UNIVERSITY OF KERALA
Thiruvananthapuram

DRAFT

M.Sc. Zoology – Semester System

Revised syllabus

(for 2020 admissions onwards)

March 2020

M.Sc. Zoology – Semester System

Revised Syllabus, Course Structure & Mark Distribution

Semester	Paper Code	Title	Distribution of hours / semester	Instruction 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, Instrumentation & 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, Quantitative Analysis & Research Methodology	100	5	-	3	25	75	100
	Z0 223	Cell Biology, MolecularBiology& Bioinformatics	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 & Developmental 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 SemesterAssessment;

*** Tutorial 30 hours per week**

UNIVERSITY OF KERALA
M.Sc. Zoology – Semester System
Revised syllabus (2019)

Semester I
ZO 211 Systematics and Evolutionary Biology
Total 100 hours (50+50 hrs)

AIM: To introduce the nature and scope of various aspects of Sytematics, Animal taxonomy and Classification practiced in biological science with special reference to Animal Science.

COURSE OBJECTIVES: To impart knowledge on the basic aspects on Animal taxonomy and classification and demonstrate knowledge and understanding the naming of the species and get the idea about the phylogeny and evolutionary history.

Systematics **(50hrs)**

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

1.1. Historical resume of systematics
1.2. Importance and applications 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. Dimentins 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 genomis
4.3.2. DNA bar coding and Barcoding of life

4.3.3. Phylogenetic trees

Evolutionary Biology **(50 hrs)**

Module. 5. Cosmic evolution and the Origin of life (**5 hrs)**

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

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

Module. 6. Molecular Evolution **(15 hrs)**

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

Module. 7. Biochemical and genomic evolution **(15 hrs)**

7.1. The evolutionary history of proteins and concept 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 the endocrine systems, Hormones and evolution.

Module. 8. Origin of Higher Categories **(15 hrs)**

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.

References

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3. Campbell, N.A and J.B.Reece.2009. Biology (8thedn). Benjamin Cummings Publ.NY,USA
4. David,M.H, Craig Moritz and K.M. Barbara. 1996. Molecular Systematics. Sinauer Associates, Inc.
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21. Charles W. Fox and Janson B.Wolf. 2006. Evolutionary Genetics-Concepts and Case Studies. Oxford University Press, NY. USA
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31. Hall, B.K., Pearson, R. and Mullae, G.B.2003. Environment, Evolution and Development: Toward a Synthesis. MIT Press, Cambridge MA, USA
32. Kimura, M. 1983. The neutral theory of molecular evolution. Cambridge University Press
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37. Stearns c.S. 1987. The evolution of sex and its consequences. Birakhauser, Basel, Switzerland
38. Strickberger, M.W. 2005. Evolution. Jones and Bartett Publishers, London.
39. West-Eberhard M.J. 2003. Developmental Plasticity and Evolution. Oxford University Press, oxford, UK
40. Web Resources
41. http://www.talkorigins.org
42. http://www.ucmp.berkely.edu
43. http://www.academicearth.org

ZO 212 BIOCHEMISTRY (100 hrs)

AIM: To introduce the nature and scope of various aspects of Biochemistry and Synthetic Biology.

COURSE OBJECTIVES: To impart knowledge on various biochemical molecules and path ways in life processes.Also demonstrate knowledge and understanding of the molecular machinery of living cells, the principles that govern the structures of macromolecules and their participation in molecular recognition, and understanding of the principles and basic mechanisms of metabolic control and molecular signaling.

Module I Introduction (6hrs)

1.1. Atoms and molecules, intermolecular and intramolecular interactions 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 into cations and anions, Henderson – Hasselbalch equation.

Module 2 Carbohydrates (12 hrs)

2.1. Classification and nomenclature

2.1.1. Monodsccharides: Biological importance, Glucose, fructose, galactose, mannose and ribose. Isomerism – Structural isomerismand stereoisomerism, optical isomerism, Epimerism and Anomerism.

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

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

2.1.4. Polysacchacides– Homopolysaccharides – Starch, glucogen,cellulose,Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteinsand Mucoproteins.

Module 3 Proteins (10 hrs)

3.1.1. Amino acids: Structure, classification and properties of amino acids. pKvalue 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-Clobular protein- eg Myoglobin.

3.2.5. Quaternary structure- egHaemoglobin

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

Module 4 Lipids (10 hrs)

4.1.1 Classification of lipids: Simple, compound and derived lipids. Biologicalimportance 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 andfunctions.

4.1.6. Lipoproteins.

Module 5 Nucleic Acids (8hrs)

5.1.1 Structure 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 micro RNA stability of proteins and nucleicacids.

5.1.2. Protein-nucleic acid interactions. Electrostatic interaction, hydrogenbonding stacking interactions.

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

5.1.4. Bioloogical 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 (8hrs)

7.1.1. Major metabolic pathways: Glycolysis – Fate of pyuvate.Citric acid cycle and its significance; Oxidative & substrate level phosphorylation. Pentose phosphate pathway (self study).

7.1.2. Gluconeogenesis, Cori cycle

7.1.3. Glucogen metabolism: Clllycogenesis, Glycogenolysis, adenylate cascadesystem Ca^{+2}Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis

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

7.1.5. Factors maintaining 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 sleltons 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 metabolism, plasma bilirubin, jaundice

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 (8hrs)

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 hrs)

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 hrs)

12.1. Free radicals and antioxidants, Generation of free radicals. Reactiveoxygen species. Damage produced by free radicals, Free radical scavenger systems.

