File Ref.No.7652/GA - IV - J1/2012/CU

UNIVERSITY OF CALICUT

Abstract

General & Academic - Faculty of Science - MSc Zoology programme for affiliated colleges under CBCSS PG Regulations 2019 with effect from 2020 Admission onwards - Incorporating Outcome Based Education - Implemented - Subject to ratification of Academic Council - Orders Issued.

G & A - IV - J

U.O.No. 5590/2021/Admn Dated, Calicut University.P.O, 26.05.2021

Read:-1. U.O No.10507/2019/Admn, Dated 07.08.2019

2. Item No. 1 of the minutes of the meeting of the Board of Studies in Zoology PG held on 27.02.2021.
3. Remarks of the Dean, Faculty of Science, Dated 10.03.2021.
4. Orders of the Vice Chancellor in the file even no, Dated 12.03.2021.

ORDER

1. Orders were issued vide paper read (1) above, implementing the scheme and syllabus of M.Sc Zoology Programme for affiliated colleges under CBCSS PG Regulations 2019 w.e.f 2019 admission onwards.
2. The meeting of Board of Studies in Zoology (PG) held on 27.02.2021 approved the existing syllabus of M.Sc Zoology Programme for affiliated colleges (CBCSS) incorporating Outcome Based Education (OBE) in the existing syllabus, in tune with the new CBCSS PG Regulations with effect from 2020 Admission onwards, vide paper read (2) above.
3. The Dean, Faculty of Science has approved to implement M.Sc Zoology Programme (CBCSS) incorporating Outcome Based Education (OBE) in in the existing syllabus, in tune with the new CBCSS PG Regulations with effect from 2020 Admission onwards, vide paper read (3) above.
4. Under these circumstances, considering the urgency, the Vice Chancellor has accorded sanction to implement scheme and syllabus of M.Sc Zoology Programme (CBCSS) incorporating Outcome Based Education (OBE) in in the existing syllabus, in tune with the new CBCSS PG Regulations with effect from 2020 Admission onwards, subject to ratification by the Academic Council.
5. Scheme and syllabus of M.Sc Zoology Programme for affiliated colleges (CBCSS) incorporating Outcome Based Education (OBE) in the existing syllabus, is therefore implemented with effect from 2020 Admission onwards.
6. Orders are issued accordingly.
7. U.O No.10507/2019/Admn, dtd 07.08.2019 stands modified to this extent. (modified syllabus appended).

Ajitha P.P

Joint Registrar

To

The Principals of all Affiliated Colleges

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE V/DoA/EX and EG Sections /GA I F/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

SYLLABUS

For

M.Sc Zoology

(CBCSS PG 2019)

Under Choice Based Credit SemesterSystem

(w.e.f. 2020 Admission)

University of Calicut

CALICUT UNIVERSITY

VISION AND MISSION STATEMENTS

VISION

Our vision is to to provide equitable and just access to quality higher education involving the generation, dissemination and a critical application of knowledge ; and to help students to mould themselves to become model practitioners and contributors in Zoology.

MISSION

The Mission of M.Sc Zoology program is to full fill the inquisitiveness of students in areas of Zoology and its allied subjects by giving exposure to cutting edge knowledge and experiences in practical aspects thereby contributing to personal development and service to society.

PROGRAM OUTCOME FOR M.SC. ZOOLOGY

Student will be able to develop knowledge and understanding of living organisms at several levels of biological organization from the cellular through molecular to whole organisms level and at ecosystem level in an evolutionary perspective.

Student will be able to acquire knowledge related to concepts like ecology, evolution, taxonomy, biochemistry, molecular biology etc. and apply the knowledge in new situations.

The student will develop skills in experimental techniques in the subjects of study.

The student will be able to develop scientific way of thinking and scientific attitude pertaining to the concepts in ecology, evolution, taxonomy, biochemistry, molecular biology etc.

CURRICULUM AND SYLLABUS FOR CHOICE BASED CREDIT SEMESTER SYSTEM (CBCSS -2019) M. Sc. ZOOLOGY COURSE

w.e.f. 2019 ADMISSION

FIRST SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL1C01- Biochemistry and Cytogenetics	4	30	5
ZOL1C02- Biophysics and Biostatistics	4	30	5
ZOL1C03- Ecology and Ethology	4	30	5

SECOND SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL2C04- Physiology	4	30	5
ZOL2C05- Molecular Biology	4	30	5
ZOL2C06- Systematics and Evolution	4	30	5

FIRST & SECOND SEMESTER- PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL2L01- Biochemistry, Biophysics and Biostatistics	4	24	5
ZOL2L02- Physiology, Molecular Biology and Cytogenetics	4	24	5
ZOL2L03- Ecology, Ethology, Systematics and Evolution	4	24	5

ZOL-Zoology, 1-I semester, C- Course Theory, L- Course Practical, 2- II semester

THIRD SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL3C07-Immunology	4	30	5
ZOL3C08- Developmental Biology and Endocrinology	4	30	5
ZOL3E0901- Entomology 1: Morphology and Taxonomy	4	30	5
ZOL3E0902- Environmental Biology 1: Man, Environment & Natural Resources	4	30	5

ZOL3E0903- Fishery Science 1: Taxonomy,	4	30	5
Biology, Physiology & Ecology			
ZOL3E0904- Human Genetics 1: Clinical Genetics	4	30	5
ZOL3E0905- Wildlife Biology 1: Biodiversity & Biota	4	30	5

ZOL- Zoology C- Course Theory E- Elective Theory 3- III semester

FOURTH SEMESTER – THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL4C10- Biotechnology and Microbiology	4	30	5
ZOL4E1101- Entomology II: Anatomy and Physiology	4	30	5
ZOL4E1102- Environmental Biology II: Environmental pollution	4	30	5
ZOL4E1103- Fishery Science II: Capture & Culture Fisheries	4	30	5
ZOL4E1104-- Human Genetics II: Diagnostic Genetics	4	30	5
ZOL4E1105- Wildlife Biology II: Wildlife Conservation	4	30	5
ZOL4E1201- Entomology III: Agricultural, Medical & Forensic Entomology	4	30	5
ZOL4E1202-Environmental Biology III: Environmental Conservation	4	30	5
ZOL4E1203-Fishery Science III: Harvesting, Post-harvesting Technology & Marketing	4	30	5
ZOL4E1204-Human Genetics III: Cancer Genetics & Genetic Services	4	30	5
ZOL4E1205- Wild Life Biology III : Wildlife Management	4	30	5

THIRD AND FOURTH SEMESTER PRACTICAL COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL4L04-Immunology, Developmental Biology, Endocrinology, Biotechnology, Microbiology & Microtechnique	4	24	5
ZOL4L0501- Entomology 1 & II	4	24	5
ZOL4L0502-Environmental Biology I & II	4	24	5

ZOL4L0503- Fishery Science I & II	4	24	5
ZOL4L0504-Human Genetics I & II	4	24	5
ZOL4L0505- Wildlife Biology I & II	4	24	5

ZOL4L0601- Entomology III	4	24	5
ZOL4L0602-Environmental Biology III	4	24	5
ZOL4L0603- Fishery Science III	4	24	5
ZOL4L0604- Human Genetics **III**	4	24	5
ZOL4L0605- Wildlife Biology III	4	24	5
ZOL4P07- Project Work	4	24	5
ZOL4V08- Viva Voce (Project-2 + General-2)	4	24	5

ZOL- Zoology C- Course Theory E- Elective Theory, L - Practical, V - Viva voce, P - Project, 4- IV semester

Total number of theory courses	- 12	Total number of practical courses	- 6
Credit for each theory course	- 4	Credit for each practical course	- 4
Total credits for theory course	- 48	Total credits for practical courses	- 24
Credit for Project work	- 4	Total credit for the course	- 80
Credit for Viva- voce	- 4		

1. Practical examination shall be conducted at the end of second and fourth semesters.

2. The teacher who gives guidance to project work can select any topic from the syllabi including the elective course and the topic shall be assigned to each student. The research work on this topic shall be carried out by each student under the supervision of the teacher. The report of the research work shall be submitted by each student in the form of a Dissertation which shall be attested by the Head of the Department and shall be submitted for the evaluation. A declaration by the student to the effect that the dissertation submitted by him/ her has not previously been formed the basis for the award of any degree or diploma and a certificate by the supervising teacher to the effect that the dissertation is an authentic record of work carried out by the student under his/her supervision are to be furnished in the dissertation.

3. Weightage for each core and elective theory course shall be 30 for the external examination and 5 for the internal theory examination.

4. Weightage for each core and elective practical course shall be 24 for the external examination and 5 for the internal core and elective practical examination.

5. Theory examination question paper shall contain 7 short answer questions with weightage 2 each (4 should be attended), 7 short essay questions with weightage 3 each (4 should be attended), and 4 essay questions with weightage 5 each (2 should be attended).

6. Weightage for the external practical examination can be distributed as follows:

Withsubmission Weightage		**Without submission Weightage**	
Major question (1 number)	8	Major question (1 number)	8
Minor question (2 numbers)	2x5=10	Minor question (2numbers)	2x5=10
Spotters (2 numbers)	2x1=2	Spotters (4 numbers)	4x1=4
Submission (slides)	2	Record	2
Record	2		
Total	**24**	**Total**	**24**

7. No submission is required for the practical in elective course, unless mentioned in syllabus.

8. A candidate has to submit the following at the time of practical examination - ZOL4L04 Whole mount: 4 numbers
Slides: Histology: 4 numbers
Slides:Histochemistry: 2 numbers (To test the presence of carbohydrate and protein. (Control not required)

9. If a candidate fails to submit the field study / tour report, no marks for the record be awarded.

10. Project report shall be presented using power point option. Credit given for project is limited to maximum 4 and project and general viva-voce is limited to 4.

11. A minimum of two test papers for each course have to be conducted and the average shall be counted for internal evaluation in each semester.

