to Pakistan.

Lab Outline:

a) Plant Physiology

1. Preparation of solutions of specific normality of acids/bases, salts, sugars, molal and molar solutions and their standardization.
2. Determination of uptake of water by swelling seeds when placed in sodium chloride solution of different concentrations.
3. Measurement of leaf water potential by the dye method.
4. Determination of the temperature at which beet root cells lose their permeability.
5. Determination of the effects of environmental factors on the rate of transpiration of a leafy shoot by means of a potometer/cobalt chloride paper method.

6. Extraction of chlorophyll from the leaves and separation of component pigments on a paper chromatogram.Study of absorption spectra using spectrophotometer.
7. Estimation of oxygen utilized by a respiring plant by Winkler's method.

b) Ecology

1. Determination of physical and chemical characteristics of soil.
2. Measurements of various population variables
3. Measurement of vegetation by Quadrate and line intercept methods.
4. Field trips to ecologically diverse habitats.
5. Measurements of wind velocity.
6. Measurement of light and temperature.
7. Effect of light and temperature on seed germination.

Recommended Books:

1.Ihsan, I. 1995. Plant Physiology, Biochemical Processes in Plants, UGC Press.
2.Witham and Devlin.1986 Exercises in Plant Physiology, AWS Publishers,Boston.
3.Taiz, L. and Zeiger, E. 2006. Plant Physiology.4th. Ed. Sinauers Publ. Co. Inc.Calif.
4.Salisbury F. B. and Ross C. B. 1992. Plant Physiology.5th Edition.WadsworthPublishing.Co. Belmont CA.
5.Hopkins, W. B. 1999.Introduction to Plant Physiology. 2nd Ed. John Wiley andSons. New York
6.Schultz, J. C. 2005. Plant Ecology. Springer-Verlag, Berlin.
7.Ricklefs, R. E. 2000. Ecology. W. H. Freeman and Co., UK.
8.Ricklefs. R. E. 2001. The Economy of Nature. W. H. Freeman and Co., UK.
9.Barbour, M. G., J. H. Burke and W. D. Pitts. 1995. Terrestrial Plant Ecology,The Benjamin, Cumming Publishing Co. Palo Alto, California, USA.
10Chapman, J. L. and Reiss, M. J. 1995. Ecology: Principles and Applications.Cambridge University Press.
11.Hussain, F. 1989. Field and Laboratory Manual of Plant Ecology. NationalAcademy of Higher Education, Islamabad.
12.Hussain, S. S. 1989. Pakistan Manual of Plant Ecology; National BookFoundation, Islamabad.
13.Larcher, W. 2003 Physiological Plant Ecology: Ecophysicology and StressPhysiology of Functions Groups - Springer Verlag.
14.Krebs, C. J. 1997. Ecology.Harper and Row Publishers
15.Smith, R. L. 1996. Ecology and Field Biology, Addison Wesley Longman, Inc.,New York.
16.Smith, R. L. 1998. Elements of Ecology Harper and Row Publishers, NewYork.
17.Smith, R. L. 2004.Ecology and field biology. Addison Wesley Longman, Inc.,New York.
18.Subrahmanyam, N. S. and Sambamurthy, A. V. S. S. 2000. Ecology.NarosaPublishing House. New Delhi.Townsend, C. R., Harper, J. L. and Begon, M. E. 2002. Essentials of Ecology.Blackwell Scientific Publications, UK.
19.Odum, E. P. 1985. Basic Ecology. W. B. Saunders.Journals / Periodicals:Plant Physiology, Journal of Ecology

ZOL-202: ANIMAL DIVERSITY: CHORDATES **Cr. 4(3+1)**

Objectives
The course aims to:
- Provide understanding about taxonomic characteristics and classification of each phylum
- Develop concepts of evolutionary relationship of animal kingdom
- Provide knowledge and understanding about the different animal groups with special emphasis on their phylogenetic relationships

Course Contents
Protochrodates: Structure, anatomy and organ systems; reproduction; life histories and metamorphosis; phylogenetic relationships; further phylogenetic considerations.
Fishes: Vertebrate Success in Water: phylogenetic relationships; Agnatha and Gnathostomata: locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.
Amphibians: The first terrestrial vertebrates: phylogenetic relationships; Caudata, Gymnophiona, and Anura;Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations.
Reptiles: The First Amniotes: cladistic interpretation of the amniotic lineage: Testudines or Cheonia, Rhynchocephalia, Squamata, and Crocodilia;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.
Birds: Feathers, flight and endothermy: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation.
Mammals: Specialized teeth, endothermy, hair and viviparity; diversity of mammals: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

Practicals
Museum study of:
1. Protochordates
2. Pisces
3. Amphibia
4. Reptilia
5. Aves
6. 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.*

Books Recommended

1. Hickman, C.P., Roberts, L.S., Larson, A. 2011. Integrated Principles of Zoology, 15th Ed. (International). Singapore: McGraw Hill.
2. Campbell, N.A. Biology, 9th Ed. 2011. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
3. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
4. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. Latest edition New York: McGraw Hill.
5. Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

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).

Books recommended

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

ZOL-203: PRINCIPLES OF ANIMAL PHYSIOLOGY **Cr: 4(3+1)**

Objectives

The course aims to teach the students about:

- Animals diversity adapted in different ways for their functions through modifications in body parts.
- 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.
- Organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
- The basic structure of each system that determines its particular function.

Course Contents

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

Communication I: Nerves: Neurons: structure and function; neuron-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 ventral nerve cord and ganglia, the vertebrate brain, the spinal cord, cranial and spinal nerves; autonomic nervous system.

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

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.

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.

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.

SEMESTER V

ZOL-501: FISHERIES **Cr: 3(2+1)**

Objectives

- To disseminate the history, needs and importance of fisheries and aquaculture
- To elaborate the basic components of pond fish culture
- To describe the cultureable fish species and their biology
- To impart knowledge regarding fish gears and post harvest techniques

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, application, food and feeding habits of fishes, feeding types, artificial and natural fish

food, artificial fish feeds. Fish habitat, 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. Fish diseases and their control.

Fishing gears, fishing techniques, fishing communities. Fish preservation, processing transportation and marketing.

Practicals

1. Morphological characters of a typical fish,
2. Species identification, fin formula, key to identification of commercial fishes,
3. Dissection of common fish to study its various systems.
4. Practical demonstration of induced breeding.
5. Introduction to artificial feed ingredients.

Books Recommended

1. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India.
2. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
3. Pillay, T.V.R. and M.N. Kutty 2005. Aquaculture: Principles and Practices. Blackwell Science Limited. New York.
4. Ali, S.S. 1999. An Introduction to Freshwater Fishery Biology. University Grants Commission, H-9 Islamabad.

ZOL-502: GENERAL BIOCHEMISTRY **Cr: 4(3+1)**

Objectives

The course aims to

- Provide in-depth knowledge about the polymerized organic compounds of life.
- Develop an understanding about the dynamism life as it proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work.
- Understand that inter-conversion is performed by various tools called as enzymes.
- Enable students to know how organisms harvest of energy for growth, duplication etc.

Course Contents

Amino acids, peptides and proteins: standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, cytochrome c; Proteins: level of structural organization, example of structural and functional proteins.

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 on enzyme activity.

Carbohydrates:Classification, types, important characteristics and structure of carbohydrates; cyclic structure of 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 B complex group.

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 and starch; regulation of glycogen metabolism.

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. Anaboiic or biosynthetic role of citric acid cycle intermediates; replenishing

or anaplerotic reactions and their role; regulation of citric acid cycle; Electron transport and its components, oxidative phosphorylation, chemiosmotic theory, ATP synthesis, uncouple electron transport and heat generation.

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; Ketone bodies their biosynthesis, utilization and role in the tissues; cholesterol metabolism: 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.

Practicals

1. Preparation of standard curve for glucose by *ortho*-Toluidine method.
2. Tests for detection of carbohydrates in alkaline and acidic medium.
3. Tests for detection of Disaccharides.
4. Detection of Non-Reducing sugars in the presence of Reducing sugars.
5. Demonstration of Acid Hydrolysis of Polysaccharide.
6. Separation and identification of various types of sugars, fatty acid and amino acid Thin Layer Chromatography (TLC).
7. Determination of pKa values of an amino acid by preparation of titration curves.
8. Biochemical tests for detection of different amino acids.
9. Separation of various protein fractions by precipitation method.
10. Demonstration of differential solubility of lipids in various solvents.
11. Quantitative analysis of phospholipids by estimation of inorganic phosphorous.
12. Quantitative analysis of Amylase activity from blood serum or liver.
13. Study on the effect of temperature on the enzymatic rate of reaction

Books Recommended

1. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan worth Publishers, New York.
3. Berg, J. M., Tymoczko,J. L.,Lubert Stryer. 2010. Biochemistry. 7TH Ed.
4. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D.,Darnell, J. 2012. Molecular Cell Biology.
5. McKee, T., McKee, J.R. 2003.Biochemistry: The Molecular Basis of Life. 3rd Edition, McGraw Hill.
6. Wilson, K., Walker, J. 1994.Practical Biochemistry: Principles and Techniques, 4TH Ed., Cambridge University Press.

ZOL-503: CELL & MOLECULAR BIOLOGY **Cr 4(3+1)**

Objectives

The course aims to:

- Impart knowledge about the animal cell and its complex organization of architecture
- Provide understanding about the unified role of a cell for the ultimate sustainability of the organisms.
- Enable students to understand 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 and their role in protein synthesis and drug metabolism, Golgi apparatus its role in synthesis of glycoprotein, Mitochondrial respiration and its significance as semi- autonomous organelle; Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, Glycoxysome with reference to glyoxylic acid cycle.

Nucleus: chromatin, heterochromatin, euchromatin, chromosome structure, 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 emphasis on 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: Specific role of Ribosomes, various factors, and posttranslational processing, control of gene expression in Prokaryotes.

Practicals

1. Identification of cell organelles
2. Preparation of temporary whole mount.
3. Preparation of permanent whole mount (demonstration)
4. Preparation of human blood smear and identification of Leucocytes.
5. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).

6. Squash preparation of onion root tip for mitotic stages.
7. Mounting of polytene chromosome (Drosophila/Chironomous.) Demonstration.
8. Detection and quantitative determination of chromosomal DNA and RNA.
9. Cultural and staining of bacteria and yeast.
10. Separation of different sized DNA fragments on agarose gel.
11. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).

Books Recommended

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D.2013. Molecular Biology of the Cell. Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H., Balimore, D. 2013. Molecular Cell Biology, Scientific American Inc. N.Y.
3. Friefelder, D. 2010. Molecular Biology.
4. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach,. Sinauer Associates, INC.
5. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.
6. De Robertis, E. D. P., De Robertis Jr. E. N. F. 1987. Cell and Molecular Biology, Lea & Febiger, New York.

ZOL-504: BIOSTATISTICS **Cr: 3(3+0)**

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.

Course Contents

Introduction and scope: use of statistics in biology.

Population and sample: Stages of research,

Types of data: methods of data collection. Data arrangement and presentation, formation of tables and charts.

Measures of central tendency:computation of mean, median and mode from grouped and un grouped data.

Measures of dispersion: computation of variance, standard deviation, standard error and their coefficients.

Probability rules: Binomial, poisons and normal distributions. Hypothesis testing, Student 't' test, Chi square test,

Handling of multiple samples: Analysis of variance and LSD.

Correlation and regression: Experimental designing, planning of an experiment, replication and randomization.

Books Recommended

1. Zar, J. H. 2013. Biostatistical analysis 4th Ed. Dorling Kindersley Publ. Inc
2. *Forthofer, R. N.*, Lee E. S., Hernandez, M. 2011. Biostatistics: A Guideto Design, Analysis and Discovery2nd Ed. Elsevier Inc.
3. Rao.K. V. 2009. Biostatistics:A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers Publishers.
4. Quinn, G., P., Keough M. J.2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.
5. Norman G. R., Streiner, D. L. 2000. Biostatistics: The Bare Essentials. B.C. Decke Inc.
6. Campbell, R. C. 1989. Statistics for Biologists. Cambridge University Press.

ZOL-505: WILDLIFE **Cr 3(3+0)**

Objectives

The students will learn:

- About wildlife, distribution pattern world over
- Regarding wildlife of Pakistan, threatened, endangered species
- Modern techniques used in animal tracking, data collection
- How to protect, maintain, control and preserve the health and environment of wildlife.

Course Contents

Wildlife: Animal occurrence, protection, needs of animals, maintenance, and the habitat. Techniques: Ground and aerial tracking, GPS, radiotelemetry, maps etc. Wildlife Conservation: Philosophy and significance, Biodiversity and sustainability of wildlife.