12.2. Lipid peroxidation. Preventive antioxidants.

Module 13 Biochemistry of aging (3 hrs)

13.1. Cellular aging

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

13.3. Prions, Apoptosis

Module 14 Clinical biochemistry (3 hrs)

14.1. Introduction to clinical biochemistry

14.2. Analysis of diseases (Diabletesetc)

References:

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ZO 213 Biophysics, Instrumentation and Computer Science (100 hours)

Biophysics (25 hrs)

AIM: To introduce the principle behind the functioning of various instruments, their functioning and application of various computer programmes in biological laboratories.

COURSE OBJECTIVES: To get knowledge and understanding of the application of instruments in biological laboratory and the application of various computer programmes and packages in research.

Module 1 Thermodynamics (5 hrs)

1.1. Introducation-Concept of energy and laws of Thermodynamics
1.2. Matter and energy-Life as an anergy 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 hrs)

2.1. Cosmic radiation – Gamma radiation, X-rays, UV – radiation, visible spectrum, infrared rays, microwaves and radiowaves.
2.2. Biological applications

Module 3 Radiation Biophysics (8 hrs)

3.1. Radioactivity; Detection and measurement of radiation
3.2. Radio-labelling methods,- detection and measurement of different types of radioisotopes and their applications I 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 inthyroid function analysis. Renal, liver and lung function analysis.

Module 4 Nanotechnology (4 hrs)

4.1. Introduction to Nanobiology

4.2. Nanosensors and Nanomedicines

Instrumentation (50 hrs)

Module 5 Methodology and working of microscopes (15 hrs)

5.1. Phase contrast microscope

5.2. Fluorescent microscope

5.3. Electron microscopes – TEM and SEM, 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 (8hrs)

6.1. Ordinary, high speed centrifuge

6.2. Density gradient centrifugation.

6.3. Ultracentrifugation

Module 7 Electrophoresis (7 hrs)

7.1. Principle

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 hrs)

8.1. Principle

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

Module 9 Biophysical methods (15 hrs)

9.1. Colorimeter, spectrophotometer, flame photometer

9.2. Atomic absorption spectrophotometer, florescent spectrometer

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

9.4. Molecular snalysis 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 stikulation of brain, pharmacological testing, PET (Positron emission tomography), MRI,FMRI, CAT scanning methods

Computer Science (25 hrs)

Module 10 Introduction to computers (self study)

10.1. Characteristics of computers

10.2. Hardware –input out put devises, processor Modules, storing, controlling
10.3. Characteristics of computers

Module 11 Computer generations (8 hrs)

11.1. Classification- first to 5th 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 hrs)

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 customized soft ware, developing customized software, down loading public domain soft ware, software development steps- firmware, and middle ware

Module 13 Operating systems (4 hrs)

13.1. Windows, DOS, Linux (self study)
13.2. Concept of free software

Module 14 Computer Programming (4 hrs)

14.1. Low level languages
14.2. High level languages
14.2.1. Programming language C++

Module 15 Computer and Communications (5hrs)

15.1. Introduction to Cyber security/Information security (brief mention only). LAN (local area net work) WAN (wide area network, MAN (Metropolitan area network)
15.2. Internet, email, www, social network groups etc.

REFERENCES

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Semester II

ZO221ADVANCED PHYSIOLOGY and FUNCTIONAL ANATOMY(100 hrs)

AIM: To introduce the nature and scope of various aspects of Anatomy and physiology in general and human Anatomy and physiology in particular**.**

COURSE OBJECTIVES

To impart deep knowledge on the structure and functioning of different systems in organisms from molecular level to organ systems and to the physiological attributes of whole organism.

Module 1 Introduction (self study)

1.1. Introduction to Physiology and Anatomy
1.2. A brief history of Physiology and Anatony
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 (10 hrs)

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 contration
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 failute
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
5.4. Regulation of respiration
5.5. Respiratory disturbance: Oxygen therapy, Artificial respiration

Module 6 Excretion and Osmoreguation (10 hrs)

6.1. Types of Excretion, Structure of kidney, Basic renal process 9self 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 andVertebrate eye
9.2. Tactile, Position, Pain,Thermal and taste Senses
9.3. Visual pathways organization of visual cortex. Analysis of visual information, detection of colour
9.4. Auditory pathways – Functions of cerebral cortex in hearting
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. Preganancy – 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 Physiological adaptationand Stress (5hrs)

11.1. Physiological adaptation, acclimation, acclimatization.
11.2. Concept of stress- definition, stressor, stress response, eustress, distress, acute and chronic stress, stress acclimation.
11.3. Concept of ease, recovery response, stress hormones, neuroendocrine control of stress response, role of hypothalamo-pituitary-adrenal axis.

Module 12 Sports Physiology (4 hrs)

12.1. Muscles in exercise, cardiac reserve, cardiovascular fitness, fascia training, neurobiological effects of physical exercise, physical fitness and its components.
12.2. Dope test, drugs and athletes
12.3. Fitness test. Bio energetic fuel for muscle work

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Zo222 Genetics, Quantitative Analysis and Research Methodology (100 Hrs)

AIM: To introduce the nature and scope of various aspects of Genetics, Biotechnology and signal transduction processes related with zoological science.

