

# UNIVERSITY OF SARGODHA, SARGODHA

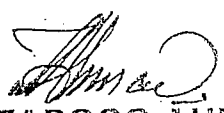
## NOTIFICATION

No.UOS/Acad/ 2400

Dated: 15.09.2010

The Syndicate in its 2/2010 meeting held on 08.07.2010 has approved the schemes of studies and syllabi of following programs for implementation from the sessions mentioned against each:-

- i) Scheme of Studies of MS / M.Phil program in Zoology for implementation on 2009-11 session (annexed-'A').
- ii) Revised Scheme of studies of MS /M.Phil & Ph.D program in Zoology for implementation from Fall Semester 2010 (annexed-'B').
- iii) Scheme of Studies of M.Sc. Zoology for implementation w.e.f 2010-12 session (annexed-'C').
- iv) Scheme of Studies of ~~BS 4-year program~~ in Zoology for implementation from 2010-14 session (annexed-'D').

  
(Ch. FAROOQ AHMAD)  
Assistant Registrar (Acad)  
for Registrar

### Distribution:-

- Chairman  
Department of Biological Sciences
- Controller of Examinations
- Notification file

### C.C:

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

## Annexure IV

## Scheme of studies for BS Zoology (Session 2010-14)

Year-I

Semester-I

Semester-II

Code	Course Title	Cr.Hr.	Code	Course Title	Cr.Hr.
ZOL-101	Principles in animal life	(3 + 1)	ZOL-102	Diversity of animals(invertebrates)	(3 + 1)
BOT-101	Diversity of plants	(3 + 1)	BOT-102	Plant systematic, anatomy and development	(3 + 1)
CHEM-101	Physical Chemistry	(3 + 1)	CHEM-102	Inorganic Chemistry	(3 + 1)
ENG-101	English-I	(3 + 0)	ENG-102	English-II	(3 + 0)
ISL-101	Islamic Studies	(2 + 0)	PKS-102	Pak-Studies	(2 + 0)
	<b>Total</b>	<b>17</b>		<b>Total</b>	<b>17</b>

Year-II

Semester-III

Semester-IV

Code	Course Title	Cr.Hr.	Code	Course Title	Cr.Hr.
ZOL-203	Diversity of animals(vertebrates)	(3 + 1)	ZOL-204	Principles of animal physiology	(3 + 1)
BOT-203	Cell biology, genetics and evolution	(3 + 1)	PSY/ES-204	Psychology	(3 + 0)
CHEM-203	Organic Chemistry	(3 + 1)	BOT-204	Plant physiology and ecology	(3 + 1)
ENG-203	English-III	(3 + 0)	CHE-204	Chemistry Special Topics	(3 + 1)
COMP-203	Computer Applications	(0 + 3)	ENG-204	English	(3 + 0)
	<b>Total</b>	<b>18</b>		<b>Total</b>	<b>18</b>

Well

.Hr.

### List of optional Papers in lieu of Thesis

#### Semester 7

Course Code	Title	Credit Hours
ZOL.421	Microbiology-I	(3+1)
ZOL.423	Entomology-I	(3+1)
ZOL.425	Endocrinology	(3+1)
ZOL.427	Hematology	(3+1)
ZOL.429	Principle of Fish Biology	(3+1)
ZOL.431	Biology of Spiders	(3+1)
ZOL.433	Molecular and clinical Endocrinology	(3+1)
ZOL.435	Ornithology-I	(3+1)
ZOL.437	Statistical ecology	(3+1)

#### Semester 8

Course Code	Title	Credit Hours
ZOL.422	Microbiology-II	(3+1)
ZOL.424	Entomology-II	(3+1)
ZOL.426	Physiology of Reproduction	(3+1)
ZOL.428	Immunology	(3+1)
ZOL.430	Fish Physiology & Breeding	(3+1)
ZOL.432	Biology & control of Vertebrate pest	(3+1)
ZOL.434	Parasitology	(3+1)
ZOL.436	Ornithology-II	(3+1)
ZOL.438	Integrated pest management	(3+1)

\*Students will study optional course in lieu of thesis from the above mentioned list depending upon the resources of department.

*[Signature]*  
Chairman  
Department of Zoology  
Gadga

UCS/Bio  
24-08

## SCHEME OF STUDIES OF BS ZOOLOGY PROGRAM

BS-4 Years Zoology program comprises of 8 semesters with 134 credit hours. Outline of the courses is as under:

### Duration of the Program:

The duration of BS Zoology is four years (08 Semesters).

General courses                      03 year (06 Semesters)

Specialization                        01 year (02 Semesters)

### Main Features of BS Zoology Program/Credit Requirements

Major Subject:                      Zoology

Duration:                              04 Years (08 Semesters)

Eligibility:                            At least 45% marks in intermediate with biology as an elective subject or equivalent

Degree Requirements:            Minimum 124 credit hours

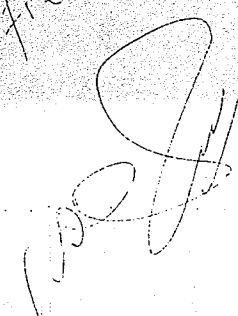
### A breakup of total credit hours as per requirements

a) General Education (Compulsory);	33
b) Major (main subject)	70
c) Minor Supporting subjects	31

Note: (a) Each Semester shall be of four and half months for teaching, one week for the conduct of examination and one week for the preparation of results;

(b) A 03+01 credit hour course means 03 credit hours of theory and 01 credit hour of practical.

vetted &  
verified

  
11-7-14



UCS/1310  
5/1/08

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### Main Features of BS Zoology Program/Credit Requirements

Major Subject:                        Zoology

Duration:                                04 Years (08 Semesters)

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### A breakup of total credit hours as per requirements

a) General Education (Compulsory);                      33

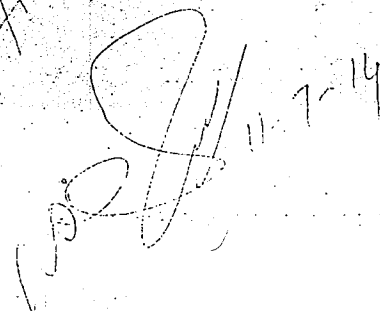
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c) Minor Supporting subjects    31

Note: (a) Each Semester shall be of four and half months for teaching, one week for the conduct of examination and one week for the preparation of results;

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11-7-14

## BS-4 YEARS PROGRAM IN ZOOLOGY

### Summary:

BS-4 Years Zoology program comprises of 8 semesters with 136 credit hours. Outline of the courses is as under.

#### Semester-I:

Course Code	Course Title	Credits
ZOL-101	Principles in Animal life	4(3 + 1)
BOT-101	Diversity of Plants	4(3 + 1)
*CHEM-101	Physical Chemistry	3(3 + 0)
ENG-101	English-I	2(2 + 0)
ISL-101	Islamic Studies	
<b>Total</b>		<b>17</b>

#### Semester-II:

Course Code	Course Title	Credits
ZOL-102	Diversity of Animals (Invertebrates)	4(3 + 1)
BOT-102	Plant systematic, Anatomy and Development	4(3 + 1)
*CHEM-102	Inorganic Chemistry	3(3 + 0)
ENG-102	English-II	2(2 + 0)
PKS-102	Pak-Studies	
<b>Total</b>		<b>17</b>

#### Semester-III:

Course Code	Course Title	Credits
ZOL-203	Diversity of Animals (vertebrates)	4(3 + 1)
BOT-203	Cell biology, Genetics and Evolution	4(3 + 1)
*CHEM-203	Organic Chemistry	3(3 + 0)
ENG-203	English-III	2(2 + 0)
COMP-203	Computer Applications	3(0 + 3)
<b>Total</b>		<b>18</b>

#### Semester-IV:

Course Code	Course Title	Credits
ZOL-204	Principles of Animal Physiology	4(3 + 1)
PSY/ES-204	Psychology	3(3 + 0)
BOT-204	Plant Physiology and Ecology	4(3 + 1)
*CHE-204	Chemistry Special Topics	3(3 + 0)
ENG-204	English	
<b>Total</b>		<b>18</b>

Chemistry courses (semester I-IV) can be rotated with subject to availability of teacher in that specialized field.

