

**CURRICULUM**

**OF**

**ZOOLOGY  
BS (4-YEAR)**

**2008**



**HIGHER EDUCATION COMMISSION  
ISLAMABAD**

## **CURRICULUM DIVISION, HEC**

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## PREFACE

Curriculum development is a highly organized and systematic process and involves a number of procedures. Many of these procedures include incorporating the results from international research studies and reforms made in other countries. These studies and reforms are then related to the particular subject and the position in Pakistan so that the proposed curriculum may have its roots in the socio-economics setup in which it is to be introduced. Hence, unlike a machine, it is not possible to accept any curriculum in its entirety. It has to be studied thoroughly and all aspects are to be critically examined before any component is recommended for adoption.

In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification No. D773/76-JEA (cur.), dated December 4<sup>th</sup> 1976, appointed the University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at the bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellor's Committee, the curriculum of a subject must be reviewed after every 3 years.

A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The new BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours. For those social sciences and basic sciences degrees, 63.50% of the curriculum will consist of discipline specific courses, and 36.50% will consist of compulsory courses and general courses offered through other departments.

For the purpose of curriculum revision various committees are constituted at the national level, comprising of senior teachers nominated by universities, degree awarding institutions, R&D organizations and respective accreditation councils. The National Curriculum Revision

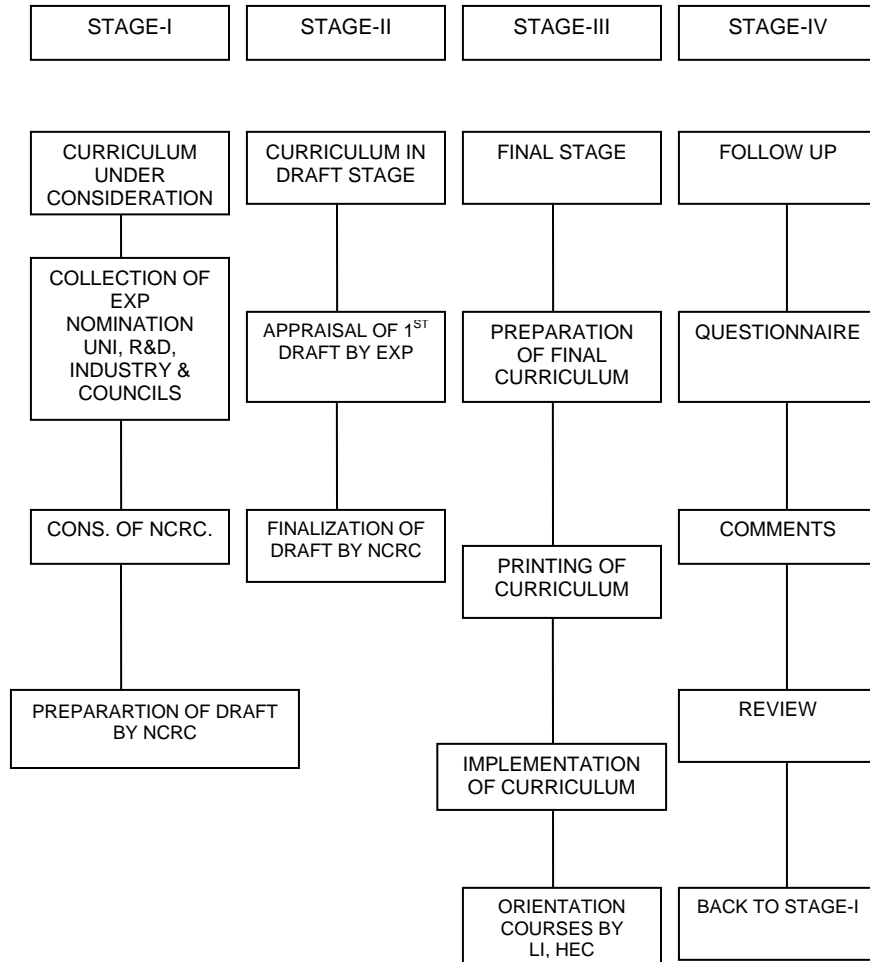
Committee for Zoology in a meeting held on March, 17, 2008 at the HEC Regional Center, Islamabad in continuation of its earlier meeting held on Nov 19-20, 2007 at HEC Regional Center, Lahore revised the curriculum in light of the unified template. The final draft prepared by the National Curriculum Revision Special Committee, duly approved by the competent authority, is being circulated for implementation in the concerned institutions.

**DR. RIAZ-UL-HAQ TARIQ**

Member Academics

June 2008

## CURRICULUM DEVELOPMENT



**Abbreviations Used:**

- NCRC. National Curriculum Revision Committee
- VCC. Vice-Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation
- REC. Recommendations
- LI Learning Innovation
- R&D Research & Development Organization
- HEC Higher Education Commission

## INTRODUCTION

A meeting of the Special National Curriculum Revision Committee to review the draft of the curriculum for BS 4 years program in Zoology at various Universities / Institutions was held on November 19 - 20, 2007 at the HEC, Regional Center, Lahore. The objective of the meeting was to adapt the curriculum of Zoology in the light of standardized template/framework developed by a joint meeting of conveners of NCRCs in basic and social sciences on April 30, 2007 at HEC Islamabad, so the curriculum developed may be brought at par with international standards.

The meeting started with recitation from the Holy Quran by Mr. Bashir Ahmed, Deputy Director, HEC, Regional Center, Lahore. Ms. Ghayyur Fatima, Deputy Director Curriculum, HEC, Islamabad welcomed the members and explained the aims and objectives of the meeting. The members unanimously decided that Prof. Dr. Kausar Jamal Cheema will be the Convener and Prof. Dr. Muhammad Ali will be the secretary of the committee.

The Following attended the meeting:

- |    |   |          |
|----|---|----------|
| 1. | Prof. Dr. Kausar Jamal Cheema,<br>Head, Department of Zoology,<br>Lahore College for Women<br>University,<br>Jail Road, Lahore. | Convener |
| 2. | Prof. Dr. Muhammad Saeed Akhtar,<br>University of Education,<br>Township Campus, Lahore.  | Member   |
| 3. | Prof. Dr. Yasmin Nawaz,<br>Chairperson, Department of Zoology,<br>University of Balochistan, Quetta.                            | Member   |
| 4. | Prof. Dr. Samina Jalali<br>Ex. Dean<br>Faculty of Biological Sciences<br>Quaid-i-Azam University,<br>Islamabad.                 | Member   |
| 5. | Prof. Dr. Muhammad Saeed Wagan,<br>Chairman, Department of Zoology,<br>University of Sindh, Jamshoro.                           | Member   |