Wildlife Agencies: National and International agencies involved in conservation and management of wildlife. International conventions, agreements.

Wildlife of Pakistan: identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan.

Wildlife rules and regulations in Pakistan: Sanctuaries, Game Reserves and National Parks in Pakistan. 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

1.Ali, S.S. 1999. Paleontology, Zoogeography& Wildlife Management. Nasim Book Depot. Hyderabad, India.

2.Roberts, T. J. 1998. The Birds of Pakistan, (Vol. II), Oxford University Press.

3.Roberts, T. J. 1992. The Birds of Pakistan, (Vol.I). Oxford University Press.

4.Magon, C.F. 1988. Biology of Freshwater Ponds. Longman and Scientific Publication.

5.Bailey, J.A. 1986. Principles of Wild life Management. John Wiley and Sons.

6.Robinson, W.L., Bolen, E.G. 1984. Wildlife Ecology and Management. McMillan, Cambridge. 7.Roberts, T.J. 1977. Mammals of Pakistan. Ernest Benon Ltd, London.

8.Ali S., Ripley S. D. 1973. A Handbook of Birds of India & Pakistan, Oxford University Press, London. Elirza Z.B, the Birds of Pakistan

SEMESTER VI

ZOL-506: ENVIRONMENTAL BIOLOGY **Cr: 4(3+1)**

Objectives

The main goal of this course is to:

- Enable students to develop strong expertise in contemporaneous themes in ecological research
- Develop critical thinking and to discuss about advanced topics in population, community and ecosystem ecology as well as in biodiversity research.
- Develop expertise to update their knowledge continuously, and to design their own research in ecology.

Course Contents

Energy: laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. Biogeochemical cycle: nitrogen, phosphorus, sulpher, water, carbon, nutrient. Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire.

Global ecosystems: (atmosphere, hydrosphere, lithosphere, ecosphere). An overview of ecosystem with special reference to ecological niche: basic concepts and types. Major ecosystem of world: Marine, Estuarine, Freshwater, Wetlands, Tundra, Forest, Grassland, Desert and Agricultural ecosystems.

Population ecology: basic population characters, growth and growth curves, population dynamics and regulations. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions.

Applied Ecology: resources and their ecological management (mineral, agricultural desalination and weather modification, forest and range management, landscape and land use);

Pollution : (definition, types, cost, origin and management); water (sources, domestic and industrial pollution, heavy metals); air (sulpher dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE & CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution.

Radiation ecology: global environmental changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, desertification, deforestation, exotic and invasive species, radioactivity leakage, environmental laws).

Practicals

1. Measurement of environmental factors on land, water and air.
2. Study of different ecosystems: pond, agricultural or grassland, forest.
3. Community analysis through different sampling techniques (quadrat, Transect),
4. Population studies mark and recapture method, statistical analysis of field data.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.
9. Experimental design and approaches in ecological research; writing a research project
10. Development of an ecological management plan of some selected area.

Books Recommended

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

ZOL-507: ANIMAL PHYSIOLOGY **Cr: 4(3+1)**

Objectives

The course aims to

- Provide information about the physiological mechanisms underlying animal functions.
- Enable students to understand neuro-endocrine coordination, physiology of heart, hemodynamics and kidney function.
- Impart information on respiratory function and gut physiology
- Give understanding about the mechanism of homeostasis, physiological regulation of temperature and its maintenance

Course Contents

Central themes in Physiology: Homeostasis, Concepts of conformity and regulation; physiological adaptations.

Membrane Physiology: Ionic distribution across membrane, Resting membrane **potentials:** Electrogenic ion pump, Donnan equilibrium, Ion channels

Nerve and Muscle Physiology: Action potentials in neurons; Electrical and chemicalsynaptic transmission; Neurotransmitters; Excitatory and inhibitory postsynaptic potentials; tetany; Muscles: Structure, types, components, muscle proteins, molecular basis of muscle contraction: sarcoplasmic reticulum and role of calcium, muscle action potentials, isometric and isotonic contraction, leverage factor, muscle fatigue.

Receptors Physiology: Receptor types: Mechanoreceptors, Olfactory and taste receptors, Photoreceptors, Photochemistry and Phototransduction; acoustico-lateralis system, Cutaneous receptors, electro-receptors. Sensory transduction, coding and adaptations. Range fractionation.

Endocrine Physiology: Gland types; Hypothalamus, Pituitary, Thyroid, Parathyroid, Pineal, Pancreatic Islets, Gastric glands, Adrenal, Ovary, Testis and Placenta; Overview of hormones; types, peptide and steroid hormones, chemistry, synthesis and roles. Hormone receptors and signal transduction. Feedback mechanisms.

Cardiovascular Physiology: Electrical activity of heart: Autorythmicity, Electrocardiography, Kymography; Hemodynamics, Relationship between blood flow, pressure and resistance. Control of cardiac activity, cardiac output and peripheral circulation.

Respiratory Physiology: Respiratory epithelia, gas exchange in gills and lungs; Transport of O2 and CO2, Structure of alveoli, lung volumes and capacities, surfactants, control of breathing; hypoxia; Hypercapnia etc., air breathing in divers.

Renal Physiology: Osmoregulation: Osmoregulation in aquatic and terrestrial animals; Kidney

and Vertebrate nephron as osmoregulatory andexcretory organ: Glomerular filtration, Tubular absorption and secretion; Nitrogenous waste products; Patterns of nitrogenous excretion and their phylogenetic significance.

Physiology of Digestion: Physiologic anatomy of digestive tract (mammalian model), Regulation of digestive secretions; Absorption of water, ions and nutrients; Potential and Movements in gastrointestinal tract; Control of motility. Deglutition, Peristalsis, Absorption, Assimilation and defecation.

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

Practicals

1. Determination of haemoglobin content, haematocrit and cell counting.
2. Preparation of blood smears.
3. 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.
4. 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.
5. Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
6. 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.
7. Effect of insulin on glycemia, study of stages in estrous cycle.

Books Recommended

1. Guyton, A.C., Hall, J.E. 2013. Textbook of Medical Physiology, 10th Ed. W.B. Saunders Company, Philadelphia.Sherwood 2013
2. Tharp, G., Woodman, D. 2010. Experiments in Physiology, 10th Ed. Bejamin Cummings.
3. Fox, S. 2010. Laboratory manual of human physiology. McGraw-Hill Sciences.Randall, D., Burggren, W., French, K., Fernald, R. 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th Ed. W.H. Freeman and Company, New York
4. Bullock, J., Boyle, J., Wang, M.B. Physiology, 4th Ed. 2001. Lippincott, Williams and Wilkins,

Philadelphia.
5. Berne, R.M., Levy, M.N. 2000.Principles of Physiology, 3rd Ed. St. Lious, Mosby.
6. Withers, P.C. 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
7. Schmidt-Nelsen, K. 1997. Animal Physiology, Adaptation and Environment, 5th Edition. Cambridge University Press, Cambridge.

ZOL-508: DEVELOPMENTAL BIOLOGY

Cr: 4(3+1)

Objectives

The course aims to:

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

Course Contents

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. Post embryonic Development and metamorphosis

Hormones as mediators of development; Regeneration in vertebrates.

Practicals

1. Study of the structure of gametes in some representative cases, i.e. frog, fish, fowl and a mammal.
2. 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/fish through induced spawning under laboratory conditions.
3. Preparation and study of serial sections of frog or chick embryos.
4. Application of microsurgical techniques on chick embryos *In vitro*.Preparation and staining of histological slides.

Books Recommended

1. Gilbert, S. F. 2012. Developmental Biology, Sinauer Associates, Sunderland, MA.
2. Klaus, K. 2001. Biological Development. 2nd Ed., McGraw Hill.
3. Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
4. Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
5. Saunders, J. W. 1982. Developmental Biology, McMillan and company.
6. Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

ZOL-509: GENETICS **Cr 4(3+1)**

Objectives

The course aims to: Provide understanding about the continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc.

- Develop the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment.

Course Contents

Classical Genetics: Scope and importance of genetics, gene concept; classical and modern),
Multiple Alleles: blood groups and coat color in rabbits.
Chromosomal Basis of Inheritance: interaction of genes, changes in chromosomal number, euploidy, aneuploidy, polyploidy; structural changes, insertion, deletion (Cri du chat syndrome), duplication and translocation
Pedigree Analysis: Normal human chromosome complement; Karyotyping. Sex-determination and Sex-linkage: Sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes.
Molecular Genetics: Elements of genetic engineering; genetic basis of diseases, like cancer, genetic control of animal development.Human Genetics;
Single and Multifactorial Disorders: Autosomal anomalies, Pseudoautosomal genes, (eg. Down syndrome, Edwards syndrome and), Single gene disorders Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria). Definition - characteristics criss-cross inheritance. Polygenic traits - Cleft lip and cleft palate,
Sex-linkedChromosomal anomalies: Klinefelters syndrome, and Turners syndrome.
Sex-influenced inheritance: Hemophilia, muscular dystrophy, color blindness.
Prenatal Diagnosis: Amniocentesis and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics.
Population Genetics: Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Practicals

1. Mitosis (Onion root tips.)
2. Meiosis (Grass hopper testes)
3. Blood groups.

4. Salivary gland Chromosomes of *Drosophila melanogaster*
5. General morphology of *Drosophila melanogaster*
6. Human Pedigree analysis problems
7. Human Genetics problems
8. Probability problems. Tossing of coins. X^2 test
9. Study of transformed bacteria on the basis of antibiotic resistance.

Books Recommended

1. Snustad, D.P., Simmons, M.J. 2003. Principles of Genetics. 3rd Ed., John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. 2001. Principles of Genetics. 7th Ed., WCB Publishers USA.
3. Lewin, B. 2000. GENE-VIII. Oxford University Press. UK.
4. Gardener, E.J., Simmons, M.J., Snustad, D.P. 1991. Principles of Genetics. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. 2014. Genetics. McMillan, New York. USA.

ZOL-510: ANIMAL BEHAVIOR Cr: 3(2+1)

Objectives

The course aims to

- Impart knowledge about animal responses to external stimuli
- Emphasize different kinds of behaviors classical and modern concepts
- Explain through examples development, evolution and occurrence of behavior
- understand the genetic and neurophysiological basis of behavior

Course Contents

Foundations of animal behavior: ethology, classical ethology
Development of beahvior: innate mechanisms, imprinting
Kinds of behavior: innate, conditioned, complex behaviour patterns, habituation.
Mechanisms of behavior: Nervous system and behavior, hormones and behavior,
Social behavior: agonistic, altruistic, kinship, mating, ritualization, dominance, territoriality
Biological rhythms: circadian clocks, clock genes etc.
Social organization: conflict, sexual behaviour, reproduction and fitness, parental care, social system.
Animal Communication: chemical attraction, in moths, honey bees, communication displays, pheromones etc.

Practicals

1. Locomotory behavior of small animals, earthworm, garden snails etc.
2. Ear pinna reflex responses in domestic cats
3. Preparation of skinner box or maze for study of mouse or rat behavior
4. Mother-pup bond in mice and rats
5. Infant killing behavior
6. Pecking behavior of chickens
7. Hiding behavior of chicks
8. Observation of birds nests and study of parental behavior
9. Altruistic behavior in monkeys

Books Recommended

1. Dugatkin, L. A. 2012. Principles of Animal Behavior. W.W. Nortan and Co. New York.
2. Scott, G. 2005.Essential Animal Behavior. Blackwell Pub. New York.

Goodenough, J., McGuire, B., Wallace, R.A. 2001.Perspective on Animal Behavior. John Wiley & Sons, New York.

SEMESTER VII

ZOL-601: SEMINAR **Cr. 1(1+0)**

The major aim of the course is to develop the writing and presentation skill among the student as well as to enhance their capacity to conceive the concept and to present at their own. The students will be assigned advanced topics in the field of Zoology.

ZOL-602: BIOLOGICAL TECHNIQUES **Cr: 3(2+1)**

Objectives

The course aims to:

- Develop scientific technical expertise, culture and work habits.
- Familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
- Develop basic understanding of the equipments usage

Course Contents

1. **Microscopy:** Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, Bright field (Compound Microscope), Scanning microscopy, Eyepiece micrometers, Camera Lucida Phase Contrast Dark field Interference microscope, Electron microscope (Observation of wet mounts of human cheek cells employing bright and dark field microscopy).
2. **Micrometery and Morphometry**: Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter), (Measurement of cell size: bacterial and eukaryotic).