COURSE OBJECTIVE: To introduce students to the science of heredity, from its basic principles to the most recent advances in the field. To impart knowledge of classical and molecular genetics.

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 (12hrs)

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 (8hrs)

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 (15 hrs)

Module 1 Introduction **(2hrs)**

1.1. Definition, history, scope of biostatistics and application of statistics in biology (self study)
1.2. Descriptive an dinferentailstatistics
1.3. Preliminary concepts – populaiton 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 11 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 111 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 1V 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 test (2 hrs)

5.1. Characteristics, advantages and disadvantages
5.2. Types (Brief account only)

Module V1 Vital statistics (2 hrs)

6.1. Introduction,uses, methods of collections
6.2. Measures of vital Statistics, life tables

Research Methodology (15 Hrs)

Module 1 Introduction (2 hrs)

1.1. Definition, meaning, objectives, and significance of research, research methods vs Methodology
1.2. Types of research – Descriptivevs. Analytical,Applied vs. Fundamental, Quantitative vs Qualitative, Conceptual vs Empirical.
1.3. Characteristics of good research, steps of working of research

Module 11 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 111 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 1V 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 V1 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 – ESO 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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Quantitative Analysis

1. Fisher.R.A., Statistical Methods for Research
2. Biometrical Genetics – Dover Publication, New York
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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 Methodoly. Narosa Publishing House, New Delhi.
13. Finney, D.J. 1980. Statistics for Biologists. Chamman and Hall, London
14. Kothari C.R., 2009. Research Methodology: Methods and Techniwues. New Age Interntional Publishers, New Delhi.
15. Oliver, P.2005. Writing Your thesis. Vistar Publications. New Delhi.

Zo223 Cell Biology, Molecular Biology and Bioinformatics (100 hrs)

AIM: To introduce the nature and scope of various aspects of Cell structure and molecular biological aspects in cell biology**.**

COURSE OBJECTIVES: The students will be introduced on the various aspects of Cell structure, function, cell replication, cell communication, protein synthesis, cell dynamics etc.

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

1.1. Diffusion of small molecules across phospholipids bilayer
1.2. Uniporter – 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 (5hrs)

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 (15 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 ncurated 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.
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Zo214 Practical 1

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 fact.
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.
12. Estimation of acetylcholine content in tissue sample.

C. Biophysics, Instrumentation and Computer Science

1. Micrometry: Measurement of microscopic objects using micrometer.
2. Seperation 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 software. E.g. PH Stat.

References

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

Practical 11

Zo 224 Advanced Physiology and Functional Anatomy

Please use software such as **Physio Ex.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. Recording of heart beat and the effect of drugs (acetylcholine and adrenaline) in fowl.
4. Effect pH different concentrations of NaCl (0.1% to 2%) on the diameter of RBCs using micrometery.
5. Estimation of RBCs and WBCs in vertebrate blood
6. Blood histology of earthworm/cockroach/fish and chick.
7. Studies on feeding-Mounting of mouth parts of housefly, honey bee and mosquito in relation to food and feeding.
8. Observation of mitochondria in yeast cells.
9. Observation on ciliary movement in bivalve gills in relation to temperature and pH.

Genetics and Quantitative analysis

10. Chromosome study – Squash preparation of Drosophila/Chironomous larvae
11. Calculation of Mean, Standard deviation, Standard Error, and Students' t-test.
12. Calculation of correlation coefficient & Test of significance.
13. Preparation of histogram, frequency polygon and pie diagram using appropriate software.

Cell and molecular biology

14. Study of meiosis- Squash preparation of grasshopper testis.
15. Histological localization of protein and glycogen in paraffin sections.
16. Estimation of DNA from tissue extract.

Semester III

Paper 1- Zo231 Microbiology and Biotechnology (100 Hours)

AIM: To introduce the nature and scope of various aspects of Developmental Biology and stem cell biology in general and human development and applications of stem cell biology in particular.

COURSE OBJECTIVE: The students will be introduced on the various aspects of developmental biology such as animal development, cellular differentiation, stem cell biology etc.

PART.A.Microbiology (50 hours)

Module 1 Introduction to Microbiology (7 hrs)

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

1.2 Microbial diversioty 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, Bergey'sMannual, (self study)

Module 2 Bacterial Cell structure and function (8hrs)

2.1 Ultrastructure of bacteria – cell membrane, cytoplasmic inclusions, nucleoid etc

2.2 Bacterial Cell Wall- structure; differences between gram positive and negative cell wass, gram staining

2.3. External components & their functions – pili, flagella, fimbriae, capsules, slime layers etc.

Module 3 Microbial Nutrition and Growth (10 hrs)

3.1 Common nutritional requirements of microorganisms- auto trophy 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, continous culture, effect of environmental factors on growth. Stress response.