- |     |   |                       |
|-----|---|-----------------------|
| 6.  | Prof. Dr. Sohail Barkati,<br>Chairman, Department of Zoology,<br>University of Karachi, Karachi.                        | Member                |
| 7.  | Prof. Dr. Syed Akram Shah,<br>Department of Zoology,<br>University of Peshawar, Peshawar.                               | Member                |
| 8.  | Prof. Dr. M. Sharif Mughal,<br>Chairperson, Department of Zoology,<br>GC University,<br>Katchery Road, Lahore.          | Member                |
| 9.  | Dr. M. Ashraf Mirza<br>Assistant Professor,<br>Department of Zoology,<br>GC University,<br>Katchery Road, Lahore.       | Member                |
| 10. | Dr. Irfan Zia Qureshi,<br>Assistant Professor,<br>Department of Animal Sciences,<br>Quaid-i-Azam University, Islamabad. | Member                |
| 11. | Dr. Asmatullah<br>Associate Professor<br>Department of Zoology<br>University of The Punjab, Lahore                      | Member                |
| 12. | Prof. Dr. Muhammad Ali,<br>Director, Centre for Undergraduate<br>studies<br>Bahauddin Zakariya University,<br>Multan.   | Member /<br>Secretary |

### **MINUTES OF THE FINAL MEETING**

A meeting of the Special National Curriculum Revision Committee to review the final draft of the curriculum for BS 4 years program in Zoology at various Universities / Institutions was held on March 17, 2008 at the HEC, Islamabad. The objective of the meeting was to finalize the curriculum of Zoology in the light of standardized template/framework developed by a joint meeting of conveners of NCRCs in basic and social sciences on April 30, 2007 at HEC, Islamabad, so the curriculum developed may be brought at par with international standards.



The meeting started with recitation from the Holy Quran by Prof. Dr. Shamsuddin Ahmad Shaikh. Ms. Ghayyur Fatima, Deputy Director Curriculum, HEC welcomed the members and updated the members for the finalization of the draft. The meeting was chaired by Prof. Dr. Kausar Jamal Cheema and Dr. Asmatullah acted as secretary of the committee.

The Following attended the meeting:

- |    |   |          |
|----|---|----------|
| 1. | Prof. Dr. Kausar Jamal Cheema,<br>Head, Department of Zoology,<br>Lahore College for Women<br>University,<br>Jail Road, Lahore. | Convener |
| 2. | Prof. Dr. Muhammad Saeed Akhtar,<br>University of Education,<br>Township Campus, Lahore.  | Member   |
| 3. | Prof. Dr. Samina Jalali,<br>Department of Animal Sciences,<br>Quaid-i-Azam University,<br>Islamabad.                            | Member   |
| 4. | Prof. Dr. Sohail Barkati,<br>Chairman, Department of Zoology,<br>University of Karachi, Karachi.                                | Member   |
| 5. | Prof. Dr. M. Sharif Mughal,<br>Chairperson, Department of<br>Zoology,<br>GC University,<br>Katchery Road, Lahore.               | Member   |
| 6. | Prof. Dr. Shamsuddin Ahmed<br>Shaikh,<br>Chairman<br>Department of Zoology,<br>University of Sindh, Jamshoro.                   | Member   |
| 7. | Dr. M. Ashraf Mirza<br>Assistant Professor,<br>Department of Zoology,<br>GC University,<br>Katchery Road, Lahore.               | Member   |

- |     |  |                  |
|-----|--|------------------|
| 8.  | Ms. Rehana Iqbal<br>Lecturer in Zoology,<br>Center for Undergraduate Studies,<br>Bahauddin Zakariya University,<br>Multan  | Member           |
| 9.  | Dr. Irfan Zia Qureshi,<br>Assistant Professor,<br>Department of Animal Sciences,<br>Quaid-i-Azam University,<br>Islamabad. | Member           |
| 10. | Dr. Asmatullah<br>Associate Professor<br>Department of Zoology<br>University of The Punjab, Lahore                         | Member/Secretary |

After detailed scrutiny, revision and discussion, the committee proposed the changes in the existing lay out in accordance with the new template provided by the HEC. The curriculum of BS 4 years program in Zoology was finalized.

## **BS (4 YEARS) ZOOLOGY PROGRAM**

### **INTRODUCTION**

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

Eligibility Criteria: F.Sc. Pre medical/ A level.

### **Objectives and Outcomes**

1. To impart knowledge about the major disciplines of Zoology. It will enable the students to understand the principles of organizations and inter-relationships in the biological systems with particular reference to animal diversity.

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

### **Career Opportunities**

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

Positions in various government and non governmental organizations, teaching and research, administration and management, forestry, pharmaceutical, agriculture, biological control program, integrated pest management, poultry, wildlife, aqua culture, fisheries, livestock and strategic areas.

### **Pedagogy (Teaching - Learning Methodologies)**

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

### **Assessment and Evaluation**

#### **Internal evaluation (left to the individual universities)**

Mid term test

Seminars and Assignments

Final Examination

## LAYOUT FOR BS ZOOLOGY (4 YEAR PROGRAMME)

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

Compulsory Requirements (the student has no choice)		General Courses to be chosen from other departments		Discipline Specific Foundation Courses		Major courses including research project/ internship		Elective Courses within the major	
9 courses		7-8 courses		9-10 courses		11-13 courses		4 courses	
Subject	Cr. hr	Subject	Cr. hr	Subject	Cr. hr	Subject	Cr. hr	Subject	Cr. hr
1. English-I	3	2.	2+	1. Principles of Animal life-I	3+	Cell and Molecular Biology	3+	Elective -I ****	2+
2. Pakistan Studies	2	3.	1	2. Principles of Animal life-II	1	Biochemistry	1		1
3. Mathematics	3	4.	2+	3. Diversity - I	3+	Physiology	3+	Elective -II ****	2+
4. English-II	3	5.	1	4. Diversity - II	1	Animal Behavior	1		1
5. Islamic Studies / Ethics	2	6.	2+	5. Form & Function-I	3+	Ecology	3+	Elective -III ****	2+
6. Biostatistics	1	7.	1	6. Animal Form & Function - II	1	Wildlife	2		1
7. English-III	2+	8.	2+	7. Developmental Biology	3+	Genetics	3+	Elective -IV ****	2+
8. Introduction to Computer	1	Note: Botany, Chemistry or any social science subjects, combination of any other related subject that exists in university as department	1	8. Biological Techniques	1	Bioinformatics	1		1
9. English-IV *	3		2	9. Evolution and Principles of Systematic	3+	Special Paper**	2		
						Research	3+		
						Project / Internship ***	1+		2+
						Research	1		1
						Project / Internship ***	3+		
						Zoogeography & Paleontology	3		
							2+		
							1		
	25		23		34		39		12

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

\*\* Fisheries / Parasitology / Microbiology / Entomology / Immunology / Environmental Sciences / Marine Zoology / Endocrinology etc. (universities may offer any other special paper depending upon the availability of the expertise)

\*\*\* Research Project / Internship will be offered over two semesters and report be submitted at the end of semester VIII for the evaluation

\*\*\*\* All elective subjects should be selected to support the opted special paper