Standard system for weight, length, volume: Calculations and related conversions of each:- Metric system- length; surface; weight - Square measures- Cubic measures (volumetric)- Circular or angular measure - Concentrations- percent volume; ppt; ppm - Chemical molarity, normality - Temperature- Celsius, centigrade, Fahrenheit. Preparation of stock solutions of various strengths

Specimen preparation for optical microscopy: **Microtomy:** Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections.

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

Separation Techniques: Chromatography: Principle, applications, types, thin layer, 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. Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field.

Practicals

3. Recording of microscopic obervations with the help of camera lucida
4. Liquid handling: proper use of pipettes and micropittes
5. Histological preparations: skeletal muscle, intestine liver and testes
6. Handling of centrifuge machines
7. Thin layer chromatography of amino acids
8. Spectrophotometric estimation of glucose
9. Spectrophotometric estimation of total proteins
10. Preservation of representative animals of various phyla
11. Electrophoretic separation of proteins
12. Electrophoretic separation of DNA

Books Recommended

1. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
2. Cheesbrough, M. 1998. District Laboratory Practice in Tropical. Countries. Part I. Cambridge University Press, UK.
3. Cheesbrough, M. 1998. District Laboratory Practice in Tropical. Countries. Part II. Cambridge University Press, UK.
4. Curos, M. 1997.Environmental Sampling and Analysis: Lab Manual. CRC Press LLC USA.
5. Curos, M. 1997.Environmental Sampling and Analysis: For Technician. CRC Press LLC. USA.
6. Slings by, D., Cock, C 1986. Practical Ecology. McMillan Education Ltd. London.

ZOL-603: PRINCIPLES AND KINETICS OF TOXICOLOGY

Cr: 4(3+1)

Objectives

- to provide knowledge and understanding about the nature and mode of action of different categories of toxicants
- to provide knowledge about the procedural protocols used in toxicological studies
- to enable the students to understand the differential effects of variety of toxicants on different cellular sites

Course Contents

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

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

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

Cellular sites of action:

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

Practicals

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

Book Recommended

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

ZOL-604: EVOLUTION & PRINCIPLES OF SYSTEMATICS **Cr: 4(3+1)**

Objectives

The course aims to:

- Provide in-depth knowledge of origin of life
- Develop concepts about forces responsible for evolutionary changes
- Study the importance and history of systematics with basic rules and regulations about the identification and naming of organisms

Course Contents

(i). Evolution

The nature and origin to life: Evidences of evolution (molecular, embryological & paleontological).

Theories of Evolution: 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.

(ii). Systematic Zoology

Importance and applications of systematics: Taxonomy in Animal science, systematics as a profession and its future perspectives.

History of taxonomy: systematics, basic terminology of systematics, theories of biological classifications.

Taxonomic characters: Kinds and weightage, microtaxonomy, taxonomic categories: specific category, infraspecific category, higher categories; Species concept.

Typological species concept: Nominalistic species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation,

Taxonomic procedures, taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

Systematics publications: International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

Practicals

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

Books Recommended

Evolution

1. Strickberger. M.W. 2012.*Evolution*.Jones & Barrett Publishers.
2. Ridley, M. 1993. Evolution. Blackwell Scientific Publications.
3. Moody, P.A. 1989. *Introduction to Evolution*, Harper and Row Publishers. New York.
4. Dobzhansky, T., Ayala, F.J., Stebbins, G.L., Valentine, J.W. 1973. Evolution. W.H. Freeman and Company.
5. Mayr, E. 1965.*Populations, Species and Evolution*, Harvard University Press.
6. Dobzhansky, T. 1951. *Genetics and the origin of species*. Columbia University Press, New York.

Systematic Zoology

1. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2nd Ed. Wiley-Blackwell.
2. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York.
3. Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw Hill, New York
4. Mayr, E. *Animal Species and Evolution*, 1985.Harvard University Press.
5. Heywood, V.H. *Taxonomy and Ecology*. 1975. Academic Press, London.
6. Whili, M.J.D. *Modes of Speciation*, 1978. W.H. Freeman and Co., San Francisco.

ZOL-605: BIOINFORMATICS **Cr: 3(2+1)**

Objectives

The course will provide:

- An introduction to bioinformatics with a focus on fundamental bioinformatics problems,
- Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

Course Contents

Introduction to BI: What is BI; history of BI; Uses of BI (Protein, Gene); comparison of BI with experimental tools.

Basic principles of computing in bioinformatics: Basic acquisition and database: DDBJ, NCBI and EMBL

Short introduction to DNA, RNA and protein: amino acids, sequence; analyzing Protein sequence by the use of BI tools; sequence-structure-function.

Retrieving protein sequences from database (FASTA): Alignment of protein\ nucleotide sequences (BLAST, CLUSTALW); Computing physico-chemical parameters of proteins (eg. PROTPARAM); Predicting elements of secondary structure of proteins (eg. PSSP); Retrieval, understanding and predicting 3D structure of protein from sequence; PTMs (eg NETPHOS etc.)

Enzyme classification: retrieval databases

Short introduction to DNA/RNA : structure, genetic code; analyzing the DNA/RNA sequence by the use of BI tools

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

PRIMER designing for PCR (PRIMER3+, PRIMER-BLAST, OLIGO-CALC etc.)

Short introduction to proteomics and genomics, and the role of bioinformatics in the pharmaceutical industry.

Practicals

1. Retrieval of FASTA sequence
2. Determination of proteins physical and chemical parameters
3. Finding similar sequences for protein and DNA
4. Multiple alignment
5. Predicting proteins secondary structure
6. Predicting RNA secondary structure
7. Predicting protein PTM
8. Finding protein families

9. Determination of gene location on chromosome
10. SNPs
11. Primer design

Books Recommended

1. Baxevanis, A.D., Ouellette, B.F.F, 2011. Bioinformatics: A Practical Guide to The Analysis of Genes and Proteins. John Wiley & sons, Inc.
2. Rastogi, S.C., Mendiratta, N.,Rastogi, P. 2011. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. PHI publishing.
3. Selzer, P., Marhofer, R. and Rohwer, A. 2008. Applied Bioinformatics: An Introduction. Springer publishing, Germany.
4. Baxevanic, A.D., Ouellette, B.F.F. 2004. Bioinformatics: A Practical Guide to The Analysis of Genes and Proteins, 3rd Ed. O'Reilly publishers.
5. Moody, G. 2004. Digital Code of Life: How Bioinformatics is Revolutionizing Science, Medicine and Business. John Wiley and Sons.
6. Westhead, D.R., Parish, J.H., Twyman, R.M. 2003. Instant Notes on Bioinformatics. Viva Books Private Limited.
7. Orengo, C. A., Jones, D.T., Thornton, J.M. 2003. Bioinformatics: Genes, Proteins and Computers (Advanced Text). Roultledge.
8. Krane, D.E. and Raymer, M.L. 2002. FUNDAMENTAL CONCEPTS OF BIOINFORMATICS. Benjamin Cummings.
9. Gibas, C. and Jambeck, P. 2001. Developing Bioinformatics Computer SKILLS. O'Reilly publishers.

Websites

1. http://www.ncbi.nlm.nih.gov
2. http://www.ebi.ac.uk
3. http://foldoc.doc.ic.ac.uk/foldoc/index.html

THESIS/OPTIONAL PAPER **Cr: 4(0+4)/ 4(3+1)**

Note: **University Option:** *To be selected from the list provided (Annexure-I) as optional paper.*

SEMESTER VIII

ZOL-606: ZOOGEOGRAPHY& PALEONTOLOGY **Cr 3(3+0)**

Objectives

The course aims to:

- Provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time.
- Impart knowledge and concepts of evolution mainly on the basis of fossil record.
- Give understanding that fossil record also provide information about the distribution of animals in the past eras.

Course Contents

(i) 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: zoogeographic division and boundaries, geographic ranges, physical features, climates, faunas and affinities of Palaearctic, Nearctic regions, Oriental, Ethiopian, Australian, and Neotropical Regions, insular fauna

Palaeogeography: Theories of continental drift and plate tectonics; Pangea.

Zoogeography of Pakistan:

(ii). Paleontology

The Planet Earth: History, age, shells of earth; atmosphere, hydrosphere, biosphere and lithosphere.

Rocks: types; Igneous rocks, sedimentary rocks and metamorphic rocks. Fossil types and uses of fossils, nature of fossils.

Fossilization: Geological time scale. Pre-Cambrian life. Post Cambrian life, Palaeozoic life, Mesozoic life, Cenozoic life.

Geochronometry: Uranium/Lead dating, radiocarbon dating, methods, index fossils; evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

Books Recommended

Zoogeography

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

Paleontology

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

2. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Brouwer, A. 1977. General Palaeontology, Oliver and Boyed, London.

ZOL-607: SYNOPSIS &RESEARCH METHODOLOGY

Cr: 2(2+0)

Objectives

The course is aims to:

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

Course Contents

Significance: objectives of research, Types of research, Research approaches,
Research process: steps involved in research process, (Survey, Observation, case study, experimental, historical and comparative methods)
Data: Types of Data, Data collection, processing, analysis, Review of literature, Research problem, Hypothesis.

Bioethics: Ethical, legal, social and scientific issues in Biological Research. Plagiarism:
Funding Sources: A brief idea about the funding agencies such as HEC, PSF, USAID etc.
Writing of Research Proposal: Thesis/Report and Research Paper:
Footnotes and Bibliography.

Books Recommended

1. Robert, A. Day. 1989. How to write and publish a scientific research paper. 3rd Edition.
2. Holmann, H.H. 1962. Biological research method. Olvyer and Boyd Ltd.

ZOL-608: BIOTECHNOLOGY

Cr: 4(3+1)

Course contents

1. Introduction to biotechnology
2. Advances in vaccine development
3. Recombinant products expression and transgenic animals and plants
4. Bioreactor design: Introduction to factors affecting bioreactor design. Description of a typical asepartic bioreactor.
5. Bioreactor configrations and scale up bio reactor system. Design of sterilization systems. Oxygen mass transfer and heat transfer in bioreactor systems.
6. Fermentation broth rheology.
7. Product recovery, waste treatment and safety.
8. Biosensors: Applications of biosensors,tranducer technology, principles of biosensors.
9. Recombinant protein production, General aspects of heterologous protein expression.
10. Bacterial expression system-Escherichia coli and Bacillus subtilis.
11. *Soccharomyces cerevisiae* as a system for expression of heterologous protein.
12. Expression in non-saccharomyces yeast species and filamentous fungi.
13. Enzymes and industry, extremozymes, enzyme evolution.
14. Microbial productions of pharmaceuticals, diagnostic proteins, vaccines, microbial toxins and insecticides.

Practical:

1. Field trip to an industry with a large scale fermenter.
2. Construction of aerobic and anaerobic bioreactor model.
3. Field trip to vaccine production unit.

RECOMMENDED BOOKS

1. David,B.,Jewell,T.R 2000.Biotecnology :demystifing the concept, Oxford University press.

2. Sedivy,J.M.,Joyner,A.L.2000.Gene targeting,Oxford University press

3. Mukhopadhyay,S.N,2004. Process biotechnology fundamentals,2nd edition. Viva booksPvt.Limited, New Dehli.

4. Goodsell,D.S.,2004.Bionanotechnology: Lesons from nature.Jhon Wiley and Sons Limited.

5. Purohit,S.S.,2002.Biotechnology:Fundamentals and applications ,Agrobios publishers.

6. Prave,p.,Faust U.,Sittig,W., and Sukatsch,D.A.,2002. Fundamentls of biotechnology,Jhonwiley and Sons.

7. Thauer,R., and Wagner,,F.,1991. Biotechnology Focus:Fundamentls applications-Information,Helen Cooper-SchluterCarlHanser,Verlag GmbH and Co.

8. Kalaitzandonakes,N.,2003. The Economic and Environmental Impacts of Argobiotech"A Global Perspective.Kluwer.

9. Tourte,Y., And Tourte,C.2005.Genetic Engineering and Biotechnology; Concepts ,Methods and Agronomoc applications .Scince publishers.