12. One seminar for each course is compulsory.

Criteria for the evaluation of dissertations	**Weightage**
1. Introduction, review of literature etc.	2
2. Objectives and relevance of the study	3
3. Methodology	4
4. Results	3
5. Discussion and interpretation	4
6. Conclusions	3
7. Involvement of the students	1

8. Style and neatness of the dissertation	1
9. References	3
	Total 24

Criteria for the Viva-voce

A. Presentation of project work- (POWER POINT Presentation)	**Weightage**
1. Quality and correctness of slides	2
2. Clarity of presentation	3
3. Communication skill	3
4. Answers to questions	4
Subtotal	**12**

B. General Viva-voce	**Weightage**
5.Knowledge of the student	4
6. Communication skill	3
7. Answers to questions	5
Subtotal	**12**

Grand Total 24

AUDIT COURSES

Each student will undergo an audit course viz. Ability enhancement course (AEC) and Professional Competency Course (PCC) in the I and II semesters respectively. The student should undergo any one course listed under each category (AEC and PCC) in the respective semesters. Each student will be under the supervision of a faculty who will be responsible for monitoring the course and evaluation. The allotment of the faculty will be decided by the Department Council. The examination and evaluation for Professional competency course should focus on evaluating the skill component involved.

1. Ability enhancement course (AEC) - (In the I semester)

a) Documentation and scientific writing
b) Paper review on a topic of choice.
c) Internship for a minimum of 40 hours.
d) Industrial or Practical training for a minimum of 40 hours.
e) Community linkage programme for a minimum of 40 hours.
f) Seminar presentation on a frontier area of biological research. The topic should be from outside the syllabus.

2. Professional Competency Course (PCC) (In the II semester)

a) Statistical (SPSS/R/any software relevant to the programme of study)

softwares

b) Museum curation skills (Taxidermy etc.)

MODEL QUESTION PAPER

I/II/III/IV**SEMESTER M.Sc. DEGREE EXAMINATION (CUCSS),** Month & Year

Branch : Zoology
Course Code :
Course Name :

Time : 3hrs Maximum Weightage:30

I. Answer any 4 of the following (Short Answer type questions) (Weightage-2)

1.
2.
3.
4.
5.
6.
7.

4 x 2 = 8

II. Answer any 4 of the following (Short essay type questions) (Weightage-3)

8.
9.
10.
11.
12.
13.
14

4 x 3 = 12

III. Answer any 2 of the following (Long essay type questions) (Weightage-5)

15.
16.
17.
18.

2 x 5 = 10

FIRST SEMESTER THEORY

ZOL1C01 - BIOCHEMISTRY AND CYTOGENETICS (90 hrs)

COURSE OUTCOMES [COs]

CO1. The student will describe the importance of various chemical interactions in the biological system
CO2. The Student develops the abilty to analyze the structure, classification, and biochemical properties of carbohydrates from other organic molecules
CO3. The student develops the ability to describe classification, structural organization, and purification techniques of proteins.
CO4. The student acquire knowledge regarding the classification and functions of lipids and fatty acids
CO5. The student develops appreciation on the mechanisms of enzyme action, inhibition, and acquire knowledge regarding classification of enzymes that facilitate the functioning of enzymes
CO6. The student develops appreciation on Watson and Crick model of DNA
CO7. The student will explore various anabolic and catabolic pathways of biomolecules such as glucose, nucleic acids, amino acids and lipids.
CO8. The student develops a conceptual knowledge regarding the principles of energetics in biological systems.
CO9. The student acquire knowledge about the structure and functions of Cellular components, plasma membrane and its models, membrane transport mechanisms and properties , cytoskeletal elements and Intracellular trafficking.
CO10. The student gain knowledge of Chromatin structure and chromosomal alterations, Interrupted genes, gene families and extra chromosomal inheritance.
CO11. The student explore and appreciate the importance of cellular adhesion molecules, cell-cell and cell - matrix interactions, intercellular communications along with noted signal transduction pathways and intracellular signaling mechanisms and their significance.
CO12. The student will describe the process and significance of necrosis and apoptosis and, its regulation in the cellular level

Part A. Biochemistry (54 hrs)

Unit - I - Chemistry and functions of Biomolecules

1. Introduction (2 hrs)

Macromolecules and their subunits

1.1. Chemical bonds of biomolecules (Covalent and Non-covalent bonds)

2. Carbohydrates (8hrs)

Classification of carbohydrates with examples-

Structure of monosaccharides- glucose, fructose, galactose, mannose and ribose .

Methods of representation of sugars (Ball and stick, projection formula and perspective formula)

Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples, Mutarotation

Biological roles of monosaccharides.

Structure and biological roles of maltose, sucrose,,lactose, trehalose and cellobiose.

Hompolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratan sulphate, heparin and agar-agar.

3. Proteins (6 hrs)

Amino acids

Classification: (a) on the basis of number of amino and carboxyl group (b) on the basis of the chemical composition of side chain (c) based on the polarity of side chain (R)

Amphoteric properties of amino acids

pK value and Isoelectric point (pI) of amino acids

Peptide bond and peptides (di, tri, tetra, oligo and polypeptide).

Structure of protein

Primary structure, Secondary structure (Alpha helix, Beta-parallel & antiparallel and Beta-pleated sheet), random coil conformation, Tertiary structure, Quarternary structure.

Brief note on protein domains, motifs, folds and Ramachandran plot.

Biological roles of proteins

4. Lipids (5 hrs)

Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids.

Biological roles of lipids - as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers etc

Prostaglandins - Chemical nature and functions.

Fatty acids - definition; essential fatty acids

Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids

Nomenclature of fatty acids - Genevan system

5. Nucleic acids (3 hrs)

Structural organization of DNA (Watson -Crick model)

Structural organization of t-RNA; brief note on micro-RNA

Biological roles of nucleotides and nucleic acids

Unit - II - Enzymes (7 hrs)

1. Classification- (I.U.B. system)
2. Mechanism of enzyme action: Formation of enzyme substrate complex-

Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Factors influencing enzyme action

3. Enzyme kinetics - Michaelis-Menten equation - derivation; significance of Km and Vmax Values. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.
4. Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
5. Classification, Structure and functions of Vitamins.Vitamins as co-enzymes.

Unit - III - Bioenergetics (2 hrs)

1. Laws of thermodynamics and biological system- Enthalpy, Entropy, Free energy concept .
2. Energy of activation, Standard free energy change.
3. Role of ATP as a free energy carrier in the biological system.

Unit - IV - Metabolism and biosynthesis of biomolecules

1. Carbohydrate metabolism (8 hrs)

Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid

Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex

Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain

Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown .

Pentose phosphate pathway (HMP pathway) and its significance

Uronic acid pathway

2. Amino acid metabolism (4 hrs)

Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine,methionine, tryptophan, isoleucine, histidine, valine.

Fate of amino acids in the body

Transamination, Decarboxylation and deamination reactions in the biological system.

3. Lipid metabolism (5 hrs)

Oxidation of fatty acids

Biosynthesis of fatty acids

Biosynthesis of cholesterol

4. Nucleic acid metabolism (4 hrs)

Biosynthesis and degradation of purines and pyramidines

Part B. Cytogenetics (36 hrs)

1. Introduction to Cytogenetics (1 hr)

2. Membrane structure and function . (4 hrs)

Molecular organization of cell membrane - Lipid bilayer and membrane protein.Molecular models of cell membrane.

Cell permeability-osmosis, diffusion, ion channels, active transport, membrane pumps.

Mechanism of sorting and regulation of intracellular transport.

Electrical properties of membranes.

Microvilli and cell coat.

3. Structural organization and function of intracellular organelles- (6 hrs)

Nucleus, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum, Ribosomes, Peroxisomes and Cytoskeleton.

4. Organization of chromosomes and genes. (6hrs)

Structure of chromatin and chromosomes, heterochromatin, euchromatin unique and repetitive DNA

Chromosomal changes- euploidy, aneuploidy, chromosomal aberrations- Structural alterations- gene mutations- molecularchanges- deletion, duplication, translocation, inversion and sister chromatid exchange.

Interrupted genes and gene families.

Concept of gene- Allele, multiple alleles, pseudoallele, complementation tests.

Extrachromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance.

5. Cellular communication (6 hrs)

General principles of cell communication

Cell-cell interactions – cell adhesion and roles of different adhesion molecules

Intercellular attachments- gap junctions, desmosomes, intermediary and tight junctions.

Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.

Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

6. Cell signaling (8 hrs)

Signal transduction

Concept of cell-signaling

Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, Ca2+/calmodulin, PKC, Ca-MK, Enzyme linked receptors, Receptor tyrosine kinase (RTK), signaling of growth factors, Tyrosine kinase associated receptors, JAK- STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Receptor serine/threonine kinase, Receptor guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors

Receptor desensitization

Signaling by nitric oxide, carbon monoxide

Signaling network

7. Apoptosis and its significance (5 hrs)

Necrosis; Programmed and induced cell death

Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis

Regulation of apoptosis - Extracellular and Intracellular

Apoptosis in *Caenorhabditis elegans, Drosophila*, mammals and bacterial population

Mechanism of cell death

Genes involved in apoptosis.

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Biochemistry

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Cytogenetics

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FIRST SEMESTER THEORY

ZOL1C02 - BIOPHYSICS AND BIOSTATISTICS (90 Hours)

Course outcomes (COs)

CO 1	The student develops conceptual knowledge regarding the basic principles of physics involved in biological processes.
CO 2	The student appreciate the biological aspects and implications of sound energy
CO 3	The student will be able to differentiate various ionizing radiations and to understand a comparative account of their biological effects.
CO 4	The student may familiarize with various biophysical and electrophysiological methods
CO 5	The student gain conceptual knowledge on the principles of microscopy and apply
CO 6	The student explore the possibilities of the applications of separation techniques.
CO 7	The student will describe gravity 'G' force and its multi-faceted applications.
CO 8	The student will explore and appreciate nano technology as a highly promising arena in biological investigations
CO 9	The student skills in various methods of data collection, tabulation and presentation of data for biological research
CO 10	The student develops ability to apply measures of central tendency and dispersion in biological research, and various types of probability distribution.
CO 11	The student analyze and apply parametric and non parametric tests and its applications in biological research
CO 12	The student learn how to apply different types of ecological indexes in biological research

Part A. Biophysics (54 hrs)

1. Colloidal System (3 hrs)

Crystalloids and Colloids,

Propertiesof colloids- Kinetic, optical and electrical properties-

Electrosmosis, Cataphoresis, Coagulation.

Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions.

Biological importance of colloids.

2. Diffusion and Osmosis (4 hrs)

Fick's laws and diffusion coefficient.

Gibb's Donnan equilibrium.

Application of diffusion processes in biology: haemolysis.

Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.

Vant Hoff's laws

Electrolytic and ionic balance in biological fluid.

3. PH (2 hrs)

3.1 Dissociation of water.
Dissociation of a weak acid.
Henderson Hasselbalch equation.
Electrometric determination of pH, pH meter
PH value calculation.
Buffer –Importance of buffers in biology.

4. Bioacoustics (5 hrs)

Characteristics of sound.
Physical basis of hearing.
Physical organization of ear.
Physical aspects of sound transmission in the ear.
Audible sound frequency.
Pitch perception and theories.
Infrasonic and ultrasonic sounds.
Echolocation; receiving and analyzing echoes

5. Radiation Biology (9 hrs)

Radioactivity, different types ionizing radiations and their sources
Radioactive disintegration. Decay curve, half-life.
Biological effects of ionizing radiations – effects at macromolecular,cellular and organ system level, effects of whole body irradiation-Radiation therapy.
Biological applications of radioisotopes.
Radiation dosimetry- dose units and dose measurement.
Radiation Detectors - GM Counter, Solid and Liquid Scintillation Counter, Proportional counter, Semiconductor detectors.
Autoradiography

6. Biophysical methods (Brief account of the following) (5 hrs).

Properties of electromagnetic radiations.
Molecular analysis using UV / visible spectroscopy.
Mass spectroscopy.
NMR and Electron Spin Resonance (ESR) spectroscopy -Applications
Structure determination using X-ray diffraction crystallography.
Circular dichroism.
Surface Plasma Resonance (SPR)

7. Electrophysiological methods (Brief) (3 hrs)

Single neuron recording.
Patch clamp recording.
ECG.
Brain activity recording.
Lesion and stimulation of brain.
Pharmacological testing.
PET (Positron Emission Tomography), MRI, fMRI, CAT.

8. Principles and applications of (8 hrs)

Fluorescent, Interference, Scanning and Transmission electron microscopes (SEM &TEM) .
Resolving powers of different microscopes.
Different fixation and staining techniques for EM (freeze-etch and freeze

fracture methods for EM-image processing methods in microscopy).
Laser and its applications in Biology

9. Separation Techniques (10 hrs)

Chromatography - Different types - Adsorption, Partition and Ion exchange chromatography
Column chromatography
Paper chromatography
Thin- layer chromatography
Gel-filtration.
Gas chromatography,
Affinity chromatography,
HPLC
Electrophoresis
Paper electrophoresis
Disc electrophoresis
PAGE, Two dimensional PAGE, Highvoltage Electrophoresis
Isoelectric focusing.

10. Influence of gravity (3 hrs)

Human body posture in the gravitational field
Influence of G force.
sForce of centrifugal acceleration - importance of aviation and space travel
Effect of positive G. Force & negative G. Forces.
Protection against G. Force
Influence of linear acceleration on the body

11. Nanotechnology (2 hrs)

Definition
Nanotechnology and its applications in the field of health care.
Role of nanotechnology in environmental management.

Part B -Biostatistics (36 hrs)

1. Introduction (2 hrs)

Biostatistics: Definition,
Characteristics of Statistics
Importance and usefulness of statistics
Limitations of Statistics

2. Data (5 hrs)

Types of data: classification based on Source of data, Compilation, Variable, Nature .
Methods of data collection and classification.
Types of sampling methods.
Advantages and disadvantages of census and sampling method.
Class intervals- exclusive and inclusive method
Frequency curve (types. skewness, kurtosis, ogive)

3. Statistical Methods: Measures of central tendency and dispersal (4 hrs)

Mean, (raw data, discrete series and continuous series)
Standard deviation, Standard error, degree of freedom (raw data, discrete series and continuous series)
Quartile deviation- Box- whisker plot

4. Probability distributions (4 hrs)

Basic concepts and definition:
Laws of probability
Probability distribution: - Binomial, Poisson and Normal

5. Statistical inference (problems to be discussed) (7 hrs)

Difference between parametric and non-parametric statistics;
Testing of hypothesis
Errors
Confidence interval; levels of significance, Critical region;
Normality test
t-test, chi-square test, F-test, ANOVA
Kruskal-Wallis, Mann-Whitney

6. Correlation and Regression (problems to be discussed) (7 hrs)

Types of correlation.
Methods to measure correlation- Scatter diagram.
Karlpearson's coefficient of correlation, Spearman's correlation
Types of regression analysis
Regression equations
Difference between regression and correlation analysis

7. Ecological data analysis (problems to be discussed) (7 hrs)

Alpha diversity
Shannon diversity index, Simpsons Dominance index, Pielou‟s evenness index, Margalef species Richness, Fisher‟s apha,
Beta diversity
Morisita Horn index, Sorenson index, Bray-Curtis similarity

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Biostatistics

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2. Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stongtton, London.
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7. Stephen W,Looney(2008) Methods in Molecular Biology-Biostatistical Methods Springer International Edition
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FIRST SEMESTER THEORY

ZOL1C03 - ECOLOGY AND ETHOLOGY (90 Hours)

Course outcomes (COs)

CO 1	The student develops ability to differentiate between the concepts of Habitat, Niche
CO 2	The student explain the concepts of, Ecosystem energetic sand Mineral cycling.
CO 3	The student learn to appreciate nature's way to maximize efficiency in utilization of energy and resources; to reduce competition.
CO 4	The student will be able describe the characteristics of population growth and species interaction.
CO 5	The student will explain the components of Ecological community, the process of Ecological succession, Biomes etc.
CO 6	The student will appreciate the complexity of relationship between organisms.
CO 7	The student will be able to describe the characteristics of various biogeographically realms, and Indian biodiversity.
CO 8	The student will be able to give explanation to the differential distribution of organisms across the world.
CO 9	The student will describe the characteristics of various biogeographically realms, and Indian biodiversity
CO 10	The student will explain the concept of Carbon credit, Carbon trading etc.
CO 11	The student will learn to analyse various aspects of Green building technology and interlinking of rivers.
CO 12	The student learn to appreciate the richness of Indian biodiversity and various strategies of Wildlife conservation
CO 13	The student will be able to describe the components of animal behaviour, factors of motivation and conflict behaviour, properties of instinctive behaviour, types of learning, adaptiveness of behaviour, importance of biological rhythms and parental care, influence of hormones on behaviour.
CO 14	The student develops appreciation about the importance of nature watch and field study.

Part-A-Ecology (54 hrs)

1. Introduction (3hrs)

Habitat and niche

Concept of habitat and niche

Niche width and overlap

Fundamental and realized niche

Resource partitioning

Character displacement

2. Ecosystem (9 hrs)

Structure and function

Ecosystem energetics

Primary production

Energy flow models

Mineral cycling (CNP)

Trophic levels, Food chain, food web and secondary production

Decomposers and detritivores

3. Population Ecology (7 hrs)

Characteristics of a population

Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations

3.3 Sampling methods in the study of behaviour, habitat characterization

Ground and remote sensing methods

Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies, r and k selection, Demes and dispersal, interdemic extinctions, age structure of populations.

Growth and regulation of human population

4. Species interaction (5 hrs)

Types of interactions, interspecific competition

Herbivory, Carnivory, Pollination, Symbiosis; mutualism, commensalisms and proto co- operation

5. Community Ecology (4 hrs)

Nature of communities.

Characteristics of a biotic community.

Species diversity and latitudinal gradients in diversity.

5.4 Edges and ecotones.

6. Ecological succession (4 hrs)

Types, mechanisms ,changes involved in succession .

6.2 Concept of climax

7. Biogeography (6 hrs)

Major terrestrial biomes: (a) Tropical rain Forest (b) Grassland (c) Desert (d) Chaparral (e) Temperate deciduous Forest (f) Temperate boreal forest (g) Tundra (h) Savanna

8. Biogeographical zones of India (4 hrs)

(a) Trans Himalayan zone; (b) Himalayan zone; (c) Desert zone; (d) Semiarid zone; (e) Western Ghats zone; (f) Deccan plateau zone; (g) Gangetic plain zone; (h) North east zone. (i) Coastal zone; (j) Islands present near the shore line.

9. Applied Ecology (8 hrs)

Carbon credit, Carbon trading, Blue Carbon

Green building technology and its ecological importance.

Discuss the benefits and disadvantages of the idea of (brief)

a. Inter linking of major rivers of India,

b. Sethusamudram ship canal project.

c. Biodiversity with special reference to India-status monitoring and documentation, major drivers of biodiversity change.

10. Conservation Biology (4 hrs)

Principles of conservation.

Major approaches to management,

Indian case studies on conservation & management strategy (concepts of project tiger, Biosphere reserves).

Part B. Ethology (36 hrs)

1. Introduction (1 hr)

2. Concepts of Ethology (4 hrs)

Ethology as different from the other schools studying animal behavior like behaviourism.

Behaviour as a reaction to stimuli - sign stimuli, social releasers,

Ethograms, super normal stimuli, stimulus filtering.

Concepts of Fixed Action Patterns (FAP), Innate Releasing Mechanism(IRM),Action Specific Energy(ASE),Concepts of Learning and Imprinting.

3. Motivating factors (3 hrs)

General factors in motivation; Studies of motivation in guppies;

Mating systems-parental investment and reproductive success

4. Conflict behaviour- stress-displacement activities- Ritualization. (2 hrs)

5. Instinctive behaviour & reflex action, neural basis of sleep and arousal. (2hrs)

6. Learning- Neural basis of learning, memory, cognition, sleep and arousal **(3hrs)**

Biological clocks

7. Adaptiveness of behaviour (3 hrs)

JP Scott‟s categories of behaviour.