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

**STRUCTURE**

<b>Sr.</b>	<b>Categories</b>	<b>No. of courses</b>	<b>Credit Hours</b>
1.	Compulsory Requirement (No Choice)	09	25
2.	General Courses to be chosen from other departments	08	23
3.	Discipline Specific Foundation Courses	09	34
4.	Major Courses including research project / Internship	12	39
5.	Electives within the major	04	12
	<b>Total</b>	<b>42</b>	<b>133</b>

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

**MODEL SCHEME OF STUDIES FOR 4  
YEAR INTEGRATED BS (4 YEAR)**

	<b>Name of Subject</b>	<b>Credits</b>
<b>Semester-I</b>	COMPULSORY-I (English-I)	3
	COMPULSORY-II (Pakistan Studies)	2
	COMPULSORY-III (Mathematics)	3
	GENERAL- I (Bot / Etc. )	2+1
	GENERAL- II (Chem / Etc.)	2+1
	FOUNDATION-I (Principles of Animal Life-I)	3+1
		<b>18</b>
<b>Semester-II</b>	COMPULSORY-IV (English-II)	3
	COMPULSORY-V (Islamic Studies / Ethics)	2
	COMPULSORY-VI (Biostatistics)	2+1
	GENERAL-III (Bot/ Etc.)	2+1
	GENERAL-IV (Chem/ Etc.)	2+1
	FOUNDATION-II (Principles of Animal Life-II)	3+1
		<b>18</b>
<b>Semester-III</b>	COMPULSORY-VII (English-III)	3
	COMPULSORY-VIII (Introduction To Computer)	1+2
	GENERAL-V (Bot/ Etc.)	2+1
	GENERAL-VI (Chem/ Etc.)	2+1
	FOUNDATION-III (Animal Diversity-I)	3+1
		<b>16</b>
<b>Semester-IV</b>	COMPULSORY-IX (English-IV / UNIV. OPTIONAL)	3
	GENERAL-VII (Bot/ Etc.)	2+1
	FOUNDATION-IV (Animal Diversity-II)	3+1
	FOUNDATION-V(Animal Form & Function-I)	3+1
	FOUNDATION-VI(Animal Form & Function-II)	3+1
		<b>18</b>

<b>Semester-V</b>	GENERAL-VIII (Psych/ Etc.)	2
	FOUNDATION-VII (Developmental Biology)	3+1
	MAJOR-I (Cell & Molecular Biology)	3+1
	MAJOR-II (Animal Behaviour)	2+0
	MAJOR-III (Physiology)	3+1
		<b>16</b>
<b>Semester-VI</b>	FOUNDATION-VIII (Biological Techniques)	1+1
	FOUNDATION-IX (Evolution & Principles of Systematics)	3+1
	MAJOR-IV (Biochemistry)	3+1
	MAJOR-V (Ecology)	3+1
	MAJOR-VI (Wildlife)	2+0
		<b>16</b>
<b>Semester-VII</b>	MAJOR-VII (Genetics)	3+1
	MAJOR-VIII (Bioinformatics)	1+1
	ELECTIVE-I	2+1
	MAJOR-IX (Special Paper)	3+1
	MAJOR-X RESEARCH PROJ/ INTERNSHIP	3
		<b>16</b>
<b>Semester-VIII</b>	MAJOR-XI RESEARCH PROJ/ INTERNSHIP	3
	MAJOR-XII (Zoogeography & Paleontology)	2+1
	ELECTIVE-II	2+1
	ELECTIVE-III	2+1
	ELECTIVE-IV	2+1
	<b>TOTAL CREDITS 133</b> (Flexible from 133-136)	<b>15</b>

**Details of Courses**  
**CURRICULUM FOR BS 4 YEARS**  
**(8 SEMESTER) PROGRAM IN ZOOLOGY**

**Year-1**

**SEMESTER-I (Cr. 18)**

Name of Subject	Credits
COMPULSORY-I (English-I)	3
COMPULSORY-II (Pakistan Studies)	2
COMPULSORY-III (Mathematics)	3
GENERAL- I (Bot/ Etc. )	2+1
GENERAL- II (Chem/ Etc.)	2+1
FOUNDATION-I (Principles of Animal Life-I)	3+1
Total Credits	<b>18</b>

**Foundation - I PRINCIPLES OF ANIMAL LIFE – I (Cr. 3+1)**

**Aims and Objectives:**

The course aims to impart knowledge and understanding of:

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

**Course Contents**

- 1. Place of Zoology in Science**  
 A one-world view: genetic unity, the fundamental unit of life, evolutionary oneness and the diversity of life, environment and world resources; what is zoology? The classification of animals; the scientific method.
- 2. The Chemical Basis of Animal Life**  
 Atoms and elements: building blocks of all matter; compounds and molecules: aggregates of atoms; acids, bases, and buffers; the molecules of animals: fractional account of carbohydrates, lipids,



proteins, nucleotides and nucleic acids based on their structural aspects.

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

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

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

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

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

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

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

Animals and their abiotic environment; populations; interspecific interactions.

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

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

**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).

### Books Recommended

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 12<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 6<sup>th</sup> Edition (International), 2005. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 5<sup>th</sup> 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, 6<sup>th</sup> 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. Slingby, D. and Cook, C., PRACTICAL ECOLOGY. 1986. McMillan Education Ltd. UK.

### SEMESTER-II (Cr. 18)

Name of Subject	Credits
COMPULSORY-IV (English-II)	3
COMPULSORY-V (Islamic Studies / Ethics)	2
COMPULSORY-VI (Biostatistics)	2+1
GENERAL-III (Bot/ Etc.)	2+1
GENERAL-IV (Chem/ Etc.)	2+1
FOUNDATION-II (Principles of Animal Life-II)	3+1
Total Credits	<b>18</b>

**Compulsory-VI Biostatistics****(Cr. 2+1)****Aims and Objectives:**

The course will provide knowledge about the importance and use of statistics in life sciences. It will help the students to understand the methods to analyze data pertaining to their research work and to assess the significance of their experimental designs.

After this course students will be able to apply basic statistical procedures for analysis of data for practical and research.

**Course Contents**

Introduction and scope, use of statistics in biology. Population and sample. Stages of research, types of data 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.