Module 4 Industrial & Environmental Microbiology (10hrs)

4.1. Industrial Microbiology

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

4.1.2. Basis design and types of fermenters.

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

4.1.4. Microbiology of mild& foods. Preservation of milk –Pasteurization techniques. Probiotics.

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

4.1.6. Beneficial activities of microbes in food (self study)

4.1.7. Microbial quality control and safety of food (self study)

4.2. Environmental Microbiology

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

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

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

4.2.4. Bioremediation – microbial treatment of radioactive wastes and xenobiotics.

4.2.5. Microbes in decomposition and recycling process (self study)

4.2.6. Symbiotic and asymbiotic N2 –fixation (self study)

Module 5 Medical Microbiology (15 hrs)

5.1. Host-microbe interation-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)

Topics for Self Study (not for evaluative purposes)

- Classification of Bacteria, Bergy's manual
- Microbes in decomposition and recycling process
- Symbiotic and asymbiotic N2- fixation
- Microorganisms and food
- Microbial spoilage of different types of foods & Food borne diseases
- Beneficial activities of microbes in food
- Microbial quality control and safety of food

PART.B.Biotechnology (50 hrs)

Module 6 Introduction to Biotechnology (10 hrs)

6.1. History of Biotechnology (self study). Board 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 7 Molecular Cloning (15 hrs)

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, Agriculture and Animal Husbandry, Environment etc. Biotechnology Industry.

Module 8 Recent Trends in Biotechnology (15 hrs)

8.1. Synthetic Biology – description and developments in the area.
8.2. Artificial life – concept and achievement
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 9 Bioethics (5 hrs)

9.1. Ethical, legal and social issues of Biotechnology.

Module 10. Biotechnology in India (5 hrs)

10.1. History of biotechnology research in India.
10.2. India's Biotechnology Policy
10.3. Biotechnology Regulatory Agencies in India.
10.4. Comparison with developed countries

References

Microbiology

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2. Microbiology: An Introduction. Tortora, Funke & Chase. 10th edition (2009). Benjamin Cummings. ISBN: 0321550072.
3. Bacteria: The Benign, the Bad, and the Beautiful. Trudy M. Wassenaar. ISBN: 978-1-1181-0766-9. 2011, Wiley-Blackwell
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
7. Microbiology by Edward Alcamo Wiley publishing inc ISBN 0-8220-5333-0
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Biotechnology

1. Bejamin Lewin – Genes X (2011).
2. James D Watson - Molecular Biology of the Gene (6th Edition)
3. George W Burns, the Science of Genetics, Mae Millan C0 New York.
4. A Gib De Busk, Molecular Genetics, Mae Millan C0 New York.
5. Edgar Altenberg, Genetics, Oxford and IBH Publisher, New Delhi.
6. Janeway, Travens, (1996) Immunobiology Current Biology Ltd., Middle Sex House- 34-42 Cleveland Street, London.
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8. Richard Losick, (2004) Molecular Biology& Genes, Pearson Education.
9. Strickberger, M.W. Genetics, Macmillan Publishing Co., Inc., New York.
10. J.M. Walker and R. Rapley, (2002), Molecular Biology and Biotechnology, Purnima Publishing Corporation, New Delhi.

Semester III
Zo232 Ecology, Ethology and Biodiversity Conservation

AIM: To introduce the nature and scope of various aspects of Ecology and Environmental Biology in general and human environment in particular.

COURSE OBJECTIVES
Imparting basic knowledge about the environment and its allied problems. Developing an attitude of concern for the environment. Make one striving to attain harmony with Nature, Acquiring skills to help the concerned individuals in identifying and solving environmental problems.

Part 1:Ecology **(30 hrs)**
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.
Characteristic: 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 (graxing, detritus and auxiliary food cains), food, webs, trophic levels and ecological pyramids (pyramid of numbers, pyramid of biomass and pramid of energy (self study)
1.5. Classification of ecosystems based on energy input (natural unsubsidized and subsidized solar powered ecosystems, human subsidisd 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, Seconday succession, Auogenicsuccession,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 Habitant, 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 realized niche.

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

Module 4 Species Interactins (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, herbivours carnivory)

4.4. Co-evolution

Part 11:Ethology (30 hrs)

Topics for self study

History, development and applications; motivation and models ofmotivation; reflexes imprinting, habituation; neural mechanisms in behavior, hormones and behavior; Sociobiology social groups – merits and demerits, features of organized 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)

8.1. Habitat selection and territoriality.

8.2. The Evolution of communication; Development of bird song.

8.3. The evolution of reproductive behavior and mating systems.

Module 9 Biodiversity (15hrs)

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 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 freshwater, marine, esturine).

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/glagship species.

10.2. Strategies of conservation: in situ and ex situ conservation, Gene Banks, establishment of protected areas, habitat conservation captive public awareness and other relevant measures.

10.3. An evaluation of the “Project Tiger’ and “ Project Elephant” programmes.

10.4. World conservation strategy (1980O

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

Module 11International Conventions & Treaties for conservation of Biodiversity(12hrs)

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 Cllimate Change (UNFCCC), Brundtland Report (1987).

11.2. Earth summit (1992) – detailed study – Ratio Declaration on Environment and Development, Agends21,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),

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

References

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Zo233 Immunology and Developmental Biology (100 Hrs)
Immunology (40 hrs)

AIM: To introduce the nature and scope of various aspects of Immunology and Developmental biology.

COURSE OBJECTIVES: Integration and consolidation of knowledge in immunology such as nature of resistance, mode of development and growth, various aspects of development.

