

## M.Sc. Zoology (Semester System)

Candidates who have passed the B.Sc. (Hons) examination in Zoology of B.H.U. or any other examination considered to be equivalent and with Chemistry as one of the subjects, will be eligible for admission to M.Sc. Course in Zoology.

The M.Sc. course shall be completed in four semesters. The requirement for M.Sc. degree shall be of 90 credits. There shall be three types of courses with the distribution of credits as given below.

1.	Core Courses	-	54 Credits
2.	Major Elective (Specialization)	-	27 Credits
3.	Minor Electives (Theory only)	-	09 Credits

### LIST OF CORE COURSES, MAJOR ELECTIVES & MINOR ELECTIVES

#### Core Courses

<b>Theory</b>	<b>Credits</b>	<b>Lab. Exercises</b>	<b>Credits</b>
ZCT 01 Biochemistry	2	ZCL 01	0.75
ZCT 02 Cell Structure & Function	2	ZCL 02	0.75
ZCT 03 Cytogenetics	2	ZCL 03	0.75
ZCT 04 Genetics	2	ZCL 04	0.75
ZCT 05 Comparative Endocrinology of non-mammalian vertebrates	2	ZCL 05	0.75
ZCT 06 Mammalian Endocrinology	2	ZCL 06	0.75
ZCT 07 Biochemical & Molecular Biological Techniques	1.5	ZCL 07	0.75
ZCT 08 Microscopy	1.5	ZCL 08	0.5
ZCT 09 Bioinformatics	1	ZCL 09	0.5
ZCT 10 Mammalian Physiology I	2	ZCL 10	0.75
ZCT 11 Mammalian Physiology II	2	ZCL 11	0.75
ZCT 12 Fish Biology	2	ZCL 12	0.75
ZCT 13 Entomology	2	ZCL 13	0.75
ZCT 14 Chordata	1.5	ZCL 14	0.75
ZCT 15 Non-Chordata	1.5	ZCL 15	0.75
ZCT 16 Histology & Histochemistry	1.5	ZCL 16	0.75
ZCT 17 Animal Behaviour	2	ZCL 17	0.75
ZCT 18 Developmental Biology	2	ZCL 18	0.75
ZCT 19 Evolution	2	ZCL 19	0.75
ZCT 20 Parasitology	1	ZCL 20	0.5
ZCT 21 Environmental Biology	2	ZCL 21	0.75
ZCT 22 Immunology	1	ZCL 22	0.5
<b>Total</b>	<b>38.5</b>	<b>+</b>	<b>15.5 = 54</b>

Note: The laboratory exercises will be based on corresponding theory courses.

**Major Electives:** Each student has to opt only one major elective out of six as listed below that will be covered in III & IV Semesters.

<b>Theory</b>	<i>Credits</i>	<b>Lab. Exercises</b>	<i>Credits</i>
ZMAT 01 Biochemistry & Molecular Biology	18	ZMAL 01	9
ZMAT 02 Entomology	18	ZMAL 02	9
ZMAT 03 Fish Biology	18	ZMAL 03	9
ZMAT 04 Mammalian Reproductive Physiology	18	ZMAL 04	9
ZMAT 05 Molecular & Applied Endocrinology	18	ZMAL 05	9
ZMAT 06 Molecular & Human Genetics	18	ZMAL 06	9

Note: The laboratory exercises will be based on corresponding theory courses.

**Minor Electives:** Each student has to opt for minor electives of 9 credits by selecting from the courses listed below offered by this department (each of 1.5 credit) and/or the minor electives offered by other departments in the Faculty of Science.

ZMIT 01 Aquaculture

ZMIT 02 Biostatistics

ZMIT 03 Chronobiology

ZMIT 04 Ecological Biochemistry

ZMIT 05 Economic Zoology

ZMIT 06 Electron Microscopy

ZMIT 07 Gamete Biology

ZMIT 08 Neurobiology

ZMIT 09 Population Genetics

**For Non-biology Graduates**

ZMIT 10 Basic Principles of Genetics

ZMIT 11 Elementary Biochemistry

ZMIT 12 Fundamentals of Biology

ZMIT 13 Hormones & Diseases

## Semester- wise Distribution of Courses

### SEMESTER I

Theory	Lab. Exercises	
<b>Core Courses</b>	<i>Credits</i>	<i>Credits</i>
ZCT 01 Biochemistry	2	ZCL 01 0.75
ZCT 02 Cell Structure & Function	2	ZCL 02 0.75
ZCT 03 Cytogenetics	2	ZCL 03 0.75
ZCT 04 Genetics	2	ZCL 04 0.75
ZCT 05 Comparative Endocrinology of non-mammalian vertebrates	2	ZCL 05 0.75
ZCT 06 Mammalian Endocrinology	2	ZCL 06 0.75
ZCT 07 Biochemical & Molecular Biological Techniques	1.5	ZCL 07 0.75
ZCT 08 Microscopy	1.5	ZCL 08 0.5
ZCT 09 Bioinformatics	1	ZCL 09 0.5
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	<b>16</b>	<b>+ 6.25 = 22.25</b>

### SEMESTER II

Theory	Lab. Exercises	
<b>Core Courses</b>	<i>Credits</i>	<i>Credits</i>
ZCT 10 Mammalian Physiology I	2	ZCL 10 0.75
ZCT 11 Mammalian Physiology II	2	ZCL 11 0.75
ZCT 12 Fish Biology	2	ZCL 12 0.75
ZCT 13 Entomology	2	ZCL 13 0.75
ZCT 14 Chordata	1.5	ZCL 14 0.75
ZCT 15 Non-Chordata	1.5	ZCL 15 0.75
ZCT 16 Histology & Histochemistry	1.5	ZCL 16 0.75
<b>Minor Electives- ZMIT</b>	4.5	
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	<b>17</b>	<b>+ 5.25 = 22.25</b>

### SEMESTER III

Theory	Lab. Exercises	
<b>Core Courses</b>	<i>Credits</i>	<i>Credits</i>
ZCT 17 Animal Behaviour	2	ZCL 17 0.75
ZCT 18 Developmental Biology	2	ZCL 18 0.75
ZCT 19 Evolution	2	ZCL 19 0.75
ZCT 20 Parasitology	1	ZCL 20 0.5
<b>Major Elective- ZMAT</b>	9	ZMAL 4.5
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	<b>16</b>	<b>+ 7.25 = 23.25</b>

### SEMESTER IV

Theory	Lab. Exercises	
<b>Core Courses</b>	<i>Credits</i>	<i>Credits</i>
ZCT 21 Environmental Biology	2	ZCL 21 0.75
ZCT 22 Immunology	1	ZCL 22 0.5
<b>Major elective- ZMAT</b>	9	ZMAL 4.5
<b>Minor electives- ZMIT</b>	4.5	
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	<b>16.5</b>	<b>+ 5.75 = 22.25</b>

**SEMESTER I**  
**CORE COURSE ZCT 01: BIOCHEMISTRY**  
(Theory Credit-2)

	Hours of Teaching
1. Thermodynamics	2
1.1 Second law and its application	
1.2 Concept of free energy and calculations based on free energy change	
2. Protein structure	4
2.1 Primary structure, peptide bond	
2.2 Secondary structure	
2.2.1 $\alpha$ helix, $\beta$ pleated sheet & bends	
2.2.2 Prediction of secondary structure, Ramachandran plot	
2.3 Tertiary structure	
2.3.1 Forces stabilizing tertiary structure	
2.3.2 Domains and motifs	
2.4 Quaternary structure	
3. Enzymes	4
3.1 Enzyme kinetics	
3.1.1 Lowering of activation energy	
3.1.2 Derivation of Michaelis-Menten equation, related calculations and MM & LB plots	
3.2 Mechanism of action	
3.2.1 Active site, substrate binding, transition state analogues and Abzyme	
3.2.2 Acid-base and covalent catalysis (Chymotrypsin, Carboxypeptidase)	
3.2.3 Concepts of regulation of enzyme activity	
4. Metabolism	4
4.1 Concept of metabolic pathways	
4.2 Gluconeogenesis	
4.3 Glycogenesis and glycogenolysis	
4.4 $\beta$ -oxidation and synthesis of fatty acids	
5. Nucleic acids	8
5.1 Structure, folding motifs, conformational flexibility and supercoiling	
5.2 DNA replication	
5.2.1 DNA polymerases	
5.2.2 Origin of replication and formation of primosome	
5.2.3 Replication fork and replisome	
5.2.4 Termination of replication	
5.3 Transcription unit, split genes	
5.4 Mechanism of transcription	
5.4.1 RNA polymerases	
5.4.2 Formation of pre-initiation complex at RNA pol II promoter	
5.4.3 Processing of hnRNA	

5.4.3.1 Capping	
5.4.3.2 Poly(A) tailing	
5.4.3.3 Splicing	
5.5 Mechanism of translation	
5.5.1 Role of ribosomes and tRNAs	
5.5.2 Formation of initiation complex	
5.5.3 Elongation and termination	
6. Genetic Engineering	2
6.1 Vectors and restriction enzymes	
6.2 Preparation of genomic & cDNA clones, and their characterization	

**Books recommended :**

1. Berg et al.: Biochemistry (5th Ed.), Freeman, 2001
2. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), Pearson, 2004
3. Mathews et al.: Biochemistry (3rd Ed.), Benjamin/Cummings Publishing, 1990
4. Segal Biochemical calculations (2nd.), John Wiley & Sons, 1976
5. Watson et al: Molecular Biology of the Gene (2nd Ed.), Benjamin/Cummings, 1976
6. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
7. Rawn: Biochemistry, Neil Patterson, 1989
8. Primrose et al: Principles of gene manipulation (6th Ed.), Blackwell Scientific, 2001.

**CORE COURSE ZCT 02: CELL STRUCTURE & FUNCTION**  
(Theory Credit-2)

	Hours of Teaching
1. Prokaryotes	
1.1 Viruses: Structure and Replication	3
1.1.1 Bacteriophage (Lambda phage, Phi x 174)	
1.1.2 Animal DNA virus ( SV 40)	
1.1.3 Retroviruses (HIV)	
1.2. Bacteria:	4
1.2.1 Structure and reproduction of <i>E. coli</i>	
1.2.2 Culture media and determination of growth rate	
1.2.3 Plasmid and their functions	
2. Eukaryotes	
2.1 Cell Membrane	3
2.1.1 Lipid bi-layer, Membrane proteins & Fluid mosaic model	
2.1.2 Transport	
2.1.2.1 Diffusion, Osmosis and measurement of osmotic pressure	
2.1.2.2 Active transport: Mechanism and related calculations	
2.2 Targetting and sorting of proteins	3
2.2.1 Processing through endomembrane system	
2.2.2 Targetting of cytosolic proteins	
2.3 Mitochondria	3
2.3.1 Structure: Assemblies of respiratory chain & Fo-F1 ATPase	

2.3.2 Oxidative phosphorylation	
2.3.3 ATP and other high energy phosphate compounds	
2.4 Cytoskeleton: Organization of Microtubules, Microfilaments and Intermediary filaments	1.0
2.5 Nucleolus: Structure and biogenesis of ribosomes	1.5
2.6 Cell Signalling	2.5
2.6.1 Cell-cell interaction	
2.6.2 Chemical mediators	
2.6.3 Cell surface and intracellular receptors	
2.7 Cell death, Apoptosis	1.5
3. Buffers	1.5
3.1 pH and its determination	
3.2 Derivation of Henderson-Hasselbalch equation	
3.3 Maintenance of pH in cells	
3.4 Preparation of buffers and related calculations	

### Book recommended

1. Alberts et al: Molecular Biology of the Cell(4th Ed.),Garland,2002
2. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
3. DeRobertis & DeRobertis: Cell & Molecular Biology, Lea & Febriger, 1987
4. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
5. Michael Jr.: Microbiology, Tata McGraw Hill, 1993

### CORE COURSE ZCT 03: CYTOGENETICS (Theory Credit-2)

	Hours of Teaching
1. Eukaryotic chromatin structure and chromosome organization	9
1.1 Classes of DNA	
1.2 Chromosomal proteins: histones and their modifications, non-histone proteins, scaffold/matrix proteins	
1.3 Levels of chromatin condensation at interphase and metaphase stages	
1.4 Nuclear matrix and organization of interphase nucleus	
1.5 Centromere, kinetochore and telomere	
1.6 Metaphase chromosome bandings	
2. Giant chromosomes: models for studies on chromosome organization and gene expression	4
3. Cell division	7
1. Mitosis	
3.1.1 Role of maturation promoting factor	
3.1.2 Chromosomal movement	
3.1.3 Exit from mitosis	
3.2 Cytokinesis	
3.3 Meiosis	
3.3.1 Overview	

- 3.3.2 Chromosome pairing and recombination
- 3.3.3 Genetic regulation of meiosis
- 4. Human cytogenetics 6
  - 4.1 Karyotype and nomenclature of metaphase chromosome bands
  - 4.2 Chromosome anomalies and disease
    - 4.2.1 Common syndromes caused by aneuploidy, mosaicism, deletion and duplication
    - 4.2.2 Chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumour)
    - 4.2.3 Fragile site and X-linked mental retardation

#### Books Recommended

1. Alberts *et al*: Essential Cell Biology (Garland, 1998)
2. Alberts *et al*: Molecular Biology of the Cell (Garland, 2002)
3. Bostock & Sumner: Eukaryotic Chromosome (North-Holland, 1987)
4. DeRobertis & DeRobertis: Cell and Molecular Biology (Lee & Febiger, 1987)
5. Karp: Cell and Molecular Biology (John Wiley & Sons, 2002)
6. Lewin, Genes VIII (Wiley, 2004)
7. Lodish *et al*: Molecular Cell Biology (Freeman, 2000)
8. Pollard & Earnshaw: Cell Biology (Saunders, 2002).

### CORE COURSE ZCT 04: GENETICS (Theory Credit-2)

	Hours of Teaching
1. Mendel's laws and their chromosomal basis	1
2. Extensions of Mendelism	1
2.1 Dominance relationships	
2.2 Epistasis	
2.3 Pleiotropy	
2.4 Expressivity and penetrance	
3. Methods of gene mapping	6
3.1 3-point test cross in <i>Drosophila</i>	
3.2 Gene mapping in human by linkage analysis in pedigrees	
3.3 Tetrad analysis in <i>Neurospora</i>	
3.4 Gene mapping in bacteria by conjugation, transformation and transduction	
4. Gene Mutation and DNA repair	6
4.1 Types of gene mutations	
4.2 Methods for detection of induced mutations	
4.3 P-element insertional mutagenesis in <i>Drosophila</i>	
4.4 DNA damage and repair	
5. Nature of the gene and its functions	6
5.1 Evolution of the concept of gene	
5.2 Fine structure of gene (rII locus)	

5.3 Regulation of gene activity in <i>lac</i> and <i>trp</i> operons of <i>E.coli</i>	
5.4 General introduction to gene regulation in eukaryotes at transcriptional and post-transcriptional levels, organization of a typical eukaryotic gene, transcription factors, enhancers and silencers; Non-coding genes	
6. Organization and function of mitochondrial DNA	1
7. Recombinant DNA technology	5
7.1 Restriction enzymes, Plasmid and phage vectors for cloning	
7.2 Genomic and cDNA libraries; detection of genes and their products by Southern and northern hybridizations	
7.3 Genetic manipulations of plants and animals	
7.4 Basic concepts of molecular detection of genetic disorders and gene therapy	

### Books Recommended

1. Brooker: Genetics : Analysis and Principles (Addison-Wesley, 1999)
2. Gardner *et al*: Principles of Genetics (John Wiley, 1991)
3. Griffith *et al*: Modern Genetic Analysis (Freeman, 2002)
4. Hartl & Jones: Essential Genetics: A Genomic Perspective (Jones & Bartlet, 2002)
5. Lewin, Genes VIII (Wiley, 2004)
6. Russell: Genetics (Benjamin Cummings, 2002)
7. Snustad & Simmons: Principles of Genetics (John Wiley, 2003).

### CORE COURSE ZCT 05: COMPARATIVE ENDOCRINOLOGY OF NON-MAMMALIAN VERTEBRATES (Theory Credit-2)

	Hours of Teaching
1. Vertebrate endocrine system	1
2. Hypothalamo-hypophysial system	8
2.1 Concept of neurosecretion	
2.2 Hypothalamic neurosecretory centres	
2.3 Median eminence: Structure and function	
2.4 Neurohypophysis: General organization	
2.5 Neurohypophysial octapeptide hormones	
2.6 Adenohypophysis: General organization	
2.7 Distribution of pituitary cell types and functions (teleost pituitary model)	
3. Urophysis: Structure and functions	2
4. Pineal organ: Structure and functions	2
5. Comparative anatomy of thyroid gland and its role in amphibian metamorphosis	3
6. Comparative anatomy of adrenocortical and medullary homologues	2
7. The gonads	6
7.1 Structure of testis and ovary	
7.2 Steroidogenic sites	
7.3 Steroid hormones and their functions	
8. Endocrine control of colour change in amphibians with emphasis to	



pars intermedia function	2
9. Endocrine control of osmoregulation in fish	2

### Books Recommended

1. Bentley: Comparative Vertebrate Endocrinology, Cambridge University Press, 1998
2. Chester-Jones et al.: Fundamentals of Comparative Endocrinology, Plenum Press, New York, London, 1987.
3. Gorbman et al.: Comparative Endocrinology, John Wiley & Sons, New York, 1983
4. Norris: Vertebrate Endocrinology, (2nd ed.), Lea & Febiger, 1997.
5. Schreibman & Pang: Vertebrate Endocrinology Vol. I-IV, Fundamentals & Biomedical Implications, Academic Press, 1985 & onwards.

## CORE COURSE ZCT 06: MAMMALIAN ENDOCRINOLOGY (Theory Credit -2)

	Hours of Teaching
1. Introduction	1
1.1 Chemical nature of hormones	
1.2 Hormone Secretions (apocrine, holocrine, and merocrine)	
1.3 Hormone Delivery	
1.4 Hormonal feedback in homeostasis	
2. Mechanism of hormone action	3
2.1 Protein Hormones	
2.1.1 Membrane receptors	
2.1.2 G-proteins and control of adenylate cyclase	
2.1.3 Cyclic AMP cascade	
2.1.4 Other signal Transduction systems (PLC and PLA pathways)	
2.2 Steroid hormones	
3. Hypothalamo-hypophysial System	10
3.1 General organization	
3.2 Neurohypophysial octapeptides (Oxytocin and Vasopressin)	
3.3 Hypophysiotropic hormones: Chemistry localization and actions	
3.4 Adenohypophysial hormones: Chemistry and physiological roles of	
3.4.1 Somatotropin and Prolacin	
3.4.2 Glycoprotein hormones (FSH, LH and TSH)	
3.4.3 Pro-opiomelanocortin (ACTH, MSH, $\beta$ -LPH & $\beta$ -endorphin)	
3.5 Neural control of adenohypophysis	
4. Thyroid Gland	2
4.1 Biosynthesis of thyroid hormones	
4.2 Control of secretion	
4.3 Physiological roles	
5. Steroid hormone biosynthesis and pathways	1
6. Testis	2

6.1 Organization	
6.2 Physiological roles of androgens	
6.3 Inhibin	
7. Ovary	3
7.1 Organization	
7.2 Physiological roles of Estrogen, Progesterone and Relaxin	
7.3 Inhibin	
8. Adrenal Cortex	2
8.1 Organization	
8.2 Control of mineralocorticoid and glucocorticoid secretions	
8.3 Physiological roles of glucocorticoid and mineralocorticoid	
9. Adrenal Medulla: Catecholamine biosynthesis, release and its physiological roles	1
10. Role of parathormone: Calcitonin and vitamin D in calcium homeostasis	1
11. Endocrine Pancreas: Biosynthesis and physiological actions of Insulin and Glucagon	2

#### **Books Recommended**

1. Hadley: Endocrinology, Prentice hall. International Edition. 2000
2. Norris: Vertebrate Endocrinology (2nd ed). Lea & Febriger. 1997
3. Brooks and Marshall: Essentials of Endocrinology, Blackwell Science. 1995
4. Turner and Bagnara: General Endocrinology, W. B. Saunders Company Philadelphia. 1984
5. Larson: Williams Text Book of Endocrinology, 10th edition. W. B. Saunders Company, Philadelphia. 2002.