**Foundation-II PRINCIPLES OF ANIMAL LIFE-II****(Cr. 3+1)****Aims and Objectives:**

The course imparts knowledge and understanding of:

- a. cell division and its significance in cell cycle.
- b. concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.
- c. animal behaviour and communication.
- d. theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

## Course Contents

- 1. Cell Division**  
Mitosis, cytokinesis, and the cell cycle: an overview; control of the cell cycle; meiosis: the basis of sexual reproduction; gamete formation.
- 2. Inheritance Patterns**  
The birth of modern genetics; Mendelian inheritance patterns; other inheritance patterns; environmental effects and gene expression.
- 3. Chromosomes and Gene Linkage**  
Eukaryotic chromosomes; linkage relationships; changes in chromosome number and structure.
- 4. Molecular Genetics: Ultimate Cellular Control**  
DNA: the genetic material; DNA replication in eukaryotes; genes in action; control of gene expression in eukaryotes; mutations; applications of genetic technologies; recombinant DNA.
- 5. Animal Behaviour**  
Four approaches to animal behaviour; proximate and ultimate causes; anthropomorphism; development of behavior; learning; control of behavior; communication; behavioral ecology; social behavior.
- 6. Evolution: A Historical Perspective**  
Pre-Darwinian theories of change; Lamarck: an early proponent of evolution; early development of Darwin's ideas of evolution and evidences; the theory of evolution by natural selection; evolutionary thought after Darwin; biogeography.
- 7. Evolution and Gene Frequencies**  
The modern synthesis: a closer look; the Hardy-Weinberg theorem; evolutionary mechanisms: population size, genetic drift, natural selection, gene flow, mutation, and balanced polymorphism; species and speciation; rates of evolution; molecular evolution; mosaic evolution.

## Books Recommended

- Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
- Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
- Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> Edition (International), 2000. Singapore: McGraw Hill.
- Kent, G.C. and Miller, S. COMPARATIVE ANATOMY OF VERTEBRATES. 2000. New York: McGraw Hill.

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

### Practicals

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

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

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

### Books Recommended

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

## Year-II

### Semester-III (Cr. 16)

Name of Subject	Credits
COMPULSORY-VII (English-III)	3
COMPULSORY-VIII (Introduction To Computer)	1+2
GENERAL-V (Bot/ Etc.)	2+1
GENERAL-VI (Chem/ Etc.)	2+1
FOUNDATION-III (Animal Diversity-I)	3+1
Total Credits	<b>16</b>

**Foundation-III ANIMAL DIVERSITY-I (Cr. 3+1)**  
*(CLASSIFICATION, PHYLOGENY AND ORGANIZATION)*

**Aims and Objectives:**

The course is designed to provide students with:

- a. concepts of evolutionary relationship of animal kingdom.
- b. knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

**Course Contents**

- 1. Introduction**  
Classification of organisms; evolutionary relationships and tree diagrams; patterns of organization.
- 2. Animal-Like Protists: The Protozoa**  
Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations.
- 3. Multicellular and Tissue Levels of Organization**  
Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations.
- 4. Triploblastics and Acoelomate Body Plan**  
Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations.
- 5. Pseudocoelomate Body Plan: Aschelminths**  
Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations.

**6. Molluscan Success**

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

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

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

**8. Arthropods: Blueprint for Success**

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

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

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

**Books Recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> 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, 6<sup>th</sup> 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*, *Entamoeba histolitica*, *Leishmania*, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus butterfly.
10. Preparation of permanent stained slides of the following: *Obelia*, *Daphnia*, Cestode, Parapodia of *Nereis*.

## Books Recommended

1. Hickman, C.P. 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.

## Semester-IV (Cr. 18)

Name of Subject	Credits
COMPULSORY-IX (English-IV / UNIV. OPTIONAL)	3
GENERAL-VII (Bot/ Etc.)	2+1
FOUNDATION-IV (Animal Diversity-II)	3+1
FOUNDATION-V(Animal Form & Function-I)	3+1
FOUNDATION-VI(Animal Form & Function-II)	3+1
Total Credits	<b>18</b>

**Foundation-IV ANIMAL DIVERSITY-II (Cr. 3+1)**  
(CLASSIFICATION, PHYLOGENY  
AND ORGANIZATION)

### Aims and Objectives:

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



## Course Contents

- 1. Echinoderms**  
Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cyclophores, and chaetognaths.
- 2. Hemichordates and Invertebrate Chordates**  
Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations.
- 3. Fishes: Vertebrate Success in Water**  
Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.
- 4. Amphibians: The First Terrestrial Vertebrates**  
Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations.
- 5. Reptiles: The First Amniotes**  
Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhychocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations.
- 6. Birds: Feathers, Flight, and Endothermy**  
Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and

temperature regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation.

- 7. Mammals: Specialized Teeth, Endothermy, Hair, and Viviparity**  
Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

### **Books Recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International) 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> 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, 6<sup>th</sup> 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.

**Foundation -V ANIMAL FORM AND FUNCTION-I (Cr. 3 + 1)**  
(A COMPARATIVE PERSPECTIVE)

**Aims and Objectives:**

The course aims to teach the students about:

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

**Course Contents**

**1. Protection, Support, and Movement**

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

**2. Communication I: Nerves**

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

**3. Communication II: Senses**

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

**4. Communication III: The Endocrine System and Chemical Messengers**

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

**5. Circulation, Immunity, and Gas Exchange**

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

**Books recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> 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, 6<sup>th</sup> 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*, *Rana tigrina*, *Varanus*, fowl and rabbit.

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

3. Earthworm or leech; cockroach, freshwater mussel, *Channa* or *Catla catla* or *Labeo* or any other local fish, frog, pigeon and rat

or mouse and rabbits are representative animals for study in dissections.

4. Study of models or preserved brains of representative animals and notes on adaptations.
5. Study of nervous system of earthworm and a fish.
6. Study of endocrine system in an insect and a rabbit.
7. Study of different types of blood cells in blood smear of rabbit.
8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

### **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.

### **Foundation-VI ANIMAL FORM AND FUNCTION-II (Cr. 3 + 1)** *(A COMPARATIVE PERSPECTIVE)*

#### **Aims and Objectives:**

The course deals with the:

- a. Basis of structure and functions of animal nutrition, digestion, homeostasis and temperature regulation.
- b. It introduces the basic concepts in reproduction and development in animal kingdom.
- c. Provides knowledge about the development of chordate body plan and fate of germinal layers.

#### **Course Contents**

##### **1. Nutrition and Digestion**

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

**2. Temperature and Body Fluid Regulation**

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

**3. Reproduction and Development**

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

**4. Descriptive Embryology**

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

**Books Recommended**

1. Hickman, C.P., Roberts, L.S. and Larson, A. INTEGRATED PRINCIPLES OF ZOOLOGY, 11<sup>th</sup> Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. ZOOLOGY, 5<sup>th</sup> Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. BIOLOGY OF INVERTEBRATES, 4<sup>th</sup> 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, 6<sup>th</sup> Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

## Practicals

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

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

## 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.

## YEAR-III

### Semester-V (Cr. 16)

Name of Subject	Credits
GENERAL-VIII (Psych/ Etc.)	2
FOUNDATION-VII (Developmental Biology)	3+1
MAJOR-I (Cell & Molecular Biology)	3+1
MAJOR-II (Animal Behaviour)	2
MAJOR-III (Physiology)	3+1
Total Credits	<b>16</b>

**Foundation-VII DEVELOPMENTAL BIOLOGY (Cr. 3 + 1)**

### Aims and Objectives:

The course will provide detailed knowledge about the principal features of development, cellular basis of morphogenesis, mechanisms of cellular

differentiation and concepts of induction in development. It will provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. The concept related to the theory in Developmental Biology will be practically demonstrated in this course. In the continuity of the animals during reproduction following the union of the traits from the parents in their gametes, the zygote proceeds through enormous phenomena of development up to their emergence resembling to the parents. The concepts of all these developmental mechanisms will be communicated to the students in this course.