**Semester -V:**

Course Code	Title of the Course	Credits
ZOL-501	Fisheries	3(2+1)
ZOL-503	Cell & Molecular Biology	4(3+1)
ZOL-505	Biochemistry	4(3+1)
ZOL-507	Wild Life/Animal Morphology	3(2+1)
ZOL-509	Biostatistics	3(2+1)
<b>Total</b>		<b>17</b>

**Semester -VI:**

Course Code	Title of the Course	Credits
ZOL-502	Genetics	4(3+1)
ZOL-504	Animal Physiology	4(3+1)
ZOL-506	Developmental Biology	4(3+1)
ZOL-508	Ecology	4(3+1)
ZOL-510	Animal Behavior	3(2+1)
<b>Total</b>		<b>19</b>

**Semester -VII:**

Course Code	Title of the Course	Credits
ZOL-601	Evolution & Principles of Systematics	4(3+1)
ZOL-603	Principles of Toxicology	4(3+1)
ZOL-605	Seminar	1(i+0)
ZOL-607	Biological Techniques & Bio-Informatics	3(2+1)
ZOL-609	Microbiology I*/ Thesis	4(3+1)/4
<b>Total</b>		<b>16</b>

**Semester -VIII:**

Course Code	Title of the Course	Credits
ZOL-602	Zoogeography & Paleontology	3(2+1)
ZOL-604	Logic & Reasoning	2(2+0)
ZOL-606	Introduction to Biotechnology	4(3+1)
ZOL-608	Microbiology II*/ Thesis	4(3+1)/4
<b>Total</b>		<b>13</b>

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\*In lieu of thesis optional courses will be offered from the list attached depending upon the resources of the department.

List of Optional Papers in lieu of Thesis

Semester VII:

Course Code	Title	Credit Hours
ZOL.421	Microbiology-I	4(3+1)
ZOL.423	Entomology-I	4(3+1)
ZOL.425	Endocrinology	4(3+1)
ZOL.427	Hematology	4(3+1)
ZOL.429	Principle of Fish Biology	4(3+1)
ZOL.431	Biology of Spiders	4(3+1)
ZOL.433	Molecular & Clinical Endocrinology	4(3+1)
ZOL.435	Ornithology-I	4(3+1)
ZOL.437	Statistical Ecology	4(3+1)

Semester VIII:

Course Code	Title	Credit Hours
ZOL.422	Microbiology-II	4(3+1)
ZOL.424	Entomology-II	4(3+1)
ZOL.426	Physiology of Reproduction	4(3+1)
ZOL.428	Immunology	4(3+1)
ZOL.430	Fish Physiology & Breeding	4(3+1)
ZOL.432	Biology & control of Vertebrate pest	4(3+1)
ZOL.434	Parasitology	4(3+1)
ZOL.436	Ornithology-II	4(3+1)
ZOL.438	Integrated Pest Management	4(3+1)

# Details of BS Courses (Zoology)

(Session 2006 Onwards)

## SEMESTER-I

### ZOL-101: PRINCIPLES OF ANIMAL LIFE (3+1)4

#### Course Contents:

#### 1. Place of Zoology in Science

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

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

Atoms and elements: building blocks of all matter; compounds and molecules: aggregates of atoms; acids, bases, and buffers; the molecules of animals: fractional account of carbohydrates, lipids.

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

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

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

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

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

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

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

Animals and their abiotic environment; populations; interspecific interactions.

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

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

#### 8. Cell Division



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

### 9. Inheritance Patterns

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

### 10. Chromosomes and Gene Linkage

Eukaryotic chromosomes: linkage relationships; changes in chromosome number and structure.

### 11. Molecular Genetics: Ultimate Cellular Control

DNA: the genetic material; DNA replication in eukaryotes; genes in action; control of gene expression in eukaryotes; mutations; applications of genetic technologies; recombinant DNA.

### 12. Animal Behavior

Four approaches of animal behavior: proximate and ultimate causes; anthropomorphism; development of behavior; learning; control of behavior; communication; behavioral ecology.

### 13. Evolution: A Historical Perspective

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

### 14. Evolution and Gene Frequencies

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

### Practicals

#### 1. Tests for different carbohydrates, proteins and lipids.

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

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

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

#### 3. Plasmolysis and deplasmolysis in blood.

#### 4. Protein digestion by pepsin.

#### 5. Ecological notes on animals of a few model habitats.

6. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

7. Study of mitosis in onion root tip.

8. Study of meiosis in grasshopper testis (Students should prepare the slides).

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

9. Problem based study of Mendelian ratio in animals.

10. Multiple alleles study in blood group.

11. Survey study of a genetic factor in population and its frequency.

12. Study of karyotypes of *Drosophila*, Mosquito.

13. Study of cytochemical detection of DNA in protozoa and avian blood cell.

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

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

(Note for 8-9: Prepared slides and preserved specimen and/or projection slides and/or CD-ROM computer projections may be used).

16. Study to demonstrate nervous or endocrine basis of behavior (conditioned reflex or aggression or parental behavior).

17. Study to demonstrate social behavior (documentary film be shown, honey bee, monkey group in a zoo).

#### Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 12th Edition (International), 2004. Singapore: McGraw Hill.

2. Miller, S.A. and Harley, J.B. ZOOLOGY, 6th Edition (International), 2005. Singapore: McGraw Hill.

3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 5th Edition (International). 2000. Singapore: McGraw Hill.

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

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

6. Miller, S.A. GENERAL ZOOLOGY LABORATORY MANUAL. 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.

7. Hickman, C.P. and Kats, H.L., LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY, 2000, Singapore: McGraw Hill.
8. Molles, M.C. ECOLOGY: CONCEPTS AND APPLICATIONS, 6<sup>th</sup> Edition, 2005, McGraw Hill, New York, USA.
9. Odum, E. P. FUNDAMENTALS OF ECOLOGY, 3<sup>rd</sup> Edition, 1994, W.B. Saunders, Philadelphia.
10. Slingsby, D. and Cook, C., PRACTICAL ECOLOGY, 1986, McMillan Education Ltd: UK.

### BOT-101: DIVERSITY OF PLANTS 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 (Phycia)
- 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, 3<sup>rd</sup> Ed. W.M.C. Brown Publishers.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology, 4<sup>th</sup> Ed. John Wiley and Sons Publishers.
4. Agrios, G. N. 2004. Plant pathology 8<sup>th</sup> 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 3<sup>rd</sup> 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: PHYSICAL CHEMISTRY 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. Bragg's method of crystal structure analysis. X-rays crystallography of sodium chloride. The powder method of crystal structure analysis.

**Quantum theory and Atomic Structure** i.e., wave and particle nature of matter De Broglie equation. Schrodinger wave equation, solution for particle in 1D box, quantization concept, Heisenberg Uncertainty Principle, Pauli Exclusion 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, Carnot cycle, change of entropy with change in temperature, pressure and volume.

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**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 Lindermann'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. Ostwald dilution law. Dissociation constant. Calculation of pH for a typical weak 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  $KI + I_2 \rightleftharpoons KI_3$
14. Conductometric titration of strong acid and strong base.

### Recommended Books

1. Chaudhry, G.R., *Text Book of Physical Biological Sciences*, 2<sup>nd</sup> 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*", 5<sup>th</sup> Ed. Longman: Publishers, NY (1972)
5. Jones, M., "*Elements of Physical Biological Sciences*" 3<sup>rd</sup> Ed. Benjamin Cummings Publishing Company Inc., NY (1993).
6. Adamson, A. W., "*Understanding Physical Biological Sciences*" 3<sup>rd</sup> 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*" Ilimi 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*" 9<sup>th</sup> 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*", 2<sup>nd</sup> Ed., John Wiley & Sons, London (1975).

ENG-101: ENGLISH-I 3(3+0)

Course Contents:

1. An introduction to: Language, Communication, Grammar
2. Sentence: Definition, Parts: Subject, Predicate, Phrase, Clause  
Types--- Simple, Compound, Complex, Multiple, Declarative, Interrogative, Imperative, Exclamatory; Optative.
3. Parts of Speech: Nouns, Pronouns, Adjective, Verbs, Adverbs, Prepositions, Conjunctions, Interjections.

Error Analysis.