#### **CORE COURSE ZCT 07: BIOCHEMICAL & MOLECULAR BIOLOGICAL TECHNIQUES** (Theory Credit- 1.5)

	Hours of Teaching
1. Centrifugation	2
1.1 Basic principles	
1.2 Types of rotors	
1.3 Clinical, high speed & ultracentrifuge	
2. Spectrophotometry	2
2.1 Beer-Lambert's law, molar extinction coefficient and calculation	
2.2 Absorption spectrum	
2.3 Colorimeter and UV- vis Spectrophotometer	
3. Electrophoresis	3
3.1 Agarose- and polyacrylamide gel	
3.2 Two-dimensional	
3.3 Isoelectrofocussing	
4. Chromatography	3
4.1 Paper and Thin layer chromatography	
4.2 Column chromatography	
4.2.1 Gel filtration	
4.2.2 Ion-exchange	

4.2.3 Affinity	
4.3 Introduction to FPLC and HPLC	
5. Radio-tracer techniques	4
5.1 Unit of radioactivity and half life	
5.2 Measurement of radioactivity ( $\beta$ and $\gamma$ emission)	
5.3 Applications of radioisotopes	
5.4 Safety measures	
6. Detection of nucleic acids and proteins	4
6.1 Southern and Northern blotting	
6.2 Western blotting	
6.3 ELISA	
6.4 PCR	

### Books Recommended

1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed.), Benjamin/Cumin, 1993
2. Freifelder: Physical Biochemistry (2nd Ed.), Freeman, 1982
3. Holme and Peck: Analytical Biochemistry (3rd Ed.), Tata McGraw Hill, 1998
4. Plumer: An Introduction to Practical Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
5. Switzer and Garrity: Experimental Biochemistry 92nd Ed.), Freeman, 1999
6. Wilson and Walker: Practical Biochemistry (3rd Ed.), Cambridge Univ. Press, 2000.

### CORE COURSE ZCT 08: MICROSCOPY

(Theory Credit- 1.5)

	Hours of Teaching
1. Basic principles of microscopy	2
2. Types of microscopes and their biological applications	16
2.1 Bright-field microscope, numerical aperture, limit of resolution, types of objectives, ocular & stage micrometers	
2.2 Dark-field microscope	
2.3 Phase-contrast microscope	
2.4 Differential interference contrast microscope	
2.5 Fluorescence microscope	
2.6 Confocal microscope	
2.6.1 <i>In situ</i> hybridization and immunostaining	
2.7 Atomic force microscope	
2.8 Transmission and scanning electron microscopes	
3. Photomicrography and image processing	2

### Books Recommended

1. Alberts *et al*: Molecular Biology of the Cell, Garland, 2002
2. Karp: Cell and Molecular Biology, John Wiley & Sons, 2002
3. Lodish *et al*: Molecular Cell Biology, Freeman, 2000
4. Pollard & Earnshaw: Cell Biology, Saunders, 2002
5. Ruthman: Methods in Cell Research, Bell & Sons, 1970.

**CORE COURSE ZCT 09: BIOINFORMATICS**  
(Theory Credit- 1)

	Hours of Teaching
1. Basics of computers (CPU, I/O units) and operating systems	1
2. Introduction and scope of Bioinformatics	1
3. Computer networking	2
3.1 Internet and E-mail	
3.2 Concept of home pages and web-sites	
3.3 World Wide Web, Uniform Resource Locators	
4. Archiving and retrieval of information	6
4.1 Search engines	
4.2 Data bases	
4.2.1 Nucleic acid sequences	
4.2.2 Genomes	
4.2.3 Protein sequence and structures	
4.2.4 Bibliographic	
4.3 Access to molecular biology data bases	
4.3.1 Entrez	
4.3.2 Sequence retrieval system (SRS)	
4.3.3 Protein identification resource (PIR)	
5. Sequence alignments and phylogenetic trees	3

**Books Recommended**

1. Barnes & Gray (ed): Bioinformatics for geneticists, Wiley (2003)
2. Lesk: Bioinformatics, Oxford (2003, Indian ed)
3. Westhead et al: Bioinformatics Instant Notes, Viva Books (2003, Indian ed)

**SEMESTER II**

**CORE COURSE ZCT 10: MAMMALIAN PHYSIOLOGY-I**  
(Theory Credit-2)

	Hours of Teaching
1. Circulation	9
1.1 Blood	
1.1.1 Haemopoiesis	
1.1.2 Haemostasis	
1.1.3 Haemoglobin: Structure and function	
1.2 Lymph: composition and dynamics	
1.3 Heart	
1.3.1 Origin and conduction of cardiac impulse	
1.3.2 Cardiac cycle	
2. Respiration	8

- 2.1 Pulmonary ventilation
  - 2.1.1 Respiratory centers: organization and function
  - 2.1.2 Surfactant
- 2.2 Gaseous exchange through respiratory membrane and tissues
- 2.3 Basal metabolic rate and its measurement
- 2.4 Respiratory adjustments
  - 2.4.1 Hypoxia and oxygen therapy
  - 2.4.2 Dyspnea
  - 2.4.3 Periodic breathing
  - 2.4.4 Respiratory buffering
  - 2.4.5 High altitude: decreased pressure of gas, hypoxic effects, mountain sickness and acclimatization
- 3. Excretion 7
  - 3.1 Urine formation
    - 3.1.1 Glomerular filtration
    - 3.1.2 Tubular reabsorption and secretion
    - 3.1.3 Counter current mechanism
    - 3.1.4 Hormonal regulation
  - 3.2 Acid-base balance and homeostasis

### Books Recommended

1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001
3. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003
5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins, 1981.

## CORE COURSE ZCT 11: MAMMALIAN PHYSIOLOGY-II (Theory Credit-2)

	Hours of Teaching
1. Nervous system	8
1.1 Axonal transmission	
1.1.1 Motor neuron and other types of neurons	
1.1.2 Genesis of membrane potential and action potential	
1.1.3 Sodium-potassium pump	
1.2 Synaptic transmission	
1.2.1 Types of synapses and synaptic knobs	
1.2.2 Excitatory and inhibitory post-synaptic potential	
1.2.3 Chemical transmission, neurotransmitters (acetylcholine, or catecholamines, serotonin and GABA)	
1.3 Autonomic nervous system (Sympathetic and parasympathetic)	
2. Vision and hearing	4
2.1 Eye	

2.1.1 Retinal components	
2.1.2 Photoreceptors: Ionic basis of potential generation	
2.2 Ear	
2.2.1 Cochlea, basilar membrane, and organ of Corti	
2.2.2 Genesis of action potential in afferent nerve fibers	
3. Muscle	6
3.1 Ultrastructure of skeletal muscle fibers	
3.2 Muscle proteins	
3.3 Sequence of events in contraction and relaxation of skeletal muscle	
3.4 Energetics of muscle contraction	
3.5 Muscle twitch, summation, tetanus and fatigue	
3.6 Isotonic and isometric contraction	
4. Nutrition	6
4.1 Overview of digestion and absorption of macronutrients	
4.2 Gastrointestinal hormones and regulation	
4.3 Obesity and starvation	
4.4 Stimulation of hunger and thirst	

### Books Recommended

1. Ganong: Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
2. Guyton and Hall: Text Book of Medical Physiology (10th Ed.), W.B. Saunders, 2001
3. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
4. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003
5. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins, 1981.

### CORE COURSE ZCT 12: FISH BIOLOGY (Theory Credit-2)

	Hours of Teaching
1. Introduction to fishes	1
1.1 Opportunities in Ichthyology	
1.2 How and why fish are studied	
1.3 Major groups of living fishes	
2. Form and locomotion	2
3. Fins	3
3.1 Types of fins	
3.2 Origin of fins	
4. Respiratory organs	4
4.1 Water breathing	
4.2 Air – breathing	
5. Swim bladder	2
6. Electric organs	2
7. Bioluminescent organs	2

8. Sound producing organs	1
9. Poisonous and Venomous fishes	2
10. Fish migration	1
11. Fisheries	
11.1 Definition and classification	2
11.2 Outlines of fish culture in ponds	2
11.3 Economic importance and nutritional value of fishes	2

### Books recommended

1. Brown, M.E. Physiology of fishes, Vols. 1 and 2, Academic press, 1957
2. Hoar, W.S. & Randall, O.J. Fish Physiology, Vols I-X, Academic Press, 1969- onwards
3. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R. Ichthyology, John Wiley, 2003.
4. Norman and Greenwood: A History of Fishes, Third Ed., Ernest Bvenn Limited, 1975.
5. S.S. Khanna and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
6. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries, Kitab Mahal ,1985

### CORE COURSE ZCT 13: ENTOMOLOGY (Theory Credit-2)

	Hours of Teaching
1. Importance and taxonomic richness of insects	1
2. External anatomy	6
2.1 Segmentation and tagmosis	
2.2 Integument	
2.2.1 Structure of cuticle	
2.2.2 Types of cuticle	
2.2.3 Sclerotization	
2.2.4 Epidermis and basement membrane	
2.2.5 Coloration	
2.2.6 Functions of cuticle	
2.2.7 Molting	
2.3 Head	
2.3.1 Head capsule	
2.3.2 Antennae	
2.4 Thorax	
2.4.1 Thorax segmentation	
2.4.2 Legs	
2.4.3 Wings	
3. Internal anatomy and physiology	10
3.1 Locomotion: Crawling, wriggling, swimming, walking and flight	
3.2 Nervous system and co-ordination	
3.3 Endocrine system and function of hormones	

3.3.1 Endocrine centers (NSC, CC, CA, PTG)	
3.3.2 Hormones	
3.4 Circulatory system	
3.4.1 Diaphragm and heart	
3.4.2 Haemolymph and its functions	
3.5 Respiratory system	
3.5.1 Spiracles and their general structure	
3.5.2 Trachea and tracheoles	
3.5.3 Respiration: Aquatic and endoparasitic insects	
3.6 Gut, digestion and nutrition	
3.6.1 Structure of the gut	
3.6.2 Digestion and absorption of food	
3.6.3 Fat body	
3.7 Excretory system and waste disposal	
3.7.1 Malpighian tubules and rectum	
3.7.2 Nitrogen excretion	
3.8 Reproductive system	
3.8.1 The female system	
3.8.2 The male system	
3.8.3 Vitellogenesis	
4. Sensory systems	3
4.1 Mechanical stimuli	
4.1.1 Tactile mechanoreceptor and position receptor	
4.1.2 Sound reception and sound production	
4.2 Thermoregulation (ectothermy and endothermy)	
4.3 Chemical stimuli: Chemoreception	
4.4 Insect vision	
4.4.1 Dermal detection	
4.4.2 Stemata and ocelli	
4.4.3 Compound eyes	
5. Insect development and life history	1
5.1 Growth	
5.2 Phases in insect ontogeny (embryonic, larval, metamorphosis and imaginal phases)	
5.3 Voltinism and diapause	
5.4 Polymorphism and polyphenism	
6. Introduction to Applied Entomology	7
6.1 Insects: Friends and foes	
6.2 Insect-plant interaction	
6.3 Elementary knowledge of general methods of insect pest management	
6.4 Agricultural Entomology: Major pests ( <i>no life cycles</i> ) and their control in following crops: Paddy, sugarcane, cotton, vegetables (potato, Lady's finger, cauliflower), fruits (mango, citrus, pomegranate)	
6.5 Medical Entomology: Insects as vectors of diseases and their control	



### Books Recommended

1. Atwal: Agricultural pests of India and south east Asia, Kalyani Publishers, 1986
2. Chapman: The Insects: structure and function 4<sup>th</sup> Ed. ELBS, 1998
3. Imms: A general text book of entomology 2 vols. Asia publishing house, 1977
4. Klowden: Physiological systems in Insects, Academic Press 2002
5. McGavin: Essential Entomology, Oxford Univ. Press 2001 New Delhi
6. Srivastava: A text book of applied entomology Vol I & II Kalyani Publishers, New Delhi, 1988, 1993
7. Wigglesworth: Principles of Insect Physiology, ELBS, 1972.

### CORE COURSE ZCT 14: CHORDATA

(Theory Credit-1.5)

	Hours of Teaching
1. Characteristic features and affinities of the following:	5
1.1 Protochordata	
1.1.1 Hemichordata	
1.1.2 Urochordata	
1.1.3 Cephalochordata	
1.2 Cyclostomes	
1.3 Dipnoi	
2. Origin of the following:	4
2.1 Amphibia	
2.2 Reptiles	
2.3 Birds	
2.4 Mammals	
3. Adaptive radiation in Chordates	5
3.1 Aquatic	
3.2 Terrestrial	
3.3 Aerial	
3.4 Arboreal	
3.5 Fossorial	
4. Parental care in Amphibians	1
5. Skull in Reptiles	1
6. Venom and anti-venom in Ophidians	1
7. Flightless birds	1
8. Modification of beaks, feet and palate in birds	1
9. Dentition	1
10. Stomach in ruminants	1

### Books Recommended

1. Boolootian, R. A. and Stiles, K. A., College Zoology, 10<sup>th</sup> edition, Macmillan Publishing Co., Inc. New York, 1981.
2. Colbert, E. H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates: A history of the backboned animals through time, 5<sup>th</sup> edition, John Wiley - Liss, Inc., New York, 2002.

3. Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York, 1971.
4. Goodrich, E. S, Studies on Structure and Development of Vertebrates, Dover Publication, New York, 1958.
5. Hildebrand, M. Analysis of Vertebrate Structure, 4<sup>th</sup> edition, John Wiley & Sons, Inc., New York, 1995.
6. Jordan, E. L. and Verma, P. S., Chordate Zoology. S. Chand & Company Ltd, 1998.
7. Kotpal, R. L. The Birds, 4<sup>th</sup> edition, Rastogi Publications, Shivaji Road, Meerut, 1999.
8. Marshall, A. J., Biology and Comparative Physiology of Birds, Volume I & II, 1960.
9. McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Vertebrate Life, Macmillan Publishing Co., Inc., New York, 1979.
10. Moore, J. A., Biology of Amphibia, Academic Press, 1964.
11. Parker, T. S. and Haswell, W. A., TextBook of Zoology, Vol. II, ELBS, 1978.
12. Romer, A. S. and Parsons, T. S., The vertebrate body, 6<sup>th</sup> edition, CBS Publishing Japan Ltd, 1986.
13. Sinha, A. K., Adhikari, S. and Ganguli, B. B.: Biology of Animals, Vol. II, New Central Book Agency, Calcutta, 1988.
14. Young, J. Z. The life of vertebrates, 3<sup>rd</sup> edition, ELBS with Oxford University Press, 1981.

**CORE COURSE ZCT 15: NON-CHORDATA**  
(Theory Credit-1.5)

	Hours of Teaching
1. Protozoa (Protist animals)	4
1.1 Nucleus and reproduction	
1.2 Colonial protozoans and theories on the origin of metazoans	
2. Porifera: Canal system	2
3. Cnidaria	4
3.1 Nematocysts	
3.2 Polymorphism in Siphonophora	
4. Annelida	4
4.1 Adaptive radiation in polychaetes	
4.2 Trochophore larva: structure and significance	
5. Mollusca	4
5.1 Nervous system	
5.2 Modifications of foot	
6. Arthropoda (excluding insects)	3
6.1 Affinities of trilobites	
6.2 Crustacean larvae and their significance	
7. Echinodermata: larval forms and their significance	2
8. Salient features and affinities of:	5
8.1 Placozoa	
8.2 Mesozoa	
8.3 Ctenophora	
8.4 Rotifera	

- 8.5 Phoronida
- 8.6 Echiura
- 8.7 Sipuncula

**Books Recommended**

1. Barnes: Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes: The Invertebrates – A synthesis, 3rd edition, Blackwell, 2001
3. Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
4. Marshall: Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
5. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001

**CORE COURSE ZCT 16: HISTOLOGY & HISTOCHEMISTRY**  
(Theory Credit-1.5)

	Hours of Teaching
1. Fixation and Fixatives	3
1.1. Types of fixatives	
1.2. Chemistry of fixation	
1.3. Choice of Fixatives	
2. Tissue processing	2
2.1. Dehydration	
2.2. Clearing and Embedding	
3. Microtomy	2
3.1. Types of microtomes	
3.2. Sectioning paraffin blocks	
4. Staining of paraffin sections	2
4.1. Principle and methods of staining	
4.2. Histological stains	
4.3. Haematoxylin and Eosin	
5. Principles and methods of histochemical localization and identification of the following:	
5.1. Carbohydrate moieties	3
5.1.1 Glycogen and glycoproteins with oxidizable vicinal diols by Periodic acid Schiff method	
5.1.2 Glycoproteins with carboxyl groups and/or O-sulphate esters by Alcian blue methods	
5.2 Protein end groups	2
5.2.1 General proteins by Bromophenol blue method	
5.2.2 –NH <sub>2</sub> groups by Nihydrin-Schiff method	
5.2.3 - SS groups by Performic acid –Schiff and performic acid- alcian blue methods	
5.3 Lipid moieties	2
5.3.1 General lipids by Sudan black B method	

5.3.2 Neutral lipids by total Sudan III and Sudan IV methods	
5.4 Nucleic acids	1
5.4.1 Methyl green pyronin for DNA and RNA	
5.4.2 Feulgen reaction for DNA	
5.5 Enzymes: Acid and alkaline phosphatases by Metal precipitation and Azo dye methods	2
6. Immunocytochemistry: Basic principles	1
7. Fluorescence histochemistry: Basic principles	1

### Books Recommended

1. Bancroft, J.D. & Stevens, A. Theory and Practice of Histological techniques, Churchill-Livingstone, 2002
2. Casselman, W.G.B. : Histochemical techniques, John Wiley, 1959
3. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4<sup>th</sup> ed.), Churchill-Livingstones, 1980-1993

## SEMESTER III

### CORE COURSE ZCT 17: ANIMAL BEHAVIOUR

(Theory Credit-2)

	Hours of Teaching
1 Introduction	3
1.1 Questions about behaviour	
1.2 Patterns of behaviour	
2 Development of behaviour	4
2.1 Genetic basis of behaviour	
2.2 Hormone-brain relationship	
2.3 Bird song development	
3 Neural basis of behaviour	4
3.1 Stimulus filtering	
3.2 Biological rhythms	
4 Exploitation of resources	3
4.1 Decision making	
4.2 Predator-prey relationship	
5 Communication and animal signals	5
5.1 Communication	
5.2 Evolution of animal signals	
6 Reproductive strategies and parental care	4
6.1 Sexual selection	
6.2 Mating systems	
6.3 Parental care	
7 Social organization	5
7.1 Altruistic behaviour and concept of Inclusive fitness	

- 7.2 Evolution of helpful behaviour
- 7.3 Evolution of eusocial behaviour

### Books Recommended

1. Alcock : Animal Behaviour- An Evolutionary Approach. (7<sup>th</sup> ed.) Sinaur Associates, Inc. 2001.
2. Drickamer & Vessey: Animal Behaviour –Concepts, Processes and Methods (2<sup>nd</sup> ed.), Wadsworth, 1986.
3. Gadagkar: Survival Strategies-Cooperation and Conflict in Animal Societies. Universities Press,1998.
4. Goodenough et al : Perspectives on Animal Behaviour, Wiley, 1993.
5. Grier : Biology of Animal Behaviour, Mosby, 1984.
6. Hallidy and Slater : Animal Behaviour(vols. I-3) Blackwell Scientific Publ., 1983.
7. Krebs & Davis : Behavioural Ecology. (3<sup>rd</sup> ed.) Blackwell, 1993.
8. Lehner : Hand Book of Ethological Methods.(2<sup>nd</sup> ed.) Garland, 1996.
9. Manning & Dawkins : An introduction to Animal Behaviour (5<sup>th</sup> ed.), Cambridge Univ. Press, 1998.
10. Slater & Halliday : Behaviour and Evolution,(1<sup>st</sup> ed.) Cambridge Univ. Press, 1994.