10. Chirtou, P.,and Harry Klee, H.,2004.Handbook of plant biotechnology,2-Volume Set .Jhon Wiley And Sons Limited.

THESIS/ RESEARCH PROJECT /OPTIONAL PAPER **Cr: 4(0+4)/ 4(3+1)**

Note: **University Option:** *To be selected from the list provided (Annexure-I) as optional paper.*

ANNEXURE-I

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

COURSE CONTENTS OF SOME ELECTIVE AND SPECIAL COURSES

***Elective/Special**

ZOL-609: AQUACULTURE **Cr: 4(3+1)**

Objectives

- To equip the students with advanced knowledge about aquaculture, its development and future role in human nutrition. This will enable the young students to understand principles of aquaculture and its relationship with biological systems which is important for better planning and management of aquatic resources in Pakistan
- To teach about different aquaculture species, their rearing facilities and management by using advanced techniques

Course Contents

The concept of aquaculture; principles of aquaculture management. Aquaculture in raceways, cages and enclosures, comparative aquaculture economics of a cage, raceway and enclosure. Use of wastewaters in aquaculture. Mari-culture: Substrate system, sea water ponds. Aquaculture in fresh and brackish waters. Aquaculture in practice: Culture of algae, seaweeds, mollusks and crustaceans. Integration of aquaculture with agriculture poultry and livestock farming. Culture of freshwater prawns and shrimps: History of development, present status, breeding requirements, incubation and hatching of eggs, rearing of larvae and juveniles. Artificial feeds for aquaculture: Feed constituents, diet formulation and processing. Role of biotechnology in sustainable aquaculture development.

Practicals

1. Determination of water quality for aquaculture
2. Determination of metals (Cd, Zn, Co, Mn, Fe) in water, plankton and fish
3. Fish feed formulation and processing

Books Recommended

1. Metha, V. 2009. Fisheries and Aquaculture Biotechnology. 2nd Ed. Campus Books International, New Delhi, India.
2. Sharma, O. P. 2009. Handbook of Fisheries and Aquaculture. Agrotech Publishing Academy, Udaipur, New Delhi, India.
3. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
4. Pandey, B. N., S. Deshpande and P. N. Pandey. 2007. Aquaculture. APH Publishing Corporation, New Delhi, India.
5. Parker, R. O. 2004. Aquaculture Science 4th Ed. Delmar Learning, London, UK.
6. Chakraborty, C. and A. K. Sadhu. 2001. Biology, Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn. Dya Publishing House, New Delhi, India.

ZOL-610: BASIC HUMAN GENETICS **Cr: 4(3+1)**

Objectives

- To provide an overview of human genetic concepts and clinical disorders
- To teach students how to apply the knowledge of medical genetics to a variety of clinical genetic diseases

Course Contents

Nucleic acids.

Genetic linkage: family method, somatic cell hybridization, deletion mapping and duplication mapping. Introduction to human genome. Karyotyping. Patterns of transmission of single gene traits: Pedigree analysis with criteria for identification of various modes of inheritance. Genetic defects in prenatal development; oncogenes and cancer, normal chromosomes, congenital malformations. Introduction to Human genome project.

Practicals:

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

Books Recommended

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

ZOL-611: BIODIVERSITY OF INLAND AND TERRESTRIAL MOLLUSCS **Cr: 4(3+1)**

Objectives

The course is designated to provide with:

- Principles of evolutionary relationship to other animals
- Concept of phylogenetic relationship emphasizing on knowledge about animal kingdom
- Knowledge and focuses on strategies regarding the conservation of Gastropods and Bivalves and to develop pearl industry

Course Contents

Evolutionary perspective; Phylogenetic relationship with other animals; Origin of Coelom; Molluscan characteristics; Diagnostic features of shell and associated structures; Mechanism of feeding, digestion, gas-exchange, locomotion, reproduction and development in Gastropods and Bivalves; Slugs Characteristics and classification; Structure and function of Radula; Torsion and Detorsion in Gastropods. Pearl culturing; Threats; Conservative strategies and Economic importance of Molluscs.

Practicals

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

Books Recommended

1. Miller, A. S. and Harty, I. B. 2002. Zoology. 4th Edition (International) Singapore.
2. McGraw Hill.
3. Baker, G. 2001. The Biology of Terrestrial Molluscs.3rd Edition.
4. Rober, T. and Dilton, Jr. 2000. The Ecology of Freshwater Molluscas. Cambridge University Press 1-499.
5. Preston, S. B. 1915. Mollusca (Freshwater Gastropods and Decapods). Fauna of British India including Ceylon and Burma. 244 p. Taylor and Francis Red Lion Court, London.

ZOL-612: BIODIVERSITY AND WILDLIFE **Cr: 4(3+1)**

Objectives

- To enable student to understand biodiversity levels, functions and its importance
- To acknowledge Wildlife of Pakistan and its importance
- To learn Wildlife census techniques

Course Contents

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

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

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

Ecozones of Pakistan: wildlife and its distribution in different major ecozones of Pakistan.

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

Practicals

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

Books Recommended

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

ZOL-613: BIOLOGY AND CONTROL OF VERTEBRATE PESTS **Cr: 4(3+1)**

Objectives

- To impart the biology of vertebrate pests,
- To familiarize the students about the modern concepts of pests and their sustainable management
- To impart knowledge about the eco-friendly techniques used in vertebrate pest management

Course Contents

Role of vertebrate pests as vectors of zoonotic diseases. Importance of vertebrate pest management. Biology and control of common vertebrate pests in agro-ecosystems of Pakistan. Types of crops inflicted with damage and economic losses by vertebrate pests. Impact of climatic changes on pest efficiencies. Strategic pest management measures: Non-chemical and chemical measures. Pest resistance to chemicals. Estimation methods of damage on crops. Recommended and sustainable management measures in economically important crops for vertebrate pests. Induction of communicable and environmentally hazardous diseases by vertebrate pests and their management

Practicals

1. Survey of agro-ecosystems to locate their potential burrow/nest systems of various vertebrate
2. Vertebrate pest damage assessment, collection of samples and preparation of damage reports
3. Use of some mechanical measures for vertebrate pest control in agroecosystems and stored grains

Books Recommended

1. Hone, J. 2007. Analysis of Vertebrate Pest Control. 3rd Ed. Cambridge University Press, UK.
2. Koul, O., G. S. Dhaliwaland and G. W. Cuperus. 2005. Integrated Pest Management: Potential, Constraints and Challenges. CABI Publishing, London, UK.
3. Singleton, G., W. Jacos and P. Brown. 2005. A Manual of Vertebrate Pest Management in South East Asia. Australian Centre for International Agricultural Research, Canberra, Australia.

ZOL-614: BIOLOGY OF SPIDERS **Cr: 4(3+1)**

Course Contents

An introduction to Spiders; Mygalomorphae, chelicerae, spinnerets, Functional Anatomy, prosoma, opisthosoma, Metabolism; haemolymph, book lungs, haemocyanin, Neurobiology; sub-esophageal ganglion, Cuppiennius, Spider webs: cribellum, linyphiids, spider silk, Locomotion and Prey Capture: Callilepis, bombardier beetles, Argiope, Reproduction: palps, haplogynae, cocoon, Development; automized, cheliceral, molting, Ecology; ant mimicry, stridulation, Argyrodes, Phylogrny and Systematics; synapomorphies, cribellum, Mygalomorphae.

Practicals

Collection, Preservation and Identification of Spiders.Preparation of slides of genetalia, measurement, drawings and description.Study of various systems.

Books Recommended

1. Biology of Spiders. Foelix, R.F.1996. Oxford University Press
2. A Spider's World: Senses and Behavior. Barth, F.G. and Biederman-Thorson, A. 2001. Springer Verlog Berlin, Heidelberg, New York.
3. Spiders in ecological webs. Wise, D.H. 1995. Cambridge University Press.
4. Spiders of India. Sebastian, P.A. and Peter, K.V. 2009. Universities Press (India) Pvt.Ltd.

ZOL-615: BASIC MEDICAL ENTOMOLOGY **Cr: 4(3+1)**

Objectives

The course will provide detailed knowledge about the:

- Diseases and insects of medical importancein Pakistan,
- Detailed understanding of parasites and insects, their life cycle, man, intermediate host and parasite interactions and mode of transmission
- Preventive measures to control the disease and parasited.

Course Contents

Introduction to medical entomology. General overview of Insects of Medical Importance, Morphology and anatomy of insects (mosquito, house fly, sand fly, as examples).

Mosquitos born diseases:

Malaria, Dengue and Dengue hemorrhagic fever, Filariasis, and Chicken gunia and Yellow fever: Disease, parasites, their types and life cycle. Vector and, its life cycle. Parasite, intermediate host and human interactions and transmission of diseases. Prevention, treatment and control of disease and vector.

Flies born diseases

A general overview of diseases transmitted by House flies, (life cycle of the house fly, its control and prevention of diseases transmitted by house fly) Leishmeniasis and sleeping sickness : (disease, parasite, vector; life cycle of parasite and vector, transmission of disease; control of disease and vector

Ticks and Mites born diseases

Plague, scabies, and Congo fever: (disease, parasite, vector; life cycle of parasite and vector, transmission of disease; control of disease and vector

Practicals

1. Collection and identification of vector for malaria and Dengue
2. Study of prepared slide of malarial parasites
3. Study of the morphology of mosquitoes, house fly and cockroach
4. Collection and morphological study of ticks
5. Dissection of mosquito and cockroach to study of anatomy of vectors

Books Recommended

1. Mike Service, (Ed) 2008. Medical Entomology for Students. Cambridge University Press,
2. Eldrige H, Edman BF.(Eds) 2004 Medical Entomology A Textbook on Public Health and Veterinary Problems Caused by Arthropods Springer

ZOL-616: CONSERVATION BIOLOGY **Cr: 4(3+1)**

Objectives

- To study historical background of conservation and its comparison with the recent trends
- To study the impact of gene flow and genetic measures for conservation status of animal life
- To ascertain linkages between the conservation crisis and philosophical, economic and social communities in ecosystems

Course Contents

Conservation biology: Historical perspective. Loss of Biodiversity: Rates, causes, consequences, perspectives. Population bottlenecks and genetic diversity: Effective population numbers and fluctuating size. Gene flow and management measures: One migrant per generation rule, selection and migration, inbreeding and outbreeding depression. Molecular versus quantitative-genetic perspectives and conservation: Single species conservation, choosing species. Conservation forensics: Demographic versus genetic consideration in conservation. Habitat fragmentation. Island biogeographic theory and conservation practices. Endangered Species Act. Community level conservation: Ecological and evolutionary perspectives, ecological restoration, ecosystem stress, ecosystem management – politics and economics.

Practicals

1. Modern approaches to conservation of animals
2. Field visits, trapping and marking techniques
3. Generation of census data about animals

Books Recommended

1. Primack, R. B. 2010. Essentials of Conservation Biology, 5th Ed. Sinauer Associates, Inc. USA.
2. Groom, M. J., G. K. Meffe and C. R. Carroll. 2006. Principles of Conservation Biology. 3rd Ed. Sinauer Associates Inc., New York, USA.
3. Primak, R. B. 2004. A Primer of Conservation Biology, 3rd Ed. Cambridge University Press. UK.
4. Young, A. G. and G. M. Clarke. 2002. Genetics, Demography and Viability of Fragmented Populations. Cambridge University Press, UK.

ZOL-617: ENDOCRINOLOGY **Cr: 4(3+1)**

Course Contents:

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feed-back, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system.

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

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

Calciotrophic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides.

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

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

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

Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action.

Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition.

Endocrinology of Lactation: Hormones in lactation.

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

Functional Diversity of Hormones in Vertebrates.

Overview of Endocrine Mechanisms in Invertebrates.

Practicals

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

Books Recommended

1. Greenspan, F.S. and Strewler, G.J. BASIC AND CLINICAL ENDOCRINOLOGY, 5th Edition. 2002. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. WILLIAMS TEXTBOOK OF ENDOCRINOLOGY, W.D. 2008.Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. ENDOCRINOLOGY, 4th Edition. 2001. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R. TEXTBOOK OF ENDOCRINE PHYSIOLOGY. 4th Edition. 2000. Oxford University Press, Oxford.
5. Neal, J.M., BASIC ENDOCRINOLOGY: AN INTERACTIVE APPROACH. 2000. Blackwell Science Inc., London.

ZOL-618: ENTOMOLOGY (CLASSIFICATION OF INSECTS AND PEST MANAGEMENT)
Cr: 4(3+1)

Aims and Objectives:
The students will
- learn to identify the pests damaging to the crops
- understand methods of population estimation of the pest
- become aware of the applications of different control strategies

Course Contents

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

Brief account of biological control, chemical control and integrated pest management common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Household pests and their management. Knowledge of Pests of cotton, rice, sugarcane.

Practicals

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

Books Recommended

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

ZOL-619: ENTOMOLOGY-I **Cr:4(3+1)**

Course Contents:

General characteristics of insects. Relationship with other Arthropods, splitting up into different evolutionary lines, Reasons for success of the insects in diverse environments.

Hard Parts: General segmentation, tagmatosis and organization.

Cuticle: Detailed structure along with its biochemistry. Epidermal layer; its structure and function.Basementmembrane.Colors of insects.cuticular outgrowths and appendages sclerotization.

Head: cephalization, sclerites, modifications.

