UNIVERSITY OF KERALA
Thiruvananthapuram

M.Sc. Zoology – Semester System

Revised syllabus
(for 2013 admissions onwards)

March 2013

Preamble

The University of Kerala decided to revise the syllabus of all P. G. Programmes with effect from the academic year 2013-14 as part of its continued efforts to provide the latest information to the students. Accordingly, the P. G. Board of studies in Zoology held two workshops involving representatives of the eleven colleges offering P. G. course (M. Sc. Zoology) under the University of Kerala during 15th June and 20th July 2012. After deliberations and incorporating the suggestion of external experts such as Dr. Shaju Thomas, Chairman, P. G. Board of Studies in Zoology of M. G. University, Kottayam, the syllabus was revised. The existing syllabus was updated by the addition of relevant information contents, web resources and avoiding duplication with the existing U G Syllabus, as far as possible. The UGC-CSIR NET syllabus was also taken into consideration. Similarly, the decision of the University Grants Commission banning the use of animals for dissections was considered while designing the practical experiments.

Four faculty members were selected as coordinators of the four semesters in the meeting held on 15th June, 2012:

Semester – I – Dr. Kunhikrishnan, University College, Thiruvananthapuram

Semester – II – Dr. Vijayamohan, BJM Govt. College, Chavara

Semester – III – Dr. G. Nagendra Prabhu, S. D. College, Alleppey

Semester – IV – Dr. Indira B, S. N. College, Cherthala

During the meeting held on 20th July, 2012, the chairman suggested that 2 of the existing semester coordinators should oversee the compilation of the entire syllabus. Consequently Dr. B. Indira and Dr. G. Nagendra Prabhu were entrusted with the overall coordination. The syllabi, prepared by the teachers assigned and compiled by the semester coordinators were circulated among the participants by email and feedback incorporated, as recieved. The draft syllabus was discussed and approved by the P. G. Boad of Studies held on 13th March 2013.

The Chairman and Members of the P. G. Board of Studies would like to place on record their gratitude to the entire faculty who took part in the discussion and contributed to the design of the syllabus, which will be effective from the academic year 2013-14. Comments &, suggestions for improvement are welcome.

Dr. Subash Peter

Thiruvananthapuram — Chairman PGBOS in Zoology &

15-03-2013 — Head, Department of Zoology,

University of Kerala

General Instructions

1. Study of local fauna is to be made compulsory and included as part of field visit, as applicable.

2. The Practical Record valuation is to be done by external examiners as the present system of Internal Valuation is making the students take it lightly.

3. Web resources, CDs, appropriate software etc should be used as far as possible.

4. The Project should be given importance. Name of the supervising teachers is to be included in the dissertation. The project should be valued by the examiners who conduct the viva voce.

5. The topics for project should be decided during the beginning to the 3rd semester and the student should present a brief review and proposed methodology towards the middle of the semester in an internal presentation in the Department, involving all students and teachers.

6. A final departmental level presentation based on LCD/OHP/Laptop should be made at the end of the 4th semester, including all students and teachers.

7. A presentation using LCD/OHP/Laptop before the external examiners during the viva voce which will be the basis of awarding marks.

8. 25 marks is allotted for viva voce and 75 for the project report as per guidelines.

UNIVERSITY OF KERALA

M.Sc. Zoology – Semester System

Revised Syllabus, Course Structure & Mark Distribution

Semester	Paper Code	Title	Distribution of hours / semester	Instructional hours/week L	P	Duration of ESA (Hrs)	Maximum Marks CA	ESA	Total
1	ZO 211	Systematics & Evolutionary Biology	100	5	-	3	25	75	100
	ZO 212	Biochemistry	100	5	-	3	25	75	100
	Z0 213	Biophysics, Instrume & Computer Science	100	5	-	3	25	75	100
	Z0 214	Practical	120	-	10	4	25	75	100
	Total for S 1		**450***	**15**	**10**	**-**	**100**	**300**	**400**
2	ZO 221	Advanced Physiology & Functional Anatomy	100	5	-	3	25	75	100
	ZO 222	Genetics, Quantitativ Analysis & Research Methodolo	100	5	-	3	25	75	100
	Z0 223	Cell & Molecular Biology	100	5	-	3	25	75	100
	Z0 224	Practical	120	-	10	4	25	75	100
	Total for S 2		**450***	**15**	**10**	**-**	**100**	**300**	**400**
3	ZO 231	Microbiology & Biotechnology	100	5	-	3	25	75	100
	ZO 232	Ecology, Ethology & Biodiversity Conservation	100	5	-	3	25	75	100
	Z0 233	Immunology & Advanced Dev. Biology	100	5	-	3	25	75	100
	Z0 234	Practical	120	-	10	4	25	75	100
	Total for S 3		**450***	**15**	**10**	**-**	**100**	**300**	**400**
4	ZO 241	Special Paper 1	100	8	-	3	25	75	100
	ZO 242	Special Paper 2	100	7	-	3	25	75	100
	Z0 243	Special Paper Practical 1	100	-	5	3	25	75	100
	Z0 244	Special Paper Practical 2	120	-	5	4	25	75	100
	Total for S 4		**450***	**15**	**10**	**-**	**100**	**300**	**400**
	ZO 201	Project	-	-	-	-	25 marks	75 marks	100
	ZO 202	Comprehensive *Viva Voce*					-	100	100
Grand Total			**-**	**-**	**-**	**-**	**400**	**1400**	**1800**

L – Lecture, P – Practical; T – Tutorial; CA Continuous Assessment; ESA – End Semester Assessment;

*** Tutorial 30 hours per week**

UNIVERSITY OF KERALA
M.Sc. Zoology – Semester System
Revised syllabus (2013)

Semester I

Zoo 211 Systematics and Evolutionary Biology

Total 100 hours **(50 + 50 hrs)**

Systematics

Module 1.Definition and basic concepts of systematics and taxonomy- 5 hrs

1.1.Historical resume of systematics

1.2. Importance and application of systematics in biology

1.3.Material basis of systematics

Module 2 Taxonomic tools and techniques 15 hrs

2.1.Taxonomic Procedures-collection, preservation, curetting and process of identification.

2.2.Taxonomic characters of different kinds- quantitative and qualitative analysis of variation, Process of typification, different zoological types (holotype, paratype etc) and their significance.

2.3. Taxonomic keys- different kinds of taxonomic keys, their merits and demerits

2.4. Systematic publications- preparation of taxonomic publications

2.5. International code of zoological nomenclature, its operative principles. Implication and application of important rules

2.6 Zoological nomenclature - formation of scientific names of various taxa (Homonymy and Synonymy)

Module 3. Taxonomic characters and dimensions of speciation 15 hrs

3.1. Taxonomic characters- different kinds, origin of reproductive isolation, biological mechanism genetic incompactibility

3,.2. Dimentions of speciation- types of lineage changes. Production of additional lineage.

3.3.Species concept- species category, different species concepts, sub species, deme and other intra specific categories, hierarchy of categories

Module 4. Trends in systematic 15 hrs

4.1.Chemotaxonomy

4.2 Cytotaxonomy

4.3.Molecular systematics

4.3.1. Recent trends based on proteomics and genomics

4.3.2. DNA bar coding and Barcoding of life

4.3.3. Phylogenetic trees

Evolutionary Biology (50 Hours)

Module 5 Cosmic evolution and origin of life **5 Hours**

5.1. Cosmic evolution : origin of the universe, matter-time-space continuum. Theory of oscillating universe. Origin of galaxies, stellar systems, planets and earth

5.2. Origin of life -Physical basis of life, extra terrestrial life.

Module 6 Molecular evolution **15 Hours**

6.1. Gene evolution
6.2. Evolution of gene families, molecular drive
6.3. Aminoacid sequence divergence in proteins
6.4. Nucleotide sequence divergence in DNA
6.5. Molecuar clocks
6.6. Ancient DNA

Module 7 Biochemical and genomic evolution **15Hours**

7.1. The evolutionary history of proteins and concepts of molecular clock
7.2. Outline of origin of prokaryotic and eukaryotic genomes
7.3. The C Value paradox
7.4. Evolutionary history of neural integration
7.5. Evolution of endocrine systems, Hormones and evolution

Module 8 Origin of Higher categories **15 Hours**

8.1. Origin of metazoa, Theories of origin
8.2. Origin, evolution and extinction of Trilobites
8.3. Origin and evolution of vertebrate groups- Pisces, Amphibia, Reptilia, Aves and mammals
8.4. Phylogenetic gradualism and punctuated equilibrium
8.5. Micro and macro evolution
8.6. Stages in Primate Evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin-Hominid fossils.
8.7. Cytogenetic and Molecular basis of origin of man-African origin of modern man- Mitochondrial Eve, Y chromosomal Adam, - early migration, hunter-gatherer societies.
8.8. Evolution of human brain- communication, speech and language. Evolution of culture.

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A Functional Evolutionary Approach. Thomson/Cole, Singapore

Simpson:

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West- Eberhard M.J. 2003. *Developmental Plasticity and Evolution*. Oxford University Press, Oxford, UK

Web Resources

http://www.talkorigins.org

http://www.ucmp.berkely.edu

http://www.academicearth.org

ZO 212 BIOCHEMISTRY 100 Hours

Module I. Introduction 6 hrs.

1.1 Atoms, molecules, intermolecular and intramolecular interaction

Bonds- covalent and electrovalent bonds, ionic bond, hydrogen bond.

1.2 Water: Biological importance, pH and Acid - base balance. Buffers: Biological importance.

1.3 Unique solvent properties , electrolytic dissociation in to cations and anions, Henderson-Hasselbalch equation

Module 2. Carbohydrates 12 hrs.

2.1 Classification and nomenclature

2.1.1. Monosaccharides:**,** Biological importance, Structural representations of sugars- Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – Structural isomerism and stereoisomerism, optical isomerism, Epimerism and Anomerism.

2.1.2. Reactions of monosaccharides: Oxidation, reduction, ester formation, Osazone formation. Glycosidic bond.

2.1.3. Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose.

2.1.4. Polysaccharides**:** Homopolysaccharides- Starch, glycogen, cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Module 3. Proteins 10 hrs.

3.1.1. Aminoacids: Structure, classification and properties of amino acids. p*K* value and iso-electric point of amino acids. Peptide and peptide synthesis. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins

3.2.1. Proteins – structure and Classification-Primary structure of protein (eg. insulin)

3.2.2. Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map.

3.2.3. Fibrous proteins- examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons.

3.2.4. Tertiary structure- Globular protein- eg Myoglobin.

3.2.5. Quaternary structure – eg Haemoglobin

3.2.6. Tissue protein in health and diseases, -Collagen, structure and synthesis, abnormal collagens, elastin, keratins, muscle proteins, lens proteins and cataract

Module 4. Lipids 10 hrs.

4.1.1. Classification of lipids: Simple, compound and derived lipids. Biological importance of lipids.

4.1.2. Fatty acids: classification, nomenclature.

4.1.3. Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions- Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number oxidation,Ketosis,*Reichert-Meissl*-Wollny value

4.1. 4.Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens. Glycolipids, Sphingolipids

4.1.5.Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes. Prostaglandins- Structure, types, synthesis and functions.

4.1.6. Lipoproteins.

Module 5. **Nucleic Acids** **8 hrs.**

5.1.1Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson – Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA and microRNA stability of proteins and nucleic acids

5.1.2. Protein-nucleic acid interactions. Electrostatic interaction, hydrogen bonding stacking interactions.

5.1.3.DNA binding proteins- DNA regulatory proteins, folding motifs, finger motifs, Zipper motifs, conformation flexibilities.

5.1.4. Biological roles of nucleotides and nucleic acids.

Module 6. Enzymes **10 hrs.**

6.1.1.Classification- (I.U.B. system) co-enzymes, iso-enzymes, ribozyme.

6.1.2.Enzyme specificity.

6.1.3.Mechanism of action of enzymes. Formation of enzyme substrate complex. Various theories.

6.1.4. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance . Enzyme velocity and factors influencing enzyme velocity. Enzyme inhibition- suicide inhibition and feedback inhibition.