### CORE COURSE ZCT 18: DEVELOPMENTAL BIOLOGY (Theory Credit-2)

	Hours of Teaching
1. Fertilization in mammals	3
1.1. Recognition of gametes and acrosomal reaction	
1.2. Prevention of polyspermy and gamete fusion	
1.3. Activation of egg metabolism	
2. Early development	16
2.1. Cleavage: Patterns	
2.2. Gastrulation: Fate maps, cell movement and formation of germ layers in echinoderms, birds and mammals	
2.3. General concept of	
2.4.1 Induction: mesoderm development	
2.4.2 Determination: Imaginal discs of insects	
2.4.3 Differentiation: Formation of fruiting bodies in <i>Dictyostellium</i>	
2.5. Body pattern formation	
2.5.1 Origin of anterior-posterior and dorsal-ventral polarity in <i>Drosophila</i> : Involvement of maternal, segmentation and homeotic genes	
2.5.2. Organization of HOX gene in vertebrates	
2.5.3 Axis formation in Amphibians: Nieuwkoop Centre and Primary Organizer	
2.5.4 Axis formation in birds and mammals: Involvement of pattern forming genes	
3. Late embryonic development	4
3.1. Vulva formation in <i>Caenorhabditis</i>	
3.2. Formation of neural tube in vertebrates	

- |   |   |
|---|---|
| 3.3. Development of limb in vertebrates: Involvement of HOX and other pattern forming genes |   |
| 4. Hormonal control of metamorphosis in Amphibians  | 1 |
| 5. Regeneration of Salamander limbs: Polar Coordinate model                                 | 1 |
| 6. Introduction to senescence and apoptosis   | 2 |
| 7. Embryonic stem cells and their applications  | 1 |

**Books Recommended**

1. Alberts *et al.*: Molecular biology of the cell. Garland, 2002.
2. Gilbert: Developmental biology. Sinauers, 2003.
3. Kalthoff: Analysis of biological development. McGraw-Hill, 1996.
4. Wolpert: Principles of development. Oxford, 2002.

**CORE COURSE ZCT 19: EVOLUTION**  
(Theory Credit-2)

	Hours of Teaching
1. An overview of evolutionary thoughts, developments and the concept of synthetic theory	2
2. Population genetics	3
2.1 Gene frequencies in Mendelian population	
2.2 Hardy-Weinberg law-its formalization and application	
2.3 Conditions for the maintenance of genetic equilibrium	
3. Elemental forces of evolution	5
3.1 Mutation	
3.2 Selection (types of selection, selection coefficient, selection in natural population)	
3.3 Random genetic drift	
3.4 Migration	
4. Chromosomal, allozyme and DNA polymorphisms	
4.1. Adaptive genetic polymorphism	
4.2. Balanced polymorphism and heterosis	
4.3. Genetic coadaptation and linkage disequilibrium	
4. Isolating mechanisms	2
5. Concepts of species and models of speciation: allopatric, sympatric and stasipatric	3
6. Phylogenetic relationship	5
7.1 Chromosome phylogeny in <i>Drosophila</i> (based on inversion polymorphism)	
7.2 Molecular phylogenies	
7.3 Neutral theory	
7.4 Molecular clock	

**Books Recommended**

1. Dobzhansky Th. (1964): Genetics and the Origin of Species. Columbia.
2. Dobzhansky Th. et al. (1976): Evolution. Surjeet Publ.

3. Freeman S. and Jon C. Herron (1998): Evolutionary Analysis. Prentice Hall
4. Futuyma D. J. (1998): Evolutionary Biology. Sinauer
5. Hartl D. L. and A. G. Clark (1989 & 1997): Principles of Population Genetics. Sinauer
6. Kimura M. (1984): The Neutral Theory of Molecular Evolution. Cambridge.
7. Li Wen-Hsiung and Dan Graur (1991): Fundamentals of Molecular Evolution. Sinauer
8. Mayr E. (1966): Animal Species and Evolution. Belknap Press
9. Ridley M. (1993): Evolution. Blackwell.
10. Strickberger M. W. (2000): Evolution. Jones and Bartlett
11. White M. J. D. (1978): Modes of Speciation. Freeman

**CORE COURSE ZCT 20: PARASITOLOGY**  
(Theory Credit-1)

	Hours of Teaching
1. Parasitism	1
1.1 General consideration	
1.2 Types of parasites	
1.3 Type of hosts	
1.4 Symbiosis and commensalism	
2. Protozoan parasites	4
2.1 Distribution, habit and habitat, structure life cycle and diseases caused by selected pathogenic protozoan parasites of man:	
2.1.1 <i>Entamoeba histolytica</i>	
2.1.2 <i>Trypanosoma gambiense</i>	
2.1.3 <i>Leishmania donovani</i>	
2.1.4 <i>Plasmodium vivax</i>	
3. Helminth parasites	9
3.1 General characters, organization and larval forms of Platyhelminthes and Nematelminthes	
3.2 Distribution, habit and habitat, structure and life cycle of economically important helminth parasites of man and domesticated animals:	
3.2.1 <i>Echinococcus granulosus</i>	
3.2.2 <i>Hymenolepis nana</i>	
3.2.3 <i>Schistosoma haematobium</i>	
3.2.4 <i>Paragonimus westermani</i>	
3.2.5 <i>Trichinella spiralis</i>	
3.2.6 <i>Wuchereria bancrofti</i>	

**Books Recommended**

1. Chatterjee: Parasitology, Chatterjee Medical Publishers, 1981.
2. Chandler & Read: Introduction to Parasitology, Wiley, 1970.
3. Noble & Noble: Parasitology, Lea & Febiger, 1973.
4. Smith: Animal Parasitology, Cambridge University Press, 1996.

## MAJOR ELECTIVE ZMAT 01-BIOCHEMISTRY & MOLECULAR BIOLOGY

### Course I: Nucleic Acids

(Theory Credit-3)

	Hours of Teaching
1. Eukaryotic genome	12
1.1 Introduction to structural and functional genomics	
1.2 Denaturation & renaturation of DNA, unique and repetitive DNA sequences (LINEs, SINEs)	
1.3 Chromatin organization: histones and non-histone chromosomal proteins, nucleosomes and higher order structures, telomere, chromatin modifications	
1.4 DNA replication: DNA polymerases, ARS and initiation in yeast, eukaryotic chromatin replication, regulation	
1.5 DNA repair and recombination	
1.6 Human genome: mapping and characteristics	
2. Transcription and transcriptome	12
2.1 RNA polymerases in eukaryotes, general and specific transcription factors, assembly of pre-initiation complex, enhanceosomes, elongation factors and elongation	
2.2 Promoter analysis and characterization: Deletion mapping, Transient/stable expression system, S1/RNase mapping, EMSA, DNase I Footprinting.	
2.3 Types of introns and mechanism of splicing; RNA editing, catalytic RNA	
2.4 Regulation of initiation of transcription, post-transcriptional gene silencing, RNA interference.	
3. Genetic engineering	12
3.1 Tools: Restriction enzymes and other enzymes for DNA manipulation, cloning vectors, oligonucleotide synthesis	
3.2 Cloning strategies: cDNA and genomic libraries, expression and interaction based cloning, positional cloning	
3.3 Screening of clones: Preparation of probes, hybridization (Southern, Northern and colony/plaque), immuno-screening	
3.4 Characterization of clones: Sequencing of clones and genomes, microarray	
3.5 PCR and its applications	
3.6 Application: Transgenic organisms (GMOs), Animal cloning, Site-directed mutagenesis, Generation of knock-out animals, Gene therapy, DNA drugs	
3.7 Ethical and social issues	

#### Books Recommended

1. Freifelder: Essentials of Molecular Biology, John & Bantlet, 1993



2. Lewin: Gene VIII, Oxford Univ. Press, 2004
3. Brown: Genomes (2nd Ed.), Wiley-Liss, 2002
4. Brown: Gene Cloning, Blackwell, 2001
5. Sambrook & Russell: Molecular Cloning, Cold Spring Harbor, 2001
6. Primrose: Principles of Gene Manipulation, Blackwell, 2001
7. Asubel et al: Current Protocol in Molecular Biology, Wiley, 1994
8. Lodish et al: Molecular Cell Biology (5th Ed.), Freeman, 2004
9. Goldsby et al: Kubey Biochemistry, Freeman, 2001
10. Gesteland et al: RNA World (2nd Ed.), Cold Spring Harbor, 1999.

**ZMAT 01-Course II: Proteins**  
(Theory Credit-3)

	Hours of Teaching
1. Protein chemistry	22
1.1 Structural and functional diversity	
1.2 Purifications & characterization	
1.3 Determination of Primary structure	
1.3.1 Amino acid composition	
1.3.2 N- & C- terminal determination	
1.3.3 Amino acid sequence determination	
1.4 Forces and interactions involved in structural organization of fibrous and globular proteins	
1.5 Prediction of higher order structure from the amino acid sequences	
1.6 Structure-function relationship	
1.7 Protein denaturation	
1.8 Molecular chaperones and protein folding	
1.9 Biosynthesis of protein (Translation)	
1.10 Post-translational processing, targeting and turnover	
1.11 Chemical synthesis of peptides	
1.12 Recombinant proteins, their expression and application	
2. Immunology	14
2.1 B- and T- Cells and their interaction	
2.2 Immunoglobulin genes and their diversity	
2.3 Major histo-compatibility complex, antigen processing	
2.4 Complement system	
2.5 Immunodeficiency diseases	
2.6 Hybridoma and monoclonal antibody	
2.7 Interferon	
2.8 Immunotoxins	

**Books recommended**

1. Nelson et al: . Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
3. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004

4. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
5. Rawn: Biochemistry, Neil Patterson, 1989
6. Mahler & Cordes: Textbook of Biological Chemistry, Harper, 1966.

**ZMAT 01-Course III: Enzymology**  
(Theory Credit-3)

	Hours of Teaching
1. Nomenclature and classification	1
2. Mechanism of enzyme action	1
2.1 Enzyme substrate binding	
2.2 Binding energy, entropy change	
3. Active site structure and determination	2
3.1 Irreversible inhibitors, affinity labeling & suicide inhibitors	
4. Kinetics	6
4.1 Single substrate reactions: Steady state and equilibrium kinetics	
4.2 Michaelis-Menten equation and plot	
4.3 Linear kinetic plots: Lineweaver Burk, Edie Hofstee, Cornish Bowden	
4.4 Calculations on enzyme kinetics	
5. Multi-substrate reactions	2
5.1 Random sequential	
5.2 Ordered	
5.3 Theorel-Chance mechanism	
5.4 Ping-pong (double reciprocal) mechanism	
6. Enzyme Inhibition	3
6.1 Competitive; Non-competitive; Un-competitive and mixed	
6.2 Determination of nature of inhibition and $K_i$ by LB & Dixon plots	
7. Regulation: allosterism, covalent modifications	2
8. Multi enzyme complex and multifunctional enzymes	2
9. Enzyme distribution, diversity and evolution	1
10. Coenzymes and cofactors	2
11. Enzyme assay: principles and techniques	2
Fixed time, continuous and coupled assays (Spectrophotometric, Isotopic, Spectrofluorometric & Titrimetric.)	
12. Enzyme purification	9
12.1 Objective and strategy	
12.2 Choice of source	
12.3 Methods of homogenization	
12.4 Methods of separation	
12.5 Basis of solubility (pH treatment; Salting in & salting out; Changing dielectric constant; Heat treatment)	
12.6 Basis of size and mass	

- (Centrifugation; Dialysis; Ultrafiltration; Gel filtration)
- 12.7 Basis of charge (polarity)
  - (Ion-exchange; iso-electric focusing; Electrophoresis; hydrophobic chromatography)
- 12.8 Specific binding
  - (Affinity binding; Affinity elution; Dye-ligand binding; Immuno adsorption Covalent binding)
- 12.9 Crystallization
- 12.10 Evaluation of purification
  - Recovery and fold of purification
  - Homogeneity of the purified enzyme
  - (Native and denaturing electrophoresis; Isoelectrofocussing; Ultracentrifugation; N-terminal determination)
  - Determination of enzyme structure
  - Molecular weight, sub-unit pattern and amino acid sequence
  - Enzyme storage and stability *in vitro*
  - Selection of purification methods

13. Enzyme technology: Enzyme engineering, Immobilization 3

#### Books Recommended

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
2. Berg et al: Biochemistry (5th Ed.), Freeman, 2002
3. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004
4. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
5. Rawn: Biochemistry, Neil Patterson, 1989
6. Mahler & Cordes: Textbook of Biological Chemistry, Harper, 1966
7. Price & Stevens: Fundamentals of Enzymology (2nd Ed.), Oxford University Press, 1988
8. Engel: Enzyme kinetics: The steady state approach, Chapman and Hall, 1981
9. Segal: Biochemical calculations (2nd Ed.), John Wiley & Sons, 1976
10. Fersht, A. Enzyme Structure and Mechanisms (2nd Ed.), WH Freeman and Company, 1985.

### MAJOR ELECTIVE ZMAT 02: ENTOMOLOGY

#### Course I: Structure and function of insects-I

(Theory Credit-3)

	Hours of Teaching
1. Digestive system	6
1.1 Digestion	
1.2 Absorption	
1.3 Nutrition	
1.3.1 Nutritional requirements	
1.3.2 Ectosymbiotic fungi	
1.3.3 Endosymbionts	
1.3.4 Nutritional effects on growth and development	

2. Excretory system	8
2.1 Organs of excretion	
2.2 Nitrogenous excretion	
2.2.1 Excretory products	
2.2.2 Storage excretion	
2.2.3 Urine production	
2.3 Modification of primary urine	
2.3.1 Terrestrial and salt water insects	
2.3.2 Control of diuresis	
2.3.3 Water regulation	
2.3.4 Detoxification	
3. Circulatory system	18
3.1 Circulation	
3.2 Haemocyte behaviour	
3.2.1 Classes of haemocytes: criteria for characterizing haemocytes	
3.2.2 The origin and longevity of haemocytes	
3.2.3 Haemopoietic organs	
3.2.4 Changes in the haemocyte population	
3.2.5 Recruitment and cessation	
3.2.6 Alterations in recognition and response	
3.3 Haemolymph proteins	
3.3.1 Current technology (protein purification, sequence information, immunological techniques)	
3.3.2 Storage proteins (arylphorins, storage protein uptake)	
3.3.3 Lipophorin (function, structure)	
3.3.4 Haemolymph protein sequestered by ovary	
3.3.5 Antibacterial proteins	
3.3.6 Lectins	
3.3.7 Protease inhibitors	
3.3.8 Enzymes in haemolymph	
3.3.9 Peptides in haemolymph	
3.3.10 Chromoproteins	
3.3.11 Specific transport proteins	
3.4 Thermoregulation and heat exchange	
3.4.1 Avenues of heat exchange	
3.4.2 Temperature and physiological performance	
3.4.3 Endothermy during flight	
3.4.4 Endothermy during non-flight activity	
3.4.5 Ectothermy	
3.4.6 Immunity	
4. Reproductive system	8
4.1 Anatomy of reproductive organs	
4.2 Spermatogenesis	
4.3 Oogenesis	

- 4.4 Mating
- 4.5 Insemination
- 4.6 Oviposition

**ZMAT 02 -Course II: Insect pests and their control**  
(Theory Credit-3)

	Hours of Teaching
1 Insect pests	2
1.1 Causes of success of insects	
1.2 Origin of insect pests	
1.3 Factors affecting the abundance of insects	
2 Insect pest control	1
2.1 Natural control	
2.2 Applied control	
2.2.1 Cultural control	2
2.2.1.1 Modifying the physical environment: Physical barriers and mulches	
2.2.1.2 Agronomic practices	
2.2.1.2.1 Crop rotation	
2.2.1.2.2 Tillage practices	
2.2.1.2.3 Planting/Harvesting date manipulation	
2.2.1.2.4 Sowing/Planting density	
2.2.1.2.5 Inter cropping	
2.2.1.2.6 Trap cropping	
2.2.1.2.7 Irrigation	
2.2.1.2.8 Fertilisers and organic farming	
2.2.2 Mechanical control	1
2.2.3 Chemical control	12
2.2.3.1 Formulations and insecticide toxicity	
2.2.3.2 Botanical pesticides	
2.2.3.2.1 Pyrethrins	
2.2.3.2.2 Rotenone	
2.2.3.2.3 Sabadilla	
2.2.3.2.4 Ryania	
2.2.3.2.5 Nicotine	
2.2.3.2.6 Neem	
2.2.3.2.7 Limonene and Linalool	
2.2.3.3 Inorganic insecticides	
2.2.3.4 Synthetic organic insecticides and their mode of action	
2.2.3.4.1 Organochlorines	
2.2.3.4.2 Organophosphates	
2.2.3.4.3 Carbamates	
2.2.3.4.4 Pyrethroids	

2.2.3.4.5	Neonicotinoids	
2.2.3.5	Insect growth regulators	
2.2.3.5.1	Concept of hormonal control of insects	
2.2.3.5.2	Juvenoids	
2.2.3.5.3	Ecdysoids	
2.2.3.5.4	Antihormones	
2.2.3.5.5	Chitin inhibitors	
2.2.4	Biological control	5
2.2.4.1	Parasitoids	
2.2.4.2	Predators	
2.2.4.3	Methods for using biocontrol agents	
2.2.4.3.1	Classical Biological Control	
2.2.4.3.2	Augmentation and Inoculation Techniques	
2.2.4.3.3	Conservation biological control and habitat manipulation	
2.2.5	Microbial control	5
2.2.5.1	Bacteria	
2.2.5.2	Virus	
2.2.5.3	Protozoa	
2.2.5.4	Nematodes	
2.2.5.5	Fungi	
2.2.6	Behavioural control	3
2.2.6.1	Semiochemicals	
2.2.6.1.1	Types of pheromones and allelochemicals	
2.2.6.1.2	Formulation of pheromones	
2.2.6.2	Uses of pheromones in pest management	
2.2.6.2.1	Monitoring	
2.2.6.2.2	Mass trapping	
2.2.6.2.3	Mating disruption	
2.2.7	Genetic control	2
2.2.7.1	Methods of genetic manipulation	
2.2.7.2	Field trials	
2.2.8	Biotechnological control	3
2.2.8.1	Transgenic plants	
2.2.8.2	Transgenic biocontrol agents	
2.2.8.3	Environmental impact of biotechnological control	
2.2.9	Insect attractants, repellents and antifeedants	2
2.2.10	Integrated pest management	4
2.2.10.1	Concept of injury levels	
2.2.10.1	Economic injury level	
2.2.10.2	Economic threshold level	
2.2.10.2	Procedure in establishing an IPM programme	
2.2.10.3	Integration of control tactics	

**ZMAT 02 -Course III: Structure and function of insects-II**  
(Theory Credit-1.5)

	Hours of Teaching
1. Nervous system	4
1.1 Basic components and functioning	
1.2 Brain	
2. Visual system	4
2.1 Functional unit of compound eye	
2.2 Image formation	
2.3 Light and dark adaptations	
2.4 Stemmata	
3. Ocellar system	7
3.1 Distribution and structure (phylogeny, structure, ontogenic development)	
3.2 Functional properties of ocellar neurons	
3.2.1 Spatial properties	
3.2.2 Absolute sensitivity	
3.2.3 Speed of signal transmission	
3.3 Behavioural roles of Ocelli	
3.4 Neural organization of ocellar pathways	
3.5 Molecular basis of the ocellar system	
3.6 Information processing in the ocellar system	
4. Sound production	5
4.1 Mechanism of sound production	
4.2 Neural regulation of sound production	
4.3 Significance of sound	