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 and 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 (4hrs)

5.1 Complement systems-General features

5.2 Classical pathway and alternate pathway complement receptors, biological effect of complements.

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 (4 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)

4.2 Mechanism of axis formation in amphibians; Niewkoopcentre.

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

4.4 Stem cells, totipotency, plury 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.

References

Developmental Biology

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Immunology

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PRACTICALS

Zo234 Microbiology, Biotechnology, Ecology, Immunology and Developmental Biology

Microbiology and 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 of bacteria
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
9. Detection of coliform bacteria by H_2S paper strip method for monitoring water quality.
10. Culturing of paramecium to observe ciliary movement.

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

5. Demonstration of phagocytes in insect hemocytes.

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 embroyo.
5. Study of different types of eggs: insect egg, frog's egg, hen's egg, mammalian egg-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 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 (eg. Grass land, arid land, wet land)
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.).
10. Mounting cercaria of flukes in aquatic birds.

Semester IV
Special Subject: Endocrinology

Zo241 Vertebrate Endocrinology (100hrs)

AIM: To introduce the nature and scope of various aspects of vertebrate and invertebrate endocrinology and Human Reproductive Physiology.

COURSE OBJECTIVES: To impart knowledge on the human endocrinology and understand the principles and mechanisms involved in endocrinology.

Module 1 Introduction (5 hrs)

1. Historical perspective
2. General Classes of chemical messengers
   Peptide hormones, steroid hormones, bioamines, eicosanoids, chalones, neurotransmitters, neuropeptides, neurosteroids, neurohormones, lumones, phytohormones, synthetic hormones.

Module 2 Vertebrate endocrine glands (30 hrs)

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. Hypothalamohypophysical interaction
7. Eicosanoids-Biochemistry and biological action. Prostaglandins, prostacyclins, thromoboxanes, leukotrienes.
8. Evolution of endocrine glands-a brief account.

Module 3 Mechanism of hormone action (30 hrs)

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
1. Cell surface receptors (Mode of action of peptide hormones)
   Receptor structure
   Regulation of receptor number
2. Second messengers of hormonal action
   Cyclic nucleotides; Inositol triophosphate; Diacyl glycerol; Genomic action of cAMP
3. Signal transduction
   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 (5 hrs)

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

Module 5 Hormones and Cancer (10 hrs)

1. Relationship of hormones to carcinogens and development of cancers from inappropriate hormonal treatment.

2. Hormone 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 (10 hrs)

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

Module 7 Endocrine methodology (10 hrs)

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
5. Recombinant DNA techniques and genetic engineering

References

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1. Williams Text Book of Endocrinology edited by Jean D. Wilson and Daniel W. Foster, Saunders Company 8thEdn. 1992.
2. Hormones from Molecular to disease Elby-Elienne-ErulieBautieu and Paul A. Kelly 1990.
3. Endocrinology-Basic and Clinical Principle-P. Michael Corn and Shlomo Mel Med. Humana Press The Totowa. 1997
4. Vertebrate Endocrinology-Daniel O.Norris Academic Press. 3r edn. 1997.
5. General and Comparative Endocrinology, Turner and Bangara, Saunders Company
6. Comparative Endocrinology-P.J. Bentley, 1997
7. Hormones and Evolution-Barrington, 1979.
8. Hormones-Anthony-W.Norman and Gerald Litwark-Academic Press. 1997.

Special Subject: Endocrinology

ZO242Physiology of Reproduction(With special reference to mammals) (100hrs)

AIM: To introduce the nature and scope of various aspects of vertebrates especially mammals.

COURSE OBJECTIVES: To impart knowledge on mammalian reproduction and understand the principles and mechanisms involved in reproduction.

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. Physiolog 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.
5. Male infertility and Sexual Dysfunction – W.J.G. Hellstrom, Springer-Verlag, New York. 1997.
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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. Frog, chick and rat (any two animals)
2. Histology of ovary of fish, calotes, frog, chick and rat (any two animals)
3. Dissection of male and female reproductive system of frog, calotes, chick and rat.
4. Vaginal smear of rat
5. Sperm smear of any one vertebrate
6. Demonstration of induced ovulation in any one vertebrate

Zo244 Endocrinology

Vertebrate Endocrinology

7 Dissection of endocrine glands in fish, frog, 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/frog
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

Aim: To introduce the various methods of Ichthyology. Morphology, food and feeding.

Aim: To impart knowledge on diversity, adaptation, and other physiological aspects related to fish, to enhance the students knowledge and application in fishery and Aquaculture.

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

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 upto family – distinguishing characters with examples
1.5 Barcoding in fish taxonomy

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

1.2 Deep sea fishes
1.3 Cave dwelling fishes
1.4 Hill stream fishes

1.5 Air-breathing fishes
1.6 Venomous fishes
1.7 Larvicidal fishes and biological control
1.8 School in gin fishes

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

3.1 Gross external anatomy of fishes
3.2 Body form diversity
3.3 Fins- type, 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 (10hrs)

1.1 Basic anatomy of digestive system of aacartilaginous and a bony fish
1.2 Food and feeding habits- natural food, feeding habits and adaptations; feeding in relation to season, growth, sex and breeding; gastro-somatic index
1.3 Digestion, absorption and utilization of food
1.4 Growth in fishes- length and growth relationship, growth curve and growth studies using scales and condition factor.

