FATIMA MATA NATIONAL COLLEGE
KOLLAM, KERALA
(Autonomous)

MSc Degree in Zoology
(Semester System)
Course Structure and Syllabus

Board of Studies in Zoology
March 2015

Scheme of Instruction

1. The M.Sc Zoology programme conducted by the Department of Zoology shall be governed by Fatima Mata National College, Kollam.

2. The course programme will extend for a period of two years. Each year will have two semesters i.e. First year- Semester I and Semester II, second year-semester III and semester IV.

3. The medium of instruction shall be English.

4. Each semester will have three papers and one practical.

5. It is mandatory for each student to submit a project assigned at the beginning of semester III. The project will be finally submitted by the end of semester IV. The project may involve either laboratory or field work. Date of submission of project is to be fixed by the department.

6. The M.Sc Zoology programme will have Fish Biology and Fishery Science as a special subject. The papers will be studied during IV Semester.

Details of Examinations

1. ESA examination shall be conducted at the end of each semester as per academic calendar notified by the college.

2. English shall be the medium of instruction and examinations

3. Each semester will carry 400 marks and will have two components as follows:

   A: Continuous assessment = 30 marks
   i . Two Class Tests = 15 marks
   ii. Attendance = 5 marks
   iii. Assignment = 5 marks
   iv. Seminar = 5 marks
   Total = 30 marks x 4 =120 marks

   B: End semester examination = 70 marks x 4 =280 marks

   Total = 400 marks x 4 semesters = 1600 marks
   Project - CA 25 marks + ESA 75 marks = 100 marks
   Comprehensive viva voce = 100 marks
   Grand total for 4 semesters = 1800 marks

4. Continuous assessment will be broadly based on attendance in theory and practical (5marks), assignment (5 marks), seminar (5 marks), and test paper.(15 marks). These distributions of marks could be modified based on the decision of the departmental Academic council.

5. A comprehensive viva voce shall be conducted by a Board of faculty members and the maximum marks allotted are 100.

6. Improvement and reappearance in the end semester examination will be permitted. However, no student shall be admitted for ESA examination for any semester after a period of three years from the date of admission to Sem I of M.Sc Zoology course.

7. A minimum of 75 % of attendance will be required for appearance to ESA examination. This shall be certified by the Head of the Dept. of Zoology prior to ESA examination and displayed in the concerned notice board.

8. ln the beginning of semester III, the student should decide the topic for project. Towards the middle of SEM Ill, the student should present a brief review and methodology in an internal presentation in the Dept. involving all students and teachers. A final departmental level presentation should be made at the end of SEM IV, including all students and teachers.

9. The project should be evaluated by the external examiners who conduct the viva *voce.* A presentation using LCD/OHP/Laptop before the external examiners during viva voce which will be the basis of awarding marks. 25 marks is allotted for viva vote and 75 for the project.

10. The practical Record valuation is to be done by external examiners during the practical ESA Examination.

Table 1 .Scheme of Instruction

Semester	Course Code	Title of Course	Distribution of Hours/Semesters	Instructional hours /Week	
				L	P
SEM 1	**15PZO 11**	Biosystematics,Taxonomy&Evolutionary biology	100	5	-
	15PZO12	Biochemistry	100	5	-
	15PZO13	Biophysics, Instrumentation & Computer Science	100	5	-
	15PZO14	Practical	120	-	10
SEM II	**15P15PZO**	Advanced physiology & Functional Anatomy	100	5	-
	15PZO22	Genetics, Quantitative Analysis & Research methodology	100	5	-
	15PZO23	Cell & Molecular Biology	100	5	-
	15PZO24	Practical	120	-	10
SEM III	**15PZO31**	Microbiology & Biotechnology	100	5	-
	15PZO32	Ecology,Ethology &Biodiversity Conservation	100	5	-
	15PZO33	Immunology & Advanced Developmental biology	100	5	-
	15PZO34	Practical	120	-	10
SEM IV	**15PZO41**	Ichthyology	100	8	-
	15PZO42	Fisheries & Aquaculture	100	7	-
	15PZO43	special, paper- Practical	100	-	5
	15PZO44	special paper — Practical	120	-	5
	15PZO45	Project			
	15PZO46	Comprehensive viva voce			

Table II :Scheme of Question Paper -Theory Courses				
Question Type	**Total No of Questions**	**Number of Questions to be answered**	**Marks for each Questions**	**Total Marks**
Very brief notes	14	11	2	22
Short notes	10	6	4	24
Short essays	4	2	7	14
Essay	2	1	10	10
Total	30	20		70

Semester 1
Biosystematics, Taxonomy and Evolutionary Biology

Course Code- 15PZ011

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

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

1.1. Historical resume of Biosystematics

1.2. Importance and application of Biosystematics 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. Interpretation and application of important rules

2.6 Zoological nomenclature-formation of scientific norms of various taxa (Homonymy & Synonymy)

Module 3. Taxonomic characters and dimensions of speciation (15 hrs)

3.1 Taxonomic characters- different kinds, origin of reproductive isolation, mechanism genetic incompatibility

3.2 Dimensions of speciation- types of lineage changes. Production of additional

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

3.4 Evolution of Biodiversity Indices- Shannon Weiner index,Dominenece index

Module 4. Trends in Systematics (15 hrs)

4.1 Chemotaxonomy

4.2 Cytotaxonomy

4.3 Molecular Taxonomy

4.4 Recent trends based on proteomics and genomics

4.5 DNA bar coding and Bar-coding of life

4.6 Phylogeny in systematics

Evolutionary Biology (50 Hrs)

Module 5. Cosmic evolution and 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 and earth

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

Module 6 Molecular evolution **15 Hours**

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

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

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

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

8.1.Origin of metazoan, 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-Mitochondria Eve, Y chromosomal Adam, - early migration, hunter-gatherer societies.