**ZMAT 02 - Course IV: Industrial Entomology**  
(Theory Credit-1.5)

	Hours of Teaching
1 Sericulture	10
1.1. Mulberry sericulture	
1.1.1 Cultivation of food plants	
1.1.2 Bioecology of mulberry silkworms	
1.1.3 Rearing of silkworms	
1.1.4 Harvesting and processing of cocoons	
1.1.5 Reeling appliances	
1.1.6 Diseases of <i>Bombyx mori</i>	
1.1.7 Predators and parasitoids of silkworm and their management	
1.2 Non-Mulberry sericulture:	
1.2.1 Tasar sericulture	
1.2.1.1 Cultivation of food plants	
1.2.1.2 Bioecology and rearing of tasar silkworms	

1.2.1.3	Pupation and cocoon formation	
1.2.1.4	Stifling and reeling of cocoons	
1.2.2	Muga sericulture	
1.2.2.1	Cultivation of food plants	
1.2.2.2	Bioecology and rearing of muga silkworms	
1.2.2.3	Pupation and cocoon formation	
1.2.2.4	Grainage technology	
1.2.2.5	Stifling and reeling of cocoons	
1.2.3	Eri sericulture	
1.2.3.1	Cultivation of food plants	
1.2.3.2	Bioecology and rearing of tasar silkworms	
1.2.3.3	Pupation and cocoon formation	
1.2.3.4	Stifling and reeling of cocoons	
2	Apiculture	7
2.1	Kinds of honeybees	
2.2	Organization of bee colony	
2.3	Life-history and behaviour of bees	
2.4	Dance language of honeybees	
2.5	Diseases of honeybees	
2.6	Beekeeping methods	
2.6.1	Equipment and tools	
2.6.2	Apiary management	
2.6.2.1	Hiving a colony	
2.6.2.2	Controlling swarming	
2.6.2.3	Handling of bees	
2.6.2.4	Extraction of honey and wax	
2.7	Bee products	
3	Lac culture	4
3.1	Lac insect and its life history	
3.2	Host plant management	
3.3	Strains of lac insects	
3.4	Propagation of lac insects	
3.5	Lac crop management	
3.6	Natural enemies of lac insects and their management	
3.7	Lac extraction	

**Books Recommended (see the list for semester IV)**

**MAJOR ELECTIVE ZMAT 03: FISH BIOLOGY**  
**Course I: Capture Fishery and Nutrition**  
 (Theory Credit-3)

	Hours of Teaching
1. The Inland Capture Fishery resources of India	
1.1 Riverine fisheries	
1.1.1 Different river System	1
1.1.2 Riverine fisheries resources	1
1.1.3 Regulation and exploitation	1



1.1.4	Improvement of fish stocks	2
1.1.5	River pollution	2
1.1.6	Dams and their effect on fish migration and remedial measures	2
1.2	Cold water fishery	3
1.2.1	Cold water fisheries resources	
1.2.2	Fisheries management and Development in cold water.	
1.3	Lacustrine fisheries resources	3
1.4	Estuarine fisheries	4
1.4.1	Estuarine fisheries resources	
1.4.2	Problems confronting brackish-water capture fisheries.	
2	Marine fishery	3
3	Marine fishery resources of India.	
4	Chemical composition and nutritional value of fish	3
5	Nutrition	
5.1	Physiological roles of nutrients	1
5.2	Food and feeding habits of freshwater fishes, prawn, mussel and oysters	2
5.3	Nutritional bio-energetics	1
5.4	Nutrient requirement ( proteins, lipids, carbohydrates, minerals and vitamins) for various growth stages of freshwater carp, prawn and mussel	2
5.5	Conventional and non conventional feed sources	1
5.6	Presence of anti nutritional factors and their removal procedures.	1
5.7	Supplementary feed:	
5.7.1	Kind of supplementary feeds	1
5.7.2	Composition and nutrient source	1
5.7.3	Feeding frequency	1
5.7.4	Formulation and processing of feeds	1
5.7.6	Storage and quality control of feeds	1
5.7.7	Feed dispensing methods	1
5.7.8	Live feed culture.	1

**ZMAT 03 -Course II: Culture Fisheries**  
(Theory Credit-3)

		Hours of Teaching
1.	Fish culture systems	
1.1	Ponds	
1.1.1	Fish farm : Construction and lay out of different types of ponds	3
1.1.2	Pond management	
1.1.2.1	Physico-chemical properties of pond water and soil and their maintenance	3
1.1.2.2	Manuring (organic and inorganic) and liming	3

1.1.2.3 Pond stocking and productivity	2
1.1.2.4 Composite fish farming and poly-culture	2
1.1.2.5 Predatory and weed fishes and their eradication	2
1.1.2.6 Aquatic vegetation and its control	2
1.1.2.7 Biological means of increasing production	2
1.1.2.8 Brood pond management for culturable indigenous and exotic carps	2
1.2 Cage	1
1.3 Rafts	1
1.4 Pens	1
1.5 Raceways	1
2. Age and Growth	
2.1 Growth rate and aging	2
2.2 Length weight relationship	1
2.3 Gonadosomatic index	1
3. Exotic fishes and their role in fish farming	2
4. Fish culture in paddy fields	1
5. Sewage-fed fisheries	1
6. Larvivorous fishes	1
7. Fish culture with recirculated water	1
8. Eel culture	1
9. Formulation and operation of different types of hatcheries	2
10. Hatchery management	2

**ZMAT 03 - Course III: Fish Physiology I (based on Teleosts)**  
(Theory Credit-3)

	Hours of Teaching
1. Integument	
1.1 Epidermis	
1.1.1 Mucogenic	3
1.1.2 Keratinized epidermis	2
1.2 Dermis	
1.2.1 General organization	1
1.2.2 Scales	1
1.2.3 Chromatophores	2
2. Respiration	
2.1 Aquatic respiration	
2.1.1 Gills	2
2.1.2. Mechanisms of respiration	3
2.1.2.1 Counter current principle	
2.1.2.2 Water flow across the gills	
2.1.2.3 Respiratory pump	
2.1.2.4 Pump musculature and skeleton	

2.1.2.5	Gas exchange	
2.2	Air-breathing	
2.2.1	Accessory respiratory organs and respiratory epithelium	4
2.2.2	Physiological adaptation in air-breathing fishes	2
2.3	Transport of respiratory gases	
2.3.1	Transport of oxygen	1
2.3.2	Transport of carbon dioxide	1
3.	Digestion	
3.1	Alimentary canal and its modifications in relation to food and feeding habits	2
3.2	Digestive fluids and enzymes.	2
3.3	Digestion and absorption of lipid, protein and carbohydrate	2
3.4	Gastrointestinal motility control	1
4.	Swim bladder	
4.1	General organization and circulation	1
4.2	Composition of swim bladder gas, its secretion and maintenance	2
4.3	Removal of gas from swim bladder	1
4.4	Functions of swim bladder	
5.	Circulation	
5.1	Heart and aortic arches	1
5.2	Regulation of cardiac activity	1
5.3	Hemodynamics	
5.4	Cardiac output	1
5.5	Circulation time	1
5.6	Blood pressure	1
5.7	Fish haemoglobins	

**Books Recommended (see the list for semester IV)**

**MAJOR ELECTIVE ZMAT 04: MAMMALIAN REPRODUCTIVE PHYSIOLOGY**  
**Course I: Neuroendocrinology of Reproduction**  
 (Theory Credit-3)

	Hours of Teaching
1. Hypothalamic control of pituitary hormone secretion: Relevance to reproduction	28
1.1 Gonadotropes and Lactotropes	
1.2 Dynamics of gonadotropin release	
1.3 Hypothalamic pulse generator	
1.4 GnRH: distribution and mechanism of action	
1.5 Gonadotrophic hormones	
1.5.1 Chemistry	
1.5.2 Biosynthesis	

- 1.5.3 Receptors
- 1.5.4 Physiological roles
- 1.5.5 Bioassays
- 1.5.6 Dynamics of prolactin release, chemistry, & physiological roles
- 2. Regulation of reproductive cycles in mammals 12
  - 2.1. Menstrual cycle in humans
  - 2.2. Oestrous cycle in rat and sheep
  - 2.3. Role of environmental factors in seasonal reproduction in mammals
    - 2. 3.1 Photoperiod
    - 2. 3.2 Temperature
    - 2. 3.3 Rainfall
    - 2. 3.4 Food Supply
    - 2. 3.5 Social Impact

**ZMAT 04 - Course II: Sex differentiation & Reproductive processes**  
(Theory Credit-3)

	Hours of Teaching
1. Sex determination & differentiation	12
1.1 Mechanism of sex determination	
1.2 Sexual differentiation	
1.2.1 Gonadal differentiation	
1.2.2 Differentiation of genital tract	
1.2.3 Brain differentiation	
1.2.3.1. Evidences in support of sexual dimorphism of brain	
1.2.3.2. Sexual dimorphism of brain in humans	
1.2.3.3. Role of gonadal steroids	
1.3 Hermaphroditism	
2. Gonadal steroid hormones	12
2.1 Synthesis	
2.2 Transport	
2.3 Receptors	
2.4 Mechanism of action	
2.5 Agonists and antagonists	
3. Reproductive processes and their control	16
3.1 Puberty	
3.2 Pregnancy	
3.2.1 Recognition	
3.2.2 Maintenance: Placental steroid hormones and polypeptides hormones	
3.2.3 Parturition	
3.2.4 Lactation	

**ZMAT 04 - Course III: Female Reproduction**  
(Theory Credit-3)

	Hours of Teaching
1. Regulation of ovarian function	20
1.1 Follicular development and selection	
1.2 Regulation of steroidogenesis	
1.3 Oocyte maturation	
1.4 Mechanism of ovulation	
1.4.1 Hormonal and molecular changes during periovulatory period	
1.4.2 Factors involved in follicular rupture	
1.5 Follicular atresia	
1.6 Corpus luteum	
1.6.1 Formation and morphology of luteal cells	
1.6.2 Maintenance	
1.6.3 Luteolysis	
2. Fertilization	8
2.1 Gamete transport in female genital tract	
2.2 Capacitation	
2.3 Sperm interaction with zona pellucida	
2.4 Acrosome reaction	
2.5 Sperm-egg fusion	
3. Early embryogenesis and biology of ovum implantation	12
3.1 Pre-implantation embryo development	
3.2 Functional markers of embryo	
3.3 Blastocyst and uterine events during implantation	
3.4 Molecular basis of uterine-blastocyst interaction	
3.5 Cellular and endocrine aspects of implantation	
3.6 Types of implantation	

**Books Recommended (see the list for semester IV)**

**MAJOR ELECTIVE ZMAT 05: MOLECULAR & APPLIED ENDOCRINOLOGY**  
**Course I: Hormones, Receptors and Hormone action**  
(Theory Credit-3)

	Hours of Teaching
1. Hormones	18
1.1 An overview of hormones, types and cellular sources	
1.2 Biosynthesis of:	
1.2.1 Protein hormones	
1.2.2 Steroid hormones	
1.2.3 Thyroid hormones	
1.2.4 Catecholamines	
1.2.5 Eicosanoids	

1.3 Release and transport: Hormone carrier proteins	
1.4 Metabolism and excretion	
2. Hormone receptors: structure and function	18
2.1 Plasma membrane receptors	
2.1.1 Kinase cascade receptors	
2.1.2 G-protein coupled receptors	
2.2 Second messengers of hormones	
2.2.1 cAMP -protein kinase A	
2.2.2 PLC-protein kinase C	
2.2.3 Eicosanoids and hormone action	
2.3 Termination of hormone action	
2.4 Intracellular receptors	
2.4.1 Steroid hormone receptors	
2.4.2 Thyroid hormone receptors	
2.4.3 Calmodulin	
2.5 Direct membrane action of steroid hormones	
3. Pathophysiology of hormone receptors and hormone analogues as drugs	6

**ZMAT 05 - Course II: Brain-pituitary integration of endocrine systems**  
(Theory Credit-3)

	Hours of Teaching
1. Anatomy and physiology of endocrine hypothalamus	20
1.1 Hypothalamic nuclei	
1.2 Afferent connections	
1.3 Hypophysiotropic hormones	
1.3.1 TRH	
1.3.2 GnRH	
1.3.3 CRH	
1.3.4 GHRH and PACAP	
1.3.5 Somatostatin	
1.3.6 Nitric oxide	
1.3.7 Monoamines	
1.3.8 Endorphins	
1.4 Hypothalamic octapeptide hormones	
1.4.1 Vasotocin family	
1.4.2 Vasopressin	
1.4.3 Oxytocin	
2. Adenohypophysis	15
2.1 Development	
2.2 Differentiation of cell types	
2.3 Role of transcription factor PIT-1	
2.4 Neural control of:	
2.4.1 Pituitary- adrenal axis	
2.4.2 Pituitary- thyroid axis	

2.4.3	Pituitary- gonadal axis	
2.4.4	Prolactin	
2.4.5	Growth hormone	
2.4.6	MSH	
3.	Pineal gland – A neuroendocrine transducer	7
3.1	Melatonin synthesis, rhythms and photoperiodic measurement	
3.2	Pineal and biological clock	

**ZMAT 05 - Course III: Endocrine Methodologies**  
(Theory Credit-3)

		Hours of Teaching
1.	Methods for studying endocrine function	8
1.1	Model systems	
1.1.1	Animal model	
1.1.2	Isolated organs or tissues	
1.1.3	In vitro models	
1.1.4	Ablation methods	
1.1.4.1	Surgical	
1.1.4.2	Chemical	
1.1.4.3	Radio-isotopic	
1.1.5	Transplantation	
1.1.6	Parabiosis	
1.1.7	Immunization	
1.2	Identification of hormone- producing cells	10
1.2.1	Histological - cytological techniques	
1.2.2	Histochemical techniques	
1.2.3	Electron microscopy	
1.2.4	Autoradiography	
1.2.5	Immunocytochemistry	
1.2.6	In situ hybridization	
2.	Measurement of hormones and receptors	10
2.1	Hormone assays	
2.1.1	Bioassays	
2.1.2	Chemical assays	
2.1.3	Immunoassays	
2.1.3.1	RIA	
2.1.3.2	ELISA	
2.2	Receptor assays	
3.	Purification and characterization of hormones–General considerations	4
3.1	Steroid hormones	
3.2	Protein hormones	
4.	Production of protein hormones by Recombinant technology	1
5.	Manipulation of endocrine functions	5

- 5.1 Hormone delivery
  - 5.1.1 Types of sustained release devices
  - 5.1.2 Pulsatile release
  - 5.1.3 Hormone residues
- 6. Transgenic animals 4
  - 6.1 Production of transgenic animals
  - 6.2 Uses of transgenic animals

**Books Recommended (see the list for semester IV)**

**MAJOR ELECTIVE ZMAT 06: MOLECULAR & HUMAN GENETICS**  
**Course I: Human Genetics**  
 (Theory Credit-3)

	Hours of Teaching
1. History of Human Genetics	1
2. Patterns of inheritance	10
2.1 Pedigree construction, inheritance patterns (autosomal, sex-linked, sex-limited and sex-influenced), risk assessment	
2.2 Mitochondrial inheritance	
2.3 Complexities associated with inheritance (penetrance and expressivity, new mutations, anticipation, co-dominance, pseudo-dominance, genetic heterogeneity, imprinting, Lyonisation, mosaicism and chimerism)	
2.4 Consanguinity and its effects	
3. Complex traits	10
3.1 Oligogenic trait	
3.2 Polygenic trait	
3.3 Multifactorial trait: Nature-nurture concept	
3.3.1 Family, twin and adoption studies	
3.3.2 Genetic susceptibility, heritability, empiric risk	
3.4 Threshold trait	
4. Mapping and identifying a disease gene	15
4.1 Genetic mapping of the locus	
4.1.1 DNA markers- RFLP, microsatellites, SNPs	
4.1.2 LOD score analysis, linkage disequilibrium mapping (haplotype analysis)	
4.2 Cloning the disease gene: functional and positional cloning, candidate gene approach	
4.3 Identifying and confirming the disease gene: mutation detection, validation in animal model systems	
4.4 Genetic mapping of complex traits	
4.4.1 Non-parametric linkage analysis: affected sib-pair method, association studies	
5. Pharmacogenetics and Ecogenetics	3



**ZMAT 06 - Course II: Recombinant DNA Techniques**  
(Theory Credit-1.5)

	Hours of Teaching
1. Techniques in Genetic Engineering	12
1.1 Cloning vectors, probes, nucleic acid detection by blotting and hybridization	
1.2 Preparation and screening of genomic and cDNA libraries	
1.3 Oligonucleotide synthesis	
1.4 Polymerase chain reaction	
1.5 DNA sequencing	
1.6 DNA fingerprinting	
1.7 Expression of recombinant proteins	
1.8 DNA-protein and protein-protein interactions- gel mobility shift assay, foot printing, western and south-western blotting, Yeast 2-hybrid system	
2. Gene function analysis (models- <i>Drosophila</i> , mouse)	8
2.1 Random mutagenesis, mutation screens, complementation & suppression	
2.2 Manipulation of genes, site-specific mutagenesis, Transgenesis	
2.3 Targetted mutagenesis, gene knockout and gene knock-in methods	
2.4 Reporter genes and temporal/site specific expression	
2.5 RNAi and specific gene silencing	

**ZMAT 06 - Course III: Developmental Genetics**  
(Theory Credit-1.5)

	Hours of Teaching
1. Overview of genetic control of embryonic development and pattern formation	2
2. Epigenetic modifications	6
2.2 Imprinting	
2.3 Endoreplication and amplification	
2.4 Chromatin diminution	
2.5 Programmed DNA rearrangements	
3. Sex determination and dosage compensation	6
4. Medical implications of developmental genetics	6
4.1 Infertility	
4.2 Teratogenesis	
4.3 Stem cells and tissue engineering	

**ZMAT 06-Course IV: Genomics**  
(Theory Credit-2)

	Hours of Teaching
1. Diversity of genomes	16
1.1 Overview of pro- and eukaryotic genomes	
1.1.1 Comparative genomics of prokaryotes	

- 1.1.2 Comparative genomics of eukaryotes
- 1.1.3 Human Genome mapping strategies  
(genetic and physical mapping)
- 1.1.4 Integrated map and organization of human genome
- 1.2 Functional organization of chromatin in eukaryotes
- 1.3 Modes of genomic innovations
  - 1.3.1 Mutations
  - 1.3.2 Gene duplication – gene families, pseudogenes
  - 1.3.3 Transposable elements: prokaryotes, yeast,  
*Drosophila*, human
  - 1.3.4 Lateral and horizontal transfer among genomes
- 2. Genomic expression profiling 10
  - 2.1 Concepts of transcriptome and proteome
  - 2.2 Microarray technology, 2D-electrophoresis, protein sequencing,  
mass spectrometry
  - 2.3 Prediction, diversity and multiplicity of protein functions
  - 2.4 Sequence homology and predictions of gene functions
  - 2.5 Applications in human disease

**ZMAT 06 - Course V: Advanced Genetic Techniques in *Drosophila***  
(Theory Credit-1)

	Hours of Teaching
1. Life cycle and advantages of <i>Drosophila</i> as a model genetic system	3
1.1 Embryonic development	
1.2 Larval stages and tissue types	
1.3 Pupa and metamorphosis	
1.4 Adult morphology and internal organs	
1.5 Spermatogenesis and oogenesis	
2. Nomenclature of gene mutations and chromosome rearrangements, balancer chromosomes	1
3. Polytene chromosomes: maps, puffing and utility	2
4. Mitotic recombination and generation of somatic clones for developmental studies	2
5. Mutagenesis	3
5.1 X-ray and chemical mutagenesis	
5.2 P-element insertional mutagenesis	
6. Germline transformation with P-element based vectors	2