4. Tenses: Active Voice and Passive Voice-
5. Clause analysis and synthesis:
6. Use of Dictionary and vocabulary Building

7. Poems:

1. New Year Resolution	:	Elizabeth Sewell
2. Tartary	:	Walter De La Mare
3. The Huntsman	:	Edward Lowbury
4. The Character of a Happy Life	:	Sir Henry Wotton
5. One Art	:	Elizabeth Bishop
6. Death the Leveller	:	James Shirley

8. Short Stories:

1. The Duchess and the Jeweller	:	Virginia Woolf
2. The Voice	:	S.V.Pritchett
3. A Passion in the Desert	:	Honore De Balzac



8. Essays:

- |                              |                    |
|------------------------------|--------------------|
| 1. Spoon Feeding             | W.R. Inge          |
| 2. Nagasaki H August 9, 1945 | Michaïto Sch' maru |
| 3. My Tailor                 | Step[h]en Leacock  |
| 4. The Damned Human Race     | Mark Twain         |

ISL-101: ISLAMIC STUDIES

University of Sargodha

انصاب برائے اسلامیات لازمی

For BS 4 Years Class

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اساتذہ کرام کو مطلع کیا جا رہا ہے کہ اس امتحان کے لیے طلبہ کو درج ذیل کتابیں پڑھنی چاہئیں۔

60 نمبر	اسلام کی تاریخ و تمدن (پروفیسر ایچ بی کھن)
20 نمبر	اسلام کی تاریخ و تمدن (پروفیسر ایچ بی کھن)
20 نمبر	اسلام کی تاریخ و تمدن (پروفیسر ایچ بی کھن)

اساتذہ کرام کو مطلع کیا جا رہا ہے کہ اس امتحان کے لیے طلبہ کو درج ذیل کتابیں پڑھنی چاہئیں۔

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اساتذہ کرام کو مطلع کیا جا رہا ہے کہ اس امتحان کے لیے طلبہ کو درج ذیل کتابیں پڑھنی چاہئیں۔

60 نمبر	اسلام کی تاریخ و تمدن (پروفیسر ایچ بی کھن)
20 نمبر	اسلام کی تاریخ و تمدن (پروفیسر ایچ بی کھن)
20 نمبر	اسلام کی تاریخ و تمدن (پروفیسر ایچ بی کھن)

قرآن مجید کی آیات کے ترجمہ اور تفسیر

- (i) السجدة آیات 26-30 (ii) النحل آیات 1-10 (iii) النمل آیات 1-11
- (iv) القصص آیات 1-20 (v) المؤمن آیات 1-11 (vi) المؤمنون آیات 1-10
- (vii) البقرة آیات 1-5 (viii) البقرة آیات 175-185 (ix) البقرة آیات 195-215
- (x) البقرة آیات 225-232

انبارِ کتب و رسائل اسلامیہ

پتہ: لاہور

اس کتاب کی اشاعت کا مقصد علم و معرفت کو عام کرنے اور انسانیت کو جو حقیقت پر مبنی ہے اس کی طرف متوجہ کرنا ہے۔ اس کتاب کی اشاعت کے ذریعہ ہمیں امید ہے کہ اللہ تعالیٰ ہمیں اس کام میں کامیاب کرے گا۔

اس کتاب کی اشاعت کے لیے ہمیں بہت سی سہولتیں فراہم کرنے والے اداروں اور اشخاص کا شکریہ ادا کرنا چاہیے۔ ان کے تعاون و تعاون کے بغیر اس کتاب کی اشاعت ناممکن ہوتی۔

### SMESER-II

## ZOL-102: DIVERSITY OF ANIMALS (INVERTEBRATES) (Cr. 3+1)4 (CLASSIFICATION, PHYLOGENY AND ORGANIZATION)

### Course Contents:

#### 1. Introduction

Classification of organisms; evolutionary relationships and treediagrams; patterns of organization.

#### 2. Animal-Like Protists: The Protozoa

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

#### 3. Multicellular and Tissue Levels of Organization

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

15  
functions: reproduction and classification up to class. Phylum: ctenophora; further phylogenetic considerations.

#### 4. Triploblastics and Acoelomate Body Plan

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

#### 5. Pseudocoelomate Body Plan: Aschelminths

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

#### 6. Molluscan Success

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

#### 7. Annelida: The Metameric Body Form

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

#### 8. Arthropods: Blueprint for Success

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

#### 9. Hexapods and Myriapods: Terrestrial Triumphs

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

#### 10. Echinoderms

Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in: asterozoa, ophiurozoa, echinozoa, holothurozoa and erinozoa; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, and chaetognaths.

#### Books Recommended

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

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

**Practicals**

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, Paramecium as representative of animal like protists. (Prepared slides).
2. Study of sponges and their various body forms.
3. Study of principal representative classes of phylum Coelenterata.
4. Study of principal representative classes of phylum Platyhelminthes.
5. Study of representative of phylum Rotifera, phylum Nematoda.
6. Study of principal representative classes of phylum Mollusca.
7. Study of principal representative classes of phylum Annelida.
8. Study of principal representative classes of groups of phylum Arthropoda.
9. Brief notes on medical/economic importance of the following: Plasmodium, Entamoebahistolitica, Leishmania, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.
10. Preparation of permanent stained slides of the following: Obelia, Daphnia, Cestode, Parapodia of Nereis.

**Books Recommended**

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

**BOT-102: PLANT SYSTEMATIC, ANATOMY AND DEVELOPMENT/  
EMBRYOLOGY 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.

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- 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, 3<sup>rd</sup> 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. 3<sup>rd</sup> Edition, Regency Publications, New Delhi.
  13. Naik, V. N. 2005 Taxonomy of Angiosperms. 20<sup>th</sup> 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, Phytol.

**CHEM-102: INORGANIC CHEMISTRY 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, pK<sub>a</sub>, pK<sub>b</sub> 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.**

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chemistry of d-Block Elements i.e., Electronic configuration. General characteristics of d-block elements. Werner'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  $\text{KMnO}_4$ .
12. Percentage determination of ferric ions in ferric alum using  $\text{KMnO}_4$  solution.
13. Determination of purity of commercial potassium oxalate using  $\text{KMnO}_4$  solution.
14. Estimation of ferrous ions using  $\text{K}_2\text{Cr}_2\text{O}_7$  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', 2<sup>nd</sup> Edition; New Kitab Markaz, Faisalabad, Pakistan (2001).
3. Bhatti, H.N. and Nasir, B.A. 'Modern Inorganic Biological Sciences', 1<sup>st</sup> Edition, The Carvan Book House, Lahore, (2000).
4. Albert, C.F., Wilkinson G. and Gaus, P.L. 'Basic Inorganic Biological Sciences', 3<sup>rd</sup> Edition, John Wiley & Sons, Inc. NY (1995).
5. Lee, J.D., 'Concise Inorganic Biological Sciences', 5<sup>th</sup> Edition, Chapman & Hall, UK (1996).
6. Jolly, W.L., 'Modern Inorganic Biological Sciences', 'Biological Sciences', 2<sup>nd</sup> Edition McGraw Hill, NY (1991).
7. Shriver, D.F., Atkins P.W. and Langford, C.H. 'Inorganic Biological Sciences', 2<sup>nd</sup> Edition, Oxford Press, UK (1994).
8. Housecroft, C.E. and Sharpe, A.G., 'Inorganic Biological Sciences', 3<sup>rd</sup> 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', 5<sup>th</sup> Edition, Benjamin-Cummings, NY (1989).
11. Vogel, A.I. 'A Text Book of Macro and Semimicro Qualitative Inorganic Analysis', Longman Green & Co. NY (1995).

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12. Skoog, D., West, D.M and Holler, F.J. *Analytical Biological Sciences*, 6<sup>th</sup> Edition Saunders College Publications, UK (1994).
  13. Graham, H and Man, H. *Biological Sciences in Context* 5<sup>th</sup> 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).