8. External stimulus - circadian rhythms (3 hrs)

8.1- Proximate and Ultimate factors.

8.2-Types of orientation-reafference theory of Von Holst & Mittel Steadt. 8.3-Navigation & migration

9. Parental care - (6 hrs)

Mating systems, Parental investment and Reproductive Success.

Development of behavior.

Social communication; Social dominance; Use of space and territoriality; domestication and behavioural changes; Social behaviour of termites & Primates;

10. Evolution and advaptiveness of behaviour (4 hrs)

Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour.

11. Hormones and Behaviour- (5 hrs)

Hormones of gonads, adrenal gland , Pituitary gland,-Hormonal effects on different behavioural patterns , Maternal behavour- mechanism of hormonal action.

References

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FIRSTSEMESTER PRACTICALS

ZOL2L01 - BIOCHEMISTRY

CO1	The student develops skills to perform and compare the importance of pH in biological processes.
CO2	The student familiarize with qualitative tests to identify and distinguish various carbohydrates.
CO3	The student learn to conduct qualitative analysis to identify proteins and non-protein nitrogenous substances.
CO4	The student acquire skills to perform quantitative tests for carbohydrates, lipids, proteins and non- protein nitrogenous substances.

1. Actual acidity and titrable acidity of a strong and a weak acid.
2. Comparison of the buffering capacities of two buffers of same pH
3. Qualitative tests for carbohydrates
   a) Qualitative tests for monosaccharides (Glucose and fructose)
   b) Qualitative tests for disaccharides (Lactose, Maltose & Sucrose)
   c) Qualitative tests for polysaccharides (Dextrin & Starch)
   d) Identification of unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitable tests.
4. Quantitative estimation of carbohydrates
   Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O- Toludine method)
   Estimation of total carbohydrate by phenol-sulphuric acid method
5. Qualitative tests for proteins
   a) Colour reactions with proteins (Albumin, Casein, Peptones & gelatin)
   b) Precipitation reactions with proteins (Albumin, Casein, Peptones & gelatin)
   c) Identification of unknown protein (Albumin, Casein, Peptones & gelatin)
6. Qualitative tests for non-protein nitrogenous substances (urea, uric acid and creatinine)
7. Identification of unknown carbohydrates, protein and non-protein nitrogenous substances from a given solution.

8. Quantitative estimation of proteins
    a) Estimation of proteins by Biuret method
    b) Isolation of casein from cow's milk
9. Quantitative estimation of non-protein nitrogenous substances
    a) Quantitation of blood urea by diacetyl monoxine method
    b) Determination of urine creatine by alkaline picrate method
10. Quantitative estimation of lipids
    a) Estimation of total serum cholesterol by Zak's method
    b) Saponification number of oils - coconut oil & ground nut oil.
    c) Iodine number of fats

ZOL2L02 - CYTOGENETICS

CO 1	The student develops skills on the basics of differential centrifugation
CO 2	The student explore the knowledge to process and visualize salivary gland polytene chromosome from drosophila larva
CO 3	The student gain hands own training in preparing squash preparation of grass hopper testis , to visualize stained chromosomes to identify meotic stages
CO 4	The student will be able to compare and evaluate the karyotypes and abnormalities

1. Homogenization, cell fractionation and isolation of nuclear fraction.
2. Preparation and maintenance of Drosophila larva.
3. Preparation of salivary gland polytene chromosome from Drosophila larva.
4. Grasshopper testes- squash preparation to study various meiotic stages.
5. Study of normal human karyotype (male and female) .
6. Study of genetic syndromes- Down‟s , Klinefelter‟s , Turner‟s and Edward‟s.

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1. Plummer David, T.(2007). An introduction to practical biochemistry -Tata Mc Graw-Hill, New Delhi.
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ZOL2L01 - Biophysics and Biostatistics

CO1	Th student familiarize with the instruments/ techniques in biophysics; P^H meter, Paper chromatoraphy, TLC, Gel electrophoresis
C02	The student learn the applications of colorimetry in quantitative analysis
C03	The student gather knowledge regarding collection, grouping and graphical representation of data with special emphasis on Microsoft Excel.
C04	The student learn to calculate measures of dispersion and their applications in data analysis.
C05	Familiarising with data interpretation in statistics; ANOVA, Correlation and Regression analysis.

Biophysics

1. pH meter and measurement of pH
2. Paper chromatography of amino acids
3. Separation and identification of amino acids in mixtures
4. Thin layer chromatography.
5. Gel electrophoresis.
6. Determination of unknown concentration of coloured solutions by calibration curve using colorimeter.
7. Absorption spectrum and max of a coloured solution (KMnO4).
8. Drawings using Camera lucida.

Biostatistics

1. Preparation of frequency table with given data
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams. (prepare same graph in Excel and keep print out)
3. Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve. (prepare same graph in Excel and keep print.
4. Computation of measures of central dispersion anthropometric data of School children. (prepare same in Excel and keep print outs and add steps for excel)
5. Simulation of binomial and poison distributions .
6. Estimation of mean number of children per family(data from at least 10 families nearby campus) (prepare same in Excel and keep print outs and add steps for excel).
7. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA. (Prepare same in Excel and keep prints out and add steps for excel).
8. Regression analysis and correlation analysis of a data of height and weight of a group of students. (prepare same in Excel and keep print outs and add steps for excel)

References

1. Daniel, M. (1998). Basic Biophysics for Biologists.. Agri. Botanica, Bikaner.
2. Das, D.(1987). Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.

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6. John T (2002) Practical statistics for environmental and biological scientists .John Wiley and Sons.

ZOL2L03 - Ecology and Ethology

Part A. Ecology

1. Identification of marine planktons.
2. Quantitative estimation of marine planktons.
3. Estimation of BOD in polluted water sample.
4. Estimation of salinity in water samples.
5. Estimation of nitrates-nitrogen in water samples.
6. Separation and identification of soil arthropods using Berlese funnel.
7. Determination of moisture content of soil sample.
8. Determination of water holding capacity of soil sample.
9. Testing the transparency of water using Secchi disc
10. Determination of primary productivity in pond water using light and dark bottle.
11. Study of termitorium / ant colony
12. Principle and application of the following instruments-GPS, Thermo hygrometer, Altimeter, Air samplers, soil samplers, Berlese funnel, Lux meter, anemometer, Rain gauge, Plankton net, Plankton counting chamber, Weather balloon, Secchi disc etc (at least six items)
13. FIELD STUDY-A study tour of at least five days duration (need not be at a stretch) to observe the ecology and behaviour of animals should be under taken. The places of visit include inter tidal region, fresh water bodies, lakes, rivers, hill streams, wetlands, mangroves, forests grasslands, drinking water treatment plants, and sewage treatment plants. A report of the field study is to be included in the practical record to be submitted at the time of examination.

Part B Ethology

1. Studying and reporting the behaviour and ecology of animals in selected fields (Social spider/ Jungle babbler/white headed babbler or Bonnet Macaques)
2. Foraging behaviour of ants.
3. Study of circadian rhythm
4. Behavioural reaction to moisture and light

References:

1. NC Aerry, N.C. (2010) - A manual of environmental analysis . Ane books private limited.
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SECOND SEMESTER THEORY

ZOL2C04-PHYSIOLOGY (90 Hours)

Course outcomes (Cos)

CO1. The student create an awareness among the society to promote balanced lifestyle and improve people's diet
CO2. The student will be able to explain the role of nutrition in health
CO3. Discuss the physiology of various organ systems in the body
CO4. The student will be able to differentiate the structure and functions of various organs in the human body
CO5. The student will describe different functional areas of cerebral cortex
CO6. The student will describe the cardiac cycle
CO7. The student will be able to discuss the physiology and mechanisms of respiration
CO8. The student will Identify and define neuro-anatomical structures
CO9. The student will summarize the various neurological disorders
CO10. Discuss different types of excretory organs in different animal groups
CO11. Explain the role of excretory system in the regulation of water balance, ,acid base balance and electrolyte balance
CO12. Identify the symptoms of life style diseases and suggest ways to control them
CO13. Explain the environment's influence on the physiological function and performance of living organisms

1. Nutrition (10 hrs)

Constituents of normal diet and their daily requirements.

Physiological calorie value of food stuffs.

Antioxidant nutrients.

Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation.

The role of hormones and neurotransmitters in the control of gastrointestinal motility.

Energy balance and obesity-causes and consequences.

BMR and its significance.

2. Excretory System (12 hrs)

Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules).

Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus structure, parts and function.

Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)

Regulation of water balance -Mechanism of concentration of urine – CounterCurrent system (counter current multiplier and counter current

exchanger).

Renal regulation of acid- base balance & electrolyte balance.

Structure of urinary bladder, micturition reflex and micturition.

Renal clearance – definition, concept and significance; clearance value of urea,creatinine, phosphate, potassium, chloride and sodium.

3. Respiratory system (10 hrs)

Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia).

Physiological anatomy and histology of respiratory passage and lungs.

Mechanism of pulmonary ventilation (inspiration & expiration) .

Alveolar ventilation, dead space and its effect on alveolar ventilation.

Role of surfactant in alveolar expansion.

Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity).

Exchange of gases- partial pressures involved-lung and tissues.

Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO_2, PCO_2, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin).

Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

4. Nervous system (21 hrs)

Organisation of human brain.

Cerebrum and cerebral lobe.

Cerebral cortex and its functional areas- Motor cortex, Broca's area , somatosensory cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex, wernick's area, Brodman map, cerebral dominance .

Cortical white matter- commissures, association fibers, projection fibers,corpus callosum and fornix, basal nuclei-organisation and function.

Brain stem- organisation and function.

Cerebellum- structure and function.

Diencephalon – organisation and function.

Functional brain systems - Limbic system and reticular formation.

Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.

Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinso's disease.

Memory- definition, types of memory- short term, intermediate long term and long term memory, consolidation of memory.

PNS and Autonomic nervous system.

Spinal cord – structure.

Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and golgi tendon organ.