Module 5. Excretion and osmoregulation (5hrs)

1.1 Brief account of structure and function of kidney
1.2 Hormonal control of excretion and osmoregulation

Module 6. Locomotion (10hrs)

6.1 Types of locomotion – swimming and non-swimming
6.2 Body form and locomotion
6.3 Fins and locomotion
6.4 Swim bladder and buoyancy- origin and function
6.5 Weberian ossicles and its significance

Module 7. Sense organs in fishes (10hrs)

7.1 Later all in essence 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 (10hrs)

8.1 Structure and function of - Pituitary gland, ultimobranchial gland, caudal neuro secretory 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 (10hrs)

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 (10hrs)

10.1 Sex determination in fishes
10.2 Recent trends and techniques in 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 (15hrs)

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 (10hrs)

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 (20hrs)

3.1 Harvesting- precautions obswrved during harvesting, sorting, grading the catch
3.2 Nutritive value of fish and biochemical composition of fish flesh
3.3 Fish spoilage and preservation
3.4 Fish preservation and processing – Icing and freezing, canning, salting, drying, curing, smokingetc
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 (5hrs)

4.1 Transportation and marketing: Overseas market for diversified products and principal world market for diversified sea food products
4.2 Fisheries Extension: extension philosophy and extension methodology
4.3 The status of Indian fishery co-operative movement and fish farmers development agencies

Aquaculture

Module 5. Aquaculture (10hrs)

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 (10hrs)

6.1 Bionomics of cultivable species of fish and shell fish (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 (3hrs)

7.1 Nutritional requirement of a culture fish

7.2 Feed-Live and formulated

7.3 Procedure of feed formulation

Module 8. Methods of freshwater and brackish water fish culture (15hrs)

8.1 Monoculture – Indian major carps (Catla, Rohu, Mrigal), exotic species, Tilapia

8.2 Composite culture

8.3 Culture of air-breathing fishes- ecology of swamps and 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. Mari culture in India (7 hrs)

9.1 Sea farming and sea ranching

9.2 Prawn culture

9.3 Pearl culture and culture of edible mollusks

9.4 Turtle farming

9.5 Sea weed cultivation

Module 10. Integrated fish culture (5 hrs)

10.1 Paddy cum fish culture
10.2 Fish-livestock farming- manorial 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 and soil samples of fish ponds for analyzing hydrographical parameters

Study tour
Visit to fisheries institute and fishing harbours to study the following:
1. Freshwater and brackish water aquaculture
2. Fishing operations
3. Fish preservation and processing
4. Boat building and net making
5. Fisheries research, survey, education and examination

Special Subject: Fish Biology and Fishery Science
Practical I
Zo 243-Ichthyology

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

Dissection and Mounting
3. Membranous labyrinth
4. Ampullae of Lorenzini
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
10. Effect of NaCl/KCL on fish chromatophores.
11. Determination of the rate of oxygen consumption of a fish at room temperature.
12. Determination of gonado somatic index.
13. Measurement of fecundity rate in a fish.
14. Qualitative and quantitative analysis of gut content in a herbivorous and carnivorous fish.
15. Determination of gastro somatic index.
16. Smear preparation of fish blood to study the morphology of different cellular elements .
17. Differential count of fish WBC.

Fish Genetics

18. Sex determination in fishes.
19. Hybridization techniques in fishes.
20. 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 (Phosphate/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
13. Preparation of any one fish by product
13. Estimation of muscle protein
13. Estimation of muscle glycogen

Fishing crafts and gear

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

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35. www. FISH.BIOL.ORG
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Semester IV
Special Subject- Insect Science
ZO 241 General Entomology (100hrs)

Aim: To introduce students to the importance of entomology, classification of insects, their anatomy, embryology, classification, toxicologymanagement etc.,

Objective: To acquaint the students with external morphology of the insect's body, Pest management etc.,

Unit 1 Introduction (5hrs)

1.1. Origin and evolution of insect.
1.2. Fossil Insects.
1.3. Insect-plant interdependence (Co-evolution).

Unit 2 Anatomy (20hrs)

2.1. Integument : Histology of the basic components, Chemical composition of cuticle, sclerotization, physical properties of cuticle, coloration, permeability, characteristics, molting and external integumentary processes.
2.2. Head- General morphology of head (Opisthognathus, Prognathus, Hypognathus). Head segmentation, Head skeleton, Tentorium, Modifications in head capsule, Mouth parts- modifications based on feeding mechanisms. Antennae- Structure, functions and types.
2.3. Thorax- Segementation- Structure and modifications.
2.4. Abdomen- Segmentation- Structure and characteristics.
2.5. Wings- Origin and evolution of wings, venation- structure, wing modifications.
2.6. Appendages- Segmentation- structure- Adaptive radiation of legs.

Unit 3. Embryogenesis (20hrs)

3.1. Types of eggs, Formation of blastoderm and germ layers, formation of germ band and extra embryonic membranes.
3.2. Differentiation of germ layers.

3.3. Segmentation, Appendage formation and blastokinesis, organogenesis, polyembryony, control of embryogenesis, Ovipartity, Viviparity, Oviposition, eclosion, post embryonic morphogenesis.
3.4. Growth, metamorphosis, endocrine mechanism in metamorphosis.