### **Course 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.

### Major- I CELL & MOLECULAR BIOLOGY (Cr. 3+1)

#### Aims and Objectives:

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

#### Course Contents

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

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

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

### **Major- III PHYSIOLOGY**

**Cr. 3+1)**

#### **Aims and Objectives:**

The basic functional expression in animals is the membrane irritability understood in the form of nerve impulse. This course particularly imparts the concepts and mechanisms of integration in the different functional systems of the animals. These mainly constitute the mechanisms of nervous system and the hormonal system for the coordination. The motility and locomotion also contributes in the integration of the animal to its environment, therefore, also included in this section.

## Course Contents

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

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

**Receptors Physiology:** Transduction; Sensory coding; Range fractionation; Sensory adaptations; Mechanoreception: Hair cell mechanism particularly in acoustico-lateralis system of vertebrates; Cutaneous receptors; Cellular and molecular mechanisms in taste and olfactory reception; Photoreception: 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<sub>2</sub> and CO<sub>2</sub> between respiratory surface (the lungs) and body cells. Regulation of lungs respiration; Gas transfer in water (gills) and its regulation. Respiratory responses in extreme conditions as hypoxia; Hypercapnia in air breathing divers.

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

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

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

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

### Major-II ANIMAL BEHAVIOUR

(Cr. 2)

### 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 VI (Cr. 16)

Name of Subject	Credits
FOUNDATION-VIII (Biological Techniques)	1+1

FOUNDATION-IX (Evolution & Principles of Systematics)	3+1
MAJOR-IV (Biochemistry)	3+1
MAJOR-V (Ecology)	3+1
MAJOR-VI (Wildlife)	2
Total Credits	<b>16</b>

### Foundation-VIII BIOLOGICAL TECHNIQUES (Cr. 1+1)

#### Contents (Theory and Practical)

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

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

**Specimen preparation for optical microscopy.**

**Standard system for weight, length and volume.** Preparation of stock solutions of various strengths.

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

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

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

**Spectrophotometry:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption.

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

#### Books Recommended

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

3. Curos, M. ENVIRONMENTAL SAMPLING AND ANALYSIS: FOR TECHNICIAN. 1997. CRC Press LLC. USA.
4. Cheesbrough, M. DISTRICT LABORATORY PRACTICE IN TROPICAL COUNTRIES. Part I. 1998. University Press Cambridge, UK.
5. Cheesbrough, M. DISTRICT LABORATORY PRACTICE IN TROPICAL COUNTRIES. Part II. 1998. University Press Cambridge, UK.
6. Slingsby, D. and Cock, C. PRACTICAL ECOLOGY. 1986. McMillan Education Ltd. London.

**Foundation-IX EVOLUTION AND PRINCIPLES  
OF SYSTEMATICS (Cr. 2+1)**

**Aims and Objectives:**

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

*(Note: Evolution and Principles of Systematic Zoology 60% and 40% weightage, respectively. Three questions from Evolution and two questions from Systematic will be attempted by the students).*

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

## **Books Recommended**

### **Evolution**

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

### **Systematic Zoology**

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

### **Practicals**

Study of preserved invertebrate species and their classification upto class level. Collection, preservation and identification of common species with the help of keys. Methods of statistical analysis of samples from



populations T-test, Analysis of variance etc. Preparation of keys for the identification of specimens.

**Major-IV                      BIOCHEMISTRY                      (Cr. 3+1)**

**Aims and Objectives:**

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

**Course Contents**

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

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

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

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

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

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

**Metabolism:** detailed description of glycolysis and catabolism of other hexoses; regulation and bioenergetics of glycolysis. Anabolic role of glycolysis; fate of pyruvate under aerobic and anaerobic conditions,

lactate, acetyl CoA and ethanol formation; alcoholic fermentation; gluconeogenesis, its regulation and significance in the tissues; feeder pathways in glycolysis; utilization of other carbohydrates in glycolysis; 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 or anaplerotic reactions and their role; regulation of citric acid cycle.

**Lipid metabolism:** oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis of triacylglycerol; utilization of triacylglycerol; activation of fatty acids and their transportation to mitochondria; beta-oxidation; bioenergetics of beta-oxidation; oxidation of unsaturated and odd chain fatty acids; omega oxidation pathway; biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; fatty acid synthetase (FAS) 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.

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, London.
2. Wilson, K & Walker, J. **PRACTICAL BIOCHEMISTRY: PRINCIPLES AND TECHNIQUES**, 4<sup>th</sup> Edition, 1994. Cambridge University Press.

**Major-V ECOLOGY (Cr. 3 + 1)**

### **Aims and Objectives:**

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

## Course Contents

An overview of concepts of ecosystem with emphasis on interaction and homeostasis. Basic global ecosystems (atmosphere, hydrosphere, lithosphere, ecosphere). Biogeochemical cycle: nitrogen, phosphorus, 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

Measurement of environmental factors on land, water and air. Study of different ecosystems: pond, agricultural or grassland, forest. Community analysis through different sampling techniques (quadrat, Transect). Population dynamics of grasshoppers. Adaptive features of animals in relation to food and environment. Food chain studies through analysis of gut contents. Analysis of polluted and fresh water for biotic and abiotic variations. Field visits for study of selected terrestrial habitat and writing notes. Development of an ecological management plan of some selected area.

**Major-VI WILDLIFE**

**(Cr. 2)**

## 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..
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 Benon 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.

**YEAR-IV**  
**SEMESTER-VII (Cr. 16)**

Name of Subject	Credits
MAJOR-VII (Genetics)	3+1
MAJOR-VIII (Bioinformatics)	1+1
ELECTIVE-I	2+1
MAJOR-IX (Special Paper)	3+1
MAJOR-X RESEARCH PROJ / INTERNSHIP	3
Total Credits	<b>16</b>

**Major-VII GENETICS**

**(Cr. 3 + 1)**

**Aims and Objectives:**

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

**Course Contents**

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

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

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

## Books Recommended

1. Snustad, D.P. and Simmons, M.J. PRINCIPLES OF GENETICS. 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. Gardner, 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.  $X^2$  test
9. Study of transformed bacteria on the basis of antibiotic resistance.

## Major-VIII      BIOINFORMATICS      (Cr. 1+1)

### Aims and Objectives:

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

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

## COURSE CONTENTS (THEORY AND PRACTICAL)

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

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



15. **Basic Principles of Computing in Bioinformatics:** Running computer software, Computer operating systems, software downloading and installation, Database management.