## ENG-102: ENGLISH-II 3(3+0)

### Course Contents

- Narration
- Punctuation
- Note-Taking
- Oral Presentation Skills
- Paragraph Writing

### Poems:

- |   |                      |
|---|----------------------|
| 1. The Divine Image                         | William Blake        |
| 2. Sonnet Composed Upon Westminster Bridge: | William Wordsworth   |
| 3. Youth and Age                            | S.T. Coleridge       |
| 4. To Wordsworth                            | Percy Bysshe Shelley |
| 5. Patriot and Traitor                      | Robert Browning      |
| 6. When You are Old                         | William Butler Yeats |

### Short Stories:

- |                         |                     |
|-------------------------|---------------------|
| 1. Mayhew               | S. Maugham          |
| 2. The New Constitution | Saadat Hassan Manto |
| 3. Breakfast            | John Steinbeck      |

### One Act Plays:

- |                  |                  |
|------------------|------------------|
| 1. The Bears     | Anton Chekhov    |
| 2. Smoke-Screens | Harold Brighouse |

### Essays:





## SEMESTER-III

ZOL-203: DIVERSITY OF ANIMALS (CHORDATA) (Cr. 3+1H)

### Course Contents:

#### 1. Hemichordates and Invertebrate Chordates

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

#### 2. Fishes: Vertebrate Success in Water

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

#### 3. Amphibians: The First Terrestrial Vertebrates

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

#### 4. Reptiles: The First Amniotes

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

#### 5. Birds: Feathers, Flight, and Endothermy

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

#### 6. Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity

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

Books Recommended

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

Practicals

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

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

Books Recommended

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

BOT-203: CELL BIOLOGY, GENETICS AND EVOLUTION 4(3+1)

a) Cell Biology

1. Structure and Function of Bio-molecules
  - i. Carbohydrates
  - ii. Lipids
  - iii. Proteins
  - iv. Nucleic Acids
2. Cell: Cell theory, cell types (prokaryotes, eukaryotes), basic properties of cell.

3. Brief description of following cell-organelles

- i. Cell wall      ii. Cell membrane      iii. Nucleus  
iv. Endoplasmic reticulum      v. Plastids  
vi. Mitochondria      vii. Ribosomes  
viii. Dictyosomes      ix. Vacuoles

4. Reproduction in somatic and embryonic cell, mitosis, meiosis and cell cycle

b) Genetics

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

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

3. Chromosomal aberrations; Changes in the number of chromosomes. Aneuploidy and Euploidy. Changes in the structure of chromosomes, deficiency, duplication, inversion and translocation.

c) Evolution: Introduction and theories.

Lab Outline:

Cell Biology

1. Study of cell structure using compound microscope and elucidation of ultrastructure from electron microphotographs
2. Measurement of cell size.
3. Study of mitosis and meiosis by smear/squash method and from prepared slides.
4. Study of chromosome morphology and variation in chromosome number.
5. Extraction and estimation of carbohydrate, protein, RNA and DNA from plant sources.

Genetics

1. Genetical problems related to transmission and distribution of genetic material.
2. Identification of chromosomes in plant material. Carmine/ orcein staining.
3. Determination of blood groups

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.



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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-203: ORGANIC CHEMISTRY 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 resonance. Resonance 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, racemisation, and resolution of racemic mixtures; R,S notation, diastereoisomers, 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.

Brief 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

26

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 anhydrides.

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 amines diazonium salts and preparation and application.

### Practicals

Qualitative Organic Analysis

Systematic identification of organic compounds containing groups  
Containing groups like COOH, OH, NH<sub>2</sub> 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*, Ilimi 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*, 5<sup>th</sup> Edition, John Wiley, NY. (2001).
4. Pine, S. H. *Organic Biological Sciences*, (5<sup>th</sup> 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).

ENG-203: ENGLISH-III 3(3+0):

Course Contents

- LETTER Writing (official/ formal and must discuss some problems)
- Essay Writing
- Reading Skills
- Listening Skills

Poems:

- |                            |                     |
|----------------------------|---------------------|
| 1. All the world's a stage | William Shakespeare |
| 2. On his blindness        | John Milton         |
| 3. To autumn               | John Keats          |
| 4. No buyers               | Thomas Hardy        |
| 5. Prayer before birth     | Louis Mac Neice     |
| 6. The owl critic          | James T. Field      |

Essays:

- |                                     |                             |
|-------------------------------------|-----------------------------|
| 1. One vote for this age of anxiety | Mrgaret Mead                |
| 2. On babies                        | Jerome K. Jerome            |
| 3. Islamic culture                  | Muhammad Marmaduke Pickthal |

Short Stories:

- |                      |                   |
|----------------------|-------------------|
| 1. Take pity         | Bernard Malamud   |
| 2. The necklace      | Guy De Maupassant |
| 3. The happy prience | Oscar Wilde       |

One Act Plays:

- |                            |                |
|----------------------------|----------------|
| 1. Even exchange           | Paul S. Mc Coy |
| 2. The master of the house | W. S. Houghton |

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COMP-203: COMPUTER APPLICATIONS 3(3+0)

1. What is Computer

i. Use of Computer

ii. Parts of Computer System

2. Types of Computer

i. Super Computers

ii. Mainframe Computers

iii. Mini Computers

iv. Workstation Computer

v. Micro Computers

vi. Handheld Personal Computers

vii. Tablet PC

viii. Cellular Phones

3. Hardware Components

i. Microprocessors

ii. Mother board

iii. Bus and Bus Types

iv. Cache Memory

4. Memory and Storage Devices

5. Software and Types of Software

6. Operating Systems and its types

7. Input and Output Devices

8. Internet and use of Internet

i. Search Engine

i. E-Mail

9. Practicals

1. MS Word

2. MS Excel

3. MS Power Point



SMESTER-IV

ZOL-204: PRINCIPLES OF ANIMAL PHYSIOLOGY (Cr. 3+ 1)

Course Contents:

1. Protection, Support, and Movement

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

2. Communication I: Nerves

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

3. Communication II: Senses

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

4. Communication III: The Endocrine System and Chemical Messengers

Chemical messengers: hormones chemistry, and their feedback systems; mechanisms of hormone action; some hormones of porifera, cnidarians, Platyhelminthes, nemerteans, nematodes, mollusks, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates; endocrine systems of birds and mammals.

5. Circulation, Immunity, and Gas Exchange

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

6. Nutrition and Digestion

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

### 7. Temperature and Body Fluid Regulation

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

### 8. Reproduction and Development

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

### 9. Descriptive Embryology

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

### Books Recommended

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

### Practicals

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of Labeo, Ranatigrina, 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* or *Labeo* or any other local fish, frog, pigeon and water mouse and rabbits are representative animals for study dissections.
4. Study of models or preserved brains of representative animals and notes on adaptations.
5. Study of nervous system of earthworm and a fish.
6. Study of endocrine system in an insect and a rabbit.
7. Study of different types of blood cells in blood smear of rabbit.
8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).
10. Study of excretory system in an invertebrate and a vertebrate representative (Model).
11. Study of nutritive canal in an invertebrate and a vertebrate representative (Dissection).
12. Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
13. Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
14. Study of hormonal influence of a reproductive function (Model).
15. Study of preserved advanced stages of avian and mammalian development for amniotic membranes and placenta (Model).

#### Books Recommended

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

### BOT-204: PLANT PHYSIOLOGY AND ECOLOGY 4(3+1)

#### a) Plant Physiology

1. Water relations (water potential, osmotic potential, pressure potential, matric potential). Absorption and translocation of water: Stomatal regulation.
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 C<sub>3</sub> and C<sub>4</sub> plants. Factors affecting this process, Products of photosynthesis.
4. Respiration: Definition and respiratory substrates, mechanism Glycolysis, Krebs cycle. Electron transport and oxidative phosphorylation. Anaerobic

respiration. 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 Ecophysiological responses.
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 (Quadrat 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:**

**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 Quadrat and line intercept methods.



- 4. Field trips to ecologically diverse habitats.
- 5. Measurements of wind velocity.
- 8. Measurement of light and temperature.
- 9. 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. 4<sup>th</sup> Ed. Sinauers Publ. Co. Inc. Calif.
4. Salisbury F. B. and Ross C. B. 1992. Plant Physiology. 5<sup>th</sup> Edition. Wadsworth Publishing Co. Belmont CA.
5. Hopkins, W. B. 1999. Introduction to Plant Physiology. 2<sup>nd</sup> Ed. John Wiley and Sons. 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. 1999. Terrestrial Plant Ecology, The Benjamin, Cumming Publishing Co. Palo Alto, California, USA.
10. Chapman, 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. National Academy of Higher Education, Islamabad.
12. Hussain, S. S. 1989. Pakistan Manual of Plant Ecology; National Book Foundation, Islamabad.
13. Larcher, W. 2003. Physiological Plant Ecology. Ecophysiology and Stress Physiology 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, New York.
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. Narosa Publishing House, New Delhi.
19. Townsend, C. R., Harper, J. L. and Begon, M. E. 2002. Essentials of Ecology. Blackwell Scientific Publications, UK.
20. Odum, E. P. 1985. Basic Ecology. W. B. Saunders.