6.1.5.Enzyme regulation: Types of regulation, Allosteric regulations- Key enzymes, Covalent modification.

Module 7. Carbohydrate Metabolism **8 hrs.**

7.1.1.Major metabolic pathways: Glycolysis – Fate of pyruvate.

Citric acid cycle and its significance; Oxidative & substrate level phosphorylation. Pentose phosphate pathway (self study).

7.1.2. Gluconeogenesis, Cori cycle

7.1.3. Glycogen metabolism**:** Glycogenesis, Glycogenolysis, adenylate cascade system Ca^{+2} Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis

7.1.4 Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria

7.1.5 Factors maintainig blood glucose, Normal plasma glucose level, OGT T oral glucose tolerance test

Module 8. Metabolism of Proteins, Amino acids and nucleic acids 10 hrs.

8.1.1.Amino acid metabolism: Deamination, Transamination and Trans-deamination, decarboxylation

8.1.2. Formation and disposal of ammonia. Urea cycle.
8.1.3. Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.
8.1.4.Synthesis of biologically significant compounds from different aminoacids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan.
8.1.5.Catabolism of purines and pyrimidines

8.1.6.Heme synthesis and break down- Structure , biosynthesis, porphyrins , bilirubin metaboloism, plasma bilirubin, juandice

Module 9. Metabolism of Lipids 6 hrs.
9.1.1.Beta oxidation, alpha oxidation and omega oxidation of fatty acids.

9.1.2. Formation of ketone bodies, ketosis and keto acidosis

9.1.3 *De novo* synthesis of fatty acids and fatty acid metabolism
9.1.4 Biosynthesis and regulation of cholesterol, Metabolism of cholesterol.
9.1.5 Metabolism of Triglycerides.

Module 10. Energy metabolism 8 hours

10.1. Energy rich compounds and their biological significance
10.2.Biological oxidation- Mitochondrial electron transport, oxidative phosphorylation, ATP synthesis, Chemi-osmotic theory

Module 11.Detoxification 3 hours

11.1. Formation of toxic compounds in the body

11.2. Detoxification - oxidation, reduction, hydrolysis and conjugation

Module 12 Free radicals and anti oxidants 3 hours
12.1. Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Damage produced by free radicals, Free radical scavenger systems.

12.2. Lipid peroxidation. Preventive antioxidants.

Module 13. Biochemistry of aging 3 hours

13.1. Cellular aging

13.2. Diseases associated with aging – e.g. Alzheimer's.

13.3. Prions, Apoptosis

Module 14 Clinical biochemistry **3 hours**

14.1. Introduction to clinical biochemistry

14.2. Analysis of body fluids

14.3. Examples of diseases (Diabetes etc)

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ZO 213

Biophysics, Instrumentation and Computer Science 100 hours

Biophysics 25 hours

Module 1 Thermodynamics 5 Hours

1.1. Introduction- Concept of energy and laws of Thermodynamics.

1.2. Matter and energy-Life as an energy system-order, disorder, Entropy, Enthalpy.

1.3. Photo bioenergetics: Photosynthesis – light and dark reactions, Redox couple and redox potential

1.4 Chemo-bioenergetics: electron transport and oxidative phosphorylation, Chemi-osmotic theory and binding change mechanism of ATP synthesis.

1.5 Life as an autocatalytic system

Module 2 Electromagnetic spectrum 8 Hours

2.1. Cosmic radiation, Gamma radiation, X Rays, UV radiation, visible spectrum, Infrared rays, microwaves and radio waves.

2.2. Biological applications

Module 3 Radiation Biophysics 8 Hours

3.1.Radioactivity, Detection and measurement of radiation

3.2. Radio-labelling methods,- detection and measurement of different types of radioisotopes and their applications in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material and safety guide lines

3.3 Ionizing radiation and induced mutations

3.4. Fluorescence

3.5. Nuclear medicine-Internally administered radioisotopes. Radioiodine in thyroid function analysis. Renal, liver and lung function analysis.

Module 4 . Nanotechnology 4 Hours

4.1 Introduction to Nanobiology

4.2 Nanosensors and Nanomedicines.

INSTRUMENTATION 50 hours

Module 5. Methodology and working of microscopes 15 Hours

5.1 Phase contrast microscope

5.2 Fluorescent microscope

5.3. Electron microscope- SEM and TEM, different fixation techniques for EM, Freeze etch and freeze fracture methods for EM,

5.4 Laser scan confocal microscope

5.5 Environmental scanning electron microscope

Module 6 Centrifugation **8 Hours**

6.1 Ordinary, high speed centrifuges

6.2 density gradient centrifugation

6.3, Ultracentrifugation

Module 7 Electrophoresis **7 Hours**

7.1 Principles

7.2 Gel electrophoresis- SDS PAGE, Agarose Gel Electrophoresis

7.3 High voltage electrophoresis

7.4 Immuno electrophoresis- principle and application

Module 8 Chromatography **5 Hours**

8.1. Principles

8.2. Column chromotography, Ion exchange chromatography, HPLC, Gas chromatography

Module 9 Biophysical methods **15 Hours**

9.1. Colorimeter, spectrophotometer, flame photometer

9.2 Atomic absorption spectrophotometer, fluorescent spectrometer

9.3. Infra red spectrophotometry, NMR and EMR spectroscopy, Different types of Mass spectrometry and surface plasma resonance methods

9.4. Molecular analysis using UV /visible light, fluorescence, circular dichroism,

9.5 Molecular structure determination using X ray diffraction

9.6. Electrophysiological methods- simple neuron recording, patch clamp recording, ECG, Brain activity recording, Lesions and stimulation of brain, pharmacological testing, PET (Positron emission tomography), MRI, FMRI, CAT scanning methods

COMPUTER SCIENCE **25 Hours**

Module 10 Introduction to computers -(self study)

10.1. Basic organisation of a computer- hard ware and soft ware,

10.2.Hardware-input out put devises, processor Modules ,storing, controlling

10.3. Characteristics of computers

Module 11 Computer generations **8 Hours**

11.1 Classification -first to 5^{th} generation

11.2 Notebook, laptops, PCs, workstations, mainframe system, supercomputers, client and server computers, hand held computers,- tablet pc, PDA, pocket PC , smart phone.

11.2.1. Artificial intelligence

11.3 Number systems binary, octan, hexadecimal

Module 12. Soft ware **4 Hours**

12.1.Relationship between hard ware &soft ware, system soft ware & application soft ware

12. 2. Acquiring soft ware - buying, pre written soft ware, ordering customised soft ware, developing customized software, down loading public domain soft ware, soft ware development steps- firmware, and middle ware

Module 13 Operating systems **4 Hours**

13. 1 Windows, DOS, Linux (self study)

13.2 Concept of free software

Module 14. Computer Programming **4 Hours**

14.1. Low level languages

14.2. High level languages

14.2.1.Programming language C++

Module 15 Computer and Communications **5 Hours**

15.1 LAN(local area net work)WAN(wide area network, MAN(Metropolitan area network)

15 .2 Internet , email, www, social network groups etc.

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Semester - II

ZO 221

ADVANCED PHYSIOLOGY AND FUNCTIONAL ANATOMY

Total 100 Hours

Module 1- Introduction (self study)

1.1 Introduction to Physiology and Anatomy

1.2 A brief history of Physiology and Anatomy

1.3 Cell as a living Module of the body

1.4. Fluids in the cell environment

1.5 Resistance of the cell to acidity and alkalinity

Module 2 – Support and Movement (10hrs)

2.1. Cellular movements, Cytoskeleton, Hydrostatic skeleton

2.2. Terrestrial, aquatic and aerial locomotion

2.3. Musculo skeletal system - Bones and muscles- structure and its role in locomotion with reference to humans

2.4. Theories of molecular basis of muscle contraction

2.5. Catch muscle and Fibrillar muscle

2.6. Clinical implications

Module 3- Nutrition (10 hrs)

3.1. Feeding mechanism in animals (self study)

3.2. General principles of Gastro-intestinal function

3.3. Factors that regulate quantity of food

3.4. Secretory function of the alimentary canal-hormones and enzymes

3.5. Absorption mechanism of digested nutrients

3.6. Obesity- causes and consequences

3.7.Gastro -intestinal disorders

Module 4- Circulation (12 hrs)

4.1 Body fluids in invertebrates and vertebrates

4.2.Types of heart, anatomy of heart (human) and Haemopoiesis

4.3.Coronary circulation, Heart valves and Heart sounds

4.4.Circulatory Shock, Cardiac failure

4. 5.Control of blood pressure and blood flow

Module 5- Respiration (10 hrs)

5.1.Respiratory organs of invertebrates and vertebrates and its functions

5.2.Mechanism of Pulmonary ventilation

5.3.Respiration of unusual environment – Aviation, High altitude, Deep sea diving, Foetal respiration

5.4Regulation of respiration

5.5Respiratory disturbance ; Oxygen therapy, Artificial respiration

Module 6-Excretion and Osmoregulation (10 hrs)

6. 1.Types of Excretion, Structure of kidney, Basic renal process (self study)

6.2. Osmo regulation in fresh water, marine and terrestrial animals

6.3.Regulation of sodium and water balance, Primary sodium re absorption, Urine concentration

6.4. Diuretics and kidney diseases. Creatine clearance- Plasma creatine

6.5. Haemodialysis, Peritonial dialysis and transplantation

6. 6.Regulation of acid-base balance, blood volume and extra cellular volume

6.7. Respiratory regulation of acid base balance

Module 7- Nervous Co ordination (10 hrs)

7.1. Neurons, Types of Neurons, transmission of Nerve impulse(self Study)

7.2. Giant nerve fibres in invertebrates

7.3.Development of neurons and neuronal functionality

7.4.Factors leading to neuronal death

7.5.Neuro transmitters, neuro modulators and mechanism of neuro transmitter release

7.6. Neuronal disorders-strokes, exicotoxicity and NMDA receptors

Module 8- Endocrinology (10 hrs)

8.1. Invertebrate and Vertebrate endocrine system (self study)

8.2. Classification of Hormones and nature of hormonal action

8.3. Structure and function of different hormones

8.4. Neuro-endocrine feedback and response to various stimuli

8.5. Measurement of Hormone concentration in blood

Module 9 - Somatic and Special senses (10 hrs)

9.1 Structure of Invertebrate and Vertebrate eye

9.2Tactile, Position, Pain, Thermal and taste Senses

9.3 Visual pathways - organisation of visual cortex. Analysis of visual information, detection of colour

9.4 Auditory pathways- Functions of cerebral cortex in hearing

9.5 Neuronal mechanism of sound detection and direction

Module 10-Reproduction (10 hrs)

10.1 Male reproductive system- Anatomy Spermatogenesis and transport of sperm (self study)

10.2 Hormonal control of male reproductive function

10.3 Female reproductive system- Anatomy, Ovarian function (self study)

10.4 Control of ovarian function. Uterine changes in menstrual cycle, effects of estrogen and progesterone. Androgen in women

10.5 Pregnancy - ovum transport, sperm activation, implantation and placentation

10.6 Hormonal and other changes during pregnancy- Parturition, Lactation

10.7 Birth control measures. Pre-natal diagnostic tests.

10.8 Adjustments of the infants to extra uterine life

Module 11- Stress and adaptation (6 hrs)

11.1 Eco physiology - History and Concepts

11.2 Heat exchange, Thermal strategies and Thermogenesis

11.3 Life at high and low body temperature

11.4 Stress and brain

Module 12- Sports Physiology (6 hrs)

12.1 Muscles in exercise

12.2 Dope test, drugs and athletes

12.3 Fitness test. Bio energetic fuel for muscle work

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Hill, W.R., Wyse, G.E. and Anderson,M. 2007, *Animal Physiology*, Sinauer Associates, Inc.U.S.A.

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Prosser,C.L. *Comparative Animal Physiology*, Saunder College, Philadelphia.

Ranganathan.T.S. 2008. *A Text Book of Human Anatomy*, S. Chand and Co.

Singh,D.P. 2003. *Stress Physiology*, New Age International Publishers.

Tortora,G.J. and Derickson,B. 2007. *Principles of Anatomy and Physiology.* John Wiley & Sons inc.