Unit 4. Insect Classification (15hrs)

4.1. Biology and habits of the different orders of the insects- classification upto families.
4.2. Biology and habits gall forming and leaf mining insects.
4.3. Aquatic insects- Aquatic adaptations including respiratory adaptations.
4.4. Adaptation of parasitic and predatory insects.
4.5. Seasonal adaptations- Dormancy- Diapause.

Unit 5. Insect Physiology (30hrs)

1. Insect nutrition: Anatomy and histology of foregut, mid and hind gut, Modification of git (filter chamber) processes of secretion of enzymes, microbiota, and digestion of wood, keratin, wax and silk.
2. Respiratory system: Trachea, Tracheoles, Air sacs, spiracles. Types of ventilator process- passive ventilation bulk flow and active ventilation.

Passive suction ventilation and elimination of CO_2. Ventilation in aquatic insects and endoparasitic insects during molting.

Central nervous control of ventilation.

3. Circulatory system: the dorsal vessel and accessory pumping sinuses.

Cardiac regulation and circulation- general characteristics and chemical composition of hemolymph, hemocytes, origin number and function. Other tissue associated with circulatory system.

4. Excretory system: Malpighain tubules- anatomy and histology. Orthopteran, Hemipteran, Coleopteran and Lepidopteran types. Salt and water balance, control of dieresis and gut mobility, nitrogenous excretion, insect urine.
5. Nervous system, Glandular and Muscular systems.

Structure and function of nervous system, nervous integration.

Exocrine and endocrine glands and their functions.

Skeletal muscle, visceral muscle, muscle development and maintenance.

6. Sense organs: Morphology of sense organs, sensory mechanisms, light and sound production.

5.6.1 Mechanoreception- the tactile sense, proprioceptive sense, sound perception.

.2Chemoreception- sensory coding phagostimulants and phagodeterrents.

.3Thermoreceptors- Hygroreceptors.

.4.Photoreception- Compound eyes, dorsal ocelli etc.

.5Light production and sound production- different types of sound producing organs.

7. Reproduction and morphogenesis.

.1Reproductive system and gametogenesis in male and female

.2Fertilization, Sex determination, parthenogenesis.

.3Different types of insect larvae and pupae.

Unit 6. Insect communication (10hrs)

6.1. Acoustic, visusl, tactile and chemical methods.
6.2. Role of hormone in communication.
.1Pheromones
.2Kairomones
.3Allomones
6.3. Social organization, communication and behavior with reference to Termites, Ants and Honey bees.
6.4. Insect Immunity

References

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13. Biology of insect midgut, MJ Lehane.
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ZO 242 Applied Insect Science (100hrs)

Aim: To introduce various aspects of pest control, Industrial application of entomology, pest control and management.

Objective: To familiarize various aspects of entomology like pest infestation, pest control, pest outbreak, Industrial entomology etc.,

Unit 1 Introduction Insect Pests (5hrs)

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 (8hrs)

2.1 Deforectation, Destruction of natural enemies pest resurgence.

2.2 Secondary pest outbreak, Intensive and extensive cultivation, Introduction of new crops, new varieties, hybrid varieties, cultural practices, change in agricultural 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 pests and control (20hrs)

3.1 Biology, nature of damage and control of major pests of major crops: Paddy, coconut, cotton, mango, vegetables, pulses, coffee, tea, sugarcane, banana, cashew, pepper, turmeric, ginger, cardamom, and stored products.

3.2 Insect pest of domestic animals, biology and control.

3.3 Biology of major arthropod vectors of human diseases belonging to dipteral, anoplura, siphonoptera, - control of vectors.

3.4 House hold pest insects - biology and control

Unit 4 Industrial Entomology (12hrs)

4.1 Silkworm technology – Sericulture

4.2 Honeybee- Apiculture

4.3 Lac-Insect-Lac culture

4.4 Insects as human food and as scavengers

Unit 5 Principles and Insect Control (20hrs)

5.1 Basic principles of insect control, prophylactic methods, cultural methods, mechanical methods, physical methods and legal methods.

5.2 Biological control- Brief history, theory behind classical biological control. Agents of Biological control- Parasite and parasitoids, predators and pathogenic microorganisms (bacteria, fungi and virus).

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

5.4 Important biological control products undertaken in India against insect pest.

5.5 Economic dimensions of biological control- merits and demerits.

5.6 Significance and relevance of biological control in the present regime.

Unit 6 Insect Toxicology (15hrs)

6.1 Chemical control- Insecticide formulations, inorganic and organic pesticides, Classification of insecticides- based on mode of entry, mode of action.

6.2 Synthetic organic insecticides. Organochlorine compounds (DDT, BHC, Endosulfan-heptachlor, dieldrin).

6.3 Organophosphorous insecticides- monochrotophos, tetra ethyl pyrophosphate, parathion.

6.4 Carbamates- Carbaryl, carbofuran

6.5 Botanical insecticides- chemical properties, mode of action and toxicity. (nicotine, rotenone, pyrethrum and neem, insect growth regulators).