### 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. Baxevanic, 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. Routledge.
8. <http://www.ncbi.nlm.nih.gov>
9. <http://www.ebi.ac.uk>
10. <http://foldoc.doc.ic.ac.uk/foldoc/index.html>
11. <http://wit.integratedgenomics.com/GOLD/>

### Elective-I

(Cr. 2+1)

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

### Major-IX

### SPECIAL PAPER

(Cr. 3+1)

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

**Major-X RESEARCH PROJECT/INTERNSHIP (Cr. 3)**

**SEMESTER-VIII (Cr. 15)**

<b>Name of Subject</b>	<b>Credits</b>
MAJOR-XI RESEARCH PROJ / INTERNSHIP	3
MAJOR-XII (Zoogeography and Paleontology)	2+1
ELECTIVE-II	2+1
ELECTIVE-III	2+1
ELECTIVE-IV	2+1
Total Credits	<b>15</b>

**Major-XI RESEARCH PROJECT/INTERNSHIP (Cr. 3)**

**Major-XII ZOOGEOGRAPHY AND PALEONTOLOGY (Cr. 2+1)**

**Aims and Objectives:**

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

**Course Contents**

**Zoogeography:** Branches of zoogeography (descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography). Animal distribution (cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution) Barriers and dispersal. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (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) Fossil, types and uses of fossils, nature of fossils. Processes of fossilization. Geological time scale. Pre-Cambrian life. Post Cambrian life (Palaeozoic life, Mesozoic life, Cenozoic life). Geochronometry (Uranium/Lead dating, radiocarbon dating, methods), evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

## **Books Recommended**

### **Zoogeography:**

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

### **Paleontology:**

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

### **Practicals**

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

### **Elective-II**

**(Cr. 2+1)**

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

### **Elective-III**

**(Cr. 2+1)**

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

**Elective-IV**

**(Cr. 2+1)**

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

## **ANNEXURE-I**

### **LIST OF ELECTIVE AND SPECIAL SUBJECTS**

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

1. Agricultural Biotechnology
2. Analysis of Development
3. Animal Adaptations
4. Animal Behaviour
5. Animal Communication
6. Animal Pests and Disease Producing Organisms
7. Applied Microbiology
8. Aquaculture and Fisheries
9. Arachnology
10. Behavioural Ecology
11. Biochemistry of Drugs Action
12. Biology and Control of Vertebrate Pests
13. Biomedical Technology
14. Biotechnology
15. Biotechnology in Aquaculture
16. Cancer Biology
17. Clinical Biochemistry
18. Ecological Genetics
19. Economic Zoology
20. Elements of Stratigraphy and Structural Geology
21. Endocrinology
22. Environmental Physiology
23. Environmental Pollution
24. Fish Bioenergetics

25. Fish Culture
26. Fish Ecology
27. Fish Endocrinology
28. Fish health Management
29. Fish Feeding Management
30. Hematology
31. Herpetology
32. Histology
33. Human Genetics
34. Ichthyology
35. Immunology
36. Insect Bioacoustics
37. Insect Biochemistry and Physiology
38. Insect Pathology
39. Insects of Veterinary and Medical Importance
40. Invertebrata
41. Invertebrate Palaeontology
42. Limnology
43. Mammalogy
44. Microbiology
45. Medical Biotechnology
46. Medical Microbiology
47. Molecular Biology
48. Microbiology of Extreme Environment
49. Neurobiology
50. Ornithology
51. Pharmacological and Pathological Endocrinology
52. Physiology of Functional Systems
53. Population Biology
54. Principles of Genetics
55. Quantitative Zoology

56. Radiation Biology
57. Reproductive Biology
58. Teratology
59. Techniques in Fisheries Research
60. Vector Biology
61. Vertebrate Palaeontology
62. Veterinary and Wildlife Parasitology
63. Wildlife Management and conservation
64. Zoological Microtechniques

**SPECIAL SUBJECTS  
ENTOMOLOGY (MORPHOLOGY, PHYSIOLOGY  
AND ECOLOGY)**

**Aims and Objectives:**

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

**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 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, Db. 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.

## **ENTOMOLOGY (CLASSIFICATION OF INSECTS AND PEST MANAGEMENT)**

### **Aims and Objectives:**

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

### **Course Contents**

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

## **GENERAL AND COMPARATIVE ENDOCRINOLOGY**

### **Aims and Objectives:**

- a. General concepts and principles of chemical coordination.

- b. The details of the endocrine mechanisms in relation to various functions such as reproduction and lactation.
- c. Recent trends of endocrinology in relation to diversified function.
- d. Comparative studies of endocrine mechanisms in various invertebrates and vertebrates.

## Course Contents

### **An overview of general concepts and principles of endocrinology:**

The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of 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.

**Calcitrophic 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, D.W., Kronenberg, H.M. and Larsen, P.R. WILLIAMS TEXTBOOK OF ENDOCRINOLOGY, W.D. 2008. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. ENDOCRINOLOGY, 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.

## **MOLECULAR AND CLINICAL ENDOCRINOLOGY**

### **Aims and Objectives:**

- a. To study that degeneration diseases are the results of alterations in biochemical homeostasis regulated by endocrine system.
- b. Manifestation of degeneration diseases at molecular level.

## 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, immunochemiluminometric and radioreceptor assays and their statistical procedures.

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

**Functional Pathology in Endocrine Glands:** Neuroendocrine disorder of gonadotrophin, prolactin, growth hormone, 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. 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. 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**

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.

## **PHYSIOLOGY OF COORDINATION**

### **Aims and Objectives:**

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

### **Course Contents**

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

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

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

**Endocrine System:** General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and Cholecalciferol; Hypothalamus and Pituitary: Hypothalamic regulation of pituitary, pituitary gland hormone in physiological coordination; Thyroid

gland: Functional anatomy, biosynthesis, regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and sympathetic nervous system together integrate responses to stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy, synthesis and regulation of gonadal steroids, secretory pattern of gonadal steroid at different stage of life; Male reproduction: Roles of androgen, biology and regulation of spermatogenesis, male puberty; Female reproduction: Roles of ovarian steroids, biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

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

### **Practicals**

Recording of action potentials on oscilloscope and effects of various factors on its characters; Study of synaptic activity with neuromuscular preparations; Sciatic nerve compound action potential. Demonstration of nervous system organization while studying brain, cranial nerve, spinal cord and spinal nerves. Experiments on sensory organs study. Experiments on characteristics of skeletal muscle contractions; Responses of intestinal muscles and effect of drugs. Demonstration of endocrine glands in a mammal (mouse). Effect of hormones on glycemia and calcemia; Effect of thyroxine on oxygen consumption; Effect of

androgen on accessory sex organs and of estrogens on target tissues;  
Study of estrous cycle and effects of the hormones.

## PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS

### Aims and Objectives:

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

### Course Contents

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

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

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

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

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

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



### **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. TEXT BOOK 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. Sharp, G. and Woodman, D. EXPERIMENTS IN PHYSIOLOGY, 8<sup>th</sup> Edition. 2002. Prentice Hall, London.