Tortora,G.J and S.R.Grabowski. 1996. *Principles of Anatomy and Physiology*. Harper Collins College Publishers.

Zo222 Genetics, Quantitative Analysis and Research Methodology

Total 100 Hrs

Genetics (70hrs)

Module 1 Introduction (5 hrs)

1.1. Genetics and modern agriculture
1.2. Genetics and medicine
1.3. Legal and ethical issues in genetics

Module 2 Mendelian Genetics and its Application (15 hrs)

2.1. Gene mapping
2.2. Recombination frequency
2.3. Chromosome banding
2.4. Genetics in animal breeding
2.5. General effects of inbreeding and out breeding; hybrid vigour.
2.6. Expressivity, penetrance
2.7. Modern concept of Mendelism

Module 3 Population Genetics (15 hrs)

3.1 Genetic variations
3.2 Polymorphism
3.3 Gene pool
3.4 Gene frequency
3.5 Distribution patterns
3.6 Hardy Weinberg equilibrium
3.7 Disequilibrium
3.8 Factors disrupting gene equilibrium

Module 4 Human Genetics (15 hrs)

4.1 Pedigree analysis – Karyotype analysis
4.2 X-Chrmosome dosage
4.3 Lyon hypothesis and mosaicism
4.4 Genetics of ABO system
4.5 Rh disease and its inheritance
4.6 Sickle haemoglobin and inheritance; thalassemias
4.7 Genetic disorders – Patau, Edwards, Cri-du-chat syndromes, Philadelphia chromosome.

Module 5 Microbial Genetics (12 hrs)

5.1 Retrovirus
5.2 Viral genome and multiplication – HIV genome and multiplication
5.3 Reproductive cycle of RNA viruses
5.4 Plasmids – Vector DNA – Insert DNA
5.5 Lambda Phages
5.6 Microbes in genetic engineering

Module 6 Genetics in Medicine and Forensics (8 hrs)

6.1 Human Genome Project:
6.2 Human gene therapy

6.3 DNA fingerprinting:
- 6.3.1 Applications in forensic science
- 6.3.2 Applications in paternity testing

QUANTITATIVE ANALYSIS & RESEARCH METHODOLOGY 30 hrs

QUANTITATIVE ANALYSIS 15 hrs

Module I. Introduction 2 hrs

1.1. Definition, history, scope of biostatistics and applications of statistics in biology (self study)

1.2. Descriptive and inferential statistics

1.3. Preliminary concepts - population and sample, statistic and parameter, variables, sampling (self study)

1.4. Collection of data- primary and secondary data, methods. Use of software in statistics.

Module II. Descriptive Statistics 2 hrs

2.1 Processing and classification of data, presentation of data-tabulation and graphical and diagrammatic representation (self study)

2.2. Measures of Central Tendency, problems (self study).

2.3. Measures of Dispersion-problems, Skewness and Kurtosis

2.4. Correlation and Regression, problems (self study),

Module III. Probability distribution 3 hrs

3.1. Definition, important terms and concepts

3.2. Theorems in probability

3.3. Important theoretical distributions- Binomial, Poisson, and Normal probability distributions.

Module IV. Parametric test 4 hrs

4.1. Basic idea - hypothesis testing, types of errors

4.2. Tests of significance for large and small samples- Z-test,

Chi- Square Test, Student's 't' test, F-test - problems -and ANOVA

Module V. Non-parametric tests 2 hrs

5.1. Characteristics, advantages and disadvantages

5.2. Types (Brief account only)

Module VI. Vital statistics **2 hrs**

6.1. Introduction, uses, methods of collection

6.2. Measures of Vital Statistics, life tables

RESEARCH METHODOLOGY **15 hrs**

Module I. Introduction **2 hrs**

1.1.Definition, meaning, objectives, and significance of research,

Research methods *vs* Methodology.

1.2. Types of research – Descriptive *vs*. Analytical, Applied *vs*.

Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical.

1.3.Characteristics of good research, steps of research

Module II. Research Formulation **2 hrs**

2.1. Formulation and defining a research problem, techniques involved

2.2. Literature survey-Journals, conference proceedings, books, government reports, etc,

2.3. Problem selection, formulation of working hypothesis

Module III. Research design **2 hrs**

3.1. Meaning, need and features a good research design

3, 2, Different types of research design (exploratory, descriptive,

diagnostic and hypothesis-testing research studies)

3.3. Developing a research plan.

Module IV. Execution of research plan **2 hrs**

4.1. Data collection methods-primary and secondary, sampling design (self study), measurements etc. LC 50 & Dose Response.

4.2. Analysis of data (self study)

4.3. Interpretations –advantages and techniques-and generalizations of the findings

Module V. Scientific documentation 3 hrs

5.1. Significance of report writing, types of reports

5.2. Research report writing (thesis, dissertations, research articles, etc) -

characteristics and format

5.3. Writing and preparation of articles for publication and for oral and poster presentation

5.4. Project proposal and report writing.

Module VI. Research, extension and ethics 4 hrs

6.1. Publications-abstracting and indexing journals, books, conference / seminar proceedings, periodicals, reference sources, reviews, monographs. Extension tools, impact factor, citation.

6.2. Online libraries, e-journals, e-books, e-encyclopedia, institutional websites, TED Talk.

6.3. Intellectual property Rights-copy right, patents, trademarks, geographical indications, industrial design.

6.4. Research misconduct: fabrication, falsification and plagiarism

6.5. Precaution - ISO standards for safety, lab protocols, lab animal uses, IACUC, control of hazards

6.6. Ethical norms, codes and policies for research ethic, laws in India

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3. Eldon. J., Gardner Principles of Genetics.
4. Sinnot, Dunn, Dobzhansky, Principles of Genetics: TMH Edn.
5. John D Hawkins, Gene Structure and Expression. Cambridge University Press – Edinberg Buildings – Cambridge CBZ/ZRU UK

6. PKU Nair and K. Prabhakar Achar, A Text Book of Genetics and Evolution: Konark Pubs.
7. Robert M Horton and Robert C. Tait, Genetics Engineering with PCR: Horizon Scientific Press, Wymondham Norfolk NR 19 – OEH – UK
8. R. World and S.B. Primrose, Principles of Gene Manipulation: Black Well Scientific Publishers, Melbourne, Paris.
9. Samuel Karlin Eviatar Nevo, Population Genetics and Ecology, Academic Press NY.
10. A Franklin Shull, Heredity. Mc.Graw Hill Book Co, London.
11. George W Burns, the Science of Genetics, Mae Millan C0 New York.
12. A Gib De Busk, Molecular Genetics, Mae Millan C0 New York.
13. Edgar Altenberg, Genetics, Oxford and IBH Publisher, New Delhi.
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Quantitative Analysis

1. Fisher.R.A., Statistical Methods for Research
2. Biometrical Genetics – Dover Publication, New York
3. Ostle B, Statistics in Research.
4. Agarwal, B.L. (1996) Basis Statistics. New Age International (P) Ltd. Publishers, New Delhi.
5. Bailey, N.T.J (1981). Statistical Methods in Biology. Hodder and Stongtton, London.
6. Finney, D.J. (1980). Statistics for Biologists. Chapman and Hall, London.
7. Caswell, F. (1982). Success in Statistics. John Murray Publishers Ltd., London.
8. Gupta, S.P. (1996). Statistical Methods. Sultan Chand & Sons Publishers, New Delhi.
9. Arora, P.N. and P K Malhan. 1996. Biostatistics Himalaya Pub. House
10. Bailey,N.T.J. 1994. *Statistical Methods in Biology* (3 rd edn). Cambridge University Press. London
11. Danial, W. 2006. Biostatistics : *A foundation for Analysis in Health Sciences*, John Wiley and Sons Inc., New York.
12. Dharmapalan, B. 2012. *Scientific Research Methodology*. Narosa Publishing House, New Delhi.
13. Finney, D.J. 1980.*Statistics for Biologists*. Chapman and Hall, London
14. Kothari C.R., 2009. *Research Methodology: Methods and Techniques.* New Age International Publishers, New Delhi.
15. Oliver, P.2005. *Writing Your Thesis*. Vistaar Publications. New Delhi.

Zo223 Cell Biology, Molecular Biology and Bioinformatics 100 hours

Module 1 Membrane structure, models and membrane transport (10 hrs)

1.1 Diffusion of small molecules across phospholipids bilayer
1.2 Uniport – catalysed transport
1.3 Membrane potential
1.4 Active transport by ATP powered pumps
1.5 Co-transport by symporters and antiporters

Module 2 Cell-cell signalling (8 hrs)

2.1 Cell surface receptors
2.2 Signal transduction pathways (cyclic AMP, cyclic GMP, Ras, Raf and MAP kinase pathways)
2.3 Second messenger system

Module 3 Cell cycle (6 hrs)

3.1 Cyclin and cyclin – dependent kinases
3.2 Regulation of CDK – cyclin activity
3.3 Check points in the cell cycle
3.4 Regulation of cell cycle in malignant cells

Module 4 Chromatin structure (6 hrs)

4.1 Types of Chromatin
4.2 Detailed structure of nucleosome; higher order structure of chromatin and the role of histones HI, scaffold proteins, and radial loop model

Module 5 Topology of Nucleic Acids (5 hrs)

5.1 Liking number and writhing number
5.2 DNA Super coiling
- 5.2.1 Super coiling in prokaryotes
- 5.2.2 Super coiling in eukaryotes
- 5.2.3 Role of topoisomerases

Module 6 Organization of the eukaryotic genome (12 hrs)

6.1 Genomic size and genetic content
6.2 Complexity of eukaryotic genome:
- 6.2.1 Intragenic sequences -exons, introns; split gene organization; regulatory sequences
- 6.2.2 Intergenic sequences
  - 6.2.2.1 Unique sequences
  - 6.2.2.2 Repetitive sequences: Highly repeated sequences – satellite, minisatellite and microsatellite DNAs
    Moderately repeated sequences (e.g. SINEs and LINEs)

6.3 DNA denaturation-renaturation kinetics and genome complexity; in situ hybridization.
6.4 Organelle genomes-mitochondrial and plastid DNAs

Module 7 DNA Replication, repair and recombination (14 hrs)

7.1 Prokaryotic and Eukaryotic DNA replication

7.2 DNA replication machinery.
7.3 Enzymes and accessory proteins involved in replication
7.4 DNA damage and repair
Direct reversal: photo reactivation, adaptive response
Excision repair
Mismatch repair
SOS repair and mutagenesis
ERecombination repair; Rec A and other recombinases
7.5 Damage signaling and checkpoints
7.6 DNA repair-associated disorders

Module 8 Transcription and RNA processing (8 hrs)

8.1 Prokaryotic and eukaryotic transcription
8.2 Binding the transcription complex-promoters, factors and RNA polymerases.
8.3 Regulation of transcription
8.4 Sigma factor and its role in prokaryotic transcription.
8.5 Post-transcriptional processing of RNA precursors, spliceosomes.

Module 9 Translation-gene expression (12 hrs)

9.1 Prokaryotic and Eukaryotic translation
9.2 The translation machinery
9.3 Mechanism of initiation, elongation and termination
9.4 Co-and post translational modifications of proteins.
9.5 Hormonal regulation of protein synthesis.

Module 10 Gene Regulation Mechanisms (7 hrs)

10.1 Gene regulation in eukaryotes at various levels.
10.2 Transcription factors and DNA-binding domains (Zinc-finger motif and Helix-loop-helix motif)
10.3 Transcription signals – TATA Box, CAAT BOX., Enhancers.