**Books Recommended (see the list for semester IV)**

## SEMESTER IV

### CORE COURSE ZCT 21: ENVIRONMENTAL BIOLOGY (Theory Credit-2)

	Hours of Teaching
1. Ecological principles and environmental biology	2
1.1 Introduction to environmental biology	
1.2 Concept of ecosystem	
2. Population and environmental health	6
2.1 Population dynamics	
2.1.1 Intrinsic rate of natural increase	
2.1.2 Population growth form	
2.1.3 Population fluctuations and cyclic oscillation	
2.1.4 Population density and structures	
2.1.5 r- and k- selections and carrying capacity	
2.2 Biological communities and species interactions	2
2.2.1 Types of interactions between two species	
2.2.2 Interspecific competition	
2.3 Environmental health and toxicology	8
2.3.1 Types of environmental health hazards	
2.3.2 Air pollution	
2.3.3 Water pollution	
2.3.4 Solid waste	
2.3.5 Noise pollution	
2.3.6 Radioactive pollution	
2.3.7 Bioaccumulation and biomagnification	
3. Energy in ecological system	2
3.1 Energy law	
3.2 Energy flow	
4. Conservation and management of natural resources	8
4.1 Soil and mineral resources	
4.2 Biodiversity	
4.2.1 Need for conservation of biodiversity	
4.2.2 Benefits from biodiversity	
4.2.3 Threats to biodiversity	
4.2.4 Endangered species management and biodiversity protection	

#### Books Recommended

1. Odum : Fundamentals of Ecology (Saunders, 1971)
2. Odum : Basic Ecology (Saunders, 1985)
3. Turk and Turk : Environmental Science (4th ed. Saunders, 1993)
4. Primark : A Primer of Conservation Biology ( 2<sup>nd</sup> ed. Sinauer Associates)
5. Calabrese : Pollutants and High-Risk Groups (John Wiley, 1978)
6. Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993)
7. Sharma : Ecology and Environment (Rastogi Publication, 7<sup>th</sup> ed. 2000)

8. Cunningham and Saigo : Environmental Science (McGraw Hill Boston, 5<sup>th</sup> ed., 1999)
9. Ricklefs and Miller : Ecology ( Freeman and Company, New York, 4<sup>th</sup> ed., 2000)

**CORE COURSE ZCT 22: IMMUNOLOGY**  
(Theory Credit-1)

	Hours of Teaching
1. Introduction to immune system	2
1.1 Innate and adaptive immunity	
1.2 Immune cells; type and production, immune tolerance	
1.3 Concept of clonal selection	
1.4 Complement system	
2. Humoral Immunity	6
2.1 Antigen and haptens	
2.2 Primary and secondary response	
2.3 Antibody: types, structure, function, production and diversity	
3. Cell mediated immunity	5
3.1 T-cell receptors	
3.2 MHC complexes	
3.3 Antigen: processing and presentation	
3.4 T helper cell and lymphocyte activation	
3.5 Role of cytotoxic T-cell	

**Recommended Books:**

1. Alberts *et al*: Molecular Biology of cell (4<sup>th</sup> Edition) Garland Science, 2002.
2. Ivan Roitt: Essential Immunology (6<sup>th</sup> Ed.) Oxford, Backwill, Science Publication London.
3. Elgert: Immunology understanding the immune system, John Willy & Sons, Inc. Publication, New York, 1996.
4. Abbas et al. cellular and Molecular Immunology (3rd Ed.) W.B. Saunders Company, 2000

**MAJOR ELECTIVE ZMAT 01-BIOCHEMISTRY & MOLECULAR BIOLOGY**  
**Course IV: Regulation of Intermediary Metabolism**  
(Theory Credit-3)

	Hours of Teaching
1. Intermediary metabolism and metabolic pathways	2
2. Carbohydrates: Pathways, their integration and regulation	9
3. Lipids	10
3.1 Cholesterol: Biosynthesis and degradation	
3.2 Lipid transport and storage	
3.3 Biosynthesis of eicosanoids: Prostaglandins, leucotrienes and thromboxanes	
3.4 Structure and function of eicosanoids	
4. Amino acids	12
4.1 Sources of amino acids: Dietary proteins and	

- intermediates of carbohydrate metabolism
- 4.2 Amino acids as sources for nitrogen
- 4.3 Molecules derived from amino acids: Porphyrin, bilirubin, creatine, glutathione, dopamine, noradrenaline, adrenaline, GABA, serotonin, histamine, melanin, thyroxine
- 4.4 Synthesis and significance of polyamines
- 4.5 Amino acid catabolism
  - 4.5.1 Transamination
  - 4.5.2 Deamination: Transdeamination and oxidative deamination
  - 4.5.3 Toxicity of ammonia
  - 4.5.4 Ammonia detoxification
  - 4.5.5 Urea cycle
    - 4.5.5.1 Reactions and their regulation
    - 4.5.5.2 Evolution of urea cycle
- 5. Nucleotides 6
  - 5.1 Biosynthesis and regulation of purine and pyrimidine nucleotides
  - 5.2 Catabolism of purines and pyrimidines

**Books Recommended**

1. Nelson et al: Lehninger Principles of Biochemistry (3rd Ed.), MacMillan Worth, 2000
2. Berg et al.: Biochemistry (5th Ed.), Freeman, 2002
3. Mathews et al.: Biochemistry (3rd Ed.), Pearson, 2004
4. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995
5. Rawn: Biochemistry, Neil Patterson, 1989
6. Bender, D.A.: Amino acid metabolism, John Wiley & Sons, 1985
7. Grisolia, S. et al. : The Urea Cycle, John Wiley & Sons, 1976
8. Voet & Voet: Biochemistry Vol. I & II (3rd Ed.), Wiley, 2004.

**ZMAT 01-Course V: Cell Signaling and Apoptosis**  
(Theory Credit-3)

	Hours of Teaching
1. Signal transfer	6
1.1 Ions channels	
1.2 Transporters	
1.3 Receptors	
2. Signal transduction	22
2.1 Concept of cell-signaling	
2.2 Signaling through intracellular receptors: Lipophilic hormones	
2.3 Signaling through cell surface receptors	
2.3.1 G protein linked receptors; signaling via cAMP, PKA IP <sub>3</sub> , Ca <sup>++</sup> /calmodulin, PKC, Ca-MK, ion channels (exemplified by vision)	
2.3.2 Enzyme linked receptors	

- 2.3.2.1 Receptor tyrosine kinase (RTK), signaling of growth factors,
- 2.3.2.2 Tyrosine kinase associated receptors, JAK-STAT signaling pathway
- 2.3.2.3 Receptor protein tyrosine phosphatase (PTP)
- 2.3.2.4 Receptor serine/threonine kinase
- 2.3.2.5 Receptor guanyl cyclase, cGMP, PKG
- 2.3.2.6 Histidine kinase associated receptors, bacterial chemotaxis
- 2.4 Receptor desensitization
- 2.5 Signaling by nitric oxide, carbon monoxide
- 2.6 Signaling network
- 2.7 Impairment of signaling mechanism
  - 2.7.1 Tumorigenesis: Role of oncogenes & oncoproteins
  - 2.7.2 NIDDM : low level of receptors
  - 2.7.3 Hormonal disbalance and diseases
- 3. Apoptosis 8
  - 3.1 Necrosis and programmed & induced cell death
  - 3.2 Process of apoptosis
    - 3.2.1 Initiation
    - 3.2.2 Execution: cytochrome C, caspases
    - 3.2.3 Phagocytosis
  - 3.3 Regulation of apoptosis
    - 3.3.1 Extracellular
    - 3.3.2 Intracellular
  - 3.4 Significance in development, immunity and cancer

### Books Recommended

1. Albert et al.: Molecular Biology of the Cell (4th Ed.), Garland Publishing Inc., 2002
2. Lodish et al.: Molecular Cell Biology (5th Ed.), Freeman and Company, 2004
3. Berg et al.: Biochemistry (5th Ed.), Freeman and Company, 2002
4. Murray et al.: Harper's Biochemistry (26th Ed.), Appleton & Lange, 2003.

### ZMAT 01-Course VI: Medical Biochemistry (Theory Credit-3)

	Hours of Teaching
1. Biochemical basis of diseases/disorders, diagnosis and treatment	2
2. Molecular deficiency disorders	10
2.1 Disorders of enzyme deficiency	
2.1.1 Alkaptonuria	
2.1.2 Arginino succinic acidemia	
2.1.3 Galactosuria	
2.1.4 Hartnup's disease	
2.1.5 Histidinemia	

2.1.6 Phenylketonuria	
2.1.7 Lesh-Nyhan syndrome	
2.2 Disorders of protein deficiency/defects	
2.2.1 Cystic fibrosis	
2.2.2 Sickel cell anaemia	
2.2.3 Thalassemia	
2.2.4 Hemophilia	
2.2.5 Pernicious anaemia	
2.2.6 Diabetes and obesity	
3. Storage and transport associated disorders	4
3.1 Glycogen storage disorders	
3.2 Hypercholestrolemia and atherosclerosis	
3.3 A- $\beta$ lipoproteinemia	
3.4 Tay-Sachs disease	
3.5 Gout	
4. Neurological disorders	3
4.1 Parkinsonism	
4.2 Hutington's disease	
4.3 Alzheimer's disease	
5. Septicemia	2
5.1 Biochemical and molecular mechanisms	
5.2 Therapeutic management	
6. Immunity and human health	3
6.1 Autoimmunity	
6.2 Immune system in AIDS	
6.3 Cancer and the immune system	
6.4 Transplantation immunity	
7. Drug action	3
7.1 Mechanisms	
7.2 Drug addiction, alcohol toxicity	
7.3 Catabolism of drugs	
8. Recent trends in therapy	5
8.1 Clinical applications of enzymes as diagnostic markers, analytical reagent and therapeutic agents	
8.2 Gene technology and gene therapy	
8.3 Drug delivery and targeting	
9. Biochemistry of aging and medical gerontology	4

**Books recommended**

1. Murray et al, : Harper's Biochemistry (26th Ed.), Appleton & Lange, 2003
2. Ganong: Review of Medical Physiology (21st Ed.), Lange Medical Publications, 2003
3. Alberts et al: Molecular Biology of the Cell (4th Ed.) , Garland,2002
4. Goldsby et al.: Immunology (5th Ed.), Freeman & Co.,2003
5. Bhagvan: Medical Biochemistry (4th Ed.), Hap, 2004

6. Goodman et al.: The Pharmacological Basis of Therapeutics (7th Ed.), Macmillan Publishers, 1991
7. Fogy: Principles of Medicinal Chemistry, Lea and Febinger Publications, 1981
8. Kanungo: Biochemistry of Aging, Academic Press, 1980
9. Kanungo: Genes and Aging, Cambridge University Press, 1994.

**MAJOR ELECTIVE ZMAT 02: ENTOMOLOGY**  
**Course V: Insect hormones and tanning**  
 (Theory Credit-3)

	Hours of Teaching
1. Endocrine organs and hormones	14
1.1 Historical perspective	
1.2 Endocrine glands and concept of neurosecretion	
1.3 Chemical structure of hormones	
1.4 Transport of hormones	
1.5 Mechanism of Ecdysone action	
1.6 Mechanism of JH action	
1.7 Insect growth regulators (IGRs)	
1.8 JHA as IGRs	
1.9 Roles of JH in adult insects	
1.10 Vertebrate hormones in insects	
1.11 Prostaglandins and Related Eicosanoids	
1.11.1 Introduction	
1.11.2 Historical perspectives	
1.11.3 Arachidonic acid metabolism	
1.11.4 Essential fatty acids insects	
1.11.5 Physiological roles of eicosanoids (reproduction, immunity, thermobiology, lipid metabolism)	
2. Neurotransmitters and Neuromodulator system	8
2.1 Cholinergic systems	
2.2 Biogenic amines	
2.2.1 Biogenic amine metabolism	
2.2.2 Molecular biology of biogenic amine synthesis	
2.2.3 Catecholamines	
2.2.4 Indolamines	
2.3 Amino acids	
2.3.1 Glutmatergic systems	
2.3.2 GABAergic system	
2.4 Neuropeptides	
2.4.1 FMRFamide-related peptides	
2.4.2 Cholecystokinin-related peptides	
2.4.3 Proctolin	
3. Pheromones	8



3.1	Structure of pheromone glands	
3.2	Pheromone types and functions	
3.3	Pheromone dispersal	
3.4	Specificity and Biochemical synthesis of pheromones	
4.	Chemical defenses of Insects	7
4.1	Defensive organs and their products	
4.2	Allomones	
4.3	Kairomones	
4.4	Blood as defensive secretion	
4.5	Adaptations to autointoxication	
5.	Mechanisms for Cuticular sclerotization	8
5.1	The components of sclerotized cuticle (structural proteins, chitin, catechols, enzymes)	
5.2	Dityrosine crosslinks	
5.3	Quinone tanning	
5.4	$\beta$ -sclerotization	
5.5	Differential mechanism of tanning	
5.6	Combined pathway and cross linking mechanisms	
5.7	Free radical formation	

**ZMAT 02 - Course VI : Agricultural Entomology**  
(Theory Credit-3)

		Hours of Teaching
1.	Insect – plant interactions	14
1.1	Herbivory	
1.1.1	Leaf chewing	
1.1.2	Plant mining and boring	
1.1.3	Sap sucking	
1.1.4	Gall formation	
1.1.5	Seed predation	
1.2	Insect feeding preference and host-plant selection	
1.2.1	Role of plant chemicals in stimulation of feeding and oviposition	
1.2.2	Role of plant chemicals as feeding deterrents	
1.3	Plant toxins and their effect on insects	
1.4	Insects and plant reproductive biology	
1.4.1	Pollination	
1.4.2	Myrmecochory	
1.5	Host-plant resistance	
2.	Ground-dwelling insects	4
2.1	Root-feeding insects	
2.2	Insects as scavengers	
2.3	Insect- fungal interactions	
2.3.1	Fungivorous insects	
2.3.2	Fungus farming by leaf-cutter ants	

2.3.3 Fungus cultivation by termites	
3. Aquatic insects (Environmental monitoring using aquatic insects)	1
4. Insect pests of crops	18
4.1 Major pests of the following crops, their life cycles, nature of damage caused and pest management: Paddy, wheat, sugarcane, pulses, fibre crops, oilseeds, vegetables, fruits, plantation crops and stored grain pests	
4.2 Polyphagous insect pests: Locusts, termites, hairy caterpillars, cutworms, gram pod borer, aphids	
5. Environmental impact of insecticides	3
5.1 Insect resistance to Insecticides and resurgence	
5.2 Effect on non-target animals	
5.3 Insecticide residues	
6. Forest entomology (Insects damaging forest trees and their control)	1

**ZMAT 02 - Course VII: Structure and function of insects-III**  
(Theory Credit-1.5)

	Hours of Teaching
1. Aerodynamics and the origin of insect flight	4
1.1 Early insects	
1.2 Basic aerodynamics	
1.3 Gliding cylindrical bodies	
2. Fat body	4
2.1 Structure	
2.2 Intermediary metabolism of Carbohydrates, Lipids and Proteins	
3. Bioluminescence	4
3.1 Light producing organs	
3.2 Mechanism of light production	
3.3 Control and significance of light production	
4. Insect Egg	4
4.1 Types	
4.2 Hatching	
4.3 Early embryo genesis up to blastokinesis	
5. Post embryonic development	4
5.1 Number of instars	
5.2 Growth	
5.3 Metamorphosis	
5.4 Diapause	

**ZMAT 02 - Course VIII: Medical and Veterinary Entomology**  
(Theory Credit-1.5)

	Hours of Teaching
1. Medical Entomology	10
1.1 Pests of public health importance and their control: Mosquitoes, house flies, sandflies, eye flies, lice, bedbugs, fleas	
1.2 Insect borne diseases of man : Typhus, yellow fever, dengue fever, encephalites, plague, leishmaniasis,	

sleeping sickness, malaria, filaria, onchocerciasis

- 1.3 Venoms and allergens
  - 1.3.1 Insect venoms
  - 1.3.2 Blister and urtica-inducing insects
  - 1.3.3 Insect allergenicity
- 2. Household pests 2  
Cockroaches, crickets, ants, wasps, clothes moths, silver fish, carpet beetles, furniture beetles, booklice
- 3. Veterinary entomology 7
  - 3.1 Pests of farm animals and their control
    - 3.1.1 Blood-sucking flies
    - 3.1.2 Myiasis flies
    - 3.1.3 Lice
    - 3.1.4 Fleas
- 4. Forensic entomology 2
  - 4.1 Arthropods of forensic importance
  - 4.2 Insect succession on corpse and its relationship to determining time of death.

#### **Books Recommended**

1. Alford: A textbook of Agricultural Entomology, Blackwell Science Ltd. 1999
2. Atwal: Agricultural pests of India and south-east Asia, Kalyani Publishers, New Delhi, 1986.
3. Busvine: Insects and Hygiene, Chapman and Hall, (3rd ed.) 1980
4. Dhaliwal and Arora: Principles of Insect pest management, National Agricultural Technology Information Centre, Ludhiana, 1996.
5. Dhaliwal and Arora: Trends in Agricultural Insect pest Management, Commonwealth Publ., New Delhi, 1994
6. Gillot: Entomology (2nd ed.) Plenum Press, New York, 1995
7. Gullan & Cranston: The Insects: An Outline of Entomology (2nd ed.) Blackwell Science, 2000.
8. Harborne: Introduction to Ecological Biochemistry (4th ed.) 1993
9. Norris et al. Concepts in Integrated Pest management Prentice-Hall, New Delhi, 2002
10. Pedigo: Entomology and Pest Management, Prentice Hall, New Delhi, 1989
11. Purohit: Agricultural Biotechnology (2nd ed.) Agrobios (India) 2003
12. Racheigl & Racheigl: Biological and Biotechnological control of insect pests, CRC Press, 1998
13. Schoonhoven et al.: Insect-plant Biology- from physiology to evolution (1st ed.) Chapman & Hall, 1998
14. Srivastava: A testbook of Applied Entomology Vol. I & II (2nd ed.) Kalyani Publ., 1988, 1993
15. Chandler & Read: Introduction to Parasitology, Willey International, 1970
16. Chapman: The Insects: Structure and Function 4th Ed. ELBS, 1988
17. Imms: A General Text Book of Entomology 2 Vols. Asia Publishing House, 1977
18. Klowden: Physiological Systems in Insects, Academic Press, 2002
19. McGavin: Essential Entomology, Oxford Univ. Press, 2001
20. Metcalf & Flint: Destructive and useful Insects and their control, McGraw Hill, 1962
21. Pruthi: A Text Book of Agricultural Entomology, ICAR, New Delhi, 1969

22. Rechcigl & Rechcigl: Biological control and Biotechnological Control of Insect Pest, Lewis Publishers, 1998
23. Advances in Insect Physiology Vols. 19-26 Academic Press, 1986-1996
24. Rockstein: Biochemistry of Insects, Academic Press, 1978
25. Wigglesworth: Principles of Insect Physiology, ELBS, 1972
26. Blomquist et al: Insect Pheromone Biochemistry and Molecular Biology; The synthesis and detection of pheromones and plant volatiles, Elsevier Acad. Press, 2003.