8.8. Evolution of human brain- communication, speech and language, Evolution of culture.

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- **Web Resources-** http://www.talkorigins.org , http://www.ucmp.berkely.edu , http://www.academicearth.org

Semester I

Course Code- 15PZ012 BIOCHEMISTRY (100 Hrs)

Module I. Introduction

1.1.1 Forces underlying Bimolecular Interactions covalent and - electrovalent bonds, ionic bond, hydrogen bond,Glycosidic bond, ester bond, peptide bond,Phosphodiester bond.

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

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

1.1.4 Nano particles

1.1.5 Biomaterials

Module 2 . Carbohydrates (12 Hrs)

2.1 Classification.

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

2.1.2 Reactions of mono sachharides : Oxidation, reduction, ester formation, Qsazone Formation.

2.1.3. Disaccharides: Sucrose, Lactose~maltose, Isomaltose, Cellobiose and Trehalose**.**
(Self study)

2.1.4. Polysaccharides: Homo polysaccharides- Starch, glycogen, cellulose, Chitin, Dextrans, Inulin, Pectin. Hetero polysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and

Mucoproteins.

Module 3. Proteins (10 Hrs)

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

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

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

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

3.2.4. Tertiary structure – Globular protein – eg Myoglobin.

3.2.5. Quaternary structure – eg Haemoglobin

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

Module 4. Lipids (10 Hrs)

4.1.1. Classification of Lipids: Simple, Compounds and derived Lipids. Biological importance of Lipids.

4.1.2. Fatty acids : classification ,nomenclature. **(Self study)**

4.1.3. Simple fats:Triacyglecerol (Triacyglecerides) – physical properties,Reactions - Hydrolysis, Saponification, Rancidity. Acid nwnber, Saponification number, Iodine number oxidation,Ketosis,Reichert-Meissl-Wollny value

4.1.4. Compound Iipids: Phospholipids - Lecithin, Phosphatidyl inositol, Cephalins Plasmalogens.Glycolipids,Sphingolipids.

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

4.1.6. Lipoproteins.

Module 5. Nucleic Acids (8 hrs.)

5.1.1. 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 microRNA stability of proteins and nucleic acids

5.1.2. Protein-nucleic acid interactions. Electrostatic interaction, hydrogen bonding stacking interactions. **(Self study)**

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

5.1. 4. Biological roles of nucleotides and nucleic acids.

Module 6 . Enzymes (10 hrs.)

6.1.1. Classification- (1.U .B. system) co-enzymes; iso-enzymes

6.1.2. Enzyme specificity.

6.1.3 . Mechanism of action of enzymes. Formation of enzyme substrate complex. Various theories. **(Self study)**

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

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

Module 7. Carbohydrate Metabolism (10 hrs)

7.l.l. Major metabolic pathways: Glycolysis - Fate of pyruvate.Citric acid cycle and its significance; Oxidative & substrate level phosphorylation. Pentose phosphate pathway (self study).

7.l.2. Gluconeogenesis, Cori cycle

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

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. **(Self study)**

8.1.3. Carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.

8.1.4. Synthesis of biologically significant compounds from different aminoacids with special reference to glycine, glutamic acid, phenylalanine, tyrosine and tryptophan.

8.1.5. Catabolism of purines and pyrimidines

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

Module 9. Metabolism of Lipids (6 Hrs)

9.1.1. Beta oxidation, alpha oxidation and omega oxidation of fatty acids.

9.1.2. Formation of ketone bodies, ketosis and keto acidosis

9.1.3 *De novo* synthesis of fatty acids and fatty acid metabolism

9.1.4 Biosynthesis and regulation of cholesterol, Metabolism of cholesterol.

9.1.5 Metabolism of Triglycerides.

Module 10. Energy metabolism (6 Hrs)

10.1. Energy rich compounds and their biological significance

I0.2. Biological oxidation- Mitochondrial electron transport, oxidative phosphorylation, ATP synthesis, Chemi-osmotic theory

Module 1l.Detoxification (3 Hrs)

11.1. Formation of toxic compounds in the body

11.2. Detoxification - oxidation, reduction, hydrolysis and conjugation

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

12.2. Lipid peroxidation. Preventive antioxidants.

Module 13. Biochemistry of aging (3 Hrs)

13.1. Cellular aging.

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

13.3. Prons, Apoptosis

Module 14. Clinical biochemistry (3 hours)

14.1. Introduction to clinical biochemistry

14.2. Analysis of body fluids

14.3. Examples of diseases (Diabetes etc)

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Semester I

BIOPHYSICS, INSTRUMENTATION AND COMPUTER SCIENCE

Course Code- 15PZ013

(100 hours)

Biophysics **25 hours**

Module 1 Thermodynamics **5 Hours**

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

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

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

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

1.5 Life as an autocatalytic system .

Module 2 Electromagnetic spectrum **8 Hours**

2.1. Cosmic radiation, Gamma radiation, visible spectrum, Infrared SN".\ rays, microwaves and radio waves.

2.2. Biological applications

Module 3 Radiation Biophysics **8 Hours**

3.1. Radioactivity, Detection and measurement of radiation

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

3.3. Ionizing radiation and induced mutations

3.4. Fluorescence

3.5. Nuclear medicine-[Internally administered radioisotopes. Radioiodine

in thyroid function analysis. Renal, liver and lung function analysis.