Module 11 Bioinformatics (12 hrs)

11.1 Introduction to bioinformatics, brief history and its role and importance in modern biology, internet, internet, portals, servers and search engines.
11.2 Biological databases, their purpose, primary, secondary, curated and uncurated databases types of databases (DNA, protein, RNA, functional and structural databases),
11.3 Uploading and downloading of data, FASTA format, data retrieval from databases, analyses tools and soft-wares and their applications, pair wise and multiple sequence analyses.
11.4 Construction of rooted and un-rooted phylogenetic trees, their interpretation and use in analyzing evolutionary trends, steps in phylogenetic analyses
11.5 Brief overview of computational biology, computation, prediction and modulation of biological pathways, (ex. Kegg pathways) e-cell, computational analyses of genomes and proteomes

References

1. Harvey Lodish, Arnold Berk, Sipursky, Matsudaria, David Baltomore and Darnell, (2002) Molecular Cell Biology, W.W. Freman and Company.
2. Gerald Karp (2005) Cell and Molecular Biology, John Wiley and Sons, Inc. USA
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25. Andrew Read and Dian Donnai. (2007) New Clinical Genetics. Scion Publishing Ltd.,

Zo214 Practical I

A. Systematics and Evolutionary Biology

1. Collection and identification of the following using standard keys:
   A. Insects (5 nos)
   B. Prawn (2 nos)
   C. Crab (2 nos)
   D. Fishes (5 nos)
2. Study of preservation media and tools and materials for taxidermy
3. Comparative study of prokaryotic and eukaryotic cells by staining and mounting (evolutionary significance).

B. Biochemistry

1. Titration curve of acetic acid. Titration of a measured volume of acetic acid with sodium hydroxide (NaOH) to determine the amount of acid in the given solution and pKa of acetic acid.
2. Determination of the isoelectric pH of the given amino acid by titration method.
3. Estimation of DNA/RNA
4. Quantitative estimation of glycogen of a tissue.
5. Quantitative estimation of blood glucose.
6. Quantitative estimation of serum protein.
7. Determination of acid value of the given fat.
8. Determination of saponification value of the given fat.
9. Estimation of serum cholesterol using a standard protocol
10. Determination of the Michaelis constant (Km value) for the digestion of case in by trypsin.
11. Estimation of serum cholesterol using a standard protocol.

C. Biophysics, Instrumentation and Computer Application

1. Micrometry: Measurement of microscopic objects using micrometer.
2. Separation of haemolymph of serum protein by gel electrophoresis.
3. Sketching of biological specimens using a camera Lucia.
4. Quantification estimation of Na, K, Ca of the given sample with the help of flame photometer/ spectrophotometer preparing standard curve.
5. Preparation of tables and bar diagrams using suitable softwares, from the data provided.
6. Statistical Analysis (Chi-square, t-test, correlation, regression, standard deviation and standard error) of the given data using suitable softwares. E.g. PH Stat

References

1. Hardd Varley – Practical clinical Biochemistry
2. Ranjana Chawla, - Practical Clinical Biochemistry – Methods and interpretations.
3. Hawk's Practical Physiological Chemistry
4. Jayaraman, Practical Biochemistry.

Practical II

Zo224 Advanced Physiology and Functional Anatomy

Please use software such as **PhysioEx. 9.0** where ever applicable

1. Effect of salivary amylase on starch (colorimetric)
   a) Influence of temperature and calculation Of Q10
   b) Influence of pH
2. Transport of glucose through intestinal wall (everted gut sac) of a suitable animal
3. Kymograph recording of simple twitch and summation.
4. Effect of temperature on muscle contraction.
5. Kymograph recording of heart beat and the effect of drugs (accetylcholine and adrenaline).
6. Effect pf different concentrations of NaCl (0.1% to 2%) on the diameter of RBCs using micrometry.
7. Estimation of RBCs and WBCs in vertebrate blood
8. Blood histology of earthworm/cockroach fish and chick.
9. Studies on feeding-Mounting of mouth parts of housefly, honey bee and mosquito in relation to food and feeding.

Semester III

Paper I - ZO 231 MICROBIOLOGY & BIOTECHNOLOGY [100 Hours]

Part A. MICROBIOLOGY [50 Hours]

Module I. Introduction to Microbiology (7 Hours)

1.1. Scope and history of Microbiology – mention the contributions of important Scientists who developed Microbiology as a major discipline (e.g. Pasteur, Koch etc).

1.2. Microbial Diversity including Extremophiles – brief account.

1.3. Characteristic features of microorganisms - Bacteria, Virus, Fungi & Protozoa. Mention Microalgae. Classification of Bacteria, Virus, Fungi & Protozoa.

1.4. Classification of Bacteria, Bergy's manual (self study)

Module 2. Bacterial Cell Structure & Function (8 Hours)

2.1. Ultra-structure of bacteria – cell membrane, cytoplasmic inclusions, nucleiod etc
2.2. Bacterial Cell Wall – structure, differences between gram positive and negative cell wall, gram staining.
2.3. External components & their functions – pili, flagella, fimbriae, capsules, slime layers etc.

Module III. Microbial Nutrition & Growth (10 Hours)

3.1. Common nutritional requirements of microorganisms – autotrophy and heterotrophy.
3.2. Types of culture media.
3.3. Microbial growth – overview of cell growth, generation time, measurement of growth.
3.4. Typical growth curve, continuous culture, effect of environmental factors on growth. Stress response

Module IV. Industrial & Environmental Microbiology (10 Hours)

Industrial Microbiology
Concept of fermentation. Types of fermentation – submerged, solid state – mention briefly.

Basic design and types of fermenters.

Products of Industrial Microbiology such as Alcohol, Antibiotics (e.g. Penicillin), Organic acids (e.g. Acetic acid, Lactic acid).

Microbiology of milk & foods. Preservation of milk - Pasteurization techniques. Probiotics.

Microbial spoilage of different types of foods & Food borne diseases (self study)

Beneficial activities of microbes in food (self study)

Microbial quality control and safety of food (self study)

Environmental Microbiology

Introduction to terrestrial and aquatic microbiology. Principles of Microbial Ecology.

Biogeochemical cycles – nitrogen cycle, sulphur cycle & carbon cycle. Role of microorganisms in the biogeochemical cycles.

Microbiology of waste treatment. Brief account of microbial treatment of waste water and solid wastes.

Bioremediation – microbial treatment of radioactive wastes and xenobiotics.

Microbes in decomposition and recycling process (self study)

Symbiotic and asymbiotic N2- fixation (self study)

Module V. Medical Microbiology (15 Hours)

5.1 Host-microbe interaction – process of infection, pathogenecity, virulence & infection, microbial adherence, penetration of epithelial cell layers and events in infection following penetration, Infection of blood, lymphatic system.
5.2. Exotoxins – classification, mechanism of action of exotoxins e.g. Diphtheria, Botulinum, Tetanus, and Cholera toxins.
5.3. Control of Microorganisms – various physical & chemical methods.
5.4. Use of antibiotics and other antimicrobial drugs.
5.5. Drug resistance and emergence of multiple drug resistance – recent cases of TB (XDR, TDR); NDM etc.
5.6. A survey of harmful and beneficial microbes (self study)

Part B. BIOTECHNOLOGY [50 Hours]

Module VI. Introduction to Biotechnology (10 Hours)

6.1. History of Biotechnology (self study). Broad areas of BT – traditional and modern; types – plant biotechnology, animal biotechnology and microbial biotechnology.
6.2. Techniques in biotechnology – brief description of common techniques such as tissue culture, genetic engineering, cloning etc.

Module VII. Molecular Cloning (15 Hours)

7.1. Gene cloning – basic steps in gene cloning. Isolation of donor DNA.

7.2. Vectors – types and characteristics e.g. plasmids, phages, hybrid vectors, artificial chromosomes.
7.3. Enzymes used in gene cloning – exonuclease, endonuclease, ligase, reverse transcriptase, polymerase, terminal transferase etc.
7.4. Techniques of gene transfer – calcium chloride transformation, microinjection, electroporation, shotgun cloning, *Agrobacterium* mediated transfer etc
7.5. Practical application of genetic engineering - useful products. Application in Medicine, Agriculture, Aquaculture and Animal Husbandry, Environment etc. Biotechnology Industry.

Module VIII. Recent Trends in Biotechnology (15 Hours)

8.1. Synthetic Biology – description and developments in the area.
8.2. Artificial life – concept and achievements
8.3. DNA Barcoding – concept and experimental details with examples.
8.4. GMOs and GM Foods – pros and cons.
8.5. Microbial warfare – bio-weapons and bioterrorism

Module XI. Bioethics (5 Hours)

8.5. Ethical, legal and social issues of biotechnology.

Module XII. Biotechnology in India (5 Hours)

9.1. History of biotechnology research in India.
9.2. India's Biotechnology Policy
9.3. Biotechnology Regulatory Agencies in India.
9.4. Comparison with developed countries

REFERENCES

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4. Microbiology. Pelczar, Reid and Chan. Tata-McGrawHill. Reprint 2008. ISBN 0074623206, 9780074623206.
5. Introductory Food Microbiology. H. A. Modi 2007. ISBN 8179102213.
6. Food Microbiology An Introduction by Thomas J Montville, Karl R. Mathews
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BIOTECHNOLOGY

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2. James D Watson - Molecular Biology of the Gene (6th Edition)
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Useful websites

1. http://www.microbeworld.org
2. *http://www.ncbi.nlm.nih.gov*
3. http://www.accessexcellence.org/RC/AB/BA/
4. http://www.accessexcellence.org/RC/AB/IE/
5. http://bacteriamuseum.org

Zo232: Ecology, Ethology and Biodiversity Conservation

Part 1: Ecology [30 Hours]

Topics for self study

Biotic and abiotic factors and their interactions.

Structure, basic components, their interactions and inter-relations. Fundamental concepts relating to energy - first and second laws of thermodynamics, entropy.

Gaseous and sedimentary cycles

Characteristics of population: density, natality, mortality, biotic potential, environmental resistance, growth forms, immigration, emigration and migration.

Characteristics: Species diversity, stratification, dominance, boundaries, ecotone and edge effect, ecological indicators.

Module 1: Ecological Energetics (8 Hrs)

1.1 Solar energy and photosynthetic production, efficiency of energy capturing, chemosynthesis.

1.2 Energy flow - features of energy flow (unidirectional flow and loss of energy as heat) and pathways of energy flow.

1.3 Productivity - primary production and production efficiency, secondary production, standing crop.

1.4 Food chain (grazing, detritus and auxiliary food chains), food webs, trophic levels and ecological pyramids (pyramid of numbers, pyramid of biomass and pyramid of energy (self study).

1.5 Classification of ecosystems based on energy input (natural unsubsidised and subsidised solar powered ecosystems, human subsidised solar powered ecosystem and fuel powered urban and industrial systems).

Module 2: Transition and Stability in Communities (7 Hrs)

2.1 Succession – Basic types (Primary succession, Secondary succession, Autogenic succession, Allogenic succession, Autotrophic succession, Heterotrophic succession).

2.2 Trends in succession

2.3 Stages of succession - (Nudation, Invasion, Competition and co-action, Reaction,

Climax), pulse stability.

2.4 Examples of Succession – (Succession in aquatic and terrestrial ecosystems).

2.5 Relevance of ecosystem development theory to human ecology, prospects for detritus agriculture, the compartment model.

Module 3: Concepts of Habitat, Niche and Guild (6 Hrs)

3.1 Habitat, microhabitat and niche. Different types of niches: spatial niche, trophic niche, species niche, multidimensional niche, fundamental and realised niche.

3.2 Niche overlap, Gause's principle, resource partitioning, compression hypothesis, concept of Guild, character displacement, ecological equivalents.

Module 4: Species Interactions (9 Hrs)

4.1 Intra and interspecific interactions, Types of Interspecific interactions – (Positive, Negative and Neutral).

4.2 Positive interactions (commensalism, proto-cooperation, mutualism and pollination).

4.3 Negative interactions (competition, parasitism, amensalism, predation, herbivory, carnivory).

4.4 Co-evolution

Part II: Ethology [30 Hours]

<u>Topics for self study</u>

History, development and applications; Motivation and models of motivation; reflexes, imprinting, habituation; neural mechanisms in behaviour; hormones and behaviour; Sociobiology: social groups – merits and demerits, features of organised groups; social groups in mammals, social stress; pheromones and chemical communication.

Module 5: Learning (6 Hrs)

5.1 Classification of learning: Imprinting, habituation, imitation (self study), classical conditioning, instrumental/operant conditioning, cognitive learning, latent learning, insightful learning.