5. Special senses (16 hrs)

Vision:

Structure of eyeball

Fluid systems of the eye
Layers of Retina and photoreceptors (rods & cones)
Brief notes on the neuronal cell types and neural circuitary of the retina and visual pathways from retina to visual cortex
Image formation
Formation of image on the retina.
A brief general account of electrophysiology of vision
Photochemistry of vision & colour vision

Taste:

Primary sensations of taste (agents and site of sensation)
Taste buds (location, structure, receptors and nerve supply)
Physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS)

Smell:

Olfactory membrane and receptor cells
Physiology of olfaction (stimulation of olfactory cells and transmission of smell signals to CNS)

6. Tactile response: (brief note**) (4hrs)**

Mechanoreceptors and their stimulation
Pain receptors and their stimulation
Thermal receptors and their stimulation

7. Cardiovascular system (8hrs)

Introduction: Brief description of vertebrate hearts
Structural organization of myogenic heart (in human beings).
Physiological anatomy of cardiac muscle – specialized tissue**.**
Heart as a pump.
Cardiac cycle**.**
Neural and chemical regulation of heart function**.**
Blood volume and blood pressure**.**
Physiological anatomy of coronary blood flow, coronary blood flow and its control**.**
Ischemic heart disease – mention causes.

8. Lymphatic System (5 hrs)

Lymph channels of the body**.**
Composition and formation of lymph**.**
Functions of lymph and lymphatic system including role of it in controlling Interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure.

9. Environmental Physiology (4 hrs)

Thermal regulation.
Comfort zone, normal body temperatures (oral, skin & core).
Temperature regulating mechanism (hot & cold), mention the role of hypothalamus, thyroid and adrenal glands.
Acclimatization

References

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2. William F.Ganong (1999): Review of Medical Physiology, Lange Medical

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14. Davie IV & Lewid S.M.- Practical Haematology, 6th Edn. Churchill, Livingstone, Edinburgh.

SECOND SEMESTER

ZOL2C05 - MOLECULAR BIOLOGY (90 Hrs)

Course outcomes

CO1. The student will acquire knowledge regarding the mechanism of DNA replication- both chromosomal and extra chromosomal, enzymes involved, models of replication, inhibitors and the significance of DNA replication.
CO2. The student learn to know the safeguard systems of DNA, restriction enzymes and their significance, mechanisms involved in damage and repair of eukaryotic DNA and its importance.
CO3. Learn to explain the general features of genetic code, special features of the genetic code in mitochondria, and variations in genetic code.
CO4. The student gain in-depth knowledge regarding the structural organization of mRNA in prokaryotes and eukaryotes, the mechanism of transcription, translation, post transcriptional and translational modifications, structure , biogenesis and role of ribosomes in protein synthesis ; and RNA editing.
CO5. The student will gain knowledge regarding the regulation of gene expression in Phages, Bacteria, and in Eukaryotes ; recent research findings like antisense RNA strategies and role of si RNA and mi RNA in the regulation of eukaryotic gene expression and their applications.
CO6. The components , organization and special features of eukaryotic genome, interrupted genes and their evolution; concept of gene families, and molecular evolutionary clock.
CO7. Introduction to transposition mechanisms in prokaryotes and eukaryotes , and their significance.
CO8. Molecular mechanisms of genetic recombination,models, and significance.
CO9. Special features of microbial genetics, and organelle genome, their replication and mapping.
CO10. The student gain an in depth knowledge regarding the events and regulation of cell cycle, its alteration and causes of cancer. Genes involved in the regulation of cancer and modern therapeutic interventions like immunotherapy and gene therapy.

1. DNA replication (11 Hrs)

Semidiscontinuous synthesis-Okazaki fragments

Replication origin and replication fork

Unit of replication, extra chromosomal replicon of bacterial Ti plasmid

Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase; Fidelity of replication

Replication of the ends of eukaryotic chromosome – role of telomerase

Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ-model.

Inhibitors of DNA replication – Methotrexate and Fluorodeoxyuridylate

2. Safeguard systems of DNA (5 Hrs)

Restriction: significance, role and features of Type I, II & III restriction enzymes

Modification: enzymes and significance

Repair:

Major kinds of damage to DNA and causes

Repair mechanisms: Direct reversal, Mismatch repair, Excision repair, Recombination repair, SOS response

3. Transcription of mRNA in prokaryotes and eukaryotes (10 Hrs)

Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA

Transcription in prokaryotes and eukaryotes

Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites

Transcription factors; Transcription activators and repressors

Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions

Post transcriptional modification of RNA

Capping

Polyadenylation

Splicing

RNA editing: site specific deamination and role of gRNAs

mRNA transport

4. Genetic code (5 Hrs)

Characteristics of genetic code

Start codons and stop codons

Degeneracy of the code: Wobble hypothesis and isoacceptor tRNAs

Special features of the genetic code in mitochondria, mitochondrial tRNA

Variations in the genetic code in *Mycoplasma* and *Tetrahymena*

Point mutations that alter genetic code (missense, nonsense & frameshift)

5. Ribosome: The site of protein synthesis: (2 Hrs)

Structure

Composition; Reconstitution experiments

Active centres

Biogenesis of ribosome in eukaryotes

6. Translation in prokaryotes and eukaryotes: (8 Hrs)

Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis

Aminoacyl tRNA synthetases & initiation, elongation and termination factors

Translational proof-reading

Differences in protein synthesis between prokaryotes and eukaryotes

Translational inhibitors in prokaryotes and eukaryotes –

Role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin

Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications

7. Control of gene expression at transcription and translation level: (9 Hrs)

Regulation of gene expression in Phages – alternate patterns of gene

expression for control of lytic and lysogenic cycle in λ phage
Regulation of gene expression in bacteria – basic features of tryptophan, arabinose and galactose operons
Regulation of gene expression in eukaryotes –
Role of chromatin in regulating gene expression
Activation and repression of transcription
Regulation of translation by gene arrangement
Regulation of translation by alternate pathways of transcript splicing
Antisense RNA strategies for regulating gene expression
si RNA and mi RNA in regulation

8. Eukaryotic genome: (5 Hrs)

Special features of eukaryotic genome
Features, components and reassociation kinetics of Unique, Moderately repetitive and Highly repetitive DNA
Junk DNA, Satellite DNA and Selfish DNA
Cot value and complexity of genome
Organisation of human genome (brief account)

9. Interrupted genes (4 Hrs)

Definition and explanation
Organisation and special features of interrupted genes
Evolution of interrupted genes

10. Gene families: (6 Hrs)

Definition and concept
Classification with example
Simple multigene family - organisation of rRNA gene in *Xenopus*
Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in *Drosophila*
Developmentally controlled complex multigene family
e.g., globin gene Globin genes and its products
Organisation of globin genes and its expression in Man
Evolution of globin genes
Concept of an evolutionary clock
Pseudogenes

11. Transposable genetic elements - Transposons (6 Hrs)

Definition, features and types
Transposition and mechanism
Transposons in bacteria
IS elements
Tn family
Mu phage as a transposable element
Transposons in eukaryotes
SINE, Alu family; LINE, L1
P elements in *Drosophila*
Transposons in Maize
Retroviruses and transposition

12. Molecular mechanisms involved in recombination of DNA: (5 Hrs)

Genetic recombination – types with example
Site specific recombination
Non-homologous recombination

Homologous recombination

Molecular mechanism involved in homologous recombination of DNA in eukaryotes- Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion

Role of Rec A protein in genetic recombination

13. Microbial genetics (5 Hrs)

Prokaryotic genome- *Escherichia coli* genome – basic features

Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumonia*), conjugation and sexduction, transduction

Brief note on mapping genes by interrupted mating (in bacteria)

14. Organelle genome (4 Hrs)

Chloroplast genome: special features

Mitochondrial genome

Special features of yeast mitochondrial genome, petite mutants

Special features of human mitochondrial genome.

15. Cancer (5 Hrs)

Genetic rearrangements in progenitor cells, oncogenes, protooncogenes and tumour suppressor genes

Virus-induced cancer

Alteration of cell cycle regulation in cancer

Interaction of cancer cells with normal cells

New therapeutic interventions of uncontrolled cell growth (immunotherapy and gene therapy).

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SECOND SEMESTER THEORY

ZOL2C06 - SYSTEMATICS AND EVOLUTION (90 Hours)

Part -A: Systematics (54 Hrs)

Course outcomes (Cos)

CO1. The student develops skills in the identification and taxonomic classification of organisms based on their characters
CO2. The student will be able to describe different levels of taxonomy
CO3. Aware about Place, importance, applications and goals of taxonomy
CO4. Learn about purpose of classification, use of classification, theories of biological classification and types classification
CO5. Explain taxonomic procedures like Taxonomic collections,Curation, Recording of field data, storage of collection, labelling and cataloguing of collection Identification- methods of identification, Use of keys,Taxonomic descriptions, Taxonomic and ecological publication and their difference.
CO6. The student will acquire knowledge regarding Species concept and the taxonomic diversity within species, different kinds of species, sub species and other infra specific categories, hybrids
CO7.Recognize the importance of Zoological nomenclature, International Code of Zoological Nomenclature
CO8. Interpret Principle of priority, Homonymy and Synonymy and Different kinds of types in descriptive taxonomy
CO9. Use new trends in Systematics especially Chemo and Serotaxonomy, Cytotaxonomy, Numerical taxonomy, Cladistics, Molecular systematics and DNA bar coding vs traditional taxonomy
CO10. Recognize the ethics related to taxonomic collections and publication
CO11. Realize the taxonomic impediments
CO12. Describe the mechanism of natural selection and the evolutionary mechanisms
CO13. Explain tempo of evolution
CO14.Describe molecular evolutionary theories like Neutral theory of molecular evolution, Molecular clocks- genetic equidistance- human mitochondrial molecular clock and Phylogenetic relationships
CO15. Recognize Evolutionary trends in Biochemical evolution and primates evolution
CO16 .An enhanced knowledge about the Mechanism of natural selection –
CO17. The student develops conceptual understanding on Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift, process of Isolating mechanisms-Prezygotic and Postzygotic isolating mechanisms; speciation-allopatric, peripartric-parapatric-heteropatric-sympatric speciation; ecotypes etc.
CO18. The student develops appreciation about the major processess involved in the Co-evolution; Microevolution, Macroevolution etc.
CO19. The process involved in the Gradualism and punctuated equilibrium along with anagenesis and cladogenesis will be acquired
CO20. An enhanced level of conceptual learning regarding Neutral theory of molecular evolution;

molecular divergence; molecular drive, Molecular clocks- genetic equidistance- human mitochondrial molecular clock , Phylogenetic relationships- DNA barcoding vs traditional taxonomy etc
CO21. An elevated understanding of the Biochemical evolution- Collapse of Orthogenesis along with Stages in primate evolution ; African origin for modern humans, Y-chromosomal Adam-mitochondrial Eve, the process of Communication, speech, language and self awareness in Primates etc.