6.6 Synthetic pyrethroids- definition, uses as insecticides, mode of action (pyrethrin, allethrin).

6.7 Fumigation and fumigants

6.8 Insecticide residues

6.9 Pesticide appliances

Unit 7 Pest Management (15hrs)

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 ecosystem, preventive practices, Therapeutic practices, selection of tactics

7.3 Principles of behavioural control- pheromonal considerations- communication pheromones, sex pheromones, aggregation, pheromones, orientation theories, use of other chemicals- repellants- plants allomones- Antifeedants, integration of behaviours modification with other tactics.

7.4 Autocidal control- (Chemosterilants, sterile male technique and other genetic tactics)

7.5 Pest management tactices

- 7.5.1 Ecological management of crop environment
- 7.5.2 Reducing average favourability of ecosystem
- 7.5.3 Disrupting continuity of pest requisites
- 7.5.4 Diverting pest population away from crop
- 7.5.5 Reducing the impact of insect injury

7.6 Ecological back lash and its management- resistance of population of pest management-tactics, pest population resurgences and replacement- enhanced microbial degradation, upset in community balance.

Unit 8. Insecticide Resistance (5hrs)

8.1 Genetic, physisological and biochemical mechanisms.

8.2 Insecticide metabolism- microsomal and extra microsomal

8.3 Dynamics of environmental pollution by insecticides, its impact in biosphere.

8.4 Pest residues, insecticide poisoning, biological magnification, health hazards, silent spring (Racheal Carson).

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Semester IV
Special Subject : Insect Science
Practical I
Zoo 243 (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 of insects belonging to 30 families.
3. Mounting, sketching and labeling of taxonomic features of the following.
   a) Wings in insect of 5 orders.
   b) Antennae in insects of 5 orders.
   c) Mouth parts in insects- 4 types
   d) Leg-4 types.
   e) Whole mount of 5 insects/ life stages of taxonomic importance.

Anatomy and 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 2 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 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 dmonstarte neurosecretory cells by PAVB technique.

3. Physiology

1. Quantification of proteins in fat/haemolymph
2. Quantification of glycogen in fat body.
3. Estimation of any one transaminse in insect fat body/ haemolymph.
4. Identification of atleast two free amino acids in haemolymph by paper chromatography.
5. Quantitative estimation of any two digestive enzymes (protease, amylase/ invertase).
6. Haemolymph protein profile employing PAGE (Demonstration).
7. Identification of haemocytes using Giemsa/Wright's/ BPS stain.

NOTE: Candidates shall submit a collection consisting of 30 families of insect 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 10 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 LC50 value and LD50 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 – 6 numbers.

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 and first aid.

Experimental Entomology

1. Malpighian tubule activity using suitable dyes.
2. Rearing of any two insects in the laboratory.
3. Identification of larval instars using Dyar's rule.
4. Sexing of insects- larva pupa and adult.
5. Effect of starvation on glycogen/ protein on insect fat body/haemolymph.
6. Effect of starvation on transaminase activity in insects.

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

AIM: To introduce the nature and scope of various aspects of Environmental pollution and its management in micro and macro levels.

OBJECTIVES: Imparting basic knowledge about the environmental pollution, toxicology and its allied problems. Make one striving to attain knowledge on the pollution problems and toxicological effects and toxicological procedures in experiments and analysis.

Zo241 : Pollution Biology & Environmental Physiology (100hrs)

Unit 1 Introduction (12hrs)

1.1 Environmental pollution – Concepts and definitions
1.2 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 (15hrs)

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 air pollution episodes.
2.4 Air pollution abatement technologies- Design and working of bag filters, electrostatic.

Unit 3. Noise pollution (5hrs)

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 (6hrs)

4.1 Organic pollution

4.1.1. Organic 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. Biomagnification: Toxic effects on non-target oraganisms 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).
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 (10hrs)

4.3.1. Primary, secondary and tertiary treatment systems
4.3.2. Design and operations of screens, frit chambers, sedimentation tanks and oxidation ponds.
4.3.2. Design and operations of biological treatment systems like aerated lagoons, activated sludge process, trickling filters and sludge digestion.

Unit 5. Radioactive Pollution (10hrs)

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 (12hrs)

6.1 Solid wastes and disposal (garbage, ashes, rubbish, street litter, agricultural waste, mining wastes and industrial wastes.)
6.2 Strategies of control of solid waste pollution.

Unit 7 Environmental Physiology (30hrs)

7.1 Temperature adaptation

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 classification of animals – Homoitherms 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 hyperbaric 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 H+-ATPase in relation to salinity adaptations.

7.4. Eco-physiological adaptations.

7.4.1. Mimicry and coloration
7.4.2. Echolocation
7.4.3. Bio-luminiscence
7.4.4. Electric organs

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ZO 242 Environmental Management (100hrs)

AIM: To introduce the nature and scope of various aspects of Environment management and its conservation.

COURSE OBJECTIVES: To acquire knowledge and understanding of the Environment and its management including the conservation practices, laws and regulations.

Unit 1 Resources of Earth (15hrs)

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 amangement in India.

1.2 Conservation of natural resources

1.3 Remote sensing of resource management.

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

2.1 Human interferences in ecosystems- consequences of over-exploitation

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

Unit 3. Biological conservation and management (20hrs)

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 of 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 (15hrs)

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 (15hrs)

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 (20hrs)

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 nitrogenous 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 bioassays and determination of LC50 of fish exposed to a given pollutant.
10. Effect of soil pollution on the population on earth works.
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.