Module 6: Nervous System and Behaviour (8 Hrs)

6.1 Stimulus filtering, sign stimulus, innate release mechanism and fixed action plans (FAPs).

6.2 Brain centres and learning, neural mechanism of learning and memory.

Module 7: Complex Behaviour Patterns (8 Hrs)

7.1 Orientation, Navigation and homing.

7.2 Migration (Fishes and birds).

7.3 Biological rhythms – biological clock, circadian, circannual, lunar, tidal and seasonal periodicities, sleep and arousal, genetics of biological rhythms.

Module 8: Environment, genetics and Evolution of behaviour (8 Hrs)

9.1 Habitat selection and territoriality.

9.2 The Evolution of communication; Development of bird song.

9.3 The evolution of reproductive behaviour and mating systems.

Part III: Biodiversity [40 Hours]

Module 9: Biodiversity (15 Hrs)

9.1 Introduction: Definition, levels of biodiversity (genetic diversity, species diversity and ecosystem diversity), values of biodiversity (self study).

9.2 Diversity indices: Alpha diversity, Beta diversity and Gamma diversity; the species diversity and ecosystem stability.

9.3 Biodiversity in India: Major biogeographic zones of India; India as a mega diversity nation; hot spots of biodiversity – characteristics; an outline of the features and biodiversity of hot spots in India (Western Ghats and Eastern Himalaya).

9.4 Features, structure and biodiversity of some of the Indian ecosystems: Terrestrial ecosystems (forest, grassland, desert), Aquatic ecosystems fresh water, marine, estuarine).

Module 10: Conservation Biology (13 Hrs)

10.1 Depletion of biodiversity: Current estimates of species loss, causes of biodiversity loss, impacts of biodiversity loss, Strategic species concepts: Keystone species, indicator species and umbrella/flagship species.

10.2 Strategies of conservation: *in situ* and *ex situ* conservation, Gene Banks, establishment of protected areas, habitat conservation, captive breeding, pollution control, legislative conservation, creating public awareness and other relevant measures.

10.3 An evaluation of the "Project Tiger" and "Project Elephant" programmes.

10.4 World conservation strategy (1980)

10.5 National Biodiversity Action Plan 2008: a brief outline of objectives & plans

Module 11: International Conventions & Treaties for Conservation of Biodiversity (12 Hrs)

11.1 Stockholm declaration on human Environment (1972), Convention on Regulation of Antarctic Marine Resources Activities (RAMRA, 1986), Moduleed Nations World Charter for Nature (1982), Kyoto Protocol and Framework Convention on Climate Change (UNFCCC). Brundtland Report (1987).

11.2 Earth summit (1992) – detailed study - Rio Declaration on Environment and Development, Agenda 21, Forest Principles, Convention on Biological Diversity.

11.3 Species based treaties: Migratory Bird Treaty Act (MBTA) of 1918, International Convention for the Regulation of Whaling (ICRW), Washington, 1946, Convention for the Conservation of Antarctic Seals, 1972, Convention on International Trade on Endangered Species (CITES, 1975),

11.3 Ecosystem based treaty: Ramsar Convention (1981) – Ramsar sites in India and Kerala

References

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12. **Pianka, E. R.** (2000). ***Evolutionary Ecology***. Sixth Edition. Benjamin-Cummings, Addison-Wesley-Longman, San Francisco, pp 528. ISBN: 10: 0321042883.
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16. **Townsend, C.R., Harper, J.L. & Begon, M.** (2000). ***Essentials of Ecology***. Blackwell Scientific Publishers, Massachusetts, pp 552. ISBN: 0 632 04348.
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Ethology

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Zo233 Immunology and Developmental Biology (100 Hrs)

Immunology (40 hrs)

Module 1 Introduction to Immune System (4 hrs)

1.1 Types of immunity, innate and acquired immunity; passive and active immunity; humoral and cell-mediated immunity.

1.2 Organs of immune system: Primary and Secondary lymphoid organs.

1.3 Brief account on immune cells: types and production.

Module 2 Immunogens (Antigens) (7 hrs)

2.1 General properties, Structure and function, variability and diversity.

2.2 Factors affecting antigenicity.

2.3 Epitopes and Haptens.

2.4 Adjuvants and their role in enhancing immunogenecity.

Module 3 Immunoglobulins (antibodies) (8 hrs)

3.1 General Properties-Structure and functions

3.2 Different classes of immunoglobulines (1gA, 1gD,1gE,1gG and 1gM)

3.3 Genetic basis of antibody diversity:
Immunoglobulin gene organization; Gene rearrangement and expression.

3.3.1 Somatic recombination: V (D) J recombination and functional diversity

3.3.2 Somatic hyper mutation

3.3.3 Class switching

3.4 Polyclonal & Monoclonal antibodies

3.5 Hybridoma technology – technique and applications

Module 4 Antigen-antibody interactions (6 hrs)

4.1 Primary and secondary immune responses

4.2 Theories of antibody formation (Directive theory, clonal selection theory etc.)

Module 5 Complement System (4 hrs)

5.1 Complement systems-General features

5.2 Classical and alternate pathways, complement receptors, biological effects of complement.

Module 6 Transplantation (7 hrs)

6.1 Classification of grafts

6.2 Major Histocompatibility Complex (MHC) and MHC proteins; role in tissue transplantation; Mechanism of graft retention and rejection.

6.3 General immunosuppressive therapy.

Module 7 Defects in Immune Mechanisms (6 hrs)

7.1 Defective innate immune mechanisms

7.2 Auto immune diseases

Developmental Biology **(60 Hrs)**

Module 1 Introduction (4 hrs)

1.1 Definition, history, Scope of embryology and Practical applications (self study)

1.2 The evolution of developmental patterns in unicellular protest; origin of sexual reproduction. Developmental patterns among animals-brief survey (asexual means; parthenogenesis; sexual means; gonochorism, hermaphroditism, metamorphosis, uterine development in mammals)

Module 2 Fertilization (8 hrs)

2.1 Events in fertilization

2.1.1 Cytoplasmic changes

2.1.2 Nuclear changes

2.2 Prevention of polyspermy

2.3 Significance of fertilization

Module 3 Developmental Model Systems (16 hrs)

3.1 Early development of *Drosophila*-Egg, cleavage, mid-blastula transition, gastrulation

3.2 Early development of *Caenorhabditis elegans*-Egg, cleavage and gastrulation.

3.3 Genetic control of development and embryonic axis formation.

3.3.1 Gene action in development of Drosophila:- Maternal effect genes; Segmental genes (gap genes, pair-rule gene and segment polarity gene) and Homeotic genes (homeobox and homeodomains)

3.3.2 Hox cluster genes in vertebrates

Module 4 Embryonic Induction (10 hrs)

4.1 Types of embryonic induction – Primary, Secondary and Tertiary Induction (Experiments of Spemann and Mangold) (self study)

4.2 Mechanism of axis formation in amphibians; Niewkoop centre.

4.3 The functions of organizer; the diffusible proteins of the organizer 1; the BMP inhibitors.

4.4 Stem cells, totipotency, pleury potency

Module 5 Medically assisted human reproductive technologies (12 hrs)

5.1 Conventional in vitro fertilization and embryo transfer (IVF-ET) – general protocol (Patient selection, manipulation of menstrual cycle, superovulation, oocyte retrieval, preparation of semen sample, IVF treatment, embryo transfer.

5.2 Gametic Instrafallopian Transfer (GIFT)

5.3 Zygotic Intrafallopian Transfer (ZIFT)

5.4 Tubal Embryo stage Transfer (TET)

5.5 Intra-cytoplasmic sperm injection (ICSI)

5.6 Intra Uterine Insemination (IUI)

Module 6 Cloning experiments in animals (10 hrs)

6.1 Genomic equivalence; multiple potencies; differential gene expression.

6.2 Amphibian cloning, cloning mammals, human cloning-prospects and demerits.

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Developmental Biology

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Immunology

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PRACTICAL

ZO 234 - Microbiology, Biotechnology, Ecology, Immunology & Developmental Biology

Microbiology & Biotechnology

1. Techniques for Isolation of bacteria – serial dilution, pour plate, spread plate techniques.
2. Enumeration of bacteria from water and soil.
3. Motility Testing – hanging drop method.
4. Gram staining.
5. Determination of quality of milk – methylene blue reductase test.

6. Biochemical tests – catalase test, kovac's oxidase test, gas production etc.

7. Isolation of DNA from plant/animal tissue.

8. Plasmid isolation.

Immunology

1. Antigen-antibody interaction in vitro and identification of blood groups.
2. Blood film preparation and identification of cells.
3. Detection of pregnancy using kits.
4. Immunodiffusion and Immunoelectrophoresis

Developmental Biology

1. Induced ovulation and artificial fertilization.
2. Preparation of temporary whole mounts of chick blastoderm
3. Vital staining of chick blastoderm and tracing the development of stained parts (window method)
4. Effect of drugs on heart beat of chick embryo.
5. Study of different types of eggs: insect egg, frog's egg, hen's egg, mammalian egg- using models/charts
6. Morphological and histological studies of different placental types of mammals (3 numbers)
7. Identification of cross sections of chick embryo through heart, eye and ear.

Ecology

1. Estimation of pyramid of numbers and biomass in a small ecosystem.
2. Estimation of Primary productivity using dark and light bottles.
3. Description of ecological adaptations of any 10 organisms.
4. Habituation in *Pila* / alarm response in ants or fishes / maize learning in rats.
5. Study of biodiversity indices:
    a. Population
    b. Density and relative density
    c. Frequency and relative frequency
    d. Abundance and distribution
    e. Modified similarity Index
    f. Shannon-Wiener Index
6. Composition assessment of the Taxonomic diversity/biodiversity in a habitat (grass land, wet land, etc.).

7. Assessment of Invertebrate and Vertebrate diversity in your locality (e.g. campus).
8. Quantitative estimation of planktons.
9. Poster Presentation on a relevant topic (e.g. International conventions and treaties, species interactions, biodiversity loss, etc.).

SEMESTER -IV

Special Subject: Endocrinology
Z0 241 VERTEBRATE ENDOCRINOLOGY
Total hours: 100

Module I Introduction

1. Historical perspective **(5 hrs)**
2. General Classes of chemical messengers – definition - short account

Peptide hormones, steroid hormones, bioamines, eicosanoids, chalones, neurotransmitters, neuropeptides, neurosteroids, neurohormones, lumones, Phytohormones, synthetic hormones.

Module 2. Vertebrate endocrine glands (30hrs)

1. Morphology and anatomy of endocrine glands
2. Biosynthesis of hormones (Mention key enzymes)
3. Functions of hormones
4. Disorders of hormonal imbalance
5. Hypothalamus and its secretions
6. Hypothamo-hypophysial interaction.
7. Eicosanoids – Biochemistry and biological action. Prostaglandins, prostacyclins, thromoboxanes, leukotriens.
8. A brief account the evolution of endocrine glands

Module 3. Mechanism of hormone action (30hrs)

1. General and Molecular mechanism of action of amines, polypeptide and steroid Hormones
2. Hormone receptors – Receptors as mediators of endocrine signals – Classification of endocrine receptors. Measurement of receptor ligand interaction.