Antennae: Different modes of ingestion and types of mouth parts.

Neck: Sclerites.

Thorax: Sclerites: legs, their different modifications and functions.

Wings: Origin; Different regions. Development and basal attachments, main veins and their branches (generalized insects), wing coupling.

Abdomen: Secondary appendages and external genitalia, Flight; types of flight. Aerodynamics, fuels, endoskeleton; head, thorax and abdomen.

Soft Parts: Muscular system; basic structure, types of muscles; muscle contraction and its energetics, comparative structure of all the systems. e.g., digestive, excretory, respiratory, incubatory, and nervous system and their physiology.

Sense organs: sound and light producing organs.

Nutritive requirements: Fat body, exocrine and endocrine glands including pheromones and their functions.

Reproduction: Reproductive organs and different types of reproduction in insects, egg fertilization and maturation.

Development: Embryology up to dorsal closure, different types of metamorphosis, apolysis and ecdysis and the role of endocrine secretions.

Ecology: Carrying capacity 'r' and k selection. Food chains, predation and competition, insect defenses and adaptations, diapause insect population and community studies, insect communication.

Practicals

Preparation of permanent slides.All the hard parts (antennae, mouth parts, wings, legs, terminal segments and genitalia).Different systems, especially digestive, reproductive of the following insects.American cockroach, Gryllus, grasshopper, housefly, butterfly, mosquito, any common beetle.Red cotton bug.Wasp and honey bee.Sympathetic nervous system of cockroach and gryllus. Salivary glands of cockroach, red cotton bug and honey bee.

Books Recommended

1. RICHARDS, O. W. and DAVIES, R. G. IMM'S GENERAL TEXTBOOK OF ENTOMOLOGY. Vol. 1, 10th Edition. 1977. Chapman & Hall, London,

2. Chapman, R.F. THE INSECTS: STRUCTURE AND FUNCTION, 2000. Blackwell Science Inc., London.

3. Wigglesworth, V. B. INSECT PHYSIOLOGY 8th Edition. 1984. Springer Publisher.

4. Robert L. Patton. W. B. INSECT PHYSIOLOGY. 1963. Saunders Co., Philadelphia.

5. Price, W. INSECT ECOLOGY. 1997. John Wiley & Sons.

6. Krebs, C. J. ECOLOGY: THE EXPERIMENTAL ANALYSIST ABUNDANCE. 5th Edition. 2000. Benjamin-Cummings Publishing Company.
7. Tembhare, Db. MODERN ENTOMOLOGY. 2002. Himalaya Publishing House. India.
8. Southhood, T.R.E. ECOLOGICAL METHODS. 1978. Chapman and Hall, London.
9. Yazdani, S.S., and Agarwal, M.L. ELEMENTS OF INSECT ECOLOGY. 1997. Narosa Publishing House. India.

ZOL-620: ENTOMOLOGY-II **Cr: 4(3+1)**

Course Contents

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

Brief account of biological control, chemical control and integrated pest management: common sampling techniques in insect pest management, concept of economic levels, economic damage and economic boundary, economic injury level and economic threshold. Household pests and their management.Knowledge of Pests of cotton, rice, sugarcane.

Practicals

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

Books Recommended

1. Pedigo, L.P. ENTOMOLOGY AND PEST MANAGEMENT. 1991. Maxwell MacMillan.
2. Richards, O.W. and Davies, R.J. IMM'S GENERAL TEXTBOOK OF ENTOMOLOGY. 1977.Vol-Chapman & Hall, London.
3. Metcalf, C.L. and Flint, W.P. DESTRUCTIVE AND USEFUL INSECTS. 1962. McGraw Hill.

ZOL-621: ENVIRONMENTAL ISSUES Cr: 4(3+1)

Objectives

- To provide review of the different environmental issues including ecological, conservation, pollution, resources, population and socioeconomic issues of Pakistan.
- To impart knowledge about management and planning issues using case studies.
- To enable the students to identify and analyze various environmental issues

Course Contents

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

Food production and its distribution, hunger, malnutrition and famine. Pest and pest control need and approach to pest control, integrated pest management.

Water Pollution: Human impact on water resources, Eutrophication, Combating eutrophication.

Sewage Pollution: Sewage hazards and sewage managements.

Hazardous Chemical pollution: Nature of chemical risks, pollution sources and control.

Major atmospheric Changes; Acid deposition, global warming/ cooling, greenhouse effect, Ozone depletion.

Solid Waste: Landfills, incineration, management and solutions.

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

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

Population issues: Socio-economic issues in Pakistan.

Practicals

1. Study of the various characteristics of the population with the help of the statistical data (Age profile, family size and educational status, etc).
2. Study of the types of the pesticides and their characteristics.
3. Study of the relationship between relative humidity and temperature of Lahore for a particular time period.
4. Estimation of total particulate matter in air by using air sampler.

5. Determination of Sodium and Potassium in various water samples using flame photometer.
5. Determination of Chromium, Lead and Copper in industrial effluent.
7. To study the urban environment and urban environmental issues.
8. To study the eutrophic conditions in various ponds.
9. To study noise level at different places in city (Main road crossings, Railway station, Hospital) using noise level meter.
10. To study the level of occurrence of various diseases among families of (i) Class students (ii) Low income groups (iii) High income groups.

Books Recommended

1. Botkin, D. B. and Keller, E. A. 2000. Environmental Science (Earth as a living planet). 3rd ed. John Wiley and Sons Inc. New York, USA.

2. Nebel, B. J. and Wright, R. T. 1998. Environmental Science (The way the world works). 1st ed. Prentice Hall International Inc. London, UK.

3. Bradbury, 1. K. 1998. The Biosphere. 2nd ed. John Wiley and Sons Inc. UK.

4. McKinney, M. L. and Schoch, R. M. 1998. Environmental Science (Systems and solutions). Jones and Bartltt Publications Inc. USA.

5. Ahmad, R. Z. 2000. Pakistan- A Descriptive Atlas (A comprehensive geo-politics course). 1st ed. Feroze sons Pvt. Ltd. Lahore Pakistan.

6. Khan, F. K. 1993. A Geography of Pakistan Environment (Environment, people and economy). 1st ed. Oxford University Press. New York USA.

7. Daily newspapers for current issues.

WEBSITES

http://wuw.panasia.org.sg/tcdc/pakistan

http://urww. wwfpak.org/biodiversity

http://www.populationconnection.org

http://www.epa.org.pk

http://www.unep.org

ZOL-622: FISH CULTURE **Cr: 4(3+1)**

Objectives

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

Course Contents

Aims and evolution of fish culture. Pond fish culture: Planning and construction of fish pond, water quality criteria, conditions suitable for fish culture, biological production cycle of fish pond. Culturable fishes of Pakistan. Fertilization of fish pond: Organic and inorganic fertilizers. Artificial feeding in fish culture: Fish feeding methods, different components of fish feed, composition of commonly available feed ingredients, preparation and feed storage methods.

Integrated fish farming: Concepts and practices. Fish enemies. Fish diseases and remedial measures. Fish hatchery management. Fishing gears, pre- and post-harvesting care of fish, maintenance of fish catch quality during transportation, storage and marketing. Fish processing technology.

Practicals

1. Uses of different organic and inorganic fertilizers in fish ponds
2. Identification of various fishes
3. Study of morphological characters and identification of cultureable fish species
4. Practical demonstration of induced fish breeding

Books Recommended

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

ZOL-623: FISH ECOLOGY **Cr: 4(3+1)**

Objectives

- To elaborate the interaction of fish and aquatic environment
- To describe the effects of biotic and abiotic factors on fish
- To impart knowledge regarding fish population dynamics

Course Contents

Introduction to fish ecology. Inter-relationship between fish and their abiotic and biotic environments: adaptations of fish to a biotic environmental factors; density, pressure, salinity, temperature, salt content of water, gases in solution and light. Sound and other vibrations. Bottom deposits and particles suspended in water. Movement of water and modes of fish movements. Biotic inter-relationships among fishes; intra-specific relationships between fishes and bacteria, viruses, plants and other animals. Competition and predation in freshwater communities. Fundamental links in life cycle of fishes: reproduction and development in fishes; population dynamics; movement, migration and colonization in fishes, spawning, feeding and over-wintering migrations. Over-wintering and hibernation in fishes; feeding and feeding relationships among fishes.

Practicals

1. Study of fishes with special reference to food and feeding habits.
2. Fish population estimation.
3. Study of fish with special reference to changes in ecological conditions.

Books Recommended

1. Harold M. Tyus, 2011. Ecology and Conservation of Fishes. CRC Press, Taylor and
2. Francis Group, USA
3. Pandey B.N. 2004. Fish Research. APH Publishing Corporation.
4. Kaul Bansi Lal. 1999. Advances in Fish and Wildlife Ecology and Biology. Daya
5. Publishing House Delhi.
6. Moss, B. 1998. Ecology of Freshwaters. Blackwell Scientific Series, U.K.
7. Kaul, B.L., 1996. Advances in Fish and Wildlife Ecology and Biology (Vols. I & II). Daya
8. Publishing House, N. Delhi.
9. Jafferies, M. and Mills, D. 1992. Freshwater Ecology: Principles and Applications. CBS
10. Publishers and Distributors Ltd., N. Delhi.

ZOL-624: FISH FEEDING MANAGEMENT **Cr: 4(3+1)**

Objectives

- To elaborate the significance of fish feeding,
- To impart the basic principles of artificial feed preparation,
- To understand the fate of different nutrients in fish

Course Contents

Need of supplementary/ artificial feeding of fish, Scope of artificial feeding in fish, Metabolism of feed nutrients (Protein, Lipid, Carbohydrate) in fish, Feeding practices, Different types of feeders, Diet preparation and processing techniques, Estimation of apparent nutrient digestibility. FCR and FCE indices, Food acquisition and patterns of estimation of food requirements.

Practicals

1. Ration calculation for fish feeding based on body weight, body length etc.
2. Estimation of basic nutrients in feed i.e. moisture, protein, lipid, carbohydrates and ash.
3. Formulation of fish feed.

Books Recommended

1. Lovell, T., 2012. Nutrition and Feeding of Fish. 2nd Ed. Springer Science, USA
2. Pillay T V R, M N Kutty. 2005. Aquaculture: Principles and Practices. Balckwell Publishing. UK.
3. Reddy, M.S. and Sambasiva K.R.S. 1999. A Textbook of Aquaculture. Discovery Publishing House, N. Delhi.
4. Pillay, T.V.R. 1999. Aquaculture: Principals and Practices. Fishing News Books, London.

ZOL-625: FISH PHYSIOLOGY AND BREEDING **Cr: 4(3+1)**

Objectives

- to provide sufficient knowledge about all physiological phenomena in fishes.
- to provide practical information to obtain better growth during extensive or semi-intensive culture.
- to impart knowledge about breeding of most culturable freshwater fishes by manipulating reproductive and endocrinological aspects during natural season as well as off seasons

Course Contents

Fish nutrition: Digestive system; Stomach less fishes; Stomach fishes; Digestion and absorption; Food; Plant origin; Animal origin; Feeding; Fresh food; Dry concentrates; Pelleted food.

Transportation: Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma); Circulation; Arterial system; Venous system; Capillaries; Transport of food material.

Respiration: Gills; Lungs; Skin; Swimbladder; Homeostasis.

Excretion: Kidneys; Hypo-osmotic urine; Hyper-osmotic urine; Osmoregulation.

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

Breeding: Natural (seasonal); Artificial; Hormonal induced breeding; Temperature & photoperiod; control induced breeding.

Growth: Extensive culture (due to the consumption of natural food); Semiintensive culture (due to natural & artificial food); Intensive culture (due to only dry concentrates).

Fish health: Water quality; Hygiene of fish culture facilities; Hygiene of equipment used in fish culture.

Diseases and their control: Viral; Bacterial; Fungal; Parasitic; Protozoan; Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera); Annelids (leeches); Arthropods (water ticks, water flea, water mites).

Fish migration: To nursery ground; To maturation grounds; Freshwater to marine water; Marine water to freshwater.