**MAJOR ELECTIVE ZMAT 03: FISH BIOLOGY**  
**Course IV: Harvest, Post Harvest Technology and Fish Pathology**  
 (Theory Credit-3)

	Hours of Teaching
1. Inland fishing gears and fishing methods	5
1.1 Biological factors in fishing	
1.2 Classification of fishing gears	
1.3 Natural and synthetic fibers and preparation of fishing nets	
1.4 Maintenance of nets	
2. Importance and methods of fish preservation	4
1.1 Refrigeration and freezing	
1.2 Drying	
1.3 Salting	
1.4 Smoking	
1.5 Canning,	
1.6 Pickling, pasting and spicing	
1.7 Fermentation	
1.8 Marinating	
3. Fishery by-products, their production and utilization	8
3.1 Liver oils	
3.2 Body oils	
3.3 Fish meal	
3.4 Fish flour	
3.5 Fish silage	
3.6 Fish solubles	
3.7 Fish protein	
3.8 Fish guano	
3.9 Bone meal	
3.10 Shark fins and fin rays	
3.11 Fish roes	
3.12 Fish glue	
3.13 Isinglass	
3.14 Fish skin	
3.15 Chitin	
3.16 Chitosan	

3.17 Surgical suture from fish gut	
3.18 Pearl essence	
3.19 Surimi	
3.20 Ambergris	
4. Fish Pathology, prophylaxis and therapy	
4.1 Protozoan diseases of fish	3
4.1.1 Cyclochaetiasis, Costiasis, (Sliminess of skin)	
4.1.2 Ichthyophthiriasis( White spot disease)	
4.1.3 Oodinium Velvet rust or gold dust disease	
4.1.4 Knot or Pimple disease	
4.2 Helminth diseases of fish	3
4.2.1 Diseases produced by trematod larvae - Yellow grab	
4.2.2 Black grab	
4.2.3 White grub of liver	
4.2.4 Gyrodactylus	
4.2.5 Dactylogyrus	
4.2.6 Black spot disease (Diplostomiasis)	
4.2.7 Eye Fluke (Worm cataract)	
4.2.8 Blood flukes	
4.2.9 Tapeworms	
4.2.10 Nematodes	
4.3 Crustacean parasites of fish	2
4.3.1 Argulus	
4.3.2 Lernaea	
4.3.3 Ergasilus	
4.4 Glochidia of fresh water mussels	1
4.5 Fish Leech	1
4.6 Fungal diseases of fish	1
4.6.1 Saprolegniasis	
4.6.2 Branchiomycosis (gill rot)	
4.7 Bacterial diseases of fish	4
4.7.1 Columnaris disease	
4.7.2 Cotton wool disease (Mouth Fungus)	
4.7.3 Tail and Fin rot	
4.7.4 Dropsy	
4.7.5 Furunculosis	
4.7.6 Ulcer Disease	
4.7.7 Red pest of Eels	
4.7.8 Red spot disease	
4.7.9 Tuberculosis	
4.8 Viral diseases of fish	3
4.8.1 Lymphocystis	
4.8.2 Papillomatosis (Cauliflower disease)	
4.8.3 Pox disease	

4.9 Miscellaneous diseases	4
4.9.1 Pop eye	
4.9.2 Thyroid tumor (Goiter)	
4.9.3 Autumn Sickness	
4.9.4 Tumors in fish	
4.9.5 Nutritional diseases of fish	
4.9.5.1 Avitaminoses	
4.9.5.2 Intoxications	
4.9.6 Hereditary diseases	1
4.9.6.1 Deformities	
4.9.6.2 Hydrocoele (Blue sac disease )	

**ZMAT 03 - Course V: Reproduction, Breeding and Biotechnology**  
(Theory Credit-3)

	Hours of Teaching
1. Functional morphology of gonads of teleosts	
1.1 Gametogenesis	2
1.2 Role of environmental factors (photoperiod, temperature, rainfall, salinity) on gonad maturation,	2
1.3 Gonadal steroidogenesis and its control	2
2. Role of hypothalamo-hypophyseal hormones in reproduction	2
3. Reproductive behaviour and pheromones	2
4. Types and mode of reproduction	1
5. Secondary sexual characters	1
6. Sexuality	2
6.1 Intersex	
6.2 Bisexuality	
6.3 Hermaphroditism	
7. Parental care.	1
8. Cryo-preservation of gametes and embryo	2
9. Induced breeding	7
9.1 Factors responsible for induced breeding	
9.2 Hypophysation	
9.3 Use of different synthetic and natural hormones, their formulation and mechanism of action	
9.4 Bundh Breeding	
9.5 Happa Breeding	
9.6 Hatchery Breeding	
10. Multiple breeding of carps	1
11. <i>In vitro</i> fertilization and incubation	1
12. Fish seed collection from natural resources	1
13. Identification and differentiation of eggs and hatchlings of Indian Major carps & common cat fish.	1

14. Development of fish up to hatchlings	1
15. Fish and Fish seed transport.	2
16. Fundamentals of fish genetics	2
17. Fish Biotechnology	7
17.1 Gynogenesis	
17.2 Androgenesis	
17.3 Polyploidy	
17.4 Production of monosex population	
17.5 Hybridization	

**ZMAT 03 - Course VI: Fish Physiology II ( based on Teleosts)**  
(Theory Credit-3)

	Hours of Teaching
1. Nervous system	
1.1 Brain and Cranial nerves	2
1.2 Receptors	
1.2.1 Eye	4
1.2.1.1 Structure	
1.2.1.2 Photoreceptive functions	
1.2.1.3 Formation of image	
1.2.1.4 Photoreception	
1.2.1.5 Functional adaptations	
1.2.2 Acoustico-lateralis system	4
1.2.2.1 Labyrinth	
1.2.2.2 Lateral line organs	
1.2.3 Chemoreceptors	3
1.2.3.1 Gustatory	
1.2.3.2 Olfactory	
1.2.4 Electroreceptors	2
2. Excretion and osmoregulation	7
2.1 Glomerular and aglomerular kidneys	
2.2 Excretion of nitrogenous wastes, water and ion balance	
2.2.1 Urea cycle	
2.2.2 Stenohaline teleosts	
2.2.3 Euryhaline teleosts	
2.2.4 Migratory teleosts	
3. Endocrinology	
3.1 Hypothalamo-hypophyseal system	
3.1.1 Neurosecretory system and Neuro-hypophyseal hormones	4
3.2 Functional morphology of pituitary	3
3.3 Hypothalamic control of pituitary	3
3.4 Structure and functions of the following:	8
3.4.1 Thyroid	

- 3.4.2 Ultimobranchials
- 3.4.3 Pancreas
- 3.4.4 Adrenal
- 3.4.5 Corpuscles of Stannius
- 3.4.6 Urophysis
- 3.4.7 Pineal

### **Books Recommended**

1. Bentley, P. J., Comparative Vertebrate Endocrinology, Cambridge University Press, 2000.
2. Bond, C.E., Biology of Fishes, Saunders College Publishing Philadelphia, 1979.
3. Brown, M.E., The Physiology of Fishes Vol. I, II. Academic Press, 1953 & 1957
4. C.I.F.R.I., Prawn Fisheries Bulletin No. 10, 1977.
5. Chakroff, M., Freshwater Fish Pond Culture and Management, Scientific Publishers, 1987.
6. Datta-Munshi, J.S. & Hughes G. M., Air-breathing fishes of India, Oxford and IBH Publ. Co. New Delhi, 1992.
7. Davis.H. S., Culture and Diseases of Game Fishes, University of California Press, 1956
8. Duijn, C. V., Diseases of Fishes, London Iliffe Books Ltd, 1967.
9. Evans,D.H., The Physiology of Fishes, CRC Press, 1998
10. Gopakumar, K., Singh, B.N. and Chitranshi, V.R. Fifty Years of Fisheries Research in India, Fisheries Division Indian Council of Agricultural Research, New Delhi, 2000.
11. Gorbman et al: Comparative Endocrinology, John Wiley & Sons, New York, Chichester, Brisbane
12. Hadley, M. E., Endocrinology, Prentice Hall, International Editions, 2000.
13. Hall,C. B., Ponds and Fish Culture, Agro Botanical Publishers, 1994
14. Hoar W.S. & Randall, D. J., Fish Physiology, Series Vol. I - XIV, Academic Press
15. Hora, S. L. and Pillay, T.V. R., Handbook on Fish Culture in the Indo-Pacific Region, Fisheries Division, Biology Branch, FAO, 1962.
16. Howard & Churchill, Canning technology. London
17. Huet, M., Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd., 1989.
18. Hughes, G. M. Comparative Physiology of Vertebrate Respiration, Heinemann Educational Books Ltd., 1967
19. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 1985.
20. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
21. Kreuzer, R. ,Fishery products, FAO, Fishing News (Books) Ltd., England. 1974.
22. Kurian and Sebastian. Prawns and Prawn Fisheries of India. Hindustan Publ. Co., 1976.
23. Lagler, K. F Studies in fresh water fishery biology 1950
24. Lagler, K. F., Bardach J.E., Miller R.R. and May Passino, D.R. Ichthyology, John Wiley, 2003.
25. Nilsson, S. & Holmgren, S., Fish Physiology Recent Advances, Croom Helm, London, 1986.
26. Norman, J. R. and Greenwood P. H. A History of Fishes, Third Ed., Ernest Benn Limited, London. 1975.
27. Norris, D. O., Vertebrate Endocrinology (2nd ed.), Academic Press, 1997.
28. Proceedings of International Symposium on Reproductive Physiology of fishes. 1982, 1987, 1991, 1995, 1999



29. Ribelin, W. E. & Migaki, G., The Pathology of Fishes, The Univ. of Wisconsin Press, 1975.
30. Rounsfell, G.A. and Everhart, W. H., Fishery Science: It's Methods and Applications, John Wiley & Sons, Indian Reprint International Books and Periodicals Supply Service, New Delhi 1985.
31. Santhanam, R. Fisheries Science, Daya Publishing House, 1990.
32. Singh, B. R. Advances in Fish Research, Vol. I and II Narendra Publishing House, Delhi 1993 and 1997.
33. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries, Kitab Mahal. 1985
34. The Wealth of India, Raw Materials Vol. IV, Fish and Fisheries, CSIR, 1962.

## **MAJOR ELECTIVE ZMAT 04: MAMMALIAN REPRODUCTIVE PHYSIOLOGY**

### **Course IV: Male Reproduction**

(Theory Credit-3)

	Hours of Teaching
1. Testis	22
1.1 Structure	
1.2 Spermatogenesis and cycle of the seminiferous epithelium+	
1.3 The Sertoli Cell	
1.4 The Leydig Cell	
1.5 Hormonal control of spermatogenesis	
1.6 Cell-cell interactions	
1.7 Rete testis	
2. Epididymis	8
2.1 Organization	
2.2 Function	
2.3 Regulation	
3. Male accessory sex glands	10
3.1 Structural Organization and Endocrine control	
3.2 Cellular and molecular regulation of Prostate	
3.3 Functions of sex accessory gland secretions	

### **ZMAT 04 - Course V: Control of Fertility & Sterility**

(Theory Credit-3)

	Hours of Teaching
1. Control of fertility	24
1.1 Male	
1.1.1 Chemicals suppressing hypophyseal activity, with particular reference to steroid hormones	
1.1.2 Chemicals acting directly on the testis	
1.1.3 Chemicals acting via the epididymis	
1.1.4 Surgical sterilization, with reference to vasectomy	
1.1 Female	
1.2.1 Inhibition of ovulation, with reference to oral contraceptives	
1.2.2 Surgical sterilization, with reference to tubectomy	
1.2.3 Mechanical methods, with reference to intrauterine devices (IUDs)	

1.2.4 Natural Methods (rhythm method)	
2. Control of Sterility	16
2.1 Parameters of male sterility	
2.2 Origin, cause and treatment of male sterility	
2.2.1. Azoospermia	
2.2.2. Oligozoospermia	
2.2.3. Asthenozoospermia	
2.2.4. Varicocele	
2.3 Sterility in females	
2.3.1 Tubal factors	
2.3.2 Ovarian ageing	
2.3.3 Premature ovarian failure	
2.3.4 Polycystic ovarian syndrome	
2.3.5 Luteal insufficiency	

**ZMAT 04 - Course VI: Sexual Behaviour & Reproductive Technologies**  
(Theory Credit-3)

	Hours of Teaching
1. Sexual behaviour	6
1.1 Copulatory patterns	
1.2 Hormones in sexual behaviour	
1.3 Sites of action of sex hormones	
1.4 Dimorphism	
2. Reproductive pheromones	8
2.1 Classification (signalling, releasing, primer and imprinting)	
2.2 Primer pheromones	
2.2.1 Estrous cycle disruption	
2.2.2 Male induction of estrus (the <i>Whitten</i> effect)	
2.2.3 Male induced pregnancy block (the <i>Bruce</i> effect)	
2.2.4 Pheromones and puberty	
2.3 Pheromones and receptor mechanism	
2.4 Human reproductive pheromones	
3. Hormone Replacement Therapy (HRT)	6
4. Ovulation Induction and Enhancement: Treatment of infertility	6
5. Assisted Reproductive Technology (ART)	10
5.1 Types of ART	
5.2 Cryopreservation of gametes and embryo	
5.3 Ethical, legal and emotional implications	
6. Gamete antigens in relation to fertility	4

**Books Recommended**

1. Adashi and Leung (eds): The Ovary, Raven Press, 1993.
2. Adashi *et al*: Reproductive endocrinology, Surgery and

- Technology, Lippincott-Raven publishers, 1996.
3. Findlay, J.K.: Molecular Biology of the Female Reproductive System, Academic Press, San Diego, 1994.
  4. Knobil & Neil (eds.): The Physiology of Reproduction, Vol. I & II, Raven Press, 1994.
  5. Lamming (eds.): Marshall's Physiology of Reproduction. Longman, Green & Co., 1984.
  6. Mann & Lutwak-Mann: The Male Reproductive Function and Semen, Springer-Verlag, 1981.
  7. Paulson *et al* (eds.): Andrology: Male Fertility and Sterility, Academic Press, 1986.
  8. Setchell (ed.): The Mammalian Testis, Cornell University Press, 1992.
  9. Yen *et al* (eds): Reproductive Endocrinology, W.B. Saunders, 1999.

**MAJOR ELECTIVE ZMAT 05: MOLECULAR & APPLIED ENDOCRINOLOGY**  
**Course IV: Manipulation of Reproduction**  
 (Theory Credit-3)

	Hours of Teaching
1. Endocrine Manipulation of Reproduction in mammals	20
1.1 Overview of hormonal control of reproduction	
1.2 Manipulation of the estrous cycle	
1.1.1 Hormone preparations for manipulating reproduction	
1.1.2 Use of hormone agonists to control fertility	
1.3 Methods for the detection of estrus	
1.3.1 Estrous behaviour	
1.3.2 Milk Progesterone	
1.4 Induction and synchronization of estrus	
1.4.1 Prostaglandin F <sub>2α</sub> .based systems	
1.4.2 GnRH and the ovsynch protocol	
1.4.3 Progestin- based systems	
1.5 Superovulation and embryo transfer	
<i>In vitro</i> development of embryos	
1.6 Hormones in maintenance of pregnancy	
1.7 Induction of parturition	
1.8 Inducing puberty	
1.9 Advancing cyclicity in seasonal breeders	
1.10 Immunological control of reproduction	
2. Endocrine manipulation in fishes	10
2.1 Control of reproduction	
2.2 Sex reversal	
2.2.1 Hormonal treatments	
2.2.2 Other methods	
2.3 Induction of spawning	
3. Gamete Preservation in Fish and Mammals	12

- 3.1 Sperm motility and metabolism
- 3.2 Gamete quality
- 3.3 Short-term preservation of spermatozoa
- 3.4 Short-term preservation of ova
- 3.5 Cryopreservation of gametes

**ZMAT 05 - Course V : Growth Manipulation and Animal Products**  
(Theory Credit-3)

	Hours of Teaching
1. Overview : Effects on growth, feed efficiency and lean yield	2
2. Anabolic steroids and Analogues	5
2.1 Direct and indirect effects	
2.2 Delivery systems	
2.3 Effects of sex steroids on meat quality	
2.4 Safety issues	
3. Somatotrophin	3
3.1 Direct and indirect effects	
3.2 Delivery/dose effects	
3.3 Safety/quality aspects	
4. $\beta$ -Adrenergic Agonists	3
4.1 Physiological responses to $\beta$ adrenergic agonists	
4.2 Delivery /dose	
4.3 Safety aspects	
4.4 Alternative approaches for using growth promoters	
5. Thyroid hormones : Effects on growth and development	3
6. Dietary polyunsaturated fatty acids : Metabolic effects and application	2
7. Leptin	2
7.1 Involvement in energy metabolism and reproduction	
7.2 Applications	
8. Cholecystokinin and appetite	3
8.1 Mechanism of action	
8.2. Application	
9. Insulin and glucagon	6
9.1 Physiological effects	
9.2 Dose	
9.3 Role of dietary chromium	
9.4 Safety issues	
10. Effects of stress on meat quality	3
11. Milk production	6
11.1 Hormones and mammogenesis	
11.2 Maintenance of lactation	
11.2.1 Hormonal effects	
11.2.2 Milk removal	

11.3 Metabolic diseases related to lactation	
11.3.1 Ketosis	
11.3.2 Milk fever	
12. Egg production : Hormones and their application	2
13. Wool production : Hormones and their application	2

**ZMAT 05 - Course VI : Animal Behavior, Health & Welfare**  
(Theory Credit-3)

	Hours of Teaching
1. Applications of Pheromones	8
1.1 Types of Pheromones	
1.2 Chemistry of Pheromones	
1.3 Pheromone production and release	
1.4 Detection of Pheromones	
1.5 Vertebrate Pheromones	
2. Hormonal response to stress	8
2.1 Sympatho-adrenal system	
2.2 Hypothalamic – pituitary axis	
2.3 Role of various hormones in stress responses	
2.4 Effects of stress on reproduction	
2.5 Effects on growth performance	
3. Endocrine applications in Toxicology	6
3.1 Endocrine disruptors or modulators	
3.2 Assessment of endocrine disruptor activity	
3.3 Sources of endocrine disruptors	
3.3.1 Plant-derived endocrine modulators	
3.3.2 Xenobiotic endocrine modulators	
4. Obesity	4
4.1 Cause and consequences	
4.2 Outline of hormonal involvement	
4.3 Leptin: synthesis, secretion and its role in adipogenesis	
5. Thyroid disorders and management	5
5.1 Antithyroid drugs, dietary goitrogens	
5.2 Goiter	
5.3 Myxedema	
5.4 Cretinism	
6. Insulin and glucose balance	5
6.1 Glucose homeostasis	
6.2 Insulin resistance and management	
6.3 Diabetes mellitus and management	
7. Gonads and fertility disorders	6
7.1 Amenorrhea	

- 7.2 Polycystic ovary
- 7.3 Hirsutism
- 7.4 Cryptorchism
- 7.5 Varicocoele
- 7.6 Sertoli cell syndrome

**Books Recommended**

1. G. M. Besser & M.O. Thorner. Comprehensive Clinical Endocrinology, III<sup>rd</sup> Ed. (2002), Mosby.
2. E. Knobil & D. Niell. Encyclopedia of Reproduction (1998), Academic Press.
3. P.J.Bentley. Comparative Vertebrate Endocrinology, III<sup>rd</sup> Ed. (1998), Cambridge University Press.
4. E.J.Squires. Applied Animal Endocrinology (2003), CABI Publications UK.
5. Mac E.Hadley. Endocrinology, V Ed. (2000), Prentice Hall International Inc.
6. Norris. Vertebrate Endocrinology, III<sup>rd</sup> ed. (1998). Lea & Febiger.
7. P.R. Larsson et al., Williams Text Book of Endocrinology, Xth Ed. (2002), W.B. Saunders, Philadelphia.