Journals / Periodicals:

Plant Physiology, Journal of Ecology

CHEM-204: CHEMISTRY SPECIAL TOPICS (Cr. 03)

Bio-molecules and Simple Heterocycles.

Brief introduction to the chemical nature of carbohydrates, proteins, lipids, nucleic acids, their importance in living systems. Nomenclature of simple heterocyclic structures containing O, N, S in five and six membered rings, furan pyrrole and pyridine and thiophene and their properties, synthesis and reactions of simple heterocycles

Introduction to Spectroscopy.

Spectroscopic method (IR & UV/Vis) structures elucidation of different organic compounds by these techniques.

Surface Phenomena and Colloids.

Physical adsorption and chemisorption. type of adsorption isotherms. Basic concept of Langmuir adsorption isotherm and application. type and properties of colloidal suspension. preparation and application of colloidal suspensions.

Nuclear chemistry.

Natural and artificial radioactivity, stability of nuclei, nuclear transformation, rate of radioactive, disintegration, a measurement of nuclear radiations, nuclear reaction, fusion, fission, nuclear reactor, uses of radioisotopes in various fields, nuclear hazards and safety measures.

Modern materials.

Brief introduction of liquid crystals, inorganic polymers, ceramics, fiber glass, thin films, semi conductors, composite materials.

Chemical industries.

Metallurgy of Al, manufacturing of sulphuric acid, nitric acid, fertilizers, cement and glass.

Practicals

1. Determination of adsorption parameters using Langmuir adsorption isotherm of acetic acid on charcoal.
2. Percentage determination of barium in barium nitrate by gravimetric method.
3. Gravimetric determination of nickel.
4. Structure elucidation of some simple organic compounds by spectroscopy (Spectrum interpretation).
5. Tests for lipids, proteins, carbohydrates.

Recommended Books

- 1: Voet, D. R and Voet, J. G. *BioBiological Sciences*, John Wiley & Sons, NY (2001).
- 2: Kent, J.A. *Riegel's Handbook of Industrial Biological Sciences*, CBS Publishers and Distributors, New Delhi, (1997).
- 3: Arnikar, H.J. *Nuclear Biological Sciences*. Krishna Prakashan Media (P) Ltd. (1998).
- 4: Gurdeep R. "*Advanced Physical Biological Sciences*", Krishna Prakashan Media (P) Ltd. Delhi (2002).
- 5: Younas, M., *Organic Spectroscopy*, A. H. Publisher, Lahore (2005).

ENG-204: ENGLISH-IV 3(3+0)

Course Contents

- Interviews
- Memorandum Writing
- Comprehensive & Precise Writing
- Job-Letter & C.V. Writing
- Report Writing

Poetry:

- |  |                  |
|--|------------------|
| 1. Departure and Arrival               | T.S. Eliot       |
| 2. The Road Not Taken                  | Robert Frost     |
| 3. Because I Could Not Stop For Death  | Emily Dickinson  |
| 4. Say This City Has Ten Million Souls | W.H. Auden       |
| 5. The Daisy                           | Francis Thompson |
| 6. Woman Work                          | Maya Angelou     |

Short Stories:

- |                        |                     |
|------------------------|---------------------|
| 1. The Fly             | Katherine Mansfield |
| 2. Araby               | James Joyce         |
| 3. The Tell-Tale Heart | E.A. Poe            |

Essays:

- |   |                 |
|---|-----------------|
| 1. The Last Sermon of The Holy Prophet of Islam |                 |
| 2. Work   | Bernard Russell |
| 3. Three Days to See                            | Hellen Keller   |

Novel:

- |                            |                 |
|----------------------------|-----------------|
| 1. The Old Man And The Sea | Ernst Hemingway |
|----------------------------|-----------------|

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PSY/ES-204: SOCIAL PSYCHOLOGY 3(3+0)

**Course Contents**

**1. Introduction: Nature and Scope of Social Psychology**

Understanding social behavior; social psychology: a working definition; origin & development of social psychology; how social psychology attains knowledge

**2. Social Perceptions: Knowing Others**

Nonverbal communication: the unspoken language; Attribution: understanding the causes of others behavior; impression formation and impression management; combining and using social information

**3. Social Cognition: Understanding the Social World**

Schemes and their effects; heuristics: mental shortcuts: potential sources of error: why total rationality is so rare? The interplay of affect and cognition

**4. Attitudes: Evaluating the Social World**

Forming attitudes; how do we develop the views we hold? Persuasion: using messages to change attitudes: cognitive dissonance: when our behavior affects our attitude?

**5. Social Influence: Changing Others Behavior**

Conformity: group influence in action: compliance: obedience: social influence by demand

**6. Groups and Individuals: The Consequences of Belonging**

7. Groups: their nature and function: groups and task performance: decision making by groups: leadership: patterns of influence within groups.

**Books Recommended**

1. Baron R.A., Byrne, D., & Johnson, B.T. (1998). Exploring Social Psychology (4<sup>th</sup> Ed). London: Ayllon and Bacon
2. Callon V.J., Gallois, C.; Noller., & Kashima, Y. (1991). Social Psychology. (2<sup>nd</sup> Ed). Australia: Harcourt.
3. Myers, G.R. (2003). Social Psychology. (6<sup>th</sup> Ed). New York Prentice Hall.



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## SEMESTER-V

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

#### Course Contents:

Aquaculture: the concept, mariculture, substrate system, seawater ponds, cages, enclosure, tanks; aquaculture in fresh and brackish waters. Aquaculture in practice. General characteristics of fish, shape and external features. Freshwater fishes of Pakistan. Fresh water fishing methods. Food and feeding habits of fish: water quality variables. Requisite conditions suitable for fish culture. Culturable species of fish. procurement of stocking material. Preparation and management of rearing fish ponds. Brief account on Mono-Poly and composite fish culture systems. Fertilization of fish ponds: their application and impact on fish growth and water quality. Fish feed and feeding: feed ingredients and feed conversion efficiency. Fish diseases and their control. Aquatic resources of Pakistan.

#### Books Recommended

1. Pillay, T.V.R., 1999. Aquaculture: Principles and practices. Fishing news books, U.K. nts. 2. Purdom, C.E., 1995. Genetics and fish breeding, Chapman and Hall, N.Y.
2. Parker, R., 1994. Aquaculture Science, Delmar publishers, Washington D.C
3. Ali, S.S., 1993, An introduction to freshwater fishery biology, Higher Education commission, Islamabad
4. Hute, M., 1986, Text book of Fish culture Fishing news, London.

#### Practicals

1. Study of morphological characters of a typical fish. Dissection of a bony fish to expose its various systems. Species identification based on fin formula and scale counting etc.
2. Practical demonstration of induced breeding. Artificial feeds and their constituents. Aquatic plants, aquatic insects.
3. Visit of hatchery and fish farm.

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

#### Course Contents:

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

**Cytoskeleton:** Microfilaments, Microtubules, Intermediate filaments.

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

hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glyoxysome (with reference to glyoxylic acid cycle)

Nucleus, chromatin, heterochromatin, euchromatin, chromosome structure with reference to coiling and nucleosome during different phases of cell cycle, Replication (mechanism, DNA replication in:

prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with special reference to DNA polymerases, concept of Replicons etc.). Transcription (variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved, RNA splicing, split genes, concept of Ribozymes and posttranscriptional processing), RNA transduction, Genetic code, point mutations, Translation (with reference to the specific role of Ribosomes, various factors, and posttranslational processing). Control of Gene expression in Prokaryotes

**Books Recommended**

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. MOLECULAR BIOLOGY OF THE CELL, 1989: Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H. and Baltimore, D. MOLECULAR CELL BIOLOGY, 1990. Scientific American Inc. N.Y.
3. De Robertis, E. D. P. and De Robertis Jr. E. N. F. CELL AND MOLECULAR BIOLOGY, 1987. Lea & Febiger, New York.
4. Karp, J. CELL AND MOLECULAR BIOLOGY, CONCEPTS AND EXPERIMENTS, 2005. Jhon Wiley and Sons, INC.
5. Geoffrey M.C., Robert E.H. THE CELL: A MOLECULAR APPROACH, 2007. Sinauer Associates, INC.