I. Introduction (1 hr)

2. Definition and basic concepts in Systematics and Taxonomy (4 hrs)

Levels of Taxonomy
Alpha, Beta and Gamma taxonomy
Importance and applications of taxonomy
Goals of taxonomy
Definition of systematics
Definition of classification

3. Species (4 hrs)

Monotypic species
Polytypic species
Ecospecies and Cenospecies
Morphospecies
Super species
Species as a Population Complex

4. Species Concepts (6 hrs)

Typological Species Concept
Nominalistic Species Concept
Biological Species Concept
Evolutionary Species Concept
Difficulties in the application of the biological species concept

5. Classification (7 hrs)

Uses of Classification
Purpose of Classification
Theories of Classification
(a) Essentialism (b) Nominalism
(c) Empiricism (d) Cladism (e) Evolutionary Classification
Hierarchy of Categories
The objectives of classification

6. Taxonomic Collections and the Process of identification (8 hrs)

Taxonomic collections: Types of collections, Value of Collection
Purpose of scientific collection
Preservation of Specimens
Labeling
Curating of collections
Curating of types
Identification- Methods of identification
Use of keys, types of keys.
Merits and demerits of different keys
Description and publication

7 .Taxonomic Characters (6 hrs)

Nature of taxonomic characters

Taxonomic characters and adaptation

Kinds of taxonomic characters

(a) Morphological (b) Physiological (c) Ecological (d) Ethological and (e) Geographical characters

Taxonomic characters and classification

Taxonomic characters and evolution

Functions of taxonomic characters

8. Zoological Nomenclature (6 hrs)

Brief History of nomenclature

International Code of Zoological Nomenclature

The nature of scientific names

Species and infraspecies names

Gender of generic names

Synonyms and Homonyms

The Law of Priority

Rejection of names

Type method and different kinds of types

9. Newer trends in systematics (4 hrs)

DNA Bar coding

Molecular systematics

Chemo taxonomy and serotaxonomy

Cytotaxonomy

Numerical taxonomy

Cladistics

10. Ethics related to taxonomic publications (4 hrs)

Authorship of taxonomic papers

Correspondence

Suppression of data

Undesirable features of taxonomic papers

Taxonomist and user communities

11. Taxonomic impediments (4 hrs)

Impediments in taxonomic collections and maintenance

Shortage of man power

Lack of funding for taxonomic research

Lack of training and library facilities

Impediments in publishing taxonomic work

Solutions to overcome the impediments

(a) Improve international co-operation (b) Development of taxonomic centers

(c) Need for efficient international networking (d) the desired end product

Part- B Evolution (36 Hrs)

I. Natural Selection: (7 hrs)

Mechanism of natural selection- directional, disruptive and stabilizing selection

Natural selection in islands

Sexual selection; intrasexual and intersexual selection- secondary sexual characteristics-sexy son hypothesis, good gene hypothesis

2 The Mechanisms (7 hrs)

Population genetics- populations, gene pool, gene frequency, Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in evolution

Evidence for evolution: DNA evidence, fossil evidence, embryological evidence, geological evidence, evolution in action, imperfection of evolution

Co-evolution: microevolution, macroevolution, convergent evolution (homoplasy), divergent (parallel) evolution

3 Tempo of evolution (5hrs)

Gradualism Vs punctuated equilibrium

Anagenesis Vs Cladogenesis

4 Molecular evolutions (8 hrs)

Neutral theory of molecular evolution

Molecular divergence

Molecular drive

Molecular clocks, genetic equidistance, human mitochondrial molecular clock

Phylogenetic relationships- Homology, homologous sequence of proteins and DNA, orthologous and paralogous evolution, nucleotide sequence analysis

5 Evolutionary trends (9 hrs)

Biochemical evolution- Collapse of orthogenesis

Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians, human and the African apes, African origin for modern humans, Y chromosome Adam and mitochondrial Eve

Can evolution explain language? Communication, speech, language and self awareness in primates.

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Part -A Systematics

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Part- B Evolution

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SECONDSEMESTER PRACTICALS

ZOL2L02 - PHYSIOLOGY

Course outcomes

CO 1 The student gain practical knowledge regarding the methods of analysis of enzyme activity and its dependent factors
CO2 The student will compare the effects of biotic and abiotic factors on aquatic life
CO3 The student gain a thorough practical knowledge related to the analysis of various blood parametrs

1. Kymograph: working principle and applications
2. Effect of different substrate concentration, pH and temperature on human salivary amylase activity. colorimetric method, plot graphs.
3. Qualitative demonstration of digestive enzymes in cockroach – amylases, lipases, proteases, invertases and controls.
4. Digestion in a vertebrate and calculation of peptic value.
5. Influence of temperature and pH on the ciliary activity in fresh water mussel/mytilus using silver foil. Plot graph
6. Determination of respiratory quotient – estimation of O2 consumption by an aquatic animal.
7. Determination of the rate of salt loss and gain in an aquatic animal (fish or crab).
8. Estimation of urea and ammonia in human urine. Titrimetric method.
9. Rate of glucose – absorption – calculation of Cori coefficient.
10. Estimation of haemoglobin of Fish/Man – Sahli‟s method.
11. Blood volume determination by dye dilution method (Vertebrate).
12. Blood: clotting time, bleeding time, rouleaux formation, preparation of haemin crystals.
13. Enumeration of RBCs in human blood.
14. Determination of lactic acid in muscle tissue.
15. Differential count of human WBCs
16. Haematocrit and ESR of human blood.
17. WBC total count

References:

1. Oser B. L.(1965). Hawk‟s Physiological chemistry, McGraw Hill Book Company
2. Hill R.W., Wyse G.A. (1989), Animal Physiology 2nd edition. Harper Collins Publishers
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ZOL2L02- MOLECULAR BIOLOGY

Course outcomes

CO1 The student develops practical knowledge to isolate genomic DNA from animal tissues.
CO2 The student acquire hands own training in the Quantification of DNA, RNA and Proteins by colourimetric methods
CO3 As a Core curriculum course, students completing this course along with the practical sessions will demonstrate competence in gathering, analyzing, synthesizing, evaluating and applying information gathered.

1. Estimation of DNA by Diphenyl Amine method
2. Estimation of RNA by Orcinol method
3. Estimation of Protein by Lowry‟ method.
4. Isolation of genomic DNA.
5. Isolation of DNA from Liver/Spleen/Thymus.
6. Study of principle and application of DNA finger printing.

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2. Brown, T.A. (2007): Essential Molecular Biology – A practical approach Vol. 2, Oxford University Press
3. Wilson & Walker (2006): Principles and techniques of Biochemistry and Molecular biology, Cambridge University Press.

ZOL2L03- SYSTEMATICS AND EVOLUTION

Course outcomes

CO 1 The student may gather basic knowledge regarding Collection and Identification of animals up to species level
CO2 Scientific handling of speciments collected, preservation and museum curation

Systematics

1. Collection, Preservation and Curation of specimens
2. Identification of animals (Fishes/insects/any other) up to family/ generic / species level- minimum 15 specimens.
3. Preparation of dichotomous (simple bracket) keys to selected families with reference
4. to insect orders Orthoptera, Hemiptera, Coleoptera, Diptera and Hymenoptera (minimum five specimens from each order)

Evolution

1. Exercises in convergent evolution.
2. Exercises in divergent evolution.
3. Sympatric and Allopatric speciation.
4. Exercises in co-evolution.
5. Calculation of genotype / gene frequency based on Hardy –Weinberg equilibrium.

THIRD SEMESTER THEORY

ZOL3C07 - IMMUNOLOGY (90 Hours)

Course outcomes

CO1. An in depth knowledge in the process of immune cell synthesis and maturation, antigen receptor structure and the mechanisms of antigen recognition by B-cell and T-cells.
CO2. The student will explore the Structure and diversity of immunoglobulins, antigens and its classification, production and clinical uses of monoclonal antibodies and antigen antibody interactions.
CO3. The student gain conceptual knowledge regarding key principles, procedure and applications of different Immunetechniques used in the biomedical field and to develop new methods and techniques on the basis of the earned knowledge.
CO4. Mechanisms of humoral and cellular immunity, immune cell receptor and intracellular signal cascades related to immune system activation and response.
CO5. The student explore the fundamentals of Immune effector mechanisms, chemical signaling through cytokines, its therapeutic uses and cytokine related diseases.
CO6. The complement system and its components, hypersensitivity and allergic responses, diseases related to hypersensitivity, autoimmune disorders and complement deregulation.
CO7. The student will appreciate the scientific principles behind vaccination, types of vaccines and their role in fighting diseases.
CO8. The student will be able to describe the mechanisms of autoimmunity and immune deficiency diseases.

1. **Introduction (1 hour)**
2. **Hematopoiesis (7 hours)**
   - Hematopoiesis – Lymphoid and myeloid lineages.
   - Hematopoietic growth factors.
   - Genes that regulate hematopoiesis.
   - Regulation of hematopoiesis.
   - B- Lymphocytes, T- lymphocytes and Antigen presenting cells.
3. **Antigens (8 hours)**
   - Immunogenicity, Antigenicity.
   - Factors that influence immunogenicity.
   - Adjuvants.
   - Haptens.
   - Epitopes.
   - Properties of B-cell and T- cell epitopes.
4. **Immunoglobulins (Antibodies) (10 hours)**
   - Structure and function of Antibody molecules.
   - Generation of Antibody diversity.
   - Immunoglobulin gene.
   - Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c)Idiotype.
   - B-cell receptor (BCR).