Fish behaviour: Learning and memory; Light response for maturation; Courtship behaviour; Aquarium fish behavior

Practicals:

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

Books Recommended

1. Kestin, S. C. and Warris, P.D. (Editors). 2002, Kestin farmed fish quality, Blackwell Science, oxford, UK.
2. Saksena, D.N. 1999. Ichthyology: recent research advances. Oscar Publications. India.
3. Woo, P.T.K 1995.Ffish diseases and disorder. Vol 1. Protozoan and metazoan infections. CABI Publisher.
4. Brenabe, G. 1992. Aquaculture, Vol. I. Blackwell Publishing, Oxford. UK.
5. Maseke C. 1987. Fish aquaculture. Pergamon Press, Oxford. UK.
6. Huet M. 1973. Text book of fish culture: breeding and cultivation. Blackwell Publishing Company
7. Hoar, W.S. 1971. Fish physiology. Academic Press. UK.
8. Hoar, W.S. 1969. Fish reproduction. Academic Press. UK.
9. Matty, A.J. 1985. Fish endocrinology. Timber Press, UK.
10. Gorbman, A. 1983. Comparative Endocrinology. 1st Edition. John Wiley & Sons. UK.

ZOL-626: FUNDAMENTALS OF MICROBIOLOGY

Cr: 4(3+1)

Objectives

The course is designed to

- Enable the students to work with micro-organisms.
- Understand the basic techniques of sterilization, culturing and isolation of bacteria and fungi
- Determine different characteristics of the micro-organisms.

Course Contents

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

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

Morphology and fine structure of bacteria: Size, Shape and arrangement of bacterial cells, motility, Capsules, Structure and composition of cell wall, Cytoplasmic membrane, Protoplasts, Endospore, pili.

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

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

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

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

Medical microbiology: Sources and communicability of diseases, Communicable diseases, Non-communicable diseases, Chain of infection, Etiological agents, Specificity, Source and reservoirs of etiological agents, Methods of transmission. Normal microbial flora: Significance of normal microbial flora, Origin of normal Microbial flora, Microbial flora of skin, Microbial flora of gastrointestinal tract, Microbial flora of genito-urinary tract, Sterile sides of human body, Mechanism of bacterial pathogenity.

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

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

Air microbiology: Microbial content of air, Indoor air, Outdoor air.

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

Practicals

1. Isolation of microorganisms from air.
2. Isolation of microorganisms from water.
3. Isolation of microorganisms from soil.
4. To study the morphology of moulds.
5. To study physical characteristics of bacterial colonies.
6. To study bacteria of different morphologies through simple, gram, endospore, flagellar and capsular stainings
7. Different techniques for the isolation of microorganisms.
8. Gram staining of mouth flora.
9. To study bacterial motility by hanging drop method.
10. Negative staining of bacteria.
11. Acid fast staining of bacteria.
12. To study different sterilization techniques. Isolation of spore forming bacteria from powdered milk .
13. To study viable counting of bacteria.

Books Recommended

1. Medical Microbiology. Khan, A. M. 2001. 151 ed. Time Publishers Pakistan.
2. Environmental Microbiology Vamam, A. H. and Malcolm, G. M. 2000.1st ed. Manson Publishing Ltd. USA.
3. Introductory Microbiology. Fredrick, C. R. and Charles, E. M. 1983. 151 ed. Merrill Publishing Company USA.
4. Microbiology. Pelczar, M. J. Chan, E. C. and King, N. R. 1986. 51h ed. McGraw-Hill, Inc. New York.
5. Laboratory Experiments in Microbiology. Johnson, T. R. and Case, C. L. 1992. 3rd ed. The Banjamin/Cummings Publishing Company, USA.
6. Plant and microbial biotechnology Research, NO.3. Wang, K., Herrera-Eastrella A. and Montagu, M. V. 1995. Cambridge University, Press, UK.

ZOL-627: GENERAL AND COMPARATIVE ENDOCRINOLOGY **Cr: 4(3+1)**

Objectives

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

Course Contents

An overview of general concepts and principles of endocrinology: The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feedback, biorhythms, pathology and assessment of endocrine function; Evolution of endocrine system.

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

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

Calciotrophic and Mineral Metabolism Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, phosphate and magnesium.

Pancreatic Hormones and Regulatory Peptides of the Gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides.

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

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

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

Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; Transport, metabolism and mechanism of action.

Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition.

Endocrinology of Lactation: Hormones in lactation. Endocrinology of Heart, Kidney, **Immune system:** Growth and pineal gland. Functional diversity of hormones in vertebrates; Overview of endocrine mechanisms in invertebrates.

Practicals

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

Books Recommended

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

2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. WILLIAMS Textbook of Endocrinology, W.D. 2008.Saunders Company, Philadelphia.

3. DeGroot, L.J., Jameson, J.L. Endocrinology, 4th Edition. 2001. W.B. Saunders, Philadelphia.

4. Giffin, J.E. and Ojeda, S.R. Textbook of Endocrine Physiology.4th Edition. 2000. Oxford University Press, Oxford.

5. Neal, J.M., Basic Endocrinology: An Interactive Approach. 2000. Blackwell Science Inc., London.

ZOL-628: GENERAL MICROBIOLOGY **Cr: 4(3+1)**

Objectives

The course aims to:

- Enable the students to work with microorganisms.
- Understand the basic techniques of sterilization, culturing, isolation
- Determine different characteristics of the microorganisms

Course Contents

The beginnings of Microbiology: Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology. Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's m anual.

Viruses: Bacteriophages and phages of other protests. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses.Effects of virus infection on cells. Cancer and viruses.

Morphology and fine structure of bacteria: Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material.

The Cultivation of Bacteria: Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation.

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

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

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

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

Prokaryotic Diversity: Archaea: Extremely Halophilic archaea, Methane producing archaea: Methanogens, Hyperthermophilic archaea, Thermoplasma.

Practicals

1. Preparation of culture media
2. Pure culturing and cultivation of bacteria
3. Simple, Gram, endospore, capsular, flagellar and acid fast staining of different genera of bacteria\Vital staning and microscopic observations of protozoa
4. Cultivation methods of fungi
5. Isolation of bacteriophages

Books Recommended

1. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. 2001. Microbiology: A Hhuman Perspective, McGraw Hill Higher Education.
2. Jacquelyn, G.G. 2001. Microbiology: Principles and Explorations, John Wiley & Sons Inc.
3. Madigan, M.T., Martinko, J.M. and Parker, J. 1997. Brock Biology of Microrganisms, Prentice-Hall, London.
4. Benson, H.J. 1994. MICROBIAL APPLICATIONS: LABORATORY MANUAL IN GENERAL MICROBIOLOGY, WMC Brown Publishers, England.
5. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. 1986. MICROBIOLOGY, McGraw Hill, London.
6. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. 1986. THE MICROBIAL WORLD, Prentice Hall, London

ZOL-629: HELMINTHOLOGY AND HOST-PARASITE RELATIONSHIP Cr: 4(3+1)

Objectives

The course will

- provide knowledge regarding basic principles of host parasite interactions
- impart knowledge on helminth parasites of medical, veterinary and agricultural importance

Course Contents

Part I: Helminthology Theory: Classification, Basic principles and concepts in Parasitology, Taxonomy, etiology, biology, epedemiology, pathology and pathogenesis, diagnosis, control and treatment of

Digenetic Trematodes: Schistosoma mansoni, S.japonicum, S.haematobium, Fasciola hepatica, Fasciolopsis buski, Dicrocoelium dendriticum, Paragonimus westermani, Colonorchis sinensis, Heterophyes heterophyes,

Monogenetic trematodes: Dactylogyrus vastator, Gyrodactylus, Diplozoon paradoxum and Polystoma integrimum., Cestodes: Diphyllobothriam latum, Sparganosis, Taenia saginata, T.solium. Echinococcus granulosus, E.multilocularis, Hymenolepis nana, Dipylidium caninum, Moniezia expansa.,

Nematodes: Trichuris trichiura, Capillaria hepatica, Trichenella spiralis, Strongyloides stercoralis, Ancylostoma duodenale, Necator americanus., Creeping eruption: Haemonchus contortus, Ascaris lumbricoides, Toxocara canis, Anisakis spp., Heterakis gallinarum, Enterobius vermicularis, Wuchereria bancrofti, Brugia malayi, Onchocerca volvulus, Loa loa and Dracunculus medinensis.

Part II: Host Parasite Relationship Host parasite relationship: as associative organization between two organisms. Structural aspects of the association interface. Nutrient exchanges in associations. Physiological and regulatory interactions: between associates. Behavioral Aspects of organism associations. Ecology and evolution of intimate associations; Anthelmintic resistance detection methods. Detection and characterisation of parasites causing emerging zoonoses

Practicals

1. Stage and ocular micrometry for measurement of helminths. Preparation of temporary and permanent mounts of parasites from thefollowing animals:

2. a. Fish b. Frog/toad c. Fowl/Pigeon d. Rat/Mouse.

3. Study of helminths from prepared slides. Study of eggs/larvae from feces and prepared slides. Diagnosis of medically important parasites in fecal specimen by using: Tillman's centrifugation technique, by Lugol's iodine staining technique, Baermanns procedure for nematode culture.

Books Recommended

1. Robberts, L. Sand Janovy John Jr. 2009. Foundation of Parasitology. 8th edition. McGraw Hill, Boston
2. Facust, E. C. and Russell, P. F. 2001. Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
3. Markell, E.K. Mo. Vogo. 1999. Medical Parasitology. W. B. Sundress Co: Philadelphia.
4. Chandrasoma, P. and Taylor, C.R.1997. Concise Pathology. Prentice Hali International Inc. New Jercy USA.
5. Peters, W and Gills, H.M. 1989. A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
6. Smyth, J. D. 1994. Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
7. Taylor, A.E.R & Muller, R. (1987). Genetic aspects of host parasite relationships. Symposium of the British Society for Parasitology. . Blackwell Scientific Publications Oxford
8. Whitfield, P. J. (Recent edition). The biology of parasitism; an introduction to the study of association organisms. Edward Arnold. Publishers, UK

ZOL-630: HEMATOLOGY **Cr: 4(3+1)**

Objectives

- to provide knowledge about blood formation, morphology, physiology and biochemistry of blood cells, basic mechanisms and types
- to impart knowledge about advanced techniques in studying serological and hematological techniques, blood coagulation
- to gain insight into blood related diseases

Course Contents

Blood cell formation, Erythropoises and general aspects of anemia, hyper chromic anemia and iron overload, Megaloblastic anemia and other meroblastic anemia, Hemolytic anemia. Genetic disorders of Hemoglobin. Leukopoises, Lymphocytes and their benign disorders, granulocytes and monocytes. Platelets, blood coagulation and hemostasis, bleeding disorders caused by vascular and platelet disorders.

Practicals

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

Books Recommended

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

ZOL- 631: ICHTHYOLOGY **Cr: 4(3+1)**

Objectives

- To study the evolution and taxonomy of fish,
- To providing the knowledge regarding fish biology,
- To elaborate the anatomy and physiology of fish

Course Contents

Systematic position of fish in animal kingdom, External features of fish, Fish muscular system, locomotion and energetics of swimming. Physiology of respiration and air breathing among fishes. Cardiovascular system, blood and its circulation and hydromineral balance: Osmoregulation, ionic regulation, stress responses, freezing resistance and acid-base balance. Digestion and control of gastro-intestinal motility in fish. Physiology of gas bladder: Use of gas by the fish as a source of static lift. Gas in the gas bladder: Loss, retention and secretion of gas. Process of aestivation in fish. Control of kidney function in fish. Sensory system and communication in fish: Acoustico-lateralis system, sound reception and production.

Practicals

1. Study of classification of fishes and some selected fish species
2. Study of Fish anatomy, physiology and adaptations, fish dissections
3. Study of fish habitats, fish fauna of Pakistan
4. Study of fish reproduction, oocytes and aquaculture and food requirements
5. Study of environmental, ecological and economic importance of fishes
6. Study of ornamental fishes
7. Field visits to fish hatcheries

Books Recommended

1. Lagler, K.F., J.E. Baradach and R.R. Miller. 2009. Ichthyology. John Wiley and Sons, Inc., New York, USA.

2. Moyle, P.B. and J.J. Cech. 2008. Fishes: An Introduction to Ichthyology. 6th Ed. Prentice Hall, New Jersey, USA.

3. David, H. 2003. The Physiology of Fishes 3rd Ed. CRC Press, UK.

4. Smith, L.S. 2002. Introduction to Fish Physiology. 2nd Ed. Argent Labs. Washington DC,

ZOL-632: IMMUNOLOGY **Cr: 4(3+1)**

Objectives

The course aims to

- Give understanding of the basic concepts of immunology and its importance in biological sciences
- Provide information about immunological mechanisms against different diseases
- Give understanding of immunization, immunological tolerance etc.

Course Contents

Immunology: Immunobiology, Immunophysiology, Immunopathology.

Immunity: Natural and acquired immunity, Active and passive immunity.

Antigens and elicitation of immune responses: antigens and their types, antigenicity and immunogenicity, factors important for immunogenicity of an antigen, cell mediated and humoral: nature of antigens, genetic constitution of individuals and route of administration.