Module 4 . Nanotechnology **4 Hours**

4.1. Introduction to Nanobiology

4.2. Nanosensors and Nanomedicines.

INSTRUMENTATION **(50 hours)**

Module 5. Methodology and working of microscopes **15 Hours**

5.1 Phase contrast microscope

5.2. Fluorescent microscope

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

5.4. Laser scan confocal microscope

5.5. Environmental scanning electron microscope

Module 6 Centrifugation **8 Hours**

6.1. Ordinary, high speed centrifuges .

6.2. Density gradient centrifugation

6.3. Ultracentrifugation

Module 7 Electrophoresis **7 Hours**

7.1. Principles

7.2. Gel electrophoresis- SDS PAGE, Agarose Gel Electrophoresis

7.3. High voltage electrophoresis

7.4. Immuno electrophoresis- principle and application

Module 8 Chromatography **5 Hours**

8.1. Principles

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

Module 9 Biophysical methods **15 Hours**

9.1. Colorimeter, spectrophotometer, flame photometer

9.2. Atomic absorption spectrophotometer, fluorescent spectrometer

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

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

9.5. Molecular structure determination using X ray diffraction –

9.6. Electrophysiological methods- simple neuron recording,

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

COMPUTER SCIENCE **25 Hours**

Module 10 Introduction to computers - **(self study)**

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

10.2. Hardware-input output devises, processor Modules ,storing, controlling

10.3. Characteristics of computers

Module 11 Computer generations **8 Hours**

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 Hours**

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

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

Module 13 Operating systems **4 Hours**

13.1. Windows, DOS, Linux (self study)

13.2. Concept of free software

Module 14. Computer Programming **4 Hours**

14.1. Low level languages

14.2. High level languages

14.2.1.Programming language C++

Module 15 Computer- and Communications **5 Hours**

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

15.2. Internet , email, www, social network groups etc.

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Semester – II

ADVANCED PHYSIOLOGY AND FUNCTIONAL ANATOMY (100 Hrs)

Course Code 15PZ021

Module 1- Introduction (self study)

1.1 Introduction to Physiology and Anatomy

1.2 A brief history of Physiology and Anatomy

1.3 Cell as a living Module of the body

1.4 Fluids in the cell environment

1.5 Resistance of the cell to acidity and alkalinity

Module 2 : Support and Movement (l0hrs)

2.1. Cellular movements, Cytoskeleton, Hydrostatic skeleton

2.2. Terrestrial, aquatic and aerial locomotion

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

2.4. Theories of molecular basis of muscle contraction

2.5. Catch muscle and Fibrillar muscle

2.6. Clinical implications

Module 3- Nutrition (10 hrs)

3.1. Feeding mechanism in animals (self study)

3.2. General principles of Castro-intestinal function

3.3. Factors that regulate quantity of food

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

3.5. Absorption Mechanism of digested nutrients

3.6. Obesity- causes and consequences

3.7. Castro -intestinal disorders

Module 4- Circulation (12 hrs)

4.1 Body fluids in invertebrates and vertebrates

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

4.3. Coronary circulation, Heart valves and Heart sounds

4.4. Circulatory Shock, Cardiac failure

4. 5. Control of blood pressure and blood flow

Module 5- Respiration (10 hrs)

5.1. Respiratory organs of invertebrates and vertebrates and its functions,

5.2. Mechanism of Pulmonary ventilation

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

5.4 Regulation of respiration

5.5 Respiratory disturbance; Oxygen therapy, Artificial respiration

Module 6-Excretion and Osmoregulation (10 hrs)

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

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

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

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

6.5. Haemodialysis, Peritonial dialysis and transplantation

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

6.7. Respiratory regulation of acid base balance

Module 7- Nervous Co ordination (10 hrs)

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

7.2. Giant nerve fibres in invertebrates

7.3. Development of neurons and neuronal functionality

7.4. Factors leading to neuronal death

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

7.6. Neuronal disorders-strokes, exicotoxicity and NMDA receptors

Module 8- Endocrinology (10 hrs)

8.1. Invertebrate and Vertebrate endocrine system (self study)

8.2. Classification of Hormones and nature of hormonal action

8.3. Structure and function of different hormones

8.4. Neuro-endocrine feedback and response to various stimuli

8.5. Measurement of Hormone concentration in blood

Module 9 - Somatic and Special senses (10 hrs)

9.1. Structure of Invertebrate and Vertebrate eye

9.2. Tactile, Position, Pain, Thermal and taste Senses

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

9.4. Auditory pathways- Functions of cerebral cortex in hearing

9.5. Neuronal mechanism of sound detection and direction

Module 10-Reproduction (10 hrs)

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

10.2. Hormonal control of male reproductive function

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

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

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

10.6. Hormonal and other changes during pregnancy- Parturition, Lactation.

10.7. Birth control measures. Pre-natal diagnostic tests.

10.8. Adjustments of the infants to extra uterine life

Module 11- Stress and adaptation (4 hrs)

11.1. Eco physiology - History and Concepts

11.2. Heat exchange, Thermal strategies and Thermogenesis

11.3. Life at high and low body temperature

11.4. Stress and brain

Module 12- Sports Physiology (4 hrs)

12.1. Muscles in exercise

12.2. Dope test, drugs and athletes

12.3. Fitness test. Bio energetic fuel for muscle work

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Semester II
Genetics, Quantitative Analysis and Research Methodology

Course Code 15PZO 22

(100 Hrs)

Genetics (70hrs)