Monoclonal Antibodies.
Production of Monoclonal Antibodies (Hybridoma technology).
Clinical uses of Monoclonal Antibodies.
Antibody Engineering.

5. Antigen Antibody interactions (10 hours)

Strength of antigen – antibody interactions.(a) Antibody affinity
(b) Antibody avidity.
Cross- reactivity.
Precipitation reactions.
Immunotechnics – ELISA, RIA, WesternBlot, Immunoelectrophoresis,
Flow cytometry and fluorescence.

6. Generation of B-cell and T-cell responses. (9 hours)

Humoral immunity.
Cellular immunity.
T- Cell receptor, TCR-CD3 complex.
Activation, maturation and differentiation of B-Cells.
Activation, maturation and differentiation of T- Cells.

7. Immune effector mechanism. (7 hours)

Cytokines.
Properties of cytokines.
Cytokine antagonists.
Cytokine secretion by TH1 and TH2-cells.
Cytokine related diseases. (a) Bacterial septic- shock (b) chaga's disease) (c) lymphoid and myeloid cancers.
Therapeutic uses of cytokines.
Toll- like receptors.

8. The Complement system. (6 hours)

The complement components.
The functions of complement components.
Complement activation (a) Classical pathway (b) Alternate pathway
(c) Lectin pathway.
Regulation of complement system.
Biological consequences of complement activation.
Complement deficiencies.

9. Major Histocompatibility Complex (MHC) (8 hours).

General organization and inheritance of MHC.
MHC molecules and genes.
Cellular distribution of MHC.
Antigen- processing and presentation-Exogenousand Endogenous pathways.
Presentation of non- peptide antigens.

10. Transplantation immunology (8 hours)

Auto graft, Allograft, Isograft and xenograft
Immunological basis of graft rejection.
Role of cell- mediated responses.
Transplantation antigens.
General immune suppressive therapy.

11. Hypersensitivity Reactions. (5 hours)

Allergens.
IgE- mediated (type- I) hypersensitivity.

Antibody- mediated cytotoxic (type- II) hypersensitivity.
Immune complex- mediated (type- III) hypersensitivity.
TDTH- mediated (type- IV) hypersensitivity

12. Vaccines. (5 hours)

Active and passive immunization.
Whole organism vaccines.
Recombinant vector vaccines.
DNA vaccines.
Synthetic peptide vaccines.
Multivalent vaccines.

13. Immunity and malnutrition and immune deficiency diseases. (6 hours)

Immunity and malnutrition.
Primary immune deficiency diseases. (a)Burton‟s disease (b) Di-George syndrome and SCID.
Secondary immune deficiency - AIDS.
Transmission of HIV.
Vaccines to prevent AIDS.
Autoimmunity (systemic and organ specific brief)

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THIRD SEMESTER THEORY ZOL3C08-

DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY

(90 Hours)

Course outcomes

CO1: The student will gain knowledge onbasic concepts in development.
CO2: The student will explain the process of gametogenesis, fertilization and embryonic development.
CO3: The student will appreciate the genetic, cellular and molecular basis of development.
CO4: The student will describe the process of ageing and mechanisms.
CO5: The student realize the impact of environment on development.
CO6: Describe different classes of chemical messengers and their physical characteristics.
CO7. Explain how the secretion of hormone is regulated through positive and negative feedback mechanisms.
CO8: Summarize the anatomy, regulation, and physiological functions of the hormones of the hypophysis, thyroid, parathyroid, pancreas adrenal, hypothalamus and adrenal glands.
CO9: Describe the anatomy of male and female reproductive systems including hormonal functions and pathophysiology.

Part- A - DEVELOPMENTAL BIOLOGY (54hrs)

1. Introduction: Basic concepts of development (6 hrs)

Cell fate, potency, determination and differentiation.

1.2 Commitment

Specification - autonomous, conditional, syncytial .

Genomic equivalence and cytoplasmic determinants

Morphogenetic gradients

Genomic Imprinting

The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Stem cell therapy.

2. Gametogenesis, fertilization and early development (10 hrs)

Production of gametes- Spermatogenesis and Oogenesis, Ultra structure of gamates

Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)

Zygote formation-

- Encounter of sperm and egg
- Capacitation
- Acrosome reaction
- Activation of ovum

2.3.5 Amphimixis

2.3.6. Prevention of Polyspermy (Fast block and Slow block)

Cleavage and blastula formation

Gastrulation and formation of germ layers in amphibia
Embryonic fields

3. Embryogenesis and Organogenesis (10 hrs)

Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center, primary embryonic induction, mechanism of axis formation

Anterior posterior patterning in Amphibians - Hox code hypothesis

Anterior posterior patterning in *Drosophila* – anterior forming genes (bicoid, hunchback), posterior forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes- gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realistor genes

Dorso- ventral patterning in *Drosophila*- dorsal protein gradient

Limb development in chick- Formation of the Limb Bud, Generating the Proximal-Distal Axis of the Limb, Specification of the Anterior-Posterior Limb Axis, Generation of the Dorsal-Ventral Axis

Insect wings and legs formation

Vulva formation in *Caenorhabditis elegans.*

Eye lens induction.

4. Cellular and Molecular basis of development (7 hrs)

Induction and competence- cascade of induction- reciprocal and sequential inductive events, instructive and permissive interactions.

Epithelial- Mesenchymal interactions- paracrine factors - The Hedhog family, The Wnt family, Juxtacrine signaling and cell patterning, notch pathway.

Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis.

Molecular basis of cellular differentiation – Cadherins.

5. Genetic basis of development (8 hrs)

Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcription factors, Silencers and Insulators.

Differential RNA processing- X chromosome inactivation-
dosage compensation.

Control of gene expression at the level of translation-Differential mRNA longevity, selective inhibition of mRNA translation, Selective activation of mRNA translation, micro RNAs, Control of RNA expression by cytoplasmic localization.

Post translational regulation of gene expression.

Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.

Reversibility of patterns of gene activity-cell fusion, transdifferentiation.

6. Metamorphosis, Regeneration and Ageing (7 hrs)

Metamorphosis in Amphibians and Insects and their hormonal control

Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration

Ageing – The biology of senescence, cellular and extra cellular ageing, Genes and ageing, DNA repair enzymes, Ageing and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed ageing .

7. Environmental regulation of animal development (4 hrs)

Environmental regulation of normal development - types of polyphenism
Environmental disruptions of normal development (Teratogenesis)
Teratogenic agents - Alcohol, retinoic acid, Bisphenol A(BPA), heavy metals, pathogen, Testicular Dysgenesis Syndrome, DES as an endocrine disruptor,
Endocrine disruptors as obesogens
Environmental oestrogens.
Impact of pesticide on development.

8. Developmental Mechanisms of Evolutionary change- (2hrs)

Heterotopy, Heterochrony, Heterometry, Heterotypy. (Brief)

Part B- ENDOCRINOLOGY (36 hrs)

1. Endocrine glands and their Hormones (Brief account) (5 hrs)

Hormone secreting organs and tissues -skin, liver, kidney, heart.
General classes of chemical messengers- Peptide, thyroid, steroid hormones, neurotransmitters and pheromones
Synthesis and delivery of hormones- storage, secretion and transportation
Control of hormone secretion.
Physical characteristics of hormones - latency, post-secretary modification and half- life
Physiological roles of hormones.

2. General mechanisms of Hormonal action (5 hrs)

Hormone Receptors and transducers;
Types of receptors- g protein coupled receptors, steroid receptors and nitric oxide receptors,
Regulation of receptor number, receptor activation
Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,
Receptor signal transduction
Eicosanoids and hormone action

3. Anatomy of endocrine glands; structure, physiological functions, and control of secretion of their hormones and pathophysiology (13 hrs)

Hypothalamus
Hypophysis
Thyroid
Parathyroid
Adrenal
Pancreas

4. Hormones and male reproductive physiology (7 hrs)

Synthesis, chemistry, and metabolism of androgens
Endocrine control of testicular function
Physiological roles of androgens and estrogens
Pathophysiology

5. Hormones and female reproductive physiology (3 hrs)

Synthesis, chemistry, and metabolism of Ovarian steroid hormones
Physiological roles of Ovarian steroid hormones
Hormonal regulation of female monthly rhythm
Hormonal factors in pregnancy, parturition and lactation

6. Neurohormones (3 hrs)

Gases as neural messengers

Endorphins- physiological roles, mechanism of action and pathophysiology

Brain hormones and behaviour

Neuroendocrine pathophysiology

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THIRD SEMESTER THEORY ELECTIVE

COURSE- ENTOMOLOGY-I

ZOL3E0901 -MORPHOLOGY AND TAXONOMY (90 Hours)

Course outcomes

CO1. The student will explain how insects originated and evolved on earth.
CO2. The student gain knowledge regarding fossil insects.
CO3. The student will be able to describe diversity, systematics , biology and habits of insects.
CO4. The student will explore the external morphology of insects.
CO5. The student will appreciate the behavior and ecology of insects.

1. Introduction (5 hrs)

Origin and evolution of insects: Ancestry of insects based on fossil studies. Phylogeny of insects: Atelocerata hypothesis, Pancrustacea theory. Mention phylogenomics studies.

Fossil insects. Mention extinct orders: Archodonata, Blattoptera, Coxoplectoptera, Diaphanopterodea, Glosselytrodea, Meganisoptera, Megasecoptera, Miomoptera, Monura, Palaeodictyoptera, Protelytroptera, Protodiptera,Protorthoptera and Titanoptera.