Immunoglobulins: Synthesis of antibodies, Theories of antibodies synthesis.

Detection and application of antigen-antibody reactions: in vivo and in vitro reactions.

Monoclonal antibodies: Importance, synthesis, isolation and applications

Major histocompatibility complex: types and importance, diversity in MHC proteins.

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

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

Immunological tolerance and autoimmunity: Tolerance, autoimmune diseases and types, factors responsible for autoimmunity. Transplantation immunology, Tumor immunology, Immunity against infectious diseases. Immune deficiency diseases, Immunity and malnutrition. Immunization; Immunization procedures, Vaccines and their types.

Practicals

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

Books Recommended

1. Essential immunology.Roitt, I. 1990. 2nd ed. Black well Scientific Publications. Oxford, UK.
2. Stites, D. P., Stobo, J. D., Fudnberg, H. H. and Wells, J. V. 1990. Basic and clinical immunology. Lange Medical Publications, USA.
3. Essentials of haematology. Hoff - Brand, A. B. and Pedit, J. E. 1981. Black well Scientific Publications. Oxford, UK

ZOL-633: INSECTS OF VETERINARY AND MEDICAL IMPORTANCE Cr:4(3+1)

Objectives

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

Course Contents

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.

Practicals

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

Books Recommended

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

ZOL-634: INTEGRATED PEST MANAGEMENT **Cr:4(3+1)**

Course Contents:

Introduction, approaches and objectives, past and present, theoretical foundation of pest control, opportunities and challenges for insect pest control in developing countries, concept of economic threshold level, economic injury level, economic damage and economic boundary, major threats to the natural enemies, ranking of natural enemies, concept of classical biological control, effects of different agronomic practices and habitat structure on the population dynamics of predators, relationship of biological control to the sustainable agriculture, augmentation and inoculation of natural enemies, conservation of existing natural enemies, limitation of biological control and modern trends to overcome this problem.

Practicals:

Collection and identification of important pests and their enemies, techniques to culture and maintain selected natural enemies of insect pests in the laboratory and in the fields.

Recommended Books:

1. Bradford, A. H. & Howard V. C, 2008.Theoretical Approaches to Biological Control.CambridgeUniversity Press, New Yark.
2. DeBach, P., 1991, *Biological Control by Natural Enemies*, 2nd edition, Cambridge University Press, Cambridge, MA.
3. Dent, D., 1991. Insect pest management. C.A.B International Wallingford, Oxon. UK.
4. Pedigo, L.P., 1991. Entomology and pest management. Maxwell MacMillian.
5. Van Driesche, R.G. and T.S. Bellows, Jr., 1996, *Biological Control*, Chapman and Hall. International Thomson Publishing Co.

ZOL-635: INTRODUCTION TO ENVIRONMENT **Cr: 4(3+1)**

Objectives

- To enable students to understand interrelationship between various components of the environment.
- To provide knowledge about basic concepts of matter, energy, birth of universe, solar system and origin of earth,.
- To provide knowledge about environmental geology and environment and life and human activity are considered for understanding of environment and its trans disciplinary integration.

Course Contents

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

Environmental factors; Physical, chemical and biological factors.

Variety of life and environment (brief account).

Environnent and human interactions. Environnemental pollution; types, sources, causes and effects (brief overview). Environmental issues and challenges; Deforestation, water logging, salinity, drought and desertification, Loss of natural habitat, Depletion of resources, Population and genetic diversity.

Environment and sustainable development.

Issues of social environment; Population growth, urbanization, migration, and poverty, Lifestyle and environment.

Practicals

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

Books Recommended

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

ZOL-636: LIMNOLOGY **Cr: 4(3+1)**

Objectives

- To impart the knowledge regarding physice-chemical characteristics of water,
- To elaborate the phenomenon of water quality change in natural water bodies,
- To teach about the effects of limnological factors on fish.

Course Contents:

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 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.

Practicals

1. Water sampling and water preservation techniques for physicochemical and biological analyses
2. Estimation of physical characteristics of water viz. temperature, density, light penetration and turbidity
3. Estimation of chemical characteristics of water viz. dissolved oxygen, carbon dioxide, pH, total alkalinity, total hardness, bicarbonates, chlorides, calcium, magnesium, salinity
4. Collection, preservation and study of fauna and flora of various water bodies

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.

ZOL-637: MAMMALOGY **Cr: 4(3+1)**

Objectives

- To teach the students about phylogenetic relationships of the primitive and present mammals, based on taxonomic and modern approaches
- To study the feeding and foraging periodicities of different mammalian groups and impact of environment on feeding behavior
- To ascertain different mammalian population patterns viz. concept of natality, mortality, modeling signaling and effective communication in various mammals

Course Contents

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 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.

Practicals

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

Books Recomended

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

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

3. Genoways. H.H., 2000. Current Mammalogy. Plennium Press, New York, USA.

ZOL-638: MICROBIOLOGY AND BIOTECHNOLOGY Cr: 4(3+1)

Objectives

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

Course Contents

History of microbiology, Screening of microorganisms from environmental samples,

Characterization and classification of microorganisms, cultivation, microbial growth dynamics and kinetics, Development of pure cultures and their preservation, inoculum

development (size and physiological states), mixed cultures and substrate systems, Types of fermentors, types of bioreactors, strain improvement through recombinant DNA technology, scale up theory, Applied biotechnology: case studies for industry, environment, health, and agriculture.

Practicals

1. Study of bacteria, yeasts and molds, and protozoa,
2. microscopy, preparation and sterilization of culture media,
3. isolation of pure cultures, microbial enumeration and growth estimations,
4. cultural preservation techniques, development of synchronized inocula for industrial use

Books Recommended

1. Pelczar Jr., chan, E. C. S. and Krieg, M. R., 1986. Microbiology, McGraw Hill, London.
2. Medigan, M. T., Mantinko, J. M. and Parker, J., 1997. Brock Biology of Microorganisms, Prentice Hall, International, Inc. USA
3. Peltier., G. L. A Laboratory Manual of Microbiology.
4. Benson, H. J. 1994. Microbiological Applications, Wm. C. Brown Publishers, USA.
5. Rehm, J. J., 1988. Biotechnology Fundamentals, VCH Publishers, New York.
6. Lee, B. H., 1996. Fundamentals of Food Biotechnology, VCH Publishers, New York.

ZOL-639: MICROBIOLOGY-I **Cr: 4(3+1)**

Course Contents

The beginnings of Microbiology.Microscopic examination of microorganisms.Characterization and classification of microorganisms.Morphology and fine structure of bacteria.The cultivation of bacteria.Reproduction and growth of bacteria.Pure cultures and cultural characteristics.Microbial metabolism.

Practicals

Study of bacteria, fungi and protozoa.Staining of microorganisms: simple staining, negative staining.Demonstration of special structures by stains; capsular stain, spore stain, metachromatic granule stain, acid fast stain, flagella stain.

Books Recommended

1. Benson, H.J. MICROBIAL APPLICATIONS: LABORATORY MANUAL IN GENERAL MICROBIOLOGY, 1994. WMC Brown Publishers, England.
2. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. MICROBIOLOGY, 1986. McGraw Hill, London.
3. Madigan, M.T., Martinko, J.M. and Parker, J. BROCK BIOLOGY OF MICROORGANISMS, 1997. Prentice-Hall, London.
4. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R.THE MICROBIAL WORLD, 1986. Prentice Hall, London.

ZOL-540: MICROBIOLOGY-II **Cr: 4(3+1)**

Course Contents

Bacterial physiology.The phylogeny of bacteria, Phototrophic, chemolithotrophic and methanotrophicproteobacteria, aerobic and facultatively aerobic chemoorganotrophic proteobacteria, morphologically unusual proteobacteria, Delta and epsilon proteobacteria, Firmicutes, mollicutes and actinobacteria, Cyanobacteria and prochlorophytes, Chlamydia, The planctomycetes, Verrucomicrobia, Flavobacteria and Acidobacteria, Cytophaga group, Green Sulfur bacteria, Spirochetes, Dienococci, The green non sulfur bacteria, Hyperthermophillic bacteria, Nitrospira and Deferribacter, Diversity of Archea, Euryarchaeota, Crenarchaeota.

Practicals

Culturing of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates.Isolation and stock culturing of bacteria.Quantitative plating method.Theturbidimetric estimation of microbial growth.Study of bacterial viruses.Biochemical characterization of bacteria.

Books Recommended

1. Brock Biology of Microorganisms. Madigan, M.T., Martinko, J.M. and Parker, J. 1997. Prentice-Hall, London.
2. Microbial Applications (complete version) Laboratory Manual in General Microbiology. Benson, H.J. 1994. WMC Brown Publisher, England.
3. Microbiology. Pelczar Jr., Chan, E.C.S. and Kreg, M.R. 1986. McGraw Hill, London.
4. The Microbial World. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. 1986. Prentice Hall London.

ZOL-641: MOLECULAR AND CLINICAL ENDOCRINOLOGY Cr: 4(3+1)

Course Contents

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

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

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

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

Development and Growth: Disorders of growth and puberty. Endocrine Hypertension.Polyendocrine Syndromes. Hormones and Cancers: Hormones Effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy. Geriatric Endocrinology: Endocrine and Associated Metabolism in aging: Specifically thyroid, glucose and calcium homeostasis.

Practicals

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

Books Recommended

1. Greenspan, F.S. and Strewler, G.J. BASIC AND CLINICAL ENDOCRINOLOGY, 5th Edition. 2002. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. WILLIAMS TEXTBOOK OF ENDOCRINOLOGY, 9th Edition. 1998. W.D. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. ENDOCRINOLOGY, 4th Edition. 2001. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R. TEXTBOOK OF ENDOCRINE PHYSIOLOGY. 4th Edition. 2000. Oxford University Press, Oxford.
5. Neal, J.M. BASIC ENDOCRINOLOGY: AN INTERACTIVE APPROACH. 2000. Blackwell Science Inc., London.

ZOL-642: MOLECULAR BIOLOGY **Cr: 4(3+1)**

Objectives

The course will provide

- An understanding of how molecular mechanisms are constructed and regulated
- Knowledge about different molecular biological techniques

Course Contents

Chemical, Physical and Biological Properties of DNA. Structure and chemical composition of a gene, Types of gene. DNA polymerases, their types in eukaryotes and functions. RNA, its types and structures, Types of RNA polymerases in prokaryotes and in eukaryotes. Gene expression and regulation in both prokaryotes and eukaryotes. Mutation, mutagenes,

Chemical, physical and Biological mutagenes, DNA repair. Transposons, its types, mechanism of transposition. Recombinant DNA Technology, its necessary elements, Restriction enzymes, types of restriction enzymes and their mode of action. Cloninig vectors, Plasmids as cloning vectors, bacteriophage lambda as cloning vector, Cosmids as cloning vectors and shuttle vectors. Synthesis of cDNA, Cloning in Ecoli, Yeast and in Higher eukaryotes. Anti-sense RNA. Tripple helix DNA and chromosomal walking. Applications of recombinant DNA technology.

Prcaticals

1. Separation of different sized DNA fragments on agarose gel.

2. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).

Books Recommended

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D.2013. Molecular Biology of the Cell. Garland Publishing Inc., New York.

2. Damell Jr. J., Lodisch, H., Balimore, D. 2013. Molecular Cell Biology, Scientific American Inc. N.Y.

3. Friefelder, D. 2010. Molecular Biology.

4. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach,.Sinauer Associates, INC.

5. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.

6. De Robertis, E. D. P., De Robertis Jr. E. N. F. 1987. Cell and Molecular Biology, Lea & Febiger, New York.

ZOL-643: MOLECULAR GENETICS **Cr: 4(3+1)**

Objectives

- to understand the molecular basis for transcription, translation, replication and gene regulation
- to understand molecular mechanisms in prokaryotes and eukaryotes
- to understand modern methods and applications of molecular analysis of genetic diseases

Course Contents

Plant and animal viruses (DNA and RNA)

Transposition: transposable elements, detection of transposition in bacteria, types of bacterial transposons, modes of transposition in bacteria. Genetic phenomena mediated by transposons, transposable elements in prokaryotes and eukaryotes. Gene expression in pro- and eukaryotes. Genetic transformation (all kinds). Regulation of simple and complex transcription unit. Current developments in molecular genetics: molecular techniques viz. Southern, Northern and Western blotting, PCR, RFLP, AFLP's, RAPDs, Micro-sattelites, SNPs.