### **Practicals**

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

## **PRINCIPLES OF PARASITOLOGY**

### **Aims and Objectives:**

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

### **Course Contents**

**Introduction to parasitology.** Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals.

Camers in parasitology. Some basic definitions. Basic principles and concepts. Parasite ecology and evolution. Basic principles and concepts. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms. Acquired immune response in vertebrates. Immunity in invertebrates. Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship.

**Parasitic protozoa, form, function and classification:** Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae. Other flagellated protozoa, order Retortamonadida, order Diplomonadida, order Trichomonadida, order Opalinida. The Amoebas. Order Amoebida, order Schizopyrenida. Phylum Apicomplexa, Gregarines, Coccidia and related organisms. The apical complex, class Gregarineae, class Coccidia. Phylum Apicomplexa, Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida. Phylum ciliophora, ciliated protistan parasites, class Spirotochea, class Litostomitea, class Oligohymenophorea. Phyla Microspora and Myxozoa. Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa. The Mesozoa, pioneers or Degenerates. Class Rhombozoa, class orthonectida, Phylogenetic position, physiology and Host parasite relationship. Classification of Phylum Mesozoa.

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

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

### **Books Recommended**

1. Roberts, L.S. and Janovy, J. FOUNDATION OF PARASITOLOGY, 6<sup>th</sup> Edition. 2000. McGraw Hill Book Co.
2. Hausman, K. and Hulsmann, N. T. PROTOZOOLOGY, 2<sup>nd</sup> Edition. 1996. Medical Publishers, Inc. New York.
3. Noble, E.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.D. 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.D. 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., Hucan, 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.

## **GENERAL MICROBIOLOGY**

### **Aims and Objectives:**

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

### **Course Contents**

**The beginnings of Microbiology:** Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology.

Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual.

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

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

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

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

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

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

**Prokaryotic diversity Bacteria:** Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and Chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci,

Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria; Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

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

**Microbial Ecology:** Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

**Microbial metabolism:** Fuelling reactions in aerobic and anaerobic heterotrophs and autotrophs.

**Microbial metabolism:** Biosynthesis, polymerization, assembly: Methods of studying biosynthesis, synthesis of Nucleotides, Amino acids, Lipids, Porphyrins, Proteins, Polysaccharides and peptidoglycan polymerization of building blocks, Assembly of biopolymers into cellular components.

### **Books Recommended**

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

## **APPLIED MICROBIOLOGY**

### **Aims and Objectives:**

Aims of this course to let the students know about the applications of the science of microbiology in the different fields of life. The course may initiate their interest in agricultural, industrial and/or environmental microbiology.

### **Course Contents**

**Control of microorganisms:** Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic

agents. Microorganisms and diseases: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals. Environmental microbiology: Fundamentals of microbial ecology. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage. Microbiology of food, milk and milk products.

**Industrial Microbiology:** Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

### **Books Recommended**

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

### **Practicals**

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

## **PRINCIPLES OF FISH BIOLOGY**

### **Aims and Objectives:**

The aim of this course is to enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular. It comprises morphology, anatomy, classification and some understanding about various feeding groups found in different water bodies. After having complete knowledge of above, students will be able to practice independently.

## 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. I. 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.

## FISH PHYSIOLOGY AND BREEDING

### Aims and Objectives:

The aim of this course is to provide sufficient knowledge about all physiological phenomena in fishes. The subject provides practicals information to obtain better growth by following physiological aspects during extensive or semi-intensive culture. It also emphasizes thoroughly in breeding of most culturable freshwater fish by manipulating reproductive and endocrinological aspects during natural season as well as off seasons.

## Course Contents

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

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

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

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

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

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

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

**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. Oscar Publications. India.
3. Woo, P.T.K FISH DISEASES AND DISORDER. Vol 1. PROTOZOAN AND METAZOAN INFECTIONS. 1995. CABI Publisher.
4. Brenabe, G. AQUACULTURE, Vol. I. 1992. Blackwell Publishing, Oxford. UK.



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

## RECOMMENDATIONS

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

1. Since teacher is the key person in teaching-learning process, it is imperative that he/she should be aware of or have means to be aware of the latest developments in Zoological Sciences. In order to ensure this, it is strongly recommended that all the Universities of Pakistan should hold refresher courses at graduate level.
2. University and college teachers be provided with opportunities / resources to visit foreign universities to update their knowledge and skill in accordance with the recent disciplines and research trends.
3. All colleges and universities involved in Zoology teaching must submit PC-1 form to HEC to procure funds to run BS (4 Years) Zoology program successfully.
4. Institutions must make arrangements that adequate number of teachers are available to teach core courses and courses from the school of major for the BS degree course.
5. Laboratories with prescribed facilities must be made available for BS (4 Years) Zoology program.
6. For efficient laboratory management, adequately trained technicians/ engineers (from grade 17 to 19) may be employed. They should be responsible for processing samples and maintenance of laboratory equipment.
7. Linkage in both teaching and research disciplines be encouraged between the universities, research organizations and industries.
8. As Zoology is essentially a field-oriented science; adequate field work facilities be provided at all levels.
9. At metric and F. Sc. level, Mathematics and Biology must be taught as compulsory subjects to provide students with wider option for admission to both Engineering and Medical Sciences.

## COMPULSORY COURSES IN ENGLISH

### English I (Functional English)

**Objectives:** Enhance language skills and develop critical thinking.

#### Course Contents

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

#### Comprehension

Answers to questions on a given text

#### Discussion

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

#### Listening

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

#### Translation skills

Urdu to English

#### Paragraph writing

Topics to be chosen at the discretion of the teacher

#### Presentation skills

Introduction

*Note: Extensive reading is required for vocabulary building*

#### Recommended books:

1. **Functional English**
  - a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0 194313492
  2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0 194313506
- b) Writing
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 4354057 Pages 20-27 and 35-41.
- c) Reading/Comprehension
1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 4534022.
- d) Speaking

## **English II (Communication Skills)**

**Objectives:** Enable the students to meet their real life communication needs.

### **Course Contents**

#### **Paragraph writing**

Practice in writing a good, unified and coherent paragraph

#### **Essay writing**

Introduction

#### **CV and job application**

Translation skills

Urdu to English

#### **Study skills**

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

#### **Academic skills**

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

#### **Presentation skills**

Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review*

## Recommended books:

### Communication Skills

- a) Grammar
  - 1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 194313506.
- b) Writing
  - 1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 4354057 Pages 45-53 (note taking).
  - 2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 194354065 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- c) Reading
  - 1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 194534030.
  - 2. Reading and Study Skills by John Langan
  - 3. Study Skills by Richard Yorke.