Module 1 Introduction **(5 hrs)**

1.1. Genetics and modern agriculture

1.2. Genetics and medicine

1.3. Legal and ethical issues in genetics

Module 2 Mendelian Genetics and its Application **(15 hrs)**

2.1. Gene mapping

2.2. Recombination frequency

2.3. Chromosome banding

2.4. Genetics in animal breeding

2.5. General effects of inbreeding and out breeding; hybrid vigour.

2.6. Expressivity, penetrance

2.7. Modern concept of Mendelism

Module 3 Population Genetics **(15 hrs)**

3.1 Genetic variations

3.2 Polymorphism

3.3 Gene pool 3.4 Gene frequency

3.5 Distribution patterns

3.6 Hardy Weinberg equilibrium

3.7 Disequilibrium

3.8 Factors disrupting gene equilibrium

Module 4 Human Genetics **(15 hrs)**

4.1 Pedigree analysis - Karyotype analysis

4.2 X-Chromosome dosage

4.3 Lyon hypothesis and mosaicism

4.4 Genetics of ABO system

4.5 Rh disease and its inheritance

4.6 Sickle haemoglobin and inheritance; thalassemias

4.7 Genetic disorders - Patau, Edwards, Cri-du-chat syndromes, Philadelphia chromosome.

Module 5 Microbial Genetics **(12 hrs)**

5.1 Retrovirus

5.2 Viral genome and multiplication - HIV genome and multiplication

5.3 Reproductive cycle of RNA viruses

5.4 Plasmids - Vector DNA - Insert DNA

5.5 Lambda Phages

5.6 Microbes in genetic engineering

Module 6 Genetics in Medicine and Forensics **(8 hrs)**

6.1 Human Genome Project:

6.2 Human gene therapy

6.3 DNA fingerprinting:

6.3.1 Applications in forensic science

6.3.2 Applications in paternity testing

QUANTITATIVE ANALYSIS **(15 hrs)**

Module 1. Introduction **2 hrs**

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

1.2. Descriptive and inferential statistics

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

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

Module 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 III. Probability and distribution **3 hrs**

3.1. Definition, important terms and concepts

3.2. Theorems in probability

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

Module IV. Parametric test **4 hrs**

4.1. Basic idea - hypothesis testing, types of errors

4.2. Tests of-significance for large and small samples- Z-test, Chi- Square Test, Student's t' test, F-test - problems -and ANOVA

Module V. Non-parametric tests **2 hrs**

5.1. Characteristics, advantages and disadvantages

5.2. Types (Brief account only)

Module VI. Vital statistics **2 hrs**

6.1. Introduction, uses, methods of collection

6.2. Measures of Vital Statistics, life tables

RESEARCH METHODOLOGY (15 hrs)

Module I. Introduction **2 hrs**

1.1. Definition, meaning, objectives, and significance of research, Research methods vs. Methodology.

1.2. Types of research - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

1.3. Characteristics of good research, steps of research

Module II. Research. Formulation **2 hrs**

2.1. Formulation and defining a research problem, techniques involved

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

2.3. Problem selection, formulation of working hypothesis

Module III. Research design **2 hrs**

3:1. Meaning-, need and features a good research design

3.2 Different types of research design (exploratory, descriptive, diagnostic and hypothesis-testing research studies)

3.3. Developing a research plan.

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

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

4.2. Analysis of data (self study)

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

Module V. Scientific documentation **3 hrs**

5.1. Significance of report writing, types of reports

5.2. Research report writing (thesis, dissertations, research articles, etc) characteristics and format

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

5.4. Project proposal and report writing.

Module VI. Research, extension and ethics **4 hrs**

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

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

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

6.4. Research misconduct: fabrication, falsification and plagiarism

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

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

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- Strickberger, M.W. *Genetics,* Macmillan Publishing Co., Inc., New York.
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Quantitative Analysis

- Fisher.R.A., *Statistical Methods for Research*
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- Finney, D.J. 1980.*Statistics for Biologists*. Chapman and Hall, London

- Kothari C.R., 2009. *Research Methodology: Methods and Techniques*. Nev:i Age International Publishers, New Delhi.
- Oliver; P:2005. *Writing Your Thesis*. Vistar Publications. New Delhi.

Semester II

Cell Biology, Molecular Biology and Bioinformatics (100 hours)

Course Code 15PZO23

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

1.1 Diffusion of small molecules across phospholipids bilayer

1.2 Uniport - catalysed transport

1.3 Membrane potential

1.4 Active transport by ATP powered pumps

1.5 Co-transport by symporters and antiporters

Module 2 Cell-cell signalling (8 hrs)

2.1 Cell surface receptors

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

Module 3 Cell cycle (6 hrs)

3.1 Cyclin and cyclin - dependent kinases

3.2 Regulation of CDK - cyclin activity

3.3 Check points in the cell cycle

3.4 Regulation of cell cycle in malignant cells

Module 4 Chromatin structure (6 hrs)

4.1 Types of Chromatin

4.2 Detailed structure of nucleosome; higher order structure of chromitin 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 topo isomerases

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

E Recombination repair; Rec A and other recombinases

7.5. Damage signaling and checkpoints

7.6. DNA repair-associated disorders

Module 8 Transcription and RNA processing (8 hrs)

8.1. Prokaryotic and eukaryotic transcription

8.2. Binding the transcription complex-promoters, factors and RNA polymerases.

8.3. Regulation of transcription

8.4.Sigma factor and its role in prokaryotic transcription.