3. Cell surface receptors (Mode of action of peptide hormones) Receptor structure – Regulation of receptor number.

4. Second messengers of hormonal action

Cyclic nucleotides; Inositol triophosphate; Diacyl glycerol; Genomic action of cAMP

5. Signal transuction - G proteins and dual control of adenylate cyclase; Receptor crosstalk

6. Receptor with tyrosine kinase activity, serine and threonine kinase activity
7. Receptors that are protein phosphatases
8. Receptors coupled with ligand gated ion channels
9. Direct membrane action of steroid hormones –non genomic action

Module 4 Cell growth factors (5hrs)

1. Types of growth factors-mechanism and its functional role in cellular activities:
2. Somatomedins – IGF: Epidermal Growth Factor (EGF) family; Transforming Growth factor
3. βfamily (TGFβ); Platelet derived growth factor (PDGF); Fibroblast growth factor (FGF) – Nerve Growth Factor (NGF); Hepatocyte Growth Factor (HGF)

Module 5 Hormones and Cancer (10hrs)

1. Relationship of hormones to carcinogens and development of cancers from inappropriate hormonal treatment
2. Hormones related treatment of cancer
3. Oncogenes and hormonal function
4. Hormone receptor status of Breast Cancer
5. Ectopic production of hormones by tumour cells

Module 6 Functional Endocrinology (10hrs)

1. Role of hormones in behavior of animals
2. Hormonal control of reproduction
3. Hormonal involvement in evolution
4. Influence of hormones in development process

Module 7. Endocrine methodology (10hrs)

1. Methods and techniques in endocrine research
2. Histological and cytological methods; Surgical methods, Bioassays
3. Radio isotopic studies – RIA, ELISA, EIA
4. Nucleic acid approaches in endocrinology - Recombinant DNA techniques and genetic engineering.
5. Modern trends in endocrine research

References

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2. Williams Tex Book of Endocrinology edited by Jean D.Wilson and Daniel W.Foster. Saunders Company 8th Edn. 1992.
3. Hormones from Molecular to disease – Elby-Elienne – Erulie Bautieu and Paul A.Kelly 1990.
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9. Hormones – Anthony – W. Norman and Gerald Litwark – Academic Press. 1997.

SPECICAL SUBJECT: ENDOCRINOLOGY
ZO 242: PHYSIOLOGY OF REPRODUCTION
(With special reference to mammals)

Z0 242 Total hours : 100

Module 1. Foetal and Embryonic Gonads and Genital Ducts (20 hrs)

1. 1. Comparative anatomy of genital system in vertebrates
1. 2. Origin of primordial germ cells
1.3. Differentiation of the testis: Germinal epithelium, interstitial tissue, Foetal androgens and role
1.4. Differentiation of ovary: Foetal estrogens and role
1.5. Origin and differentiation of the genital ducts: Wolffian duct, mullerian duct
1.6. Hormonal basis of sex differentiation
1.7. Histology, cytology and endocrinology of the foetal gonads
1.8. Disorders of sexual differentiation development: True hermaphroditism, Pseudohermaphroditism, Chromosomal errors and sex determination – Penile agenesis, Double Penis, Bifid Penis, Micropenis, Acruate Uterus, Double uterus.

Module 2.Physiology of Female Reproduction–I. Ovary & Reproductive cycles (12 hrs)

2.1. Anatomy of female reproductive system- Gross anatomy and histology of ovary
2.2. Ovarian hormones
2.3. Folliculogenesis and oogenesis and their hormonal control
2.4. Ovulation- Luteinization, Atresia
2.5. Reproductive cycles- Estrus and menstrual cycles- structural changes and hormonal control

Module 3. Physiology of female reproduction – II. Implantation, Pregnancy and Parturition (12 hrs)

3.1. Nidation, Desidualization
3.2. Placentation- Types, Placental hormones and their regulation
3.3. Physiology of pregnancy - Endocrine basis
3.4. Development of foetal membranes- Amnion, chorion, allantois and yolk sac
3.5. Physiology of parturition and endocrine control

Module 4. Physiology of female reproduction–III Mammary gland & Lactation (6 hrs)

4.1. Infantile mammary gland, Pubertal changes in mammary gland, Structure of adult mammary gland
4.2. Synthesis, composition and secretion of milk- galactopoesis- Milk let down
4.3. Hormonal regulation of lactation

Module 5. Physiology of Male reproduction: I. Testis, Reproductive tract and Accessory Reproductive Glands (15 hrs)

5.1. Anatomy of male reproductive system- Testis, Vasa efferentia, Epididymis, Vas Deferns, Ejaculatory ducts, Urethra, Penis
5.2. Accessory sex glands- Seminal vesicles, Prostate gland and Cowper's glands- Structure, cytology and functions
5.3. Histology of testis- Sertoli cells, Leydig cells and rete testis – structure and functions
5.4. Male sex act
5.5. Temperature regulation of testicular function
5.6. Testicular hormones- Androgens

Module 6. Physiology of Male Reproduction - Spermatology (10 hrs)

6.1. Spermatogenesis and its hormonal control
6.2. Structure of a typical mammalian sperm, Comparative morphology of sperms of mammals
6.3. Physiological maturation of sperm – initiation of motility and capacitation
6.4. Sperm motility and energetic- Factors affecting sperm motility
6.5. Biochemistry of semen

Module 7. Reproductive Behaviour (7hrs)

6.1. Concept of puberty
6.2. Adolescence- Somatic changes , psychological changes and hormonal changes
6.3. Senescence
6.4. Menopause

Module 8. Fertility regulation and Reproductive toxicology (8 hrs)
8.1. Disorders of male and female reproductive systems- Sexual dysfunction
8.2. Infertility in males and females – causes and curative measures
8.3. Birth control devices
8.4. Reproductive toxicology – effects of chemicals, drugs and alcohol on reproduction
8.5. Fertility regulation in farm animals

Module 9. Reproductive Health (10 hrs)

9.1. Sex Education and its importance
9.2. Adolescent sexual activity and adolescent stress management
9.3. Sexual harassment and its impacts
9.4. Sexually transmitted diseases

References:

1. Essentials of Medical Physiology, Leonard R. Johnson (Ed.), Academic Press.

2. Physiology of reproduction – Vol.I & II. Edited by E. Knobi & J.D. Neill. Raven Press, New York. 1994.
3. Human Reproductive Biology – R.E. Jones, Academic Press, London . 1997.
4. Comparative Endocrinology and Reproduction – Joy KP. Krishna A, Haldar L, Narosa Publishing HJouse, New Delhi. 1999.
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7. Principles of Vertebrate Reproductive Biology – HBD Sarkar, Himalaya Publishing House. 1993.
8. Current Concepts in Fertility Regulation. Edited by C.P. Puri and P.F. A. Van Look. Wiley Eastern Ltd. 1994.
9. Principles of Anatomy and Physiology , Vol II; G.I. Tortora and B.H. Derrickson , John Wiley& Sons Inc.

Semester IV
Special Subject: Endocrinology
Practical I

Zo243 Physiology of Reproduction with special reference to Mammals

1. Histology of testes of fish, calotes, chick and rat (any two animals)
2. Histology of ovary of fish, calotes, chick and rat (any two animals)
3. Dissection of male & female reproductive system of any suitable animal
4. Vaginal smear of rat
5. Sperm smear of any one vertebrate
6. Demonstration of induced ovulation in any one vertebrate

Zo244 Practical II **Vertebrate Endocrinology**

7 Dissection of endocrine glands in fish, calotes, chick and rat (any two animals)
8. Demonstration of glandectomy experiments in any two vertebrates
9. Simple experiment to study the effect of thyroxine, insulin and cortisol on blood glucose/total protein in fish or of any suitable animal
10. Preparation of single cell suspension of any one tissue for in vitro study
11. Histological study of endocrine gland using haematoxylin eosin stain in any two vertebrates
12. Disorders of endocrine glands (5 numbers for short notes)

SPECIAL SUBJECT: FISH BIOLOGY AND FISHERY SCIENCE
ZO 241: ICHTHYOLOGY

Module 1. Classification and distribution of fishes (10 Hours)

1.1. Scope and history of Ichthyology (self study)
1.2. Geographical distribution of fishes in marine and freshwater habitats
1.3. Distribution of fishes in marine and freshwater habitats in India and Kerala
1.4. Classification of fishes up to family- distinguishing characters with examples
1.5. Barcoding in fish taxonomy

Module 2. Adaptation of fishes to special conditions (10 Hours)

2.1. Deep sea fishes
2.2. Cave dwelling fishes
2.3. Hill stream fishes
2.4. Air breathing fishes
2.5. Venomous fishes
2.6. Larvicidal fishes and biological control
2.7. Schooling in fishes

Module 3. Functional morphology and bionomics of fishes (15 Hours)

3.1. Gross external anatomy of fishes
3.2. Body form diversity
3.3. Fins- types structure, function and modifications
3.4. Skin-structure and function
  3.4.1. Scalation- types of scale , structure, development and modifications
  3.4.2. Colouration-types of chromatophores, biological significance

Module 4. Food, feeding, digestion and growth in fishes (10 Hours)

4.1. Basic anatomy of digestive system of a cartilaginous and a bony fish
4.2. Food and feeding habits- natural food, feeding habit and adaptations;
  feeding in relation to season ,growth, sex and breeding; gastro-somatic index
4.3. Digestion absorption and utilization of food
4.4. Growth in fishes- length and growth relationship, growth curve
  and growth studies using scales and condition factor

Module 5. Excretion and osmoregulation (5 Hours)

5.1. Brief account of structure and function of kidney
5.2. Hormonal control of excretion and Osmoregulation

Module 6. Locomotion (10 Hours)

6.1. Types of locomotion- swimming and non-swimmimg
6.2. Body form and locomotion
6.3. Fins and locomotion
6.5. Fins and locomotion
6.6. Swim bladder and buoyancy- origin and function
6.7. Weberian ossicles and its significance

Module 7. Sense organ in fishes (10 Hours)

7.1. Lateral line sense organs, Ampullae of Lorenzini,
7.2. Chemo, mechano, thermo, and electro receptors
7.3. Structure of eye and visual pigments

Module 8. Endocrine glands in fishes (10 Hours)

8.1. Structure and function of – Pituitary gland, ultimobranchial gland, Caudal neuro-secretary cells, urophysis, corpuscles of stannous, Inter renal tissue and chromaffin tissue, islets of Langerhans, thyroid gland, gonad and pineal organ

Module 9. Reproduction in fishes (10 Hours)

9.1. Sexuality- hermaphroditism, unisexuality and bisexuality
9.2. Gonads- phases of maturity, length at first maturity, gonado-somatic index, fecundity
9.3. Reproductive behavior-sexual dimorphism, courtship, parental care, nest building

Module 10. Fish genetics (10 Hours)

10.1. Sex determination in fishes
10.2. Recent trends and techniques of hybridization
10.3. Chromosome manipulation in fishes
10.4. Transgenesis in fishes

SPECIAL SUBJECT: FISH BIOLOGY AND FISHERY SCIENCE
ZO 242: FISHERIES AND AQUACULTURE

FISHERIES

Module 1. Fishery Science (15 Hours)

1. Importance of Fishery science-Inland fisheries, Marine fisheries, capture fisheries and culture fisheries

2. Inland capture fisheries- Riverine fisheries, reservoir fisheries, cold water fisheries and estuarine fisheries

3. Marine capture fisheries in India- Offshore and deep sea fisheries- fin fish fishery, shell fish fishery (crustacean and molluscan)

Module 2. Methods of fishing (10 Hours)

2.1 Indigenous fishing crafts of India : sea fishing crafts- Catamaran, Musula boat, caravel boats, Dinghi, Dug out canoes, plank built canoes, out trigger canoes
2.2 Inland fishing crafts: Dug out and plank built boats
2.3 Mechanised Indian fishing crafts- fishing vessel characteristics
2.4 Indigenous fishing gears in India: Traditional and conventional; sea fishing gears and inland fishing gears

Module 3. Harvest and Post -harvest Technology (20 Hours)

3.1 Harvesting- precautions observed during harvesting, sorting, and grading the catch
3.2 Nutritive value of fish and biochemical composition of fish flesh
3.3 Fish spoilage and fish preservation
3.4 Fish preservation and processing- Icing and freezing , canning, salting , Drying , curing, smoking etc.
3.5 Fish products and byproducts- Liver oil, meal, manure, glue, isinglass, Leather , chitosan, fish maws, fish protein concentrate, fish fins
3.6 Fish food poisoning

Module 4. Fish Export and Extension (5 Hours)
4.1 Transportation and marketing : Overseas market for diversified products and principal world market for diversified sea food products
4.2 Fisheries extention : extension philosophy and extension methodology
4.3 The status of Indian fishery co-operative movement and Fish farmers development agencies

AQUACULTURE
Module 5. Aquaculture (10 Hours)

5.1 Scope and objectives of aquaculture ; status in India
5.2 Culture systems-
5.2.1 Criteria for space and site selection
5.2.2 Culture systems- Pond, Bheries, salt pans, tanks, race way, cage, pens etc.
5.3 Hatcheries- different types
5.4 Design and construction of aquafarms

Module 6. Breeding and seed production (10 Hours)

6.1 Bionomics of cultivable species of fish and shellfish (Mullets, milk fish, pearl spot, carps, Penaeus spp., Macrobrachium spp.)