## English III (Technical Writing and Presentation Skills)

**Objectives:** Enhance language skills and develop critical thinking

### Course Contents

#### Presentation skills

#### Essay writing

Descriptive, narrative, discursive, argumentative

#### Academic writing

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

#### Technical Report writing

#### Progress report writing

*Note: Extensive reading is required for vocabulary building*

## Recommended books:

### Technical Writing and Presentation Skills

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

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

## **Pakistan Studies (Compulsory)**

### **Introduction/Objectives**

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

### **Course Outline**

#### **1. Historical Perspective**

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### **2. Government and Politics in Pakistan**

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### **3. Contemporary Pakistan**

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges

e. Futuristic outlook of Pakistan

### **Books Recommended**

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



## **ISLAMIC STUDIES (Compulsory)**

### **Objectives:**

This course is aimed at:

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

### **Detail of Courses**

#### **Introduction to Quranic Studies**

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

#### **Study of Selected Text of Holly Quran**

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

#### **Study of Selected Text of Holly Quran**

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

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

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

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

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

### **Introduction To Sunnah**

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

### **Selected Study from Text of Hadith**

### **Introduction To Islamic Law & Jurisprudence**

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

### **Islamic Culture & Civilization**

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

### **Islam & Science**

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

### **Islamic Economic System**

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

### **Political System of Islam**

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

### **Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Umayyads
- 3) Period of Abbasids

### **Social System of Islam**

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

### **Reference Books:**

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

## Annexure “D”

Note: One course will be selected from the following six courses of Mathematics.

### COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

#### (FOR STUDENTS NOT MAJORING IN MATHEMATICS)

#### 1. MATHEMATICS I (ALGEBRA)

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

**Specific Objectives of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

#### **Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.  
*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

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

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

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

#### **Recommended Books:**

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

Boston (suggested text)

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston  
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)

**Credit Hours:** 3 + 0

**Specific Objectives of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

### Course Outline:

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.  
*Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

*Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

*Integration and Definite Integrals:* Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

### Recommended Books:

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8<sup>th</sup> edition), 2005, John Wiley, New York  
Stewart J, *Calculus* (3<sup>rd</sup> edition), 1995, Brooks/Cole (suggested text)  
Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston  
Thomas GB, Finney AR, *Calculus* (11<sup>th</sup> edition), 2005, Addison-Wesley, Reading, Ma, USA

## 3. MATHEMATICS III (GEOMETRY)

**Prerequisite(s):** Mathematics II (Calculus)

**Credit Hours:** 3 + 0

**Specific Objectives of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

### Course Outline:

*Geometry in Two Dimensions:* Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

*Circle:* Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

*Conic Sections:* Parabola, ellipse, hyperbola, the general-second-degree equation

### Recommended Books:

Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969  
Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston  
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

#### 4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

<i>Title of subject:</i>	MATHEMATICS
<i>Discipline</i>	: BS (Social Sciences).
<i>Pre-requisites</i>	: SSC (Metric) level Mathematics
<i>Credit Hours</i>	: 03 + 00
<i>Minimum Contact Hours:</i>	40
<i>Assessment</i>	: written examination;
<i>Effective</i>	: 2008 and onward

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**Aims** : To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

**Objectives** : After completion of this course the student should be able to:

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

## **Contents :**

1. *Algebra* : *Preliminaries:* Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations:* Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.
2. *Statistics* : *Introduction:* Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution:* Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency:* Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion:* Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

## **Books Recommended:**

1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.
4. Wilcox, R. R., '*Statistics for The Social Sciences*'.

## 5. Mathematics For Chemistry

**Credit Hours:** 3

**Prerequisites:** Mathematics at Secondary level

**Specific Objectives of Course:** To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

### **Course Outline:**

*Preliminaries:* Real Numbers and the Real Line, *Functions and their graphs:* Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals:* Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

### **Recommended Books:**

1. Thomas, Calculus, 11<sup>th</sup> Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8<sup>th</sup> edition, Jhon Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3<sup>rd</sup> Edition. John Wiley & Sons, Inc. 2002.
4. Frank A.Jr, Elliott Mendelson, Calculus, Schaum's Outline Series, 4<sup>th</sup> edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

## 6. MATHEMATICS FOR PHYSICS

### **Contents**

1. Preliminary calculus.
  - Differentiation  
Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz' theorem; special points of a function; theorems of differentiation.



- Integration  
Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

## 2. **Complex numbers and hyperbolic functions**

- The need for complex numbers
- Manipulation of complex numbers  
Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
- Polar representation of complex numbers  
Multiplication and division in polar form
- de Moivre's theorem  
Trigonometrical identities; finding the  $n$ th roots of unity; solving polynomial equations
- Complex logarithms and complex powers
- Applications to differentiation and integration
- Hyperbolic functions  
Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

## 3. **Series and limits**

- Series
- Summation of series  
Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series
- Convergence of infinite series  
Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
- Operations with series
- Power series  
Convergence of power series; operations with power series
- Taylor series  
Taylor's theorem; approximation errors in Taylor series; standard Maclaurin series

- Evaluation of limits

**4. Partial differentiation**

- Definition of the partial derivative
- The total differential and total derivative
- Exact and inexact differentials
- Useful theorems of partial differentiation
- The chain rule
- Change of variables
- Taylor's theorem for many-variable functions
- Stationary values of many-variable functions
- Stationary values under constraints

**5. Multiple integrals**

- Double integrals
- Triple integrals
- Applications of multiple integrals  
Areas and volumes; masses, centers of mass and centroids;  
Pappus' theorems; moments of inertia; mean values of functions
- Change of variables in multiple integrals  
Change of variables in double integrals;

**6. Vector algebra**

- Scalars and vectors
- Addition and subtraction of vectors
- Multiplication by a scalar
- Basis vectors and components
- Magnitude of a vectors
- Multiplication of vectors  
Scalar product; vector product; scalar triple product; vector triple product
- Equations of lines and planes  
Equation of a line; equation of a plane
- Using vectors to find distances  
Point to line; point to plane; line to line; line to plane
- Reciprocal vectors

**7. Matrices and vector spaces**

- Vectors spaces  
Basic vectors; the inner product; some useful inequalities
- Matrices
- The complex and Hermitian conjugates of a matrix
- The determinant of a matrix

- Properties of determinants
- The inverse of a matrix
- The rank of a matrix
- Simultaneous linear equations  
N simultaneous linear equations in N unknowns
- Special square matrices  
Diagonal; symmetric and antisymmetric; orthogonal;  
Hermitian; unitary normal
- Eigen vectors and eigen values of a normal matrix; of  
Hermitian and anti-Hermitian matrices; of a unitary matrix; of  
a general square matrix
- Determination of eigen values and eigen vectors degenerate  
eigen values

## 8. **Vector calculus**

- Differentiation of vectors  
Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields
- Vector operators  
Gradient of a scalar field; divergence of a vector field; curl of  
a vector field
- Vector operator formulae  
Vector operators acting on sums and products; combinations  
of grad, div and curl
- Cylindrical and spherical polar coordinates Cylindrical polar  
coordinates; spherical polar coordinates

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**Note: General Courses from other Departments**

Details of courses may be developed by the concerned universities according to their Selection of Courses as recommended by their Board of Studies.