**Practicals**

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

**ZOL-505: BIOCHEMISTRY (Cr. 3+1)4**

**Course Contents:**

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

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

**Carbohydrates:** classification, types, important characteristics and structure of carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin formation; disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides.

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

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

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

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

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

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

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

#### Books Recommended

1. Nelson, D. L. and Cox, M.M. LEHNINGER PRINCIPLES OF BIOCHEMISTRY, 3<sup>rd</sup> Edition, 2000. McMillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. HARPER'S BIOCHEMISTRY, 25<sup>th</sup> Edition, 2000. McGraw Hill, New York.
3. Voet, D., Voet, J.G. and Pratt, C.W. FUNDAMENTALS OF BIOCHEMISTRY, 1999. John Wiley and Sons, Inc., New York.
4. Zubay, G. BIOCHEMISTRY, 4<sup>th</sup> Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
5. Lubert, S. BIOCHEMISTRY, 4<sup>th</sup> Edition, 1995. W.H. Freeman & Company, New York.

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6. McKee, T. and McKee, J.R. BIOCHEMISTRY, THE MOLECULAR BASIS OF LIFE. 3<sup>rd</sup> Edition, 2003 McGraw Hill.

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

#### ZOL-507: WILD LIFE/ANIMAL MORPHOLOGY (CR. 2+1)3

##### Course Contents:

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

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

##### Books Recommended

1. Bailey, J.A. PRINCIPLES OF WILDLIFE MANAGEMENT, 1986. John Wiley and Sons.



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2. Ali S. and Ripley S.D. A HANDBOOK OF BIRDS OF INDIA & PAKISTAN. 1973. Oxford University Press, London.
  3. Roberts, T. J. THE BIRDS OF PAKISTAN, (Vol. I). 1992. Oxford University Press
  4. Roberts, T. J. THE BIRDS OF PAKISTAN, (Vol. II). 1998. Oxford University Press.
  5. Roberts, T.J. MAMMALS OF PAKISTAN. 1977. Ernest Benn Ltd, London.
  6. Robinson, W.L. and Bolen, E.G. WILDLIFE ECOLOGY AND MANAGEMENT. 1984. McMillan, Cambridge.
  7. Magon, C.F. BIOLOGY OF FRESHWATER POLLUTION. 1988. Longman and Scientific Publication.
  8. Boyd, C.E. and Tucker, C. S. POND AQUACULTURE AND WATER QUALITY MANAGEMENT. 1998. Boston, Kluwer Publishers Alabama.
  9. Ali, S.S. PALEONTOLOGY, ZOOGEOGRAPHY & WILD-LIFE MANAGEMENT. 1999. Nasim Book Depot, Hyderabad, India.

### ZOL-509: BIostatISTICS (Cr. 2+1)3

#### Course Contents:

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

#### Books Recommended

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

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## SEMESTER-VI

### ZOL-502: GENETICS (Cr. 3+1)4

#### Course Contents

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

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

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

#### Books Recommended

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

#### 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.  $\chi^2$  test
9. Study of transformed bacteria on the basis of antibiotic resistance.

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ZOL-504: ANIMAL PHYSIOLOGY (Cr. 3+1)4

**Course Contents:**

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

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

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

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

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

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

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

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

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



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

#### Books Recommended

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

#### Practicals

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

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

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

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

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

#### Books Recommended

1. Thorp, G. and Woodman, D. EXPERIMENTS IN PHYSIOLOGY, 8<sup>th</sup> Edition. 2002. Prentice Hall, London.



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ZOL-506: DEVELOPMENTAL BIOLOGY (Cr. 3+114)

**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.**

**Hormones as mediators of development; Regeneration in vertebrates.**

**Books Recommended**

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

**Practicals**

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

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ZOL-508: ECOLOGY (Cr. 3+1)4

**Course Contents:**

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

**Books Recommended**

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

**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).

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4. Population dynamics of grasshoppers.
  5. Adaptive features of animals in relation to food and environment.
  6. Food chain studies through analysis of gut contents.
  7. Analysis of polluted and fresh water for biotic and abiotic variations.
  8. Field visits for study of selected terrestrial habitat and writing notes.
  9. Development of an ecological management plan of some selected area.

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

**Course Contents:**

Mechanism of behavior: Nervous system and behavior, hormones and behavior, biological rhythm, development of behavior, learning behavior, communication.

Social organization: conflict, sexual reproduction, parental care, social system.

**Books Recommended**

1. Goodenough, J., McGuire, B. and Wallace, R.A. PERSPECTIVE ON ANIMAL BEHAVIOUR. 2001 John Wiley & Sons, New York.
2. Scott, G. ESSENTIAL ANIMAL BEHAVIOUR. 2005 Blackwell Pub. New York
3. Dngatkin, L. A. PRINCIPLES OF ANIMAL BEHAVIOUR. 2006 W.W. Norton and Co. New York.

**SEMESTER-VII**

**ZOL-601:EVOLUTION & PRINCIPLES OF SYSTEMATIC (Cr. 3+1)4**

**Course Contents:**

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

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

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

Systematic Zoology: Contribution of systematics to Biology: History of Taxonomy (Downward classification, upward classification, impact of the origin of species, population systematics, current trends), Microtaxonomy, phenon, Taxon; Taxonomic categories: specific category, infraspecific category, higher categories; species concepts (Typological concept; nominalistic concept, Biological concept, evolutionary concept); species mate recognition concept; non-dimensional species concept; Multidimensional species concept; Cohesion species concept;



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Difficulties in the application of biological species concepts: polytypic species, subspecies, super species, sibling species; study of major type of variation within a single population. Speciation and taxonomic decision, various types of characters, cladistic analysis, Macrotaxonomy; different kinds of taxonomic characters; Taxonomic collection and identification; definitions of Synonym, Homonym. Keys; Evolution of the theory of Nomenclature; interpretation and application of the code (stability, priority, first revisor principle) range of authority of code, concept of availability, type method formation of specific names.

#### Books Recommended

##### Evolution

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

##### Systematic Zoology

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

##### 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. Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.
4. Preparation of keys for the identification of specimens.

#### ZOL-603: PRINCIPLES OF TOXICOLOGY (Cr. 3+1)4

##### Course Contents:

History and general Introduction to the Toxicology; Types of Toxicology; Specialized areas in Toxicology; Classification of Toxic chemicals ; Types of exposure and Exposure responses including exposure characteristics; Spectrum of Undesirable effects; Variation in Toxic Responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Mutagenicity; Absorption, Distribution and Excretion of toxicants; Biotransformation/disposition of toxicants; Phase-I & Phase-II Biotransformation Reactions; Mechanisms of Toxicity; Delivery, (from site of exposure to the Target; absorption versus prtesystemic Elimination; ess. Cambridg; Distribution to and away from the Target; excretion vs Reabsorption; Toxication vs Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecules; Cellular Dysfunction



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and Resultant Toxicities. Toxicant-Induced Cellular Dysregulation, Toxic alterations of Cellular maintenance, Repair & Dysrepair.

**Books Recommended**

1. KLAASSEN, CURTIS D. (1996). Casarett & Doull's Toxicology: The basic Science of Poisons, 5<sup>th</sup> Edition (International), McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J.A., 1995. Introduction to Toxicology, 2<sup>nd</sup> Edition Taylor and Francis Ltd., London.