**MAJOR ELECTIVE ZMAT 06: MOLECULAR & HUMAN GENETICS**

**Course VI: Clinical Genetics**

(Theory Credit-3)

	Hours of Teaching
1. History, nature and frequency of genetic diseases	1
2. Molecular and Biochemical basis of genetic diseases	14
2.1 Monogenic disorders	
2.1.1 Autosomal: cystic fibrosis, thalassaemias, Charcot-Marie-Tooth syndrome	
2.1.2 X-linked: Hemophilia A, Duchenne muscular dystrophy, color blindness	
2.2 Metabolic disorders: Phenylketonuria, polysaccharidosis	
2.3 Genomic disorders: Neurofibromatosis-1	
2.4 Dynamic mutations: Huntington's disease	
2.5 Late onset disorders: Alzheimer's disease	
2.6 Imprinting disorders: Prader-Willi syndrome, Angelman syndrome	
2.7 Mitochondrial diseases: MELAS	
3. Multifactorial diseases: Atherosclerosis, Diabetes mellitus	4
4. Clinical Cytogenetics	11
4.1 Cytogenetic techniques in disease detection	
4.2 Chromosomal anomaly and clinical phenotypes	
4.3 Aneuploidy in human disease	
4.3.1 Autosomal	
4.3.2 Sex-chromosomal	
4.3.3 Aneuploidy and parental age	
4.4 Chromosomal deletions	
4.5 Microdeletion syndromes	
4.6 Uniparental disomy	
4.7 Structural rearrangements in chromosomes	
4.8 Fetal wastage and chromosomal anomalies	

5. Management of genetic disorders	4
5.1 Treatment of metabolic disorders	
5.2 Replacement therapy	
5.3 Gene therapy-	
5.3.1 Somatic versus germ line	
5.3.2 <i>Ex vivo</i> and <i>in vivo</i> gene therapy	
5.3.3 Gene therapy strategies and gene delivery vehicles	
5.3.4 Clinical applications	
5.3.5 DNA vaccines	
6. Genetic counseling	5
6.1 Concept and purpose	
6.2 Risk evaluation	
6.3 Diagnostics: chromosomal, post-natal, pre-natal, pre-implantation, pre-fertilization	
6.4 Population screening	
6.5 Legal and ethical considerations	

**ZMAT 06 - Course VII: DNA Damage, Repair and Recombination  
(Theory Credit-1.5)**

	Hours of Teaching
1. DNA damage and repair	10
1.1 Endogenous and exogenous causes, types of DNA damage	
1.2 Repair pathways in prokaryotes and eukaryotes , damage specificity	
1.2.1 Direct reversal: photoreactivation, adaptive response	
1.2.2 Excision repair, transcription-coupled repair	
1.2.3 Mismatch repair	
1.2.4 SOS repair and mutagenesis	
1.2.5 Post-replication retrieval: recombination repair, trans-lesion synthesis	
1.2.6 Double-strand break repair: non-homologous end-joining, homologous recombination repair	
1.3 Damage signaling and checkpoints	
1.4 DNA repair-associated disorders	
2. Recombination	10
2.1 Homologous recombination	
2.2 Mechanism of recombination in bacteria and mammals	
2.3 Programmed DSB generation and meiotic recombination	
2.4 Gene conversion	
2.5 Site-specific recombination	
2.5.1 Lambda phage integration and excision	
2.5.2 Classes of recombinases and types of site-specific recombination	
2.6 Transpositional recombination	
2.7 Mitotic recombination	
2.8 Recombination and genomic instability	
2.9 Application in genetic engineering	

**ZMAT 06 - Course VIII: Cancer Genetics**  
(Theory Credit-1.5)

	Hours of Teaching
1. Genetic regulation of cell cycle and apoptosis	3
2. Hallmark features of cancer	1
3. Cell transformation and tumorigenesis	8
3.1 Oncogenes	
3.2 Tumour suppressor genes	
3.3 DNA repair genes and genomic instability	
3.4 Epigenetic modifications, telomerase activity, centrosome malfunction	
3.5 Genetic heterogeneity and clonal evolution	
4. Genetic models for familial cancer: retinoblastoma, colorectal cancer, breast cancer	2
5. Genetic predisposition to sporadic cancer	1
6. Tumor progression: angiogenesis, metastasis	1
7. Tumor-specific chromosome rearrangements, tumor specific markers	1
8. Cancer and environment: physical, chemical biological carcinogens	2
9. Cancer therapy: radio-, chemo- and immuno-therapy	1

**ZMAT 06 - Course IX: Gene Expression**  
(Theory Credit-2)

	Hours of Teaching
1. Regulation of Transcription and Gene Expression	13
1.1 Chromatin remodelling and gene expression	
1.2 Activators and repressors of transcription	
1.3 Regulation of gene expression by steroid hormones, temperature shock, circadian rhythm	
1.4 Regulation of lysogenic-lytic cycle in lambda phage	
2. Post-transcriptional processing	8
2.1 RNA binding proteins and RNA motifs	
2.2 Transcription attenuation	
2.3 Splicing and alternative splicing	
2.4 Processing of pro- and eukaryotic rRNA and tRNAs	
2.5 RNA editing	
2.6 RNA targeting	
2.7 mRNA stability	
2.8 RNAi and RNA degradation	
3. Post-translational processing	5
3.1 Codon usage and codon bias	
3.2 Protein folding and molecular chaperons	
3.3 Protein processing	
3.4 Protein degradation	



**ZMAT 06 - Course X: Immunogenetics**  
(Theory Credit-1)

	Hours of Teaching
1. Immune response proteins: genetic basis of structure and diversity	1
2. Immunoglobulin gene superfamily	9
2.1 Organization of Ig gene loci	
2.2 Genetic basis of antibody diversity	
2.2.1 Somatic recombination: V(D)J recombination and junctional diversity	
2.2.2 Somatic hypermutation	
2.2.3 Allelic exclusion	
2.2.4 Class switching	
2.3 Organization of TCR gene loci and genetic basis of TCR diversity	
2.4 Organization of HLA locus: genetic polymorphism and HLA haplotypes	
3. Immune disorders	3
3.1 Primary immunodeficiency disorders	
3.2 Secondary immunodeficiency disorders	
3.3 HLA and disease association	

**Books Recommended**

1. Alberts et al, Molecular Biology of the Cell, Garland, 2002
2. Baker et al, A Guide to Genetic Counseling, Wiley, 1998
3. Bate & Martinez-Arias, The Development of *Drosophila melanogaster*, vols 1-2, CSHL Press, 1993
4. Brooker, Genetics- Analysis and Principles, Benjamin, 1999
5. Brown, Gene Cloning-An Introduction, Stanley, 1995
6. Brown, Genomes, Bios, 1999
7. Connors & Ferguson-Smith, Essentials of Medical Genetics, Blackwell, 1993
8. Cowell, Molecular Genetics of Cancer, Eaton, 2001
9. Cox & Sinclair, Molecular Biology in Medicine, Blackwell, 1997
10. Davies, Human Genetic Disease Analysis, Saunders, 1993
11. Ehrlich, DNA Alterations in Cancer, Eaton, 2000
12. Emery & Mueller, Elements of Medical Genetics, ELBS, 1992
13. Fairbanks et al, Genetics: The Continuity of Life, Wadsworth, 1999
14. Gersen & Keagle, Principles of Clinical Cytogenetics, Humana, 1999
15. Gibson & Muse, A Primer of Genome Science, Sinauer, 2002
16. Gilbert, Developmental Biology, Saunders, 2003
17. Glick & Pasternak, Molecular Biotechnology, ASM Press, 1998
18. Hartl & Jones, Genetics: Principles & Analysis of Genes & Genomes. Jones & Bartlett, 1998
19. Hartl, Essential Genetics: A Genomic Perspective, Wiley, 2002
20. Howley & Mori, The Human Genome, AP, 1999
21. Jorde et al, Medical Genetics, Elsevier, 1998
22. Korf, Human Genetics, Blackwell, 1996
23. Kuby, Immunology, Mosby, 2003
24. Lindahl & West, DNA repair & Recombination, Chapman, 1996
25. Lewin, Genes VIII, Pearson, 2004
26. Lewis, Human Genetics, WCB McGraw, 1999

27. Lodish et al, Molecular Cell Biology, Freeman, 2004
28. Mange and Mange, Basic Human Genetics, Sinauer, 1999
29. Nickoloff & Hoekstra, DNA Damage and Repair, vol II, Humana, 2001
30. Nussbaum et al, Genetics in Medicine, Saunders, 2001
31. Passarge, Colour Atlas of Genetics, Thieme, 2001
32. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000
33. Primrose & Twyman, Principles of Genome Analysis and Genomics, Blackwell, 2003
34. Rimoin et al, Principles & Practice of Medical Genetics, vols. I-III, Saunders, 2002
35. Robinson & Linden, Clinical Genetics Handbook, Blackwell, 1994
36. Roit et al, Immunology, Mosby, 2000
37. Rooney & Czepulkowski, Human Cytogenetics-A Practical Approach, IRL, 1987
38. Sambrook et al, Molecular Cloning vols. 1-3, CSHL Press, 2001
39. Snustad and Simmons, Principles of Genetics, Wiley, 2003
40. Stillman, Molecular Genetics of Cancer, CSHL Press, 1994
41. Strachan & Read, Human Molecular Genetics, Wiley, 1999
42. Sudbery, Human Molecular Genetics, Prentice Hall, 2002
43. Vogel & Motulsky, Human Genetics, Springer, 1997
44. Watson et al, Molecular Biology of the Gene, Pearson, 2004
45. Wilson, Clinical Genetics: A Short Course, Wiley, 2000
46. Wolpert, Principles of Development, Oxford, 2002
47. Young, Introduction to Risk Calculation in Genetic Counseling, Oxford, 1999

## **MINOR ELECTIVES**

### **ZMIT 01: AQUACULTURE**

(Theory- 1.5 credit)

	Hours of Teaching
1. Introduction to aquaculture	2
2. Fish farms and their management	5
3. Fish culture in paddy fields	1
4. Sewage fed fisheries	1
5. Polyculture	1
6. Fish seed production	2
6.1 Happa Breeding	
6.2 Hatchery Breeding	
7. Culture techniques	5
7.1 Prawn	
7.2 Edible Oysters	
7.3 Clams	
7.4 Pearl oysters	
8. Post harvest technology	2
8.1 Fish By-products	
8.1.1 Fish oils	
8.1.2 Fish Proteins	
8.1.3 Fish manure	

8.1.4 Fish glue	
8.1.5 Fish flour	
8.1.6 Isinglass	
8.2 Fish Preservation	2
8.2.1 Drying	
8.2.2 Salting	
8.2.3 Smoking	

### Books Recommended

1. Brody , Fishery by-products technology., AVI, Westport
2. C.I.F.R.I., Prawn Fisheries Bulletin No. 10, 1977.
3. Chakroff,M., Freshwater Fish Pond Culture and Management, Scientific Publishers, 1987.
4. Gopakumar, K., Singh, B.N. and Chitranshi, V.R. Fifty Years of Fisheries Research in India, Fisheries Division Indian Council of Agricultural Research, New Delhi, 2000.
5. Hall, C. B., Ponds and Fish Culture, Agro Botanical Publishers, 1994
6. Hora, S. L. and Pillay, T.V. R. Handbook on Fish Culture in the Indo-Pacific Region, Fisheries Division, Biology Branch, FAO, 1962.
7. Huet, M., Textbook of Fish Culture, Breeding and Cultivation of Fish, Fishing News (Books) Ltd. 1989.
8. Jhingran, V.G. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. 1985.
9. Khanna S. S. and H. R. Singh. A textbook of Fish Biology and Fisheries, Narendra Publishing House, 2003
10. Kreuzer, R., Fishery products., FAO, Fishing News Books Ltd., England, 1974.
11. Kurian and Sebastian. Prawns and Prawn Fisheries of India. Hindustan Publ. Co., 1976.
12. Lagler, K. F Studies in fresh water fishery biology 1950
13. Rounsfell, G.A. and Everhart, W.H. Fishery Science: it's Methods and Applications John Wiley & Sons, Indian Reprint International Books and Periodicals Supply Service, New Delhi 1985.
14. Santhanam, R. Fisheries Science, Daya Publishing House, 1990.
15. Srivastava, C.B.L. A Textbook of Fishery Science and Indian Fisheries, Kitab Mahal. 1985
16. The Wealth of India, Raw Materials Vol. IV, Fish and Fisheries, CSIR, 1962.

### ZMIT 02: BIOSTATISTICS

(Theory - 1.5 credit)

	Hours of Teaching
1. Calculation of Mean, Median, Mode, Range, Variance, Standard deviation, and Quartile deviation.	2
2. Concepts of Coefficient of Variation, Skewness and Kurtosis.	2
3. Linear Regression and Simple Correlation.	2
4. Elementary idea of Probability and Application of Theorems of Total and Compound Probability	2
5. Elementary idea of Random variables under their following distributions: Binomial, Poisson, Normal, Student's-t, Chi-square and F (shape, range and finding percentage points from tables)	3
6. Method of drawing of Random Sample from a Finite Population, Finding Standard Error of Sample of Mean and Confidence interval of Population Mean.	3
7. Chi-square Test of Independence and Goodness of Fit.	2

- |   |   |
|---|---|
| 8. Comparison of Means for one Sample and Two Samples (Z and t-tests)                             | 2 |
| 9. ANOVA- One Way and Multiple Comparison, Testing<br>Equality of k Variances, Randomized Blocks. | 2 |

**Books Recommended**

1. Bruning J.L. and B. L. Kintz (1977) Computational Handbook of Statistics, Scott, Foresmaln and Company.
2. Daniel W.W. (2000) Biostatistics: A Foundation for Analysis in Health Sciences, John Wiley.
3. Milton J.S. and J.O. Tsokos (1983) Statistical Methods in the Biological and Health Sciences, McGraw Hill Book Co.
4. Quinn G.P. and Keough M.J. (2002) Experimental Design and Data Analysis for Biologists, Cambridge Univ. Press.
5. Snedecor G.W. and W.G./ Cochran (1968) Statistical Methods Oxford & IBH Pub.
6. Sokal R.R. and F.J. Rohlf (2000) Biometry Freeman.
7. Steel R.G.D. and J.H. Torrie (1980) Principles and Procedures of Statistics: A Biometrical Approach, McGraw Hill Book Co.
8. Zar J.H. (2003) Biostatistical Analysis, Pearson Education.

**ZMIT 03: CHRONOBIOLOGY**  
(Theory - 1.5 credit)

	Hours of Teaching
1. Introduction	3
1.1 History	
1.2 Biological rhythms	
1.3 Biological clocks	
1.4 Significance of biological timekeeping	
2. Biological rhythms	5
2.1 Types of rhythms	
2.1.1 Circadian	
2.1.2 Circatidal	
2.1.3 Circalunar	
2.1.4 Circannual	
2.2 Methods of measurement	
2.3 Properties	
2.3.1 Entrainment	
2.3.2 Re-entrainment	
2.3.3 Phase angle difference	
2.3.4 Freerun	
2.3.5 Phase shift	
2.3.6 Phase response curve	
2.3.7 Arrhythmia	
3. Factors influencing biological rhythms	3
3.1 Environmental	
3.1.1 Photoperiod	
3.1.2 Temperature	
3.2 Other zeitgebers	
4. Centres of biological clock	3

4.1	Suprachiasmatic nuclei	
4.2	Pineal gland	
4.3	Optic lobes	
5.	Molecular bases of circadian rhythms	3
5.1	Clock genes	
5.1.1	<i>Drosophila</i>	
5.1.2	Mouse	
6.	Applied Chronobiology	4
6.1	Human circadian rhythms	
6.2	Applications of circadian rhythm principles	
6.2.1	Jet-lag/shift work	
6.2.2	Depression and sleep disorders	
6.2.3	Chronopharmacology and Chronotherapy	

### Books Recommended

1. Binkley, S. (1990): The clockwork sparrow: time, clocks, and calendars in biological organisms, Prentice-Hall, New Jersey.
2. Chandrashekar, M. K. (1985): Biological rhythms, Madras Science Foundation, Chennai.
3. Shapiro, C. M. and Heslegrave, R. J. (1996): Making the shift work, Joli Joco Publications, Inc. Toronto.
4. Nelson, R. J. (2000) An Introduction to Behavioural Endocrinology, 2<sup>nd</sup> edition, Sunderland Publishers, Massachusetts.

### ZMIT 04: ECOLOGICAL BIOCHEMISTRY (Theory - 1.5 credit)

	Hours of Teaching
1. Ecology	1
1.1 Introduction to ecology	
1.2 The concept of ecosystem	
1.3 Biological factors in the environment	
2. Brief introduction to plant chemistry (alkaloids, terpenoids, steroids, phenolics, glucosinolates)	2
3. Biochemistry of plant pollination (role of flower colour, scent, nectar and pollen)	2
4. Plant toxins and their effects on animals	3
4.1 Different classes of plant toxins	
4.2 Cyanogenic glycosides	
4.3 Cardiac glycosides, milkweeds, monarch butterfly and blue Jays	
5. Hormonal interactions between plants and animals	4
5.1 Plant oestrogens	
5.2 Insect moulting hormones in plants	
5.3 The fruit fly-cactus interaction	
5.4 Insect juvenile hormones in plants	
5.5 Pheromonal interactions and the pine bark beetle	
6. Feeding preferences of herbivores	3
6.1 Biochemical basis of plant selection by insects	
6.2 Secondary compounds as feeding attractants	
6.3 Secondary compounds as feeding deterrents	

6.4 Domestic animals, wild animals, birds and man	
7. Plant defence and animals response	3
7.1 Static plant defence	
7.2 Induced plant defence	
7.3 Animal response	
8. Animal pheromones and defence substances	3
8.1 Insect pheromones	
8.2 Mammalian pheromones	
8.3 Defence substances	

### Books Recommended

1. Harborne : Introduction to Ecological Biochemistry 4th Ed. Academic Press, 1993.
2. Schoonhoven et al.: Insect-Plant Biology, Chapman and Hall 1998.
3. Chapman and Reiss : Ecology - Principles and applications, Cambridge University Press, 1995.
4. Ricklefs and Miller : Ecology 4th ed. Freeman and Co. 2000.

### ZMIT 05: ECONOMIC ZOOLOGY

(Theory - 1.5 credit)

	Hours of Teaching
1. Economic Entomology	5
1.1 Sericulture	
1.2 Apiculture	
1.3 Lac culture	
2. Aquaculture	7
2.1 Fish culture	
2.2 Prawn culture	
2.3 Pearl culture	
3. Poultry	2
4. Dairy industry	2
5. Pest Management	5
5.1 Insects	
5.2 Rodents	

### Books Recommended

1. Venkitaraman: Economic Zoology (Sudarsana Publishers, 1983)
2. Srivastava : A Text Book of Applied Entomology, Vol. II & III (Kalyani Publishers, 1988 & 1991)
3. Shukla & Upadhyaya : Economic Zoology (Rastogi Publishers, 1999-2000)

### ZMIT 06: ELECTRON MICROSCOPY

(Theory - 1.5 credit)

	Hours of Teaching
1. Introduction and image formation	
1.1 Transmission electron microscope	3
1.2 Scanning electron microscope	2
2. Preparation of biological material for TEM	
2.1 Fixation	4
2.1.1 Types of fixatives	

2.1.2	Methods of fixation	
2.1.3	Dehydration	
2.1.4	Factors affecting quality of fixation	
2.2	Embedding media and polymerisation	2
2.3	Ultratomy	3
2.3.1	Glass and diamond knives	
2.3.2	Grids	
2.3.3	Methods of sectioning of semi-thin and ultra thin sections	
2.3.4	Flattening and collection of sections	
2.3.5	Elementary knowledge of support films (Plastic and Carbon films)	
2.4	Staining	2
2.4.1.1	Semi-thin sections	
2.4.1.2	Ultra-thin sections	
3.	Preparation of biological material for SEM	3
3.1	Fixation and dehydration	
3.2	Critical point drying	
3.3	Sputter coating	
4.	Applications of electron microscopy in histochemistry, immunocytochemistry and autoradiography	2

### Books Recommended

1. Bancroft, J. S. & Steven, A. Theory and Practice of Histological Techniques, Churchill-Livingstone, 1996.
2. Hayat, M. A. Principles and Techniques of Electron Microscopy Biological Applications (vols. 1-11) Van Nostrand
3. Hayat, M. A. Principles and Techniques of Scanning Electron Microscopy (vol. 1), Van Nostrand Reinhold Company, New York, 1974.
4. Hayat, M. A. Basic Electron Microscopic techniques, Van Nostrand Reinhold Company, New York, 1972.
5. Meek, G. A.: Practical Electron Microscopy for Biologist, John Wiley, 1970.
6. Grimstone, A. V. The electron microscope in Biology. The institute of Biology's studies in Biology No. 9. Edward Arnold Publishers Ltd. 1968.
7. Sjostrand, F.S. Electron microscopy of cells and tissues, Vol.1. Instrumentation and techniques, 1967
8. Wischnitzer S. Introduction to Electron microscopy, Pergamon Press 1989.
9. Pease, D. C., Histological Techniques for Electron Microscopy, 2<sup>nd</sup> Edition, Academic Press New York, 1964.