6.2 Breeding of fishes with special reference to Indian major carps – wet and dry bundh technique for breeding
6.3 Induced breeding
6.3.1 Induced breeding in Fish – Principle , techniques and advantages of hypophysation, selective breeding and seed production
6.3.2 Induced breeding in Shrimp- Techniques involved in shrimp breeding and seed production – eye stalk ablation etc.
6.4 Transport of live fishes- fingerlings and breeders
6.5 Cryopreservation of gametes and embryos
6.6 Common fish diseases – viral, fungal, bacterial and parasitic infections

Module 7. Nutrition in culture fishes (3 Hours)

7.1 Nutritional requirement of a culture fish
7.2 Feed- Live and formulated
7.3 Procedure of Feed formulation

Module 8. Methods of fresh water and brackish water fish culture (15 Hours)

8.1 Monoculture – Indian major carps (Catla, Rohu, Mrigal), exotic carps, Tilapia
8.2 Composite culture
8.3 Culture of air breathing fishes – ecology of swamps & use in culturing air breathing fishes
8.4 Shrimp culture: traditional and scientific brackish water culture practices in India with special reference to Kerala
8.5 Ornamental fish culture- exotic and indigenous species
8.6 Aquarium set up and maintenance; Aquarium plants and aquarium accessories
8.7 Frog culture

Module 9. Mariculture in India (7 Hours)

9.1 Sea farming and sea ranching
9.2 Prawn culture
9.3 Pearl culture and culture of edible molluscs
9.4 Turtle farming
9.5 Sea weed cultivation

Module 10. Integrated fish culture (5 Hours)

10.1 Paddy cum fish culture
10.2 Fish-livestock farming- manurial value of livestock wastes and their role in recycling for raising fish production
10.3 Sewage fed fish culture

Field work

1. Visit to freshwater and brackish water fish farms.

2. Collection of water & soil samples of fish ponds for analyzing hydrographical parameters.

Study tour

Visit to fisheries institutes and fishing harbours to study the following:

1. Freshwater and brackish water aqua culture.

2. Fishing operations

3. Fish preservation and processing

4. Boat building and net making

5. Fisheries research, survey, education and extension

SPECIAL SUBJECT: FISH BIOLOGY AND FISHERY SCIENCE
Practical I
ZO 243- ICHTHYOLOGY

Taxonomy

1. Identification and classification of 10 local fishes (Marine/freshwater) up to species level
2. Identification and classification of 5 prawns up to species level

Dissections and mounting

3. Membranous labyrinth
4. Ampullae of Lorezini

5. Brain
6. Scales-Placoid, cycloid, ctenoid.
7. Digestive system of a fish (cartilaginous or bony fish)
8. Urinogenital system of a teleostean fish
9. Pituitary gland

Fish Physiology

9. Effect of NaCl/KCl on fish chromatophores
10. Determination of the rate of oxygen consumption of a fish at room temperature
11. Determination of gonadosomatic index
12. Measurement of fecundity rate in a fish
13. Qualitative and quantitative analysis of gut content in a herbivorous and carnivorous fish
14. Determination of gastrosomatic index
15. Smear preparation of fish blood to study the morphology of different cellular elements
16. Differential count of fish WBC

Fish genetics

17. Sex determination in fishes
18. Hybridization techniques in fishes
19. Karyotyping in fishes

SPECIAL SUBJECT: FISH BIOLOGY AND FISHERY SCIENCE
Practical II
ZO 244 – Fisheries and aquaculture

Fish pond ecology

1. Determination of nutrients in the water samples from freshwater and brackish water ponds (Phosphat/sulphate/nitrate)
2. Determination of free calcium carbonate in the soil sample from freshwater and brackish water ponds
3. Determination of LC_{50} for fish exposed to a given pollutant

Fish Pathology

4. Identification of common external fish parasites (At least 5 numbers)

5. Estimation of spoilage in fish by pH method
6. Determination of bacterial plate count for fish skin, flesh and gut

Breeding Techniques

7. Mounting of pituitary gland
8. Preparation of pituitary gland extract
9. Demonstration of hypophysation technique
10. Demonstration of artificial insemination
11. Demonstration of sperm motility in a fish
12. Preparation of a formulated fish feed

Fish byproducts

13. Identification and study of fish byproducts
14. Preparation of any one fish by product
15. Estimation of muscle protein
16. Estimation of muscle glycogen

Fishing crafts and gear

17. Identification and study of different types of fishing crafts (Minimum 5 numbers)
18. Identification and study of different types of fishing gears (Minimum 5 numbers)
19. Setting up of an aquarium
20. Study of aquarium accessories
21. Study of common aquarium plants(Minimum 5 numbers)

References (Indira Teacher - to be split as per existing syllabus and placed after each paper)

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Semester IV

Special Subject-Insect Science

ZO 241 General Entomology Total 100 hrs

Unit 1 Introduction (6 hrs)

1.1 Origin and Evolution of insects.

1.2 Fossil Insects

1.3 Insect-plant interdependence (Co-evolution)

Unit 2 Anatomy (22 hrs)

2.1 Integument: Histology of the basic components, Chemical composition of cuticle, sclerotization, physical properties of the cuticle, coloration, permeability characteristics, moulting and external integumentary process.

2.2 Head-Segmentation-Structure and modifications

2.3 Thorax-Segmentation-Structure-and modifications.

2.4 Abdomen-Segmentation-structure-and Characteristics

2.5 Wings-Origin and evolution of wings, venation-structure.

2.6 Appendages-segmentation-structure-Adaptive radiation of legs.

Unit 3 Embryogenesis (22 hrs)

3.1 Formation of blastoderm and germ cells, formation of germ band & extra embryonic membranes

3.2 Differentiation of germs layers.

3.3 Segmentation, Appendage formation and blastokinesis, organogenesis, polyembryony, control of embryogenesis, Oviparity, Viviparity, Oviposition, eclosion, postembryonic morphogenesis.

3.4 Growth, metamorphosis, endocrine mechanisms in metamorphosis.

Unit 4 Insect Classification (10 hrs)

4.1 Biology and habits of the different orders of insects-classification upto families.

4.2 Biology and habits of aquatic gall forming and leaf-minig insects.

4.3 Adaptations of parasitic and predatory insects

4.4 Seasonal Adaptations-Dormancy-Diapause

Unit 5 Insect Physiology (30 hrs)

5.1 Insect nutrition: Anatomy and histology of foregut mid and hind gut. Modification of gut (filter chamber)

Process of secretion of enzymes, Microbiota&digestion of wood, Keratin wax and silk.

5.2 Respiratory system: Trachea, Tracheoles, Air sacs, Spiracles.

Types of ventilatory process-Passive ventilation bulk flow and active ventilation.

Passive suction ventilation and elimination of CO2 Ventilation in aquatic insects, end parasitic insects and during mounting.

5.3 Central nervous control of ventilation.

5.4 Circulatory system: The dorsal vessel & accessory pumping sir uses.

Cardiac regulation & Circulation-General characteristics and chemical composition of haemolymph, haemocytes, Origin, number and function. Other tissues associated with circulatory system.

5.5 Excretory system: Malpighian tubles-anatomy and histology, Orthopteran, Hemipteran, coleopteran and lepidopteran types. Salt and water balance, control of diuresis and gut mobility, nitrogenous excretion, insect urine.

5.6 Nervous system, glandurar and muscular systems.

5.6.1 Structure and function of the nervous system, nervous integration.

5.6.2 Exocrine and endocrine glands and their functions

5.6.3 Skeletal muscle, visceral muscle, muscle, muscle development and maintenance

5.7 Sense organs: Morphology of sense organs; sensory mechanisms, light and sound production

5.7.1 Mechnoreception- The tactile sense, proprioceptive sense, sound perception.

5.7.2 Chemoreception-Sensory coding phago stimulants and phagodeterrents

5.7.3 Thermoreceptores-Hygroreceptors.

5.7.4 Photoreception-Compound eyes, dorsal ocelli etc,.

5.7.5 Light production and sound production.

5.8 Reproduction and morphogenesis.

5.8.1 Reproductive system and Gametogenesis in male and female.

5.8.2 Fertilization, Sex determination, parthenogenesis

Unit 6 Insect Communication (10 hrs)

6.1 Acoustic, Visual, tactile and chemical methods.

6.2 Role of hormones in communication

6.3 Pheromones

6.4 Kairomones

6.5 Allomones

6.6 Insect immunity.

References

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10. Insect Hormones. V.J.A.Novak.
11. Modern Entomology. D.B Tembhare.
12. Phermones.M.C.Birch
13. Biology of Insect midgut.M.J. Lehane
14. Recent Advances in Insect. Physiology and Toxicology. G.T. Gujar
15. General and Applied Entomology, K.K. Nayar et.al.

ZO 242 Applied Insect Science Hours 100

Unit 1 Introduction Insect Pests (5 hrs)

1.1 Kinds of Insect pests. Major pests, minor pests, sporadic pests, endemic pests, exotic pests, seasonal pests, occasional pests, regular pests, persistant pests.

Unit 2 Causes of Pest Outbreak (8 hrs)

2.1 Deforestation, Destruction of natural enemies pest resurgence.

2.2 Secondary pest outbreak Intensive and extensive cultivation, Intriduction of new crops, new varieties, hybrid varieties, cultural practices, change in agriculturall practices-introduction of new pests.

2.3 Forecasting pest outbreaks and surveillance, short term and long term forecasting-Forecasting based on observations- Climatic and empirical factors.

Unit 3 Biology of Pest Insects. (20 hrs)

3.1 Biology, nature of damage and control of major pests of major crops. Paddy, coconut, vegetables, Pulses, coffee, tea, sugarcane, banana, tapioca, cashew, pepper, cardamom and stored products.

3.2 Insect pests of domestic animals, biology and control.

3.3 Biology of major arthropod vectors of human diseases belonging to Diptera, Anoplura, Siphonoptera-control of vectors.

3.4 House hold Pest Insects-Biology and control.

Unit 4 Industrial Entomology (12 hrs)

4.1 Silkworm Technology-Sericulture

4.2 Honey bee-Apiculture

4.3 Lac-Insect-Lac culture.

4.4 Insects as human food and as scavengers.

Unit 5 Principles of Insect Control (15 hrs)

5.1 Basic principles of Insect control, prophylactic methods, curative or direct methods.

5.2 Biological control-Brief history, theory behind classical biological control, Agents of biological control-Parasites and parasitoids, predators pathogenic micro organisms (Bacteria, fungi and viruses)

5.3 The practice of biological control-phases-conservation, Importation and colonization-mass culture and release of natural enemies.

5.4 Economic dimensions of biological control merits and demerits.

5.5 Important biological control projects undertaken in India against insect pests and weeds.

5.6 Important concepts relevant to the search for exotic beneficial insects (amenability of pests, pests and natural enemy associations in native home, climate similarities)

Unit 6 Insect Toxicology (15 hrs)

6.1 Chemical control-Inorganic and organic pesticides, pesticides of plant origin, chemosterilants, insecticide residues, insecticide formulations, appliances, fumigation& fumigants.

6.2 Principles of behavioural control-Pheromonal considerations-Communication pheromone, sex pheromone-aggregation pheromones-orientation theories use of other chemicals-repellents-plant allomones-Antifeedants, Integration of behaviours modification with other tactics.

Unit 7 Pest Management (15 hrs)

7.1 Concepts of pest management, definition, characteristics of pest management, pest management strategies and techniques.

7.2 Integrated Pest Management (IPM)-definition; IPM in Agro ecosystems, preventive practice, Therapeutic practice, selection of tactics, Integration of tactics.

7.3 Ecological Management of the Crop environment-

7.3.1 Reducing average favourability of ecosystem,

7.3.2 Disrupting continuity of pest requisites

7.3.3 Diverting Pest populations away from crop

7.3.4 Reducing the impact of insect injury.

7.4 Ecological back lash and its management-resistance of populations to pest management- tactics, Pest population resurgences and replacement-enhanced microbial degradation, upsets in community balance.