8.5. Post-transcriptional processing of RNA precursors, spliceosomes.

Module 9 Translation-gene expression (12 hrs)

9.1. Prokaryotic and Eukaryotic translation

9.2. The translation machinery

9.3. Mechanism of initiation, elongation and termination

9.4. Co-and post translational modifications of proteins.

9.5. Hormonal regulation of protein synthesis.

Module 10 Gene Regulation Mechanisms (7 hrs)

10.1. Gene regulation in eukaryotes at various levels.

10.2. Transcription factors and DNA-binding domains (Zinc-finger motif and Helix-loop-helix motif)

10.3. Transcription signals - TATA Box, CAAT BOX., Enhancers.

Module 11 Bioinformatics (12 hrs)

11.1 Introduction to bioinformatics, brief history and its role and importance in modern biology, internet, internet, portals, servers and search engines.

11.2Biological databases, their purpose, primary, secondary, curated and uncurated databases types of databases (DNA, protein, RNA, functional and structural databases),

11.3Uploading and downloading of data; FASTA format, data retrieval from databases, analyses tools and soft-wares and their applications, pair wise and multiple sequence analyses.

11.4Construction of rooted and un-rooted phylogenetic trees, their interpretation and use in analyzing evolutionary trends, steps in phylogenetic analyses

11.5Brief overview of computational biology, computation, prediction and modulation of biological pathways, (ex. Kegg pathways) e-cell, computational analyses of genomes and proteomes

REFERENCES

- Harvey Lodish, Arnold Berk, Sipursky, Matsudaria, David Baltomore and (2002) *Molecular Cell Biology*, W.W. Freman and Company.Darnell,
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- Richard Lodivk, (2004) ,*Molecular Biology & Genes*, Pearson Education
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- Benjamin Lewin, (2006) *Genes* IX - Oxford University Press
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- David E Sadava (2004) *Cell Biology*. Panima Publishing Corporation, New Delhi.
- Pollard T D and Eamshaw W.0 (2002) *Cell biology*. Elsevier Science, USA.
- Wilson K and Walker J (2006) P*rinciples and Techniques of Biochemistry and Molecular Biology*, Cambridge University Press, N.Y
- Andrew Read and Dian Donnai. (2007) *New Clinical Genetics*. Scion Publishing Ltd.,

Semester II

Practical I: Systematics, Evolutionary Biology, Biochemistry, Biophysics, Instrumentation and Computer application

Course Code 15PZO14

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 with reference to evolutionary significance
4. Study of Phylogenetic tree/ or study of homology and anlogy
5. Study on the reduction in regeneration capability of animals during evolution
6. Pattern of evolution from museum study

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. Estimation of DNA and RNA
3. Estimation of glycogen of a tissue
4. Estimation of blood glucose
5. Estimation of Serum protein
6. Determination of acid value of the given fat
7. Estimation of Cholesterol in blood by spectrophotometer
8. Determination of enzyme activity Acid/ alkaline phosphatase from a biological sample
9. Estimation of inorganic phosphate
10. Determination of the Michaelis constant (KM value) for the digestion of casein by trypsin
11. Estimation of amino acid tyrosine
12. Pesticide residue analysis of vegetable/water using TLC

C. Biophysics, Instrumentation and computer Application

1. Micrometry: Measurement of microscopic objects using micrometer
2. Isolation of mitochondria from fish liver by differential centrifugation and determination of protein yield in the fraction by Lowry method
3. Determination of molecular mass of proteins by SDS-PAGE
4. Effect of protein synthesis/DNA synthesis inhibitor on cell responses to hormone
5. Sketching of biological specimens using Camera Lucida

REFERENCE

- Hardd Varley - *Practical clinical Biochemistry*
- Ranjana Chawla, - *Practical Clinical Biochemistry - Methods and interpretations.*
- Hawk's *Practical Physiological Chemistry*
- Jayaraman, *Practical Biochemistry.*

Semester II

Practical II- Advanced Physiology and Functional Anatomy

Course Code 15PZO24

Please use software such as PhysioEx. 9.0 where ever applicable

1. Effect of salivary amylase on starch (colorimetric)
    a) Influence of temperature and calculation Of Q 10
    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 NaCI (0.1 % to 2%) on the diameter of RBCs using micrometry.
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.

Semester III

MICROBIOLOGY & BIOTECHNOLOGY (100 Hrs)

Course Code 15PZO31

PART. A. MICROBIOLOGY (50 Hrs)

Module I. Introduction to Microbiology (7 Hrs)

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

1.2. Microbial Diversity including Extremophiles - brief account.

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

l.4. Classification Bacteria, Bergys manual **(self study)**

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

2.1. Ultra-structure of bacteria - cell membrane, cytoplasmic inclusions, nucieiod etc

2.2. Bacterial Cell Wall - structure, differences between gram positive and negative cell wall, gram staining.

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

Module III. Microbial Nutrition & Growth (10 Hours)

3.1. Common nutritional requirements of microorganisms - autotrophy and heterotrophy.

3.2. Types of culture media.

3.3. Microbial growth - overview of cell growth, generation time, measurement of growth.

3.4. Typical growth curve, continuous culture, effect of environmental factors on growth Stress response

Module IV. Industrial & Environmental Microbiology (10 Hours)

Industrial Microbiology

4.1. Concept of fermentation. Types of fermentation - submerged, solid state - Mention briefly.

4.2. Basic design and types of fermenters.

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

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

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

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

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

Environmental Microbiology

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

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

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

4.4. Bioremediation - microbial treatment of radioactive wastes and xenobiotics.

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

4.6. Symbiotic and asymbiotic N2- fixation (self study)

Module V. Medical Microbiology (15 Hours)

5.1 Host-microbe interaction - process of infection, pathogenecity, virulence & infection, microbial adheience, penetration .of epithelial cell layers and events in infection following penetration, Infection of blood, lymphatic system.