### ZMIT 07: GAMETE BIOLOGY

(Theory - 1.5 credit)

	Hours of Teaching
1. Isogamy and heterogamy	1
2. Gametogenesis	3
2.1 Morphological basis of spermatogenesis	
2.2 Overview of oogenesis	
3. Ovulation	2
4. Sperm-egg interaction	4
4.1 Fertilization	

5. Gamete manipulation	10
5.1 Multiple ovulations	
5.2 In-vitro fertilization	
5.3 Cryopreservation	
5.4 Intra cytoplasmic sperm injection	
5.5 Chimera formation	
5.6 Embryonic stem cell	
6. Gamete immunology	8
6.1 Gamete specific antigens	
6.1.1 Zona pellucida antibody	
6.1.2 Sperm antibody	

### Books Recommended

1. Gilbert, S.F. Developmental Biology (7th Edition) 2003. Sinauer Associates Inc.
2. Knobil, E and Neill J.D. (Editors) Encyclopedia of Reproduction, Vol. I-IV 1998, Academic Press.

### ZMIT 08: NEUROBIOLOGY

(Theory - 1.5 credit)

	Hours of Teaching
1. Organization of the nervous system	2
1.1 Brain structure	
1.2 Cerebrospinal fluid	
2. Cells and connection of the nervous system	3
2.1 Neurons	
2.2 Glial cells	
2.3 Synapses	
2.4 Neural network	
2.5 Blood-brain barrier	
3. Neurotransmitters and Neuropeptides	1
4. Learning and Memory	2
4.1 Types	
4.2 Molecular basis	
5. Brain and behaviour	2
5.1 Motivation	
5.2 Sleep	
6. Brain aging	1
7. Brain imaging	2
7.1 CAT	
7.2 PET	
7.3 MRI	
8. Neuropathology	5
8.1 Strokes	
8.2 Epilepsy	
8.3 Alzheimer's disease	
8.4 Huntington's disease	
8.5 Parkinson's disease	

### Books Recommended

1. Longstaff: Neuroscience, Viva Books Pvt. Ltd., 2002



2. Shepherd: Neurobiology, Oxford Univ. Press
3. Ganong: Review of Medical Physiology (21st Ed.), Lange Medical Publ., 2003
4. Guyton & Hall: Textbook of Medical Physiology (10th Ed.), WB Saunders, 2001.

### **ZMIT 09: POPULATION GENETICS**

(Theory - 1.5 credit)

	Hours of Teaching
1. Genetic Constitution of a Mendelian Population	5
1.1 Mendelian Population	
1.2 Frequencies of Genes and Genotypes	
1.3 Hardy-Weinberg Principle	
1.4 Genetic Equilibrium and conditions for its maintenance	
1.5 Changes of Gene Frequencies	
2. Population Substructure	4
2.1 Hierarchical Population Structure	
2.2 Isolate Breaking: The Wahlund Principle	
2.3 Population Genetics in DNA Typing	
2.4 Inbreeding	
2.5 Assortative Mating	
3. Darwinian Selection	3
3.1 Selection in Haploid and Diploid Organisms	
3.2 Mutation-Selection Balance	
3.3 More Complex Types of Selection	
4. Random Genetic Drift	4
4.1 Random Genetic Drift and Binomial Sampling	
4.2 The Wright-Fisher Model of Random Genetic Drift	
4.3 Parallelism between Random Drift and Inbreeding	
4.4 Effective Population Size	
4.5 Balance between Mutation and Drift	
5. Quantitative Genetics	4
5.1 Types of Quantitative Traits	
5.2 Fluctuating Asymmetry	
5.3 Concept of Heritability	
5.4 Artificial Selection: Response and Prediction	
5.5 Genetic Distance and Phylogenetic Trees	
5.6 Quantitative Trait Loci (QTL)	

#### **Books Recommended**

1. Falconer D. S. (1989): Introduction to Quantitative Genetics. ELBS
2. Falconer D.S. and T. F. C. Mackay (2000): Introduction to Quantitative Genetics. ELBS
3. Futuyma D. J. (1998): Evolutionary Biology. Sinauer
4. Hartl D. L. and A. G. Clark (1989 & 1997): Principles of Population Genetics. Sinauer
5. Kimura M. (1984): The Neutral Theory of Molecular Evolution. Cambridge
6. Li Wen-Hsiung and Dan Graur (1991): Fundamentals of Molecular Evolution. Sinauer

7. Lynch M. and B. Walsh (2000): Genetics and Analysis of Quantitative Traits. Sinauer
8. Mather K. and J. L. Jinks (1971): Biometrical Genetics: the study of continuous variation. Chapman and Hall
9. Nei M. and Sudhir Kumar (2000): Molecular Evolution and Phylogenetics. Oxford
10. Polak M. (2003): Developmental Instability: causes and consequences (Ed.). Oxford.
11. Strickberger M. W. (2000): Evolution. Jones and Bartlett.

**For Non-biology graduates**  
**ZMIT 10: BASIC PRINCIPLES OF GENETICS**  
 (Theory - 1.5 credit)

	Hours of Teaching
1. Scope of Genetics	1
2. Transmission Genetics: genotype, phenotype, chromosomal basis of inheritance (meiosis, segregation, independent assortment, linkage and crossing over)	3
3. Nature and flow of genetic information	6
3.1 DNA and RNA: chemical composition and secondary structure	
3.2 Proteins and their roles as structural and catalytic molecules in biological organization	
3.3 Replication and transcription	
3.4 Genetic code and translation	
4. Concept of gene	3
5. Regulation of gene activity	4
5.1 Differential gene activity and cell differentiation	
5.2 Positive and negative regulation of gene activity	
5.3 General concepts of transcriptional and post-transcriptional of gene activity	
6. Genes and diseases (common inherited disorders in man, cancer)	2
7. Human Genome	1

**Books Recommended**

1. Griffith *et al*: An Introduction to Genetic Analysis, Freeman, 2004
2. Hartl & Jones: Essential Genetics : A Genomic Perspective, Jones & Bartlet, 2002
3. Russell: Genetics, Benjamin Cummings, 2002
4. Snustad & Simmons: Principles of Genetics, John Wiley, 2003

**ZMIT 11: ELEMENTARY BIOCHEMISTRY**  
 (Theory - 1.5 credit)

	Hours of Teaching
1. Introduction	1
1.1 Chemistry of living system	
1.2 Scope and importance	
2. Biomolecular organizations	2
2.1 Monomer and polymer concept	

2.2 Chemical interactions	
2.3 Configuration and conformation	
2.4 H <sub>2</sub> O as biological solvent	
3. Macromolecules of living cells	10
3.1 Proteins	
3.1.1 Functions and diversity	
3.1.2 Structure and conformation	
3.1.2.1 Primary structure: Amino acids, peptide bond	
3.1.2.2 Fibrous and globular proteins	
3.2 Carbohydrates	
3.2.1 Glucose as a photosynthetic product	
3.2.2 Mono-, Oligo- and Polysaccharides	
3.3 Lipids: Properties and functions	
3.4 Nucleic acids	
3.4.1 DNA and RNA: Structure and functions	
3.4.2 Nucleosomes	
3.4.3 Central dogma of information flow: Concept of genes, Replication, Transcription and Translation	
3.4.4 Recombinant DNA technology and its application	
4. Enzymes	3
4.1 Characteristics and mechanism of action	
4.2 Ribozymes	
5. Metabolism	2
5.1 Anabolism and catabolism	
5.2 Energy transduction in cells	

### Books Recommended

1. Conn, Stumpf, Bruening & Doi: Outline of Biochemistry, John Wiley & Sons
2. Murray et al.; Harper's Biochemistry, Prentice Hall

### ZMIT 12: FUNDAMENTALS OF BIOLOGY

(Theory - 1.5 credit)

	Hours of Teaching
1. Properties and diversity of living organisms: different kingdoms, uni- and multi-cellular organisms, hierarchy of tissues, organs and systems in multi-cellular higher animals (human model)	4
2. Biological macromolecules: Polysaccharides, Lipids, Proteins (structure and functions); Nucleic acids	2
3. Cell Structure: cell organelles and division of labour	1
4. Cell division: interphase nucleus and mitosis	1
5. Nature of gene and flow of genetic information: replication, transcription; genetic code and protein synthesis	3
6. Principles of inheritance and meiosis	2
7. Embryonic development and cascades of gene regulatory activity	3
8. Mechanism and process of biological evolution	2
9. Self-organization of biological systems	2

### Books Recommended

1. Green et al: Biological Science, Cambridge, Low price ed. 1996
2. Mader: Biology, McGraw Hill, 1998

### ZMIT 13: HORMONES & DISEASES

(Theory - 1.5 credit)

	Hours of Teaching
1. Scope of endocrinology	1
2. Pituitary gland	3
2.1 Introduction	
2.2 Dwarfism	
2.3 Gigantism	
2.4 Acromegaly	
2.5 Diabetes insipidus	
3. Thyroid gland	3
3.1 Introduction	
3.2 Goiter	
3.3 Myxoedema	
3.4 Cretinism	
4. Parathyroid gland	2
4.1 Introduction	
4.2 Osteoporosis	
4.3 Tetany	
5. Islets of Langerhans	2
5.1 Introduction	
5.2 Diabetes mellitus	
6. Adrenal gland	2
6.1 Introduction	
6.2 Addison's disease	
6.3 Cushing's syndrome	
7. Testis and male infertility: Use of semen analysis in male infertility	3
8. Ovary and female infertility: Polycystic ovarian disease	2
9. Hormones and cancer	1
10. Hormones and stress	1
11. Obesity	1

### Books Recommended

1. Mac E. Hadley: Endocrinology, Prentice Hall, International Edition, 2000
2. Wilson and Foster, Williams Text Book of Endocrinology 8th edition, W.B .Saunders Company Philadelphia, 1972.



**APPLICABLE FROM  
THE SESSION 2005-06**



**\*APPLICABLE FROM THE SESSION 2005-06**

**MAJOR ELECTIVES  
NUMBER OF COURSES & CREDITS  
SEMESTER III**

Existing Syllabus		Proposed Changes	
Theory Courses	Lab. Courses	Theory Courses	Lab Courses
ZMAT 01 & ZMAL 01: Biochemistry & Molecular Biology		ZMAT 01 & ZMAL 01: Biochemistry & Molecular Biology	
ZMAT 01	ZMAL 01	ZMAT 01	ZMAL 01
<b>Course I</b> 3 credits (Nucleic Acids) <b>Course II</b> 3 credits (Proteins) <b>Course III</b> 3 credits (Enzymology)	4.5 credits	<b>Course I</b> 3 credits (Nucleic Acids) <b>Course II</b> 3 credits (Proteins) <b>Course III</b> 3 credits (Enzymology)	1.5 credits 1.5 credits 1.5 credits
ZMAT 02 & ZMAL 02 : Entomology		ZMAT 02 & ZMAL 02 : Entomology	
ZMAT 02	ZMAL 02	ZMAT 02	ZMAL 02
<b>Course I</b> 3 credits (Structure and function of insects-I) <b>Course II</b> 3 credits (Insects pests and their control) <b>Course III</b> 1.5 credits (Structure and function of insects-II) <b>Course IV</b> 1.5 credits (Industrial Entomology)	4.5 credits	<b>Course I</b> 3 credits (Structure and function of insects-I) <b>Course II</b> 3 credits (Insects pests and their control) <b>Course III</b> 3 credits <b>Section-A (1.5 credits) :</b> Structure and function of insects-II <b>Section-B (1.5 credits) :</b> Industrial Entomology)	1.5 credits 1.5 credits 1.5 credits
ZMAT 03 & ZMAL 03 : Fish Biology		ZMAT 03 & ZMAL 03 : Fish Biology	
ZMAT 03	ZMAL 03	ZMAT 03	ZMAL 03
<b>Course I</b> 3 credits (Capture Fishery and Nutrition) <b>Course II</b> 3 credits (Culture Fisheries) <b>Course III</b> 3 credits (Fish Physiology)	4.5 credits	<b>Course I</b> 3 credits (Capture Fishery and Nutrition) <b>Course II</b> 3 credits (Culture Fisheries) <b>Course III</b> 3 credits (Fish Physiology)	1.5 credits 1.5 credits 1.5 credits
ZMAT 04 & ZMAL 04 : Mammalian Reproductive Physiology		ZMAT 04 & ZMAL 04 : Mammalian Reproductive Physiology	
ZMAT 04	ZMAL 04	ZMAT 04	ZMAL 04
<b>Course I</b> 3 credits (Neuroendocrinology of Reproduction) <b>Course II</b> 3 credits (Sex differentiation & Reproductive processes) <b>Course III</b> 3 credits (Female Reproduction)	4.5 credits	<b>Course I</b> 3 credits (Neuroendocrinology of Reproduction) <b>Course II</b> 3 credits (Sex differentiation & Reproductive processes) <b>Course III</b> 3 credits (Female Reproduction)	1.5 credits 1.5 credits 1.5 credits
ZMAT 05 & ZMAL 05 : Molecular & Applied Endocrinology		ZMAT 05 & ZMAL 05 : Molecular & Applied Endocrinology	
ZMAT 05	ZMAL 05	ZMAT 05	ZMAL 05
<b>Course I</b> 3 credits (Hormones, Receptors and Hormone action) <b>Course II</b> 3 credits (Brain-pituitary integration of endocrine systems) <b>Course III</b> 3 credits (Endocrine Methodologies)	4.5 credits	<b>Course I</b> 3 credits (Hormones, Receptors and Hormone action) <b>Course II</b> 3 credits (Brain-pituitary integration of endocrine systems) <b>Course III</b> 3 credits (Endocrine Methodologies)	1.5 credits 1.5 credits 1.5 credits
ZMAT 06 & ZMAL 06: Molecular & Human Genetics		ZMAT 06 & ZMAL 06: Molecular & Human Genetics	
ZMAT 06	ZMAL 06	ZMAT 06	ZMAL 06
<b>Course I</b> 3 credits (Human Genetics) <b>Course II</b> 1.5 credits (Recombinant DNA Techniques) <b>Course III</b> 1.5 credits (Development Genetics) <b>Course IV</b> 2 credits (Genomics) <b>Course V</b> 1 credits (Advanced Genetic Techniques in <i>Drosophila</i> )	4.5 credits	<b>Course I</b> 3 credits (Human Genetics) <b>Course II</b> 3 credits <b>Section-A (1.5 credits) :</b> Recombinant DNA Techniques; <b>Section-B (1.5 credits):</b> Developmental Genetics <b>Course III</b> 3 credits <b>Section-A (2 credits) :</b> Development Genetics <b>Section-B (1 credit) :</b> Advanced Genetic Techniques in <i>Drosophila</i>	1.5 credits 1.5 credits 1.5 credits

**\*APPLICABLE FROM THE SESSION 2005-06**

**MAJOR ELECTIVES**

**NUMBER OF COURSES & CREDITS**

**SEMESTER IV**

<b>Existing Syllabus</b>		<b>Proposed Changes</b>	
<b>Theory Courses</b>	<b>Lab. Courses</b>	<b>Theory Courses</b>	<b>Lab. Courses</b>
ZMAT 01 & ZMAL 01: Biochemistry & Molecular Biology		ZMAT 01 & ZMAL 01: Biochemistry & Molecular Biology	
ZMAT 01	ZMAL 01	ZMAT 01	ZMAL 01
<b>Course IV</b> 3 credits (Regulation of Intermediary Metabolism) <b>Course V</b> 3 credits (Cell Signaling and Apoptosis) <b>Course VI</b> 3 credits (Medical Biochemistry)	4.5 credits	<b>Course IV</b> 3 credits (Regulation of Intermediary Metabolism) <b>Course V</b> 3 credits (Cell Signaling and Apoptosis) <b>Course VI</b> 3 credits (Medical Biochemistry)	1.5 credits 1.5 credits 1.5 credits
ZMAT 02 & ZMAL 02 : Entomology		ZMAT 02 & ZMAL 02 : Entomology	
ZMAT 02	ZMAL 02	ZMAT 02	ZMAL 02
<b>Course V</b> 3 credits (Insects Hormones and tanning) <b>Course VI</b> 3 credits (Agricultural Entomology) <b>Course VII</b> 1.5 credits (Structure and function of insects-II) <b>Course IV</b> 1.5 credits (Industrial Entomology)	4.5 credits	<b>Course IV</b> 3 credits (Insect Hormones and tanning) <b>Course VI</b> 3 credits (Agricultural Entomology) <b>Course VI</b> 3 credits <b>Section-A (1.5 credits)</b> : Structure and function of insects-II; <b>Section-B (1.5 credits)</b> : Medical and veterinary entomology	1.5 credits 1.5 credits 1.5 credits
ZMAT 03 & ZMAL 03 : Fish Biology		ZMAT 03 & ZMAL 03 : Fish Biology	
ZMAT 03	ZMAL 03	ZMAT 03	ZMAL 03
<b>Course IV</b> 3 credits (Harvest, Post Harvest Technology and Fish Pathology) <b>Course V</b> 3 credits (Reproduction, Breeding and Biotechnology) <b>Course VI</b> 3 credits (Fish Physiology-II)	4.5 credits	<b>Course IV</b> 3 credits (Harvest, Post Harvest Technology and Fish Pathology) <b>Course V</b> 3 credits (Reproduction, Breeding and Biotechnology) <b>Course VI</b> 3 credits (Fish Physiology-II)	1.5 credits 1.5 credits 1.5 credits
ZMAT 04 & ZMAL 04 : Mammalian Reproductive Physiology		ZMAT 04 & ZMAL 04 : Mammalian Reproductive Physiology	
ZMAT 04	ZMAL 04	ZMAT 04	ZMAL 04
<b>Course IV</b> 3 credits (Male Reproduction) <b>Course V</b> 3 credits (Control of Fertility of Sterility) <b>Course VI</b> 3 credits (Sexual Behaviour & Reproductive Technologies)	4.5 credits	<b>Course IV</b> 3 credits (Male Reproduction) <b>Course V</b> 3 credits (Control of Fertility of Sterility) <b>Course VI</b> 3 credits (Sexual Behaviour & Reproductive Technologies)	1.5 credits 1.5 credits 1.5 credits
ZMAT 05 & ZMAL 05 : Molecular & Applied Endocrinology		ZMAT 05 & ZMAL 05 : Molecular & Applied Endocrinology	
ZMAT 05	ZMAL 05	ZMAT 05	ZMAL 05
<b>Course IV</b> 3 credits (Manipulation of Reproduction) <b>Course V</b> 3 credits (Growth Manipulation and Animal Products) <b>Course VI</b> 3 credits (Animal behaviour, Health & Welfare)	4.5 credits	<b>Course IV</b> 3 credits (Manipulation of Reproduction) <b>Course V</b> 3 credits (Growth Manipulation and Animal Products) <b>Course VI</b> 3 credits (Animal behaviour, Health & Welfare)	1.5 credits 1.5 credits 1.5 credits
ZMAT 06 & ZMAL 06: Molecular & Human Genetics		ZMAT 06 & ZMAL 06: Molecular & Human Genetics	
ZMAT 06	ZMAL 06	ZMAT 06	ZMAL 06
<b>Course VI</b> 3 credits (Clinical Genetics) <b>Course VII</b> 1.5 credits (DNA Damage, Repair and Recombination) <b>Course VIII</b> 1.5 credits (Cancer Genetics) <b>Course IX</b> 2 credits (Gene Expression) <b>Course X</b> 1 credits (Immunogenetics)	4.5 credits	<b>Course IV</b> 3 credits (Clinical Genetics) <b>Course V</b> 3 credits <b>Section-A (1.5 credits)</b> : DNA Damage, Repair Recombination; <b>Section-B (1.5 credits):</b> Cancer Genetics <b>Course VI</b> 3 credits <b>Section-A (2 credits)</b> : Gene Expression; <b>Section-B (1 credit)</b> : Immunogenetics	1.5 credits 1.5 credits 1.5 credits