Unit 8 Insecticide Resistance (10 hrs)

8.1 Genetic, physiological and biochemical mechanisms.

8.2 Insecticide metabolism-microsomal & extramicrosomal

8.3 Dynamics of environmental pollution by insecticides Its impact in the biosphere.

8.4 Insecticide poisoning, biological magnification, health hazards, silent spring (Rachel Carson)

References

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Semester IV

Special Subject: Insect Science

Practical I

Zo243 (Taxonomy, Anatomy Histology and Physiology)

Taxonomy

1. Identification and preparation of taxonomic key of 10 insects belonging to 10 families and 4 orders.
2. Collection, preservation and presentation and insects belonging to 30 families
3. Mounting, sketching and labeling of taxonomic features of the following.
   a) Wings in insects of 5 orders

b) Antennae in insects of 5 orders

c) Mouthparts in insects- 4 types

d) Legs-4 types

Anatomy & Histology

1. Dissection

1.1 Alimentary canal and associated glands of 4 groups of Insects with different feeding habits.

1.2 Reproductive system of any two female insects

1.3 Nervous system in any two groups

1.4 Stomatogastric Nervous system (Oesophageal, sympathetic, single recurrent nerve and paired recurrent nervous)

1.5 Endocrine system

1.6 Identification of sensilla employing a suitable staining technique.

2. Histology

2.1 Preparation of paraffin sections of insect midgut epithelium and ovary using Haematoxylin-eosin staining technique to demonstrate histological details.

2.2 Whole mount staining preparation of insect brain to demonstrate neurosecretory cells by PAVB technique.

Physiology

1. Quantification of proteins in fat body/haemolymph
2. Quantification of glycogen in fat body.
3. Demonstration of malpighian tubule activity using dyes neutral red/indigo carmine.
4. Identification of at least two free aminoacids inhaemolymph by paper chromatography
5. Quantitative estimation of any two digestive enzymes (Protease/amylase/Invertase)
6. Haemolymph protein profile employing PAGE
7. Identification haemocytes using Giemsa/Wright's/BPS stain.

NOTE: Candidates shall submit a collection consisting of 40 families of insects from different orders (It shall include dry collection, wet collection and slides including life stages) The collection shall be submitted at the time of practical examination along with practical record.

Practical II

Zo244 (Ecology, Economic Entomology and Experimental Entomology)

Ecology

1. Methods of collection and identification of soil insects (any ten numbers)
2. Field work: A field study shall be conducted to observe the insects in their natural habitat. A detailed field report shall be submitted by each student which includes observation of insects in area such as forests, grass land, aquatic insects, sandy areas etc., The field report duly certified shall be submitted at the time of practical exam along with practical record.
3. Estimation of LC 50 value and LD 50 value of any two brands of insecticides for some aquatic/terrestrial organisms.

Economic Entomology

1. Collection, Preservation, identification and presentation of following categories of pests.
   1.1 Agricultural pests of different crops 10 numbers.
   1.2 Stored-Product pests-3 numbers.
   1.3 Vectors and veterinary pests-4 numbers
   1.4 House-hold pests – 5 numbers
   1.5 Beneficial insects-6numbers.
2. Collected and identified insect specimens and pests of crops shall be submitted at the time of practical examination. Candidates shall submit a minimum of 15 wet collections.
3. Field study to collect/observe insect species of pollinators, parasitoids, predators, scavengers and weed killers.
4. Field study of various methods of pest management
   Pesticide formulation
   Pesticide application
   Safety hazards & First aid.

Experimental Entomology

1. Rearning of any two insects in the laboratory
2. Identification of Larval instars using Dyar's rule
3. Sexing of insects-Larva pupa and adult.
4. Effect of starvation on metamorphosis.
5. Demonstration of the following techniques.
    a. Neck ligation
    b. Extripation
    c. Canterization
    d. Ovariectomy

NOTE: Candidates shall submit a minimum of 15 numbers of different categories of pests at the time of practical examination along with the practical record. A duly certified field report also shall be submitted at the time of practical examination.

Semester IV

Special Subject: Environmental Physiology

Zo241: Pollution Biology & Environmental Physiology (100 Hrs)

Unit 1 Introduction (12 hrs)

1.1 Environmental pollution-Concepts and definitions

1.2 Environmental pollutants

1.2.1 Organic pollutants

1.2.2 Heavy metals, industrial effluents

1.2.3 Pesticides

1.2.4 Radioactive pollutants

1.2.5 Oil, food additives and contaminants

Unit 2 Air Pollution (15 hrs)

2.1 Chief air pollutants-occurrence, sources and effects

2.2 Interaction of air pollutants in the atmosphere-Photochemical reactions-Formation and effects of secondary pollutants and photochemical smog.

2.3 Effects of air pollutants on materials, building metals, vegetation and human health; a brief survey of major air pollution episodes

2.4 Air pollution abatement technologies – Design and working of bag filters, electrostatic

Unit 3 Noise pollution (5 hrs)

3.1 Sources

3.2 Effect of noise pollution on materials, animals and humans.

3.3 Sonic boom.

3.4 Abatement strategies

Unit 4 Water pollution (6 hrs)

4.1 Organic pollution

4.1.1 Origin and sources of organic pollutants – Biodegradable and non-biodegradable; Domestic, agricultural and industrial sources

4.1.2 Biochemical Oxygen Demand (BOD)

4.1.3 Chemical Oxygen Demand (COD) – Importance and method of estimation.

4.1.4 Effects of organic pollution on aquatic systems

4.1.5 Eutrophication – Sources and effects.

4.1.6 Biocides, fungicides and herbicides - Sources and effects

4.1.7 Biomagnifications: Toxic effects on non-target organisms and hazards to man.

4.2 Industrial pollution

4.2.1 Heavy metals-Effects of various heavy metals (such as Hg, Pb, Cd, As, Cr, Zn, etc) in the ecosystem and human population

4.2.2 Fluoride pollution on human life

4.2.3 Thermal pollution-sources, effects and control.

4.2.4 Oil spills-sources, effects and control.

4.3 Water pollution abatement technology (10 hrs)

4.3.1 Primary, Secondary and tertiary treatment systems

4.3.2 Design and operations of screens, frit chambers, sedimentation tanks and oxidation ponds.

4.3.3 Design and operations of biological treatment systems like aerated lagoons, activated sludge process, trickling filters and sludge digestion

Unit 5 Radioactive Pollution (10 hrs)

5.1 Sources of nuclear radiation

5.2 Biological effects of ionizing radiations and non-ionizing radiations.

5.3 Nuclear waste disposal

Unit 6 Terrestrial Pollution (12 hrs)

6.1 Solid wastes and disposal (garbage, ashes, rubbish, street litter, agricultural waste, mining waste and industrial wastes).

6.2 Strategies for control of solid waste pollution

Unit 7 Environmental Physiology (32 hrs)

7.1 Temperature adaptations

7.1.1 Morphological and physiological adaptations:

Relation between body size and metabolic rate. Temperature and metabolic rate: Thermal acclimation; Enzymatic acclimation;

7.1.2 Temperature classifications of animals-Homoiotherms and Poikilotherms;

7.1.3 Thermal migration

7.1.4 Implications of global warming on animals.

7.2 Pressure adaptations

7.2.1 Adaptations to hyper baric stress with particular reference to deep sea organisms.

7.2.2 Biochemical mechanisms of animals to high altitudes (hypo aria and hypoxia)

7.3 Osmoregulation and ionic regulation

7.3.1 Osmoregulation in fresh water, marine estuarine and terrestrial animals

7.3.2 Sodium pump Na^+ and K^+ATPase in relation to salinity adaptations.

7.4 Eco-physiological adaptations

7.4.1 Mimicry and colouration

7.4.2 Echolocation

7.4.3 Bio-luminescence

7.4.4 Electric organs.

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Zo242 Environmental Management Total Hours: 100

Unit 1 Resources of Earth (15 hrs)

1.1 Renewable and non-renewable resources

1.1.1 Forests, wild life, endangered species fisheries

1.1.2 Fossil fuels, minerals-their over-exploitation for domestic, agricultural and industrial purposes.

1.1.3 Water resources-protection of water shed, reclamation of sewage and waste and water management in India.

1.2 Conservation of natural resources

1.3 Remote sensing for resource management

Unit 2 Human exploitation of earth's resources (15 hrs)

2.1 Human interferences in ecosystems- consequences of over-exploitation

2.2 Brief account of weather modifications, desalination, artificial rain making, acid rain, green house effect and its consequences and destruction of ozone umbrella.

Unit 3 Biological Conservation and Management (20 hrs)

3.1 Principles of conservation

3.2 Conservation and economic use of energy and energy audit

3.3 Ecological problems due to intensive aquaculture – importance trawling ban

3.4 Conservation of wild life-present status and strategies of conservation

3.5 Deforestation and its consequences-need for scientific management and conservation of forests.

3.6 Biodiversity in India-Biodiversity conservation-*in situ* and *ex-situ* methods.

3.7 Biodiversity registering and patenting of biodiversity.

Unit 4 Environmental Policy and Education (15 hrs)

4.1 Environmental policy-social, economic and legal aspects

4.2 Environmental laws and their enforcement

4.3 Environmental awareness-role of Government, media and voluntary organizations

Unit 5 Environmental Impact Assessment and Sustainable Development (15 hrs)

5.1 Environmental Impact Assessment (EIA)

- 5.1.1 Definition, aim, principles and concepts of EIA
- 5.1.2 Elements of environmental impacts
- 5.1.3 Methods for preparing EIA-Check list method, Werner-Prestroit study
- 5.1.4 EIA Process making inventories, sampling and data processing, impact prediction and stimulation.

5.2 Sustainable Development

- 5.2.1 Concepts and dimensions
- 5.2.2 Basic needs
- 5.2.3 Unavoidable impacts and imperatives relating to sustainable development.
- 5.2.4 Alternative strategies

Unit 6 Environmental Biotechnology (20 hours)

6.1 Pollution abatement using microbes

- 6.1.1 Sewage treatment

6.1.2 Solid waste disposal

6.2 Soil enrichment by using microbes

6.3 Genetic engineering of nitrogenose gene ('*nif*' genes) and nodulation genes.

6.4 Microbial insecticides

6.4.1 Insecticidal toxin of Bacillus thuringiensis and genes) and nodulation genes.

6.4.2 Baculoviruses as biocontrol agents and their genetic engineering for improved biocontrol.

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Semester IV

Special Subject: Environmental Biology

Practical 1 ZO 243 Pollution Biology & Environmental Physiology

(10 Practicals to be carried out)

1. Analysis of soil texture using micrometry.
2. Determination of moisture content of soil.
3. Determination of soil pH (different soil samples)
4. Determination of organic carbon.
5. Determination of porosity/water retaining capacity of soil
6. Determination of chlorine in water.
7. Determination of H_2S in water
8. Determination of Ammonia in water
9. Short term biossays and determination of LC50 of fish exposed to a given pollutant.
10. Effect of soil pollution on the population of earthworks.

11. Study of indicator organisms.
12. Effect of population on the Oxygen consumption of fishes.
13. Temperature/pH preferences of fishes.
14. Field work-Students are expected to make a field study on the problem of environmental pollution in their area.

Note: The students should submit the field study report at the time of examination.

Practical II ZO 244 Environmental Management

(10 practicals to be carried out)

1. Determination of pH of water
2. Determination of electrical conductivity of water
3. Determination of turbidity of water
4. Determination of salinity of water
5. Determination of hardness of water
6. Determination of BOD and COD of polluted water.
7. Estimation of BOD and COD of polluted water.
8. Instrumentation: Principles, use and working of the following instruments.
   - 8.1 pH meter
   - 8.2 Electrical conductivity meter.
   - 8.3 Flame photometer
   - 8.4 Hygroscopic soil thermometer.

9. Estimation of primary productivity (Chlorophyll method)
10. Estimation of secondary productivity
11. Construction of pyramids of numbers and biomass from a pond collection.
12. Species diversity estimation with reference to a fresh water pond/soil.