5.2 Exotoxins - classification, mechanism of action of exotoxins e.g. Diphtheria, Botulinum, Tetanus, and Cholera toxins.

5.3 Control of Microorganisms - various physical & chemical methods.

5.4 Use of antibiotics and other antimicrobial drugs.

5.5 Drug resistance and emergence of multiple drug resistance - recent cases of TB (XDR, TDR); NDM etc.

5.6 A survey of harmful and beneficial microbes (self study)

PART. B. BIOTECHNOLOGY (50 Hours)

Module VI. Introduction to Biotechnology (10 Hours)

6.1 History of Biotechnology (self study). Broad areas of BT - traditional and modern; types - plant biotechnology, animal biotechnology and microbial biotechnology.

6.2 Techniques in biotechnology -brief description of common techniques such as tissue culture. genetic engineering, cloning etc.

Module VII. Molecular Cloning (15 Hours)

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

7.2 Vectors — types and characteristics e.g. plasmids, phages, hybrid vectors, artificial chromosomes.

7.3 Enzymes used in gene cloning – exonuclease, endonuclease, ligase, reverse transcriptase, polymerase, terminal transferase etc.

7.4 Techniques of gene transfer – calcium chloride transformation, microinjection, electroporation,

shotgun cloning, Agrobacterium mediated transfer etc

7.5 Practical application of genetic engineering - useful products. Application in Medicine, Agriculture, Aquaculture and Animal Husbandry, Environment etc. Biotechnology Industry.

Module VIII. Recent Trends in Biotechnology (15 Hours)

8.1. Synthetic Biology – description and developments in the area.

8.2. Artificial life – concept and achievements

8.3. DNA Barcoding – concept and experimental details with examples.

8.4. GMOs and GM Foods – pros and cons. 8.5. Microbial warfare bio-weapons and bioterrorism

Module XI. Bioethics (5 Hours)

8.5. Ethical, legal and social issues of biotechnology.

Module XII. Biotechnology in India (5 Hours)

9.1. History of biotechnology research in India.

9.2. India's Biotechnology Policy

9.3. Biotechnology Regulatory Agencies in India.

9.4. Comparison with developed countries

REFERENCES

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- *Microbiology: An Introduction*. Tortora, Funke & Chase. 10th edition (2009). Benjamin Cummings. ISBN: 0321550072.
- *Bacteria: The Benign, the Bad, and the Beautiful*. Trudy M. Wassenaar. ISBN: 978- 1-1181-0766-9. 2011, WileyA3Iackwell
- *Microbiology.* Pelczar, Reid and Chan. Tata-McGrawHill. Reprint 2008. ISBN 0074623206, 9780074623206.
- *Introductory Food Microbiology*. H. A. Modi 2007. ISBN 8179102213.
- *Food Microbiology An Introduction* by Thomas J Montville, Karl R. Mathews
- *Microbiology* by Edward Alcamo Wiley publishing inc ISBN 0-8220-5333-0
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BIOTECHNOLOGY

- Bejamin Lewin – *Genes* X (2011).
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- George W Bums, *The Science of Genetics*, Mae Milian CO New York.
- A Gib De Busk, *Molecular Genetics*, Mae Milian CO New York.
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- Strickberger, M.W. *Genetics*, Macmillan Publishing Co., Inc., New York.
- J.M. Walker and R. Rapley, (2002), *Molecular Biology and Biotechnology*, Pumima Publishing Corporation, New Delhi.

- **Useful websites**
- http://www.microbeworld.org
- http://www.ncbimintnih.gov
- http://www.accessexcellence.org/RC/AB/BA/
- http://www.accessexcellence.org/RC/AB/IE/
- http://bacteriamuseum.org

Semester III

Ecology, Ethology and Biodiversity Conservation

Course Code:15PZO32

Part 1: Ecology (30 Hours)

Topics for self study

1. Biotic and abiotic factors and their interactions.
2. Structure, basic components, their interactions and inter-relations. Fundamental concepts relating to energy - first and second laws of thermodynamics, entropy.
3. Gaseous-and-sedimentary cycles
4. Characteristics of population: density, natality, mortality, biotic potential,
5. Environmental resistance, growth forms, immigration, emigration and migration. Characteristics: Species diversity, stratification, dominance, boundaries, ecotone and edge effect, ecological indicators.

Module 1: Ecological Energetics (8 Hrs)

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

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

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

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

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

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

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

2.2 . Trends in succession

2.3 . Stages of succession - (Nudation, Invasion, Competition and co-action,Reaction, Climax), pulse stability.

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

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

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

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

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

Module 4: Species Interactions (9 Hrs)

1.1 . lntra and interspecific interactions, Types of Interspecific interactions - (Positive, Negative and Neutral).

1.2 . Positive interactions (commensalism, proto-cooperation, mutualisrn and pollination).

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

1.4 . Co-evolution

Part II: Ethology **(30 Hours)**

Topics for self study

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

Module 5: Learning **(6 Hrs)**

1.1 . 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)**

1.1 . Habitat selection and territoriality.

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

1.3 . The evolution of reproductive behaviour and mating systems.

Part III: Biodiversity **(40 Hours)**

Module 9: Biodiversity **(15 firs)**

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

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

diversity and ecosystem stability.