**Practicals**

Determination of LD50 values of some pesticides against any insect pest. Determination of LD50 doses of any toxic compound in mammalian system. Effect of any toxic chemicals on body weights in mice. Toxicity of some toxic compound on relative organ weights in mice. Effect of toxicant on food consumption in mice. Study of toxicity of any chemical on total leukocyte count. Effect of a toxicant on total erythrocyte count in blood of mice. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice. Study of liver function enzyme (Alanine amino transferase) activity following administration of toxic compound to experimental animals. Determination of blood glucose level following toxic exposure.

**Books Recommended**

1. Hayes, A. Wallace, 1994. Principles and Methods of Toxicology, 3<sup>rd</sup> Edition, Raven Press, New York.

**ZOL-605: SEMINAR (Cr. 1)**

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 are to be assigned advance topic relevant field of Zoology in order to develop such skills.

**ZOL-607: BIOLOGICAL TECHNIQUES & BIOINFORMATICS (2+1)3**

**Course Contents:**

**Overview of Bioinformatics:** the scope of bioinformatics, bioinformatics and internet. Useful Bioinformatics sites on Web.

**Data Acquisition:** Sequencing DNA, RNA and proteins, Determination of protein structure, Gene and protein expression data, Protein interaction data.

**Database:** Contents, Structure and Annotation: File formats, Annotated sequence databases, Genome and organism-specific databases, Miscellaneous databases.

**Retrieval of Biological Data:** Data retrieval with Entrez and DBGET/LinkDB, Data retrieval with SRS (sequence retrieval system).

**Searching Sequence Databases by Sequence similarity Criteria:** Sequence similarity searched, Amino acid substitution matrices, Database searched (FAST and BLAST), sequence filters, Interactive database searches and PSI-BLAST.

**Multiple Sequence Alignment:** Genes and Protein Families: Multiple sequence alignment and family relationships, protein families and pattern databases, protein domain families.

**Phylogenetics:** Phylogenetics, cladistics and ontology, Building phylogenetic trees, Evolution of macromolecular sequences.

Sequence Annotation: Principles of genome annotation, Annotation tools and resources.

Structural Bioinformatics: Conceptual models of protein structure, relationship of protein three-dimensional structure to protein function, The evolution of protein structure and function, Obtaining, viewing and analyzing structural data, Structural alignment, classification of proteins of known three-dimensional structure: CATH and SCOP, Introduction to protein structure prediction by comparative modeling, secondary structure prediction, advanced protein structure prediction and prediction strategies.

Microarray Data Analysis: Analysis methods, tools and resources, sequence sampling and SAGE.

Proteomic Data Analysis: Analyzing data from 2D-PAGE gels, analyzing protein spectrometry data.

Higher-order System: Modeling and reconstructing molecular pathways, protein interaction informatics, Higher-order models.

Cheminformatics in Biology: Conventions for representing molecules, Chemoinformatics resources.

Bioinformatics in Pharmaceutical industry: Bioinformatics and drug discovery, Pharmainformatics resources.

Recommended Books

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

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## SEMESTER-VIII

### ZOL-602: ZOOGEOGRAPHY & PALEONTOLOGY (2+1)3.

#### Course Contents:

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

**Principles of Paleontology:** Earth, Shells of earth; (atmosphere, hydrosphere, biosphere and lithosphere). Rock, types of rocks (igneous rocks, sedimentary rocks and metamorphic rocks) Fossils, types and uses of fossils, nature of fossils. Processes of fossilization: Geological time scale. Pre-Cambrian life. Post Cambrian life (Palaeozoic life, Mesozoic life, Cenozoic life). Geochronometry (Uranium/Lead dating, radiocarbon dating, methods); evolutionary history of man, elephant, horse and camel, Paleocology, Paleomagnetism.

#### Practicals

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

#### Books Recommended

##### Zoogeography:

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

##### Paleontology:

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

ZOL-604: LOGIC & REASONING (2+0)2

**Course Contents:**

What philosophy is and why it is worth studying; Logic: Defining and scope of logic, proposition  
The laws of Logic, Deductive reasoning, Inference, Inductive reasoning, Kinds of  
induction, Generalization, Hypothesis.

**Books Recommended**

1. Deduction by Karamat Hussain
2. Induction by Karamat Hussain
3. A critical history of greek philosophy by W.J. Stace

ZOL-606: INTRODUCTION TO BIOTECHNOLOGY (Cr. 3+1)4

**Course contents:**

Introduction to biotechnology. Advances in vaccine development. Recombinant products expression, and transgenic. Bioreactor design. Introduction to factors affecting bioreactor design. Description of a typical aseptic bioreactor bioreactor configuration and scale-up. Design of sterilization systems. Oxygen mass transfer and heat-transfer in bioreactor systems. Fermentation broth rheology. Product recovery, waste treatment, and safety. Biosensors: applications of biosensors, transducer technology, principles of transducers. Recombinant protein production, general aspects of heterologous protein expression. Bacterial expression systems- Escherichia coli and Bacillus subtilis. Saccharomyces cerevisiae as a system for expression of heterologous proteins. Expression in non-Saccharomyces yeast species and filamentous fungi. Enzymes and industry. Extremozymes, enzyme evolution. Microbial productions of: pharmaceuticals, diagnostic proteins, vaccines, microbial toxins and insecticides

**Practicals**

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

**Books recommended**

1. David, B., Jewell, T.R. 2000. Biotechnology: demystifying the concept. Oxford University press.
2. Sedivy, J.M., Joyner, A.L. 2000 gene targeting. Oxford University press.
3. Mohopadhyay, S.N. 2004. Process biotechnology fundamentals, 2<sup>nd</sup> edition. Viva books pvt.Limited
4. Goodshel, D.S. 2004. Bionanotechnology: lessons from nature. John Wiley & Sons Limited.
5. Purohit, S.S. 2002 Biotechnology: Fundamentals And applications, Agribiosis publishers.
6. Prave, P., Fraust, U., Sitting W and Sukatsh, D. A. 2002. Fundamentals of Biotechnology John Wiley & Sons Limited
7. Thauer, R., and wagner, F., 1991. Biotechnology focus : Fundamentals- Applications- Information, Helen-Cooper- Schluter Carl Hanser, Verlag GmbH Co.



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8. Klantzambakes, N. 2003, the Economic and Environment impacts of agrobiotech" a global perspective. Kluwer
  9. Tourte, Y and Tourte, C 2005. Genetic engineering and Biotechnology: concepts, Methods, and Agronomic Applications. Science publishers
  10. Christou, P., and Harry Klee, H. 2004. Handbook of plant Biotechnology, 2. Volume Set. John Wiley & Sons Limited

### OPTIONAL COURSES

\*In lieu of thesis optional courses will be offered from the list attached depending upon the resources of the department.

#### ZOL-421: MICROBIOLOGY-I (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. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. THE MICROBIAL WORLD, 1986. Prentice Hall, London.

#### ZOL-422: MICROBIOLOGY-II (Cr. 3+1)

##### Course Contents

Bacterial physiology. Prokaryotic diversity: eubacteria and archaea. Eukaryotic microorganisms; algae, fungi, protozoa, Bacteriophages. Viruses of animals and plants.

##### 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

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method. The turbidimetric estimation of microbial growth. Study of bacterial virus. 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-423: ENTOMOLOGY-I (Cr. 3+1)4

#### 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. Basement membrane. 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

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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, 10<sup>th</sup> 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 8<sup>th</sup> 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 ANALYSIS OF ABUNDANCE, 5<sup>th</sup> Edition, 2000. Benjamin-Cummings Publishing Company.
7. Tembhare, D.B. MODERN ENTOMOLOGY, 2002. Himalaya Publishing House, India.
8. Southood, 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-424: ENTOMOLOGY-II (Cr. 3+1+4)

#### 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, Grylloblattodea, Phasmida, Dermaptera, Embioptera, Zoraptera, Psocoptera, Mallophaga, Siphunculata, Thysanoptera, Neuroptera, Mecoptera, 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.

#### 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.

#### 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.



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ZOL-425: ENDOCRINOLOGY (Cr. 3+1)4

**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.

**Calcitropic 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.**

**Books Recommended**

1. Greenspan, F.S. and Strewler, G.J. BASIC AND CLINICAL ENDOCRINOLOGY, 5<sup>th</sup> Edition, 2002. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, B.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, 4<sup>th</sup> Edition, 2001. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R. TEXTBOOK OF ENDOCRINE PHYSIOLOGY, 4<sup>th</sup> Edition, 2000. Oxford University Press, Oxford.
5. Neal, J.M. BASIC ENDOCRINOLOGY: AN INTERACTIVE APPROACH, 2000. Blackwell Science Inc., London.