Practicals

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

Books Recommended

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

ZOL-644: ORNITHOLOGY- I **Cr: 4(3+1)**

Objectives

The course will

- Provide knowledge about bird diversity
- Avian anatomy, physiology and adaptations
- Bird behavior and socioeconomic and ecological importance

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. Introduction, evolution, geographical distribution. Classification Characteristics of birds, external features, identification of sex and age, reproduction and development, behavior (migration, territoriality), populations and their regulation. Anatomical,physiological adaptations to their environment, reproductive strategies, food/feed, communication (vocal, behavioral) Anatomy & physiology of game and predatory species. Birds of Pakistan: Aquatic, Forest and Game birds and birds of prey. Birds as pests.

Practicals

- Identification characteristics and taxonomy of birds to orders and families
- Dissection of sparrow, pigeon, myna, other available birds
- Anatomy of bones, skull, girdles, spine, vertebrae, feathers, plumage
- Study of gut contents of birds to understand feeding habits
- Incubation of chicken eggs to learn avian embryogenesis
- Bird stuffing and preservation of eggs
- Identification of bird species through feathers and egg shells
- Beak and claw structures
- Study of bird songs, recording bird songs, fundamental experimentation to understand bird songs in sensitive and sensorimotor phases
- Bird watching and preparation of ethograms
- Study of Predator-prey relationship among birds

- Study of Brood parasitism
- Study of flying mechanics through models

Books Recommended

1. Howell, S. N. G. 2010. Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
2. Kaiser, G. W. 2008. The Inner Bird: Anatomy and Evolution. 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.
6. 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.
13. Ali, S. 1979. The book of Indian Birds. Bombay Natural History Society, Bombay, India,
14. Bibby, C. J., Burgess, N.D. and Hill, D.A. 1992. Bird Census Techniques. Academic Press London.
15. Del Hayo, J.D., Elliot, A. and Saegatal, J. 1997. Handbook of the birds of the world. Hoatzin to Auks. Birdlife International, Lynx, editions, Barcelona.
16. Ridgway, R. 1974. Ornithology. Ayer Publishing.
17. Rand, A.L. 1974. Ornithology: an introduction. Penguin Books.
18. Roberts, T.J. 1992. Birds of Pakistan. Vol 1& 2. Oxford University Press.

ZOL-645: PARASITOLOGY **Cr: 4(3+1)**

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, classOligohymenophorea. 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.

ZOL-646: PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS **Cr: 4(3+1)**

Objectives:

- To study the details of physiological systems maintaining the homeostasis of animals.
- Interrelations of the systems
- Regulatory features of the each system's function.

Course Contents

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and cycle; Electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; Microcirculation and lymphatics; Control of cardiac output; Special circulations: Cutaneous, skeletal, coronary, cerebral, fetal.

Respiratory System: Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbon dioxide; Regulation of ventilation; Respiratory responses in extreme conditions.

Renal System: Elements of renal function; Tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostasis; Role of kidney in acid-base balance.

Gastrointestinal System: Gastrointestinal secretions and their control: Salivary, gastric, pancreatic and liver; Digestion and Absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments.

Osmoregulation: Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments.

Environmental Challenges: Temperature and animal energetics; Temperature relation of Ectotherms, Heterotherms and Endotherms; Dormancy: Special metabolic state; Body rhythms and energetic; Energy, environment and evolution.

Practicals

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

Books Recommended

1. Randall, D., Burggren, W., French, K. and Fernald, R. 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th Edition. W.H. Freeman and Company, New York
2. Tharp, G. and Woodman, D. 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.
3. Bullock, J., Boyle, J. and Wang, M.B. 2001. Physiology, 4th Edition. Lippincott, Williams and Wilkins, Philadelphia.

4. Berne, R.M. and Levy, M.N. 2000. Principles of Physiology, 3rd Edition. St. Lious, Mosby.
5. Guyton, A.C. and Hall, J.E. 2000. Text Book of Medical Physiology,10th Edition. W.B. Saunders Company, Philadelphia.
6. Withers, P.C. 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
7. Schmidt-Nelsen, K. 1997. Animal Physiology, Adaptations and Environment, 5th Edition. Cambridge University Press, Cambridge.

ZOL-647: PHYSIOLOGY OF COORDINATION

Cr: 4(3+1)

Objectives

- To study the details of nervous and hormonal coordination at molecular and cellular level in animals.
- 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

1. Recording of action potentials on oscilloscope and effects of various factors on its characters;
2. Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential.
3. Demonstration of nervous system organization while studying brain, cranial nerve,
4. Spinal cord and spinal nerves. Experiments on sensory organs study. Experiments on characteristics of skeletal muscle contractions;
5. Responses of intestinal muscles and effect of drugs.

6. Demonstration of endocrine glands in a mammal (mouse).
7. Effect of hormones on glycemia and calcemia;
8. Effect of thyroxine on oxygen consumption;
9. Effect of androgen on accessory sex organs and of estrogens on arget tissues;
10. 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, 10thEdition. 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.

ZOL-648: PHYSIOLOGY OF REPRODUCTION **Cr: 4(3+1)**

Course contents

Introduction, sex determination and differentiation: molecular aspects and chemical messengers in differentiation, hypothalamic – hypophysical gonadal axis in reproduction: hormonal and neural factors and their interaction in ovarian, testicular and reproductive targets functions; the interactions in development in estrous and menstrual cycle: the interactions in transitions from childhood to reproductive and post- reproductive states. Reproductive behaviors: physiological basis of male and female sexual behavior and maternal behavior; endocrine basis of communication in reproduction and aggression; pheromone in mammalian reproduction; rhythms in reproduction and pregnancy; hormonal mechanism in fertilization, zygote transport and implantation. Placental steroid and polypeptide hormones; recognition and maintenance of pregnancy; maternal metabolism gestation, hormonal mechanism in parturition. Lactation: hormonal mechanism in lactation, lactogenesis, galactopoiesios, milk ejection, reproductive senescence; hormonal and metabolic aspects in menopause; mechanisms in males. Fertility control mechanisms: hormonal contraceptives; rhythmic methods, immunological techniques and fertility control procedures in women; complications in their uses; fertility control in men and search for male contraceptive.

Practicals

Study of male and female reproductive tract; physiological histology of segments of male and female reproductive tracts; Recognition of spermatogonial cells, ovarian follicles and corpus luteum in gonads; study of hormonal mechanisms in super ovulation and implantation; Tests for pregnancy recognition; Experiments on role of gonads in maintenance of accessory sex gland in males and target structures in females; study of fertility control procedures in populations.

Books Recommended

1. Essential Reproduction. Evert, B.J. and Johnson, M.H., 2000. Blackwell Science Inc., Oxford.
2. William's Textbook of Endocrinology. Wilson, J.D., Foster, D. W., Kronenberg, H.M., and Larsen, P.R., 1998. W.B.Saunders Company Philadelphia.
3. The Physiology of Reproduction, Vol 1&2. Knobil, E. and Neill, J.D.et al., 1994. Raven Press New .et al., 1994. Raven Press New York.

ZOL-649: PRINCIPLE OF FISH BIOLOGY **Cr: 4(3+1)**

Course Contents:

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

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

Books Recommended

1. Kestin, S. C. and Warris, P.D. (Editors). KESTIN FARMED FISH QUALITY, 2002, Blackwell Science, Oxford, UK.
2. Woo, P.T.K FISH DISEASES AND DISORDER. Vol 1.PROTOZOAN AND METAZOAN INFECTIONS. 1995. CABI Publisher.
3. Brenabe, G. AQUACULTURE, Vol. I. 1992. Blackwell Publishing, Oxford. UK.
4. Huet M. TEXT BOOK OF FISH CULTURE: BREEDING AND CULTIVATION. 1973. Blackwell Publishing Company.

ZOL-650: PRINCIPLES OF PARASITOLOGY

Cr: 4(3+1)

Objectives

This course will

- Introduction to general parasitology
- provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance
- knowledge about their pathology, host parasite relationship and control measures

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 relatedorganisms. 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. Jr. 2005. Foundations of Parasitology.7th Edition. W.M. Brown Publishers, Chicago, London, Tokyo, Toronto.
2. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W. 2000. Veterinary Parasitology. Longman Scientific and Technical publications, Longman Group, UK.
3. Roberts, L.S. and Janovy, J. 2000. Foundation of Parasitology, 6th Edition. McGraw Hill Book Co.
4. Hausman, K. and Hulsmann, N. T. 1996. Protozoology, 2nd Edition. Medical Publishers, Inc. New York.

5. Smyth, J.D. Introduction to Animal Parasitology. 1994. Cambridge University Press.
6. Cheesbrough, M. 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I University Press Cambridge.
7. Noble, E.R. and Noble, G.A. Parasitology. 1982. The Biology of Animal Parasites. 5th Edition. Lea and Febiger Publisher.
8. Beck, J.W. and Davies, J.E. 1981. Medical Parasitology. 3rd Edition. C.V. Mosby Company, Toronto, London.

ZOL-651: PROTOZOLOGY **Cr: 4(3+1)**

Objectives

This course aims to

- Provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, life cycles and host parasite relationship
- Impart advance knowledge on various important protozoan parasites
- Give understanding about host parasite relationship and control measure

Course Contents

Part I: Protozoology: Systematic, geographical distribution, habitats, biology, pathogenesis, important symptoms, mode of transmission laboratory methods of diagnosis, and control of protozoa of medical and veterinary importance.

Part II: Pathology and Immunity: The cell and cell injury and its relationship to disease. Acute and chronic inflammations, wound healing, disorders of growth, benign and malignant tumors in case of infections immunity, and hypersensitivity in case of parasitic diseases.

Practicals

1. A study of parasitic Protozoa of medical veterinary importance with special reference to differential morphological features.
2. Preparation of permanent mounts of parasitic Protozoa.
3. Examination of human feces and from domesticated animals by using standard laboratory techniques.
4. Techniques and study of blood parasite study of different types of pathological tissues from prepared slides.

Books Recommended:

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

ZOL-652: RESTORATION ECOLOGY AND SUSTAINABLE DEVELOPMENT Cr: 4(3+1)

Objectives

- to enable the students to identify the main candidates (wetlands, lakes, rivers, forests,
- etc) for conservation.
- to train the students to develop approaches for conservation such as designing and
- management of protected areas.
- to make the students able to play the role of an active conservation biologist.

Course Contents

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

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

Practicals

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

Books Recommended

1. Primack, R. B. 2000. A Primer of Conservation Biology. 2nd ed. Sinauer Associates Inc. Publishers Sunderland, USA.
2. Cox, C. B. and Morre, P. D. 2000. Biogeography: An ecological and evolutionary approach.6th ed. Life Sciences King's College London, UK.
3. Mirza, Z. B. 1998. Illustrated Handbook of Biodiversity of Pakistan. Printopack. Rawalpindi, Pakistan.
4. Gaston, K. J. and Spicer, J. I. 1998. Biodiversity An Introduction.15th ed. Blackwell Science Ltd. UK.
5. McKinny, M. L. and Schoch, M. R. 1998. Environmental science: System and solution. 1st ed. Jones and Bartlett Publications, USA.
6. Hussain, S.S. 1992. Pakistan Manual of Plant Ecology.1 st ed. National Book Foundation, Pakistan.
7. Bradbury, I. K. 1998. The Biosphere. 1st ed. John Wiley and Sons Inc.UK

ZOL-653: STATISTICAL ECOLOGY

Cr: 4(3+1)

Course Contents

Introduction to ecological parameters, experiments and experimental design, review of ANOVA, assumptions of ANOVA, ANOVA models, mixed model ANOVA, Nested ANOVA, Factorial Experiments and Repeated Measures, linear regression and multiple regression, MANOVA, estimation of Species richness, diversity, evenness, principal component analysis, correspondence analysis, discriminate functional analysis, cluster analysis, redundancy analysis, concepts of niche overlap and resource partitioning, distribution models, interspecific association, interspecific covariation, association analysis, non linear ordinations, resemblance function, quadrat-variance methods and distance methods.

Practicals

Field surveys to collect different arthropods from different habitats and application of above mentioned statistical analysis on the collected data using statistical softwares.

Books Recommended

1. Multivariate Statistical Methods: a primer. Manly, B.F.J. 2004.Chapman and Hall.
2. Multivariate Statistics for Wildlife and Ecology Research. McGarigal,K., S. Cushman, and S.Stafford. 2000. Springer.
3. Statistical Ecology: A Primer on Methods in Computing. Ludwig, J.A. and Reynolds, J.F. 1988. John Wiely and Sons, New York.
4. The interpretation of ecological data: a primer on classification and ordination. Pielou, E.C. 1984. Wiley-interscience.

ZOL-654: WILDLIFE PARASITOLOGY **Cr: 4(3+1)**

Aims and Objectives

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

Course contents

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

Practicals

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

Books Recommended

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