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

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

Module 10: Conservation Biology (13 Hrs)

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

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

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

1.4 World conservation strategy (1980)

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

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

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

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

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

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

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Semester III

Immunology and Developmental Biology (100 Hrs)

Course Code:15PZO33

Immunology (40 hrs)

Module 1 Introduction to Immune System (4 hrs)

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

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

1.3 Brief account on immune cells: types and production.

Module 2 Immunogens (Antigens) (7 hrs)

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

2.2 Factors affecting antigenicity.

2.3 Epitopes and Haptens.

2.4 Adjuvants and their role in enhancing immunogenecity.

Module 3 Immunoglobulins (antibodies) (8 hrs)

3.1 General Properties-Structure and functions

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

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

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

3.3.2 Somatic hyper mutation

3.3.3 Class switching

3.4 Polyclonal & Monoclonal antibodies

3.5 Hybridoma technology — technique and applications

Module 4 Antigen-antibody interactions (6 hrs)

4.1 Primary and secondary immune responses

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

Module 5 Complement System (4 hrs)

5.1 Complement systems-General features

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

Module 6 Transplantation (7 hrs)

6.1 Classification of grafts

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

6.3 General immunosuppressive therapy:

Module 7 Defects in Immune Mechanisms (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 homeo domains)

3.3.2 Hox cluster genes in vertebrates.

Module 4 Embryonic Induction (10 hrs)

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

4.2 Mechanism of axis formation in amphibians; Niewkoop centre.

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

4.4 Stem cells, totipotency, pleury potency

Module 5 Medically assisted human reproductive technologies (12 hrs)

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

5.2 Gametic Instrafallopian Transfer (GIFT)

5.3 Zygotic Intrafallopian Transfer (ZIFT)

5.4 Tubal Embryo stage Transfer (TET)

5.5 Intra-cytoplasmic sperm injection (ICSI)

5.6 Tatra Uterine Insemination (IUI)

Module 6 Cloning experiments in animals (10 hrs)

6.1 Genomic equivalence; multiple potencies; differential gene expression.

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

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Semester III

PRACTICAL

Microbiology, Biotechnology, Ecology, Immunology& Developmental Biology

Course Code 15PZO34

Microbiology & Biotechnology

1. Techniques for Isolation of bacteria - serial dilution, pour plate, spread plate techniques.
2. Enumeration of bacteria from water and soil.
3. Motility Testing - hanging drop method.
4. Gram staining.
5. Determination of quality of milk - methylene blue reductase test.
6. Biochemical tests - catalase test, kovac's oxidase test, gas production etc.
7. Isolation of DNA from plant/animal tissue.
8. Plasmid isolation.

Immunology

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

Developmental Biology

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

Ecology

1. Estimation of pyramid of numbers and biomass in a small ecosystem.
2. Estimation of Primary productivity using dark and light bottles.
3. Description of ecological adaptations of any 10 organisms.
4. Habituation" in Pila / alarm response in ants or fishes / maize learning in rats.
5. Study of biodiversity indices:
    a. Population

b. Density and relative density

c. Frequency and relative frequency

d. Abundance and distribution

e. Modified similarity Index

f. Shannon- Wiener Index

2. Composition assessment of the Taxonomic diversity biodiversity in a habitat (grass land, Wet land, etc.)
3. Assessment of Invertebrate and Vertebrate diversity in your locality (e.g. campus).
4. Quantitative estimation of plankton
5. Poster Presentation on a relevant topic (e.g. International conventions and treaties, species interactions, biodiversity loss, etc.)

Semester IV

SPECIAL COURSE: FISH BIOLOGY AND FISHERY SCIENCE

ICHTHYOLOGY

Course Code: 15PZO41

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, up to family- distinguishing characters with examples

1.5. Bar-coding in fish taxonomy

Module 2Adaptation of fishes to special conditions (15 Hrs)

2.1. Deep sea fishes

2.2. Cave dwelling fishes

2.3. Hill stream fishes

2.4. Air breathing fishes

2.5. Venomous fishes ,Ornamental fishes

2.6. Larvicidal fishes and biological control

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

3.1. Gross external anatomy of fishes

3.2. Body form diversity

3.3. Fins-types structure, function and modifications

3.4. Skin-structure and function

3.4.1. Scalation - types of scale, structure, development and modifications

3.4.2. Coloration —types of chromatopho res, biological significance.

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

4.1 Basic anatomy of digestive system of a cartilaginous and a bony fish

4.2 Food and feed in habits-natural food, feeding habit and adaptations; feeding in relation to season; growth, sex and breeding; gastro-somatic index

4.3 Digestion absorption and. utilization of food

4.4 Growth in fishes- length and growth relationship, growth curve and growth studies using scales and condition- factor

Module 5. Excretion and osmoregulation (5 Hrs)

5.1. Brief account of structure and function of kidney.

5.2. Hormonal control of excretion and Osmoregulation

Module 6. Locomotion (10Hrs)

6.1. Types of locomotion-swimming non swimming

6.2. Body form and locomotion

6.3. Fins and locomotion

6.5. Fins and locomotion

6.6. Swim bladder and buoyancy-origin and function

6.7. Weberian ossicles and its significance

Module 7. Sense organ in fishes (10 Hours)

7.1. Later all in sense organs, Ampullae of Lorenzini,

7.2. Chemo, mechano, thermo, and electro receptors

7.3. Structure of eye and visual pigments

Module 8. Endocrine glands in fishes (10 Hours)

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

Module 9. Reproduction in fishes (l0 Hours)

9.1. Sexuality-hermaphroditism, uni sexuality and bisexuality

9.2. Gonads- phases of maturity, length at first maturity, gonado-somatic index, fecundity

9.3. Reproductive behavior-sexual dimorphism, courtship; parental care, nest building

Module 10. Fish genetics (10 Hours)