**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.

**ZOL-426: PHYSIOLOGY OF REPRODUCTION (Cr. 3+1+4)**

**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, galactopoiesis, 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 York.

ZOL-429: PRINCIPLE OF FISH BIOLOGY (Cr. 3+1+4)

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

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. 1. 1992. Blackwell Publishing, Oxford, UK.
4. Huet M. **TEXT BOOK OF FISH CULTURE: BREEDING AND CULTIVATION**. 1973. Blackwell Publishing Company.

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.

ZOL-430: FISH PHYSIOLOGY & BREEDING (Cr. 3+1+4)

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); Semi-intensive culture (due to natural & artificial food); Intensive culture (due to only dry concentrates).

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Fish health; Water quality; Hygiene of fish culture facilities; Hygiene of equipments 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 behaviour

#### Books Recommended

1. Kestin, S. C. and Warris, P.D. (Editors). KESTIN FARMED FISH QUALITY, 2002, Blackwell Science, Oxford, UK.
2. Saksena, D.N. ICHTHYOLOGY: RECENT RESEARCH ADVANCES, 1999. Ostar Publications, India.
3. Woo, P.T.K. FISH DISEASES AND DISORDER. Vol. I PROTOZOAN AND METAZOAN INFECTIONS, 1995. CABI Publisher.
4. Brenabe, G. AQUACULTURE, Vol. 1, 1992. Blackwell Publishing, Oxford, UK.
5. Maseke C. FISH AQUACULTURE, 1987. Pergamon Press, Oxford, UK.
6. Huet M. TEXT BOOK OF FISH CULTURE: BREEDING AND CULTIVATION, 1973. Blackwell Publishing Company
7. Hoars, W.S. FISH PHYSIOLOGY, 1971. Academic Press, UK.
8. Hoars, W.S. FISH REPRODUCTION, 1969. Academic Press, UK.
9. Matty, A.J. FISH ENDOCRINOLOGY, 1985. Timber Press, UK.
10. Gorbman, A. COMPARATIVE ENDOCRINOLOGY, 1<sup>st</sup> Edition, 1983. John Wiley & Sons, UK.

#### Practicals

Study of gut contents, Study of feeding modification and adaptation in fish, Study of respiratory adaptation in fish, Study of blood cells and their counts in normal and diseased fish, Study of water quality parameters (DO, NH<sub>3</sub>, hardness, alkalinity, turbidity, transparency, temperature, salinity), 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, Study of fish parasites, Visit to various fish seed hatcheries during breeding seasons.



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ZOL-431: BIOLOGY OF SPIDERS (Cr. 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: atomized, cheliceral, molting, Ecology, ant mimicry, stridulation, Argyrodes, Phylogeny and Systematics; synapomorphies, cribellum, Mygalomorphae.

**Practicals**

Collection, Preservation and Identification of Spiders. Preparation of slides of genitalia, 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 Verlag 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-433: MOLECULAR AND CLINICAL ENDOCRINOLOGY (Cr. 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, immunoradiometric, immunochemuminometric 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 insipidus, hypo- and hyper-tonic syndromes; Thyroid Diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper function, Disorders of Adrenal Medullary Function; Disorders of Ovarian Function and Hormonal Therapy; Abnormalities of Testicular Functions and Hormonal Therapy.



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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

### Books Recommended

1. Greenspan, F.S. and Stewler, G.J. BASIC AND CLINICAL ENDOCRINOLOGY, 5<sup>th</sup> 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, 9<sup>th</sup> Edition, 1998. W.D. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. ENDOCRINOLOGY, 4<sup>th</sup> Edition, 2001. W.B. Saunders, Philadelphia.
4. Gillin, J.E. and Ojeda, S.R. TEXTBOOK OF ENDOCRINE PHYSIOLOGY, 4<sup>th</sup> Edition, 2000. Oxford University Press, Oxford.
5. Neal, J.M. BASIC ENDOCRINOLOGY: AN INTERACTIVE APPROACH, 2000. Blackwell Science Inc., London.

### 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 anorexia; Studies of hormonal status in puberty and aging.

### ZOL-434: PARASITOLOGY (3+1)4

#### Course Contents:

Introduction to parasitology. Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals. Careers 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. Humidity 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 Retortamonadida, order Diplomonadida, order Trichomonadida, order Opalinida. The Amoebas. Order Amoebozoa, order Schizopyrenida. Phylum Apicomplexa. Gregarines. Coccidia and related organisms. The apical complex, class Gregarina, class Coccidia. Phylum Apicomplexa, Malawia, organisms, and pyroplasmids, order Haemosporida, order Pyroplasmida. Phylum ciliophora, ciliated protistan parasites, class Spirotochea, class Litostomatea, class Oligohymenophorea. Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa. The Mesozoa, pioneers or Degenerates. Class Rhombozoa, class Erthonocida. 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.

Books Recommended

1. Roberts, L.S. and Janovy, J. FOUNDATION OF PARASITOLOGY, 6<sup>th</sup> Edition, 2000, McGraw Hill Book Co.
2. Hausman, E. and Hulsman, N. T. PROTOZOOLOGY, 2<sup>nd</sup> Edition, 1996, Medical Publishers, Inc. New York.
3. Noble, J.R. and Noble, G.A. PARASITOLOGY, THE BIOLOGY OF ANIMAL PARASITES, 5<sup>th</sup> Edition, 1982, Lea and Febiger Publisher.
4. Beck, J.W. and Davies, J.E. MEDICAL PARASITOLOGY, 3<sup>rd</sup> 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.E. INTRODUCTION TO ANIMAL PARASITOLOGY, 1994, Cambridge University Press.
7. Roberts, L.S. and Janovy, J. Jr. FOUNDATIONS OF PARASITOLOGY, 7<sup>th</sup> Edition, 2005, W.M. Brown Publishers, Chicago, London, Tokyo, Toronto.
8. Beck, J.W. and Davies, J.E. MEDICAL PARASITOLOGY, 3<sup>rd</sup> 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.E. INTRODUCTION TO ANIMAL PARASITOLOGY, 1994, Cambridge University Press.
11. Roberts, L.S. and Janovy, J. Jr. FOUNDATIONS OF PARASITOLOGY, 7<sup>th</sup> Edition, 2005, Wm Brown Publishers, USA.
12. Urquhart, G.M., Trecan, J.L., Dunn, A.M. and Jennings, F.W. VETERINARY PARASITOLOGY, 2000, Longman Scientific and Technical publications, Longman Group, UK.

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.

ZOL-435: ORNITHOLOGY (Cr. 3+1+4)

Course Contents

Introduction: The contribution of ornithology to modern biology. The diversity of Birds.

The design of a flying machine- the evolution of and adaptations for flight. Adaptive radiation- Birds of the world— Orders and families. Form and Function: Anatomy and Physiology. Reproduction and Development- the amazing egg, Annual cycles, molt, migration, navigation, behavior. Demography and conservation: Social behavior: Communications- vocalizations: Song and song learning

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Practical

Field Trips

Books Recommended

1. Ornithology. Gill, F. 3<sup>rd</sup> edition.
2. Manual of Ornithology. Proctor, N.S. and Lynch, P.J. Yale University, New Haven, Connecticut 1993.
3. Sibley's Birding Basis. Sibley, D.A. and Knopf, A.A. 2002. New York.
4. The Sibley Guide to Birdlife and Behavior. Sibley, D.A. and Knopf, A.A. 2001. New York.

ZOL-437: STATISTICAL ECOLOGY (Cr. 3+1)4

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, discriminant 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. 1983. John Wiley and Sons, New York.
4. The interpretation of ecological data: a primer on classification and ordination. Pielou, E.C. 1981. Wiley-interscience.

ZOL-438: INTEGRATED PEST MANAGEMENT (3+1)4

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. Cambridge University Press, New York.
2. DelBach, 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 MacMillan.
5. Van Eriesche, R.G. and T.S. Bellows, Jr., 1996, *Biological Control*, Chapman and Hall, International Thomson Publishing Co.

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