10.1.Sexdeterminatioriinifishes

10.2. Recent trends ant techniques of hybridization

10.3: Chromosome manipulation in fishes

10.4. Transgenesis in fishes

Semester IV

SPECIAL COURSE : FISH BIOLOGY AND FISHERY SCIENCE

FISHERIES AND AQUACULTURE

Course Code: 15PZO42

FISHERIES

Module 1. Fishery Science (15 Hours)

1. Importance of Fishery science-Inland fisheries, Marine fisheries, capture fisheries and culture fisheries
2. Inland capture fisheries- Riverine fisheries, reservoir fisheries, cold water fisheries and estuarine fisheries
3. Marine capture fisheries in India- Offshore and deep sea fisheries- fin fish fishery, shell fish fishery (crustacean and molluscan)

Module 2. Methods of fishing (10 Hours)

2.1 Indigenous fishing crafts of India : sea fishing. crafts- Catamaran, Musula boat, caravel boats, Dinghi, Dug out canoes, plank built canoes, out trigger canoes

2.2 Inland fishing crafts: Dug out and plank built boats

2.3 Mechanized Indian fishing crafts- fishing vessel characteristics

2.4 Indigenous fishing gears in India: Traditional and conventional; sea fishing gears and inland fishing gears

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

3.1 Harvesting- precautions observed during harvesting, sorting, and grading the catch

3.2 Nutritive value of fish and biochemical composition of fish flesh

3.3 Fish spoil age and preservation

3.4 Fish preservation and processing- Icing and freezing, canning, salting, Drying , curing, smoking etc

3.5 Fish products and byproducts- Liver oil, meal, manure, glue, isinglass, Leather , chitosan, fish maws, fish protein concentrate, fish fins

3.6 Fish food poisoning

Module 4. Fish Export and Extension (5 Hours)

4.1 Transportation and marketing : Overseas market for diversified products and principal world market for diversified sea food products

4.2 Fisheries extension : extension philosophy and extension methodology

4.2 The status of Indian fishery co-operative movement and Fish farmers development agencies

AQUACULTURE

Module 5. Aquaculture (10 Hours)

5.1 Scope and objectives of aquaculture ; status in India

5.2 Culture systems –

5.2.1 Criteria for space and site selection

5.2.2 Culture systems- Pond, Bheries, salt pans, tanks, race way, cage, pens etc.

5.3 Hatcheries- different types

5.4 Design and construction of aqua farms

Module 6. Breeding and seed production (10 Hours)

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

6.2 Breeding of fishes with special reference to Indian major carps - wet and dry bunch technique for breeding

6.3 Induced breeding

6.3.1 Induced breeding in Fish - Principle , techniques and advantages of hypophysation, selective breeding and 'seed production

6.3.2 Induced breeding in Shrimp- Techniques involved in shrimp breeding and seed production eye stalk ablation etc.

6.4 Transport of live fishes-.fingerlings and breeders

6.5 Cryopreservation of gametes and embryos

6.6 Common fish diseases - viral, fungal, bacterial and parasitic infections

Module 7. Nutrition in culture fishes (3 Hours)

7.1 Nutritional requirement of a culture fish

7.2 Feed-Live and formulated

7.3 Procedure of Feed formulation

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

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

8.2 Composite culture

8.3 Culture of air breathing fishes - ecology of swamps & use in culturing air breathing fishes

8.4 Shrimp culture: traditional and scientific brackish water culture practices in India with special reference to Kerala

8.5 Ornamental fish culture- exotic and indigenous species

8.6 Aquarium set up and maintenance; Aquarium plants and aquarium accessories

8.7 Frog culture

Module 9.Mari culture in India (7 Hours)

9.1 Sea farming and sea ranching

9.2 Prawn culture

9.3 Pearl culture and culture of edible molluscs

9.4 Turtle farming

9.5 Sea weed cultivation

Module 10.Iritegrated fish culture (5 Hours)

10.1 Paddy cum fish culture

10.2 Fish-livestock farming- manurial value of livestock wastes and their role in recycling for raising fish production

10.3 Sewage fed fish culture

Field work

1. Visit to freshwater and brackish water fish farms.
2. Collection of water & soil samples of fish ponds for analyzing hydrographical parameters.

Study tour

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

1. Freshwater and brackish water aqua culture.
2. Fishing operations
3. Fish preservation and processing
4. Boat building and net making
5. Fisheries research, survey, education and extension

Practical I - ICHTHYOLOGY

Course Code: 15PZO43

Taxonomy

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

Dissections and Mounting

3. 5^{th} Cranial nerve of a teleost fish.
4. Accessory respiratory Organs in fish
5. Fish Brain (Mounting)

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
10. Mounting of Otolith.

Fish Physiology

11. Qualitative and 'quantitative analysis of gut content in a herbivorous and carnivorous fish
12. Determination of gastro somatic index
13. Smear preparation offish blood to study the morphology of different cellular elements
14. Differential count of fish WBC

Fish genetics

17. Sex determination
18. Hybridization techniques in fishes
19. Karyo typing in fishes

SPECIAL SUBJECT: FISH BIOLOGY AND FISHERY SCIENCE

Practical II – Fisheries and: aquaculture

Course Code 15PZO44

Fish pond ecology

1. Determination of nutrients in the water samples from freshwater and brackish water ponds (Phosphatisulphate / nitrate)
2. Determination of free calcium carbonate in the soil sample from freshwater and brackish water ponds
3. Determination of LC so for fish exposed to a given pollutant

Fish Pathology

4. Identification of common external fish parasites (At least 5 numbers)
5. Estimation of spoilage in fish by pH method
6. Determination of bacterial plate count for fish skin. flesh and gut

Breeding Techniques

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

12. Preparation of a formulated fish feed

Fish byproducts

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

Fishing crafts and gear

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

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