2. Insect classification (31 hrs)

Introduction to classification of insects. Mention Apterygota, Exopterygota, Endopterygota, Hemimetaboly and Holometaboly.(1 hr)

Apterygota: Diagnostic characteristics, biology and economic importance of the following Orders: Collembola, Protura, Diplura, Archeognata (Microcoryphia) and Thyasanura. Locomotion in Collembola. (3 hrs)

Exopterygota: Diagnostic characteristics, biology and economic importance of the following Orders and families mentioned under each order. Special topics mentioned under each order. (12hrs)

1. Ephemeroptera.
2. Odonata-mention dragon flies and damsal flies, mouthparts of naiads, mating behavior.
3. Isoptera- Castes, Termitarium, economic importance.
4. Phasmida.
5. Blattaria- Mention economic importance and important species.
6. Mantoidea & Mantophasmatodea.
7. Orthoptera-Families: Acrididae, Tetrigidae, Tettigonidae, Gryllidae, Gryllotalpidae. Stridulatory organs in Orthoptera; Locusts.
8. Thysanoptera.
9. Hemiptera; Families- Cicadidae, Jassidae, Cercopidae, Membracidae, Aphididae, Nepidae,Gerridae, Pentatomidae, Reduviidae. Medical importance of Reduviidae; Polymorphism in Aphids; Stridulation in Cicada.
10. Psocoptera.
11. Phthiraptera- Mention *Pediculus humanus* and its parasitic adaptations.
12. Dermaptera- Sexual dimorphism and parental care.
13. Plecoptera.
14. Embioptera.
15. Zoraptera.

Endopterygota: Diagnostic characteristics, biology and economic importance of the following Orders and families mentioned under each order. Special topics mentioned under each order.**(15 hrs)**

1. Coleoptera- Families: Curculionidae, Scarabaeidae, Carabidae, Cerambicidae, Lampyridae, Chrysomelidae, Elateridae, Meloidae. Mention cantharidin and bioluminescence.
2. Lepidoptera. Butterflies and Moths. Families: Noctuidae, Sphingidae,Saturnidae, Pyralidae, Papilionidae, Nymphalidae, Hesperiidae, Pieridae, Lycaenidae, Geometridae .Migration in butterflies; Butterfly farming; Silk moths.
3. Hymenoptera: Families: Vespidae, Sphecidae, Megachilidae, Apidae, Eumenidae, Xylocopidae, Formicidae, Evanidae, Braconidae, Ichneumonidae, Chalcididae, Eulophidae, Eurytomidae and Pteromalidae. Parasitic hymenoptera and biological control; Honeybees and honey production; Honeybee venom; Swarm intelligence and its application.
4. Diptera: Suborders: Nematocera and Brachycera. Families: Muscidae, Culicidae, Calliphoridae, Sarcophagidae, Simulidae, Tipulidae, Glossinidae, Drosophilidae, Psychodidae. Disease vectors; Dipterans and forensic entomology; Dipterans and bio-surgery; *Drosophila* as experimental model.
5. Siphonoptera: Mention plague.
6. Strepsiptera . Mention stylopization.
7. Neuroptera. Mention Antlions.
8. Mecoptera .
9. Megalaoptera.
10. Raphidioptera.
11. Trichoptera.

3. External morphology (36 hrs)

Segmentation and division of the body

General morphology of the Head

Opisthognathous, hypognathous and prognathous –

Head segmentation- theories about the segmentation of the head

Head skeleton- different sutures and sclerites –

Tentorium –

Modification in head capsules –

Cephalic appendages –

Antenna: structure, function & types

Gnathal appendages: types, structure & function

Mouth parts of insects

Cervix

Thorax

Thoracic segmentation

Thoracic skeleton

Endothorax

Thoracic appendages

Modifications of thoracic legs

Wings: origin and evolution of wings, structure, venation, wing coupling apparatus, morphological variations

Abdomen Segmentation
Skeletal composition
Pregenital and post genital segments
Abdominal appendages
External genitalia: male and female

4. Ecology and Behaviour (18 hrs)

Aquatic insects
Factors influencing the aquatic life
Food capture; modifications
Respiration in semi-aquatic and in truly aquatic insects
Oviposition methods
Anchorage, locomotion
Adaptations of swimming forms
Gall forming insects:
Definition and features
Formation, economic importance
Common gall pests
Extent of gall making habits
Gall as dwelling place, the position of gall
Classification of galls by Orders
Adaptation for the gall making habits
Origin and types of galls (open & closed)
Physiology of gall formation
Leaf mining insects
Definition and identification
Forms of leaf mines, economic importance
Extend of the leaf mining habits
Feeding habits and frass disposal
Ecological aspects of leaf mining
Insect-plant interdependence (co-evolution)
Social insects – social organisation
Caste differentiation
Aspects of social behaviour with reference to honey bee, termite and ant
Communication – acoustic, visual, tactile and chemical method (pheromones)
Adaptations of parasitic and predatory insects

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THIRD SEMESTER THEORY

ELECTIVE COURSE - ENVIRONMENTAL BIOLOGY- I

ZOL3E0902 - MAN, ENVIRONMENT & NATURAL RESOURCES (90 hours)

Course outcomes (Cos)

CO1: The student will describe the concepts related to Weather and Climate
CO2: The student will xplain the general features of Human population
CO3: The student will identify the different types and Functions of Ecosystems
CO4: Explain the human impact on ecosystems and sustainable development
CO5: Enumerate the various types and relevance of renewable and non-renewable natural resources
CO6: The student learn the concepts of Water management and conservation

1. Weather and climate (15 hrs)

Atmosphere- structure and composition; Local winds: Sea and land breezes; Polar easterlies, Westerlies; Trade winds;
Indian and African Monsoon;
Inversions: temperature or thermal inversions- causes –consequences – subsidence inversion;
Clouds and their formation
Cloud categories: low, middle, and high clouds: Cirrus (Ci), Cirrocumulus (Cc), and Cirrostratus (Cs), Altocumulus (Ac), Altostratus (As), and Nimbostratus (Ns), Cumulus (Cu),

2. Element and factors of climate; (15 hrs)

External factors: solar radiation- Plate tectonics - Milankovitch Theory – Orbital eccentricity - obliquity- axial precession.
Internal factors: earth's orography- oceanic and continental influence- Deforestation- surface albedo- snow and ice- volcanic activity-dust particles- Greenhouse gas concentrations -Atmosphere- ocean heat exchange- Atmospheric carbon dioxide Variations- human influences

Global climate changes – causes and consequences.
Physical evidence for climatic change – Historical and archaeological evidence- Glaciers – Vegetation -Ice cores – Dendroclimatology- Pollen analysis-Sea level change

3. Human population (10 hrs)

Exponential growth – geometric growth or geometric decay- Malthusian growth model - population momentum age structure – population pyramid, age structure diagram
Types of population pyramid - Young and aging populations – youth bulge - Current trends in global population with reference to developed and developing countries
Population explosion –Baby boom –History of population growth Projections Of population growth
Demographic transition, Carrying capacity – Human population in India

4. Ecosystem (25 hrs)

Ecosystems-a) types, natural & artificial, agroecosystems,
city ecosystems and Spacecraft ecosystems
Functions of Ecosystems-
Ecological energetics - Fixation and utilization of energy-
Primary production, factors affecting & measurements of primary production,
Eclogical efficiencies- ratios within and between trophic levels,
Lindmann‟s work, Single channel, Y shaped and universal energy flow models.
Place of man in the food chain,
Human expropriation of primary production,
Nutrient cycling, selection, diversity, decomposition and stability.
Development of ecosystems, Types and factors controlling,
changes in the trends of ecological attributes,
Relevance of ecosystem development concept to human ecology and evolution of ecosystems
Human impact on ecosystems, Human settlements, Human cultural evolution, Environmental crisis,
Environmental protection and sustainable development,
Creating sustainable cities suburbs and towns,
Meeting human needs while protecting the environment.

5. Resources of the Earth - Renewable & Non renewable (25 hrs)

Natural resources-Renewable and nonrenewable natural resources.
Depletion of natural resources and its effects.
Aquaculture. Economically important crustaceans, mussels, oysters, clams and sea weeds.(Brief)
Fishery resources of Kerala with special reference to fresh water ornamental species.
Marine products - Food value of fish, Fish meal, fish body oil,
Fish liver oil, Fish maw and other products.
Forest products -major and minor products of both plant and animal origin.
Economically important insects and their products-Honey, Lac and Silk.
Plantation crops, and their products and uses (Tea, coffee,

Rubber, Coconut, Cashew nut, Cardamom).
Mineral resources with special reference to India. Over exploitation and environmental problems citing case studies from India.
Water as a resource – Characteristics of water. Major water compartments. Hydrological cycle. Water management and conservation – Rain water harvesting technique, Surface and ground water resources of Kerala
Energy resources
Conventional energy sources (coal, Oil and natural gas and oil shale)
Non conventional energy sources -solar energy, wind energy, geothermal energy, hydropower, biomass, biogas, Tidal energy, Energy from waste, Hydrogen, and Nuclear energy. Energy crisis.

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THIRD SEMESTER THEORY ELECTIVE

COURSE - FISHERY SCIENCE - I

ZOL3E0903 -TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY (90 Hours)

Course outcomes (Cos)

CO1: The student will explore major families of fishes.
CO2: The student appreciate the functioning of different physiological systems of fish.
CO3: The student gain the basic knowledge on adaptive physiology of fishes.
CO4: The student gain conceptual knowledge on the brackish water ecology.
CO5: The student explore and appreciate varios aspects of limnologyand oceanography

1. Fish Taxonomy (10 hrs)

Fundamentals of fish taxonomy

Classification of fin fishes – mention the following families [referring to their orders] with common or economically important examples: Hemiscyllidae, Carcharhinidae, Sphyrnidae, Notopteridae, Anquillidae, Clupeidae, Chanidae, Cyprinidae, Bagridae, Siluridae, Claridae, Heteropnuestidae, Ariidae, Salmonidae, Harpodontidae, Hemiramphidae, Belonidae, Aplocheilidae, Poecilidae, Syngnathidae, Platycephalidae, Ambassidae, Carangidae, Teraponidae, Leiognathidae, Gerreidae, Nandidae, Cichlidae, Mugilidae, Trichiuridae, Channidae, Cyanoglossidae and Tetraodontidae.

2. Integument (7 hrs)

Exoskeleton

Skin and scales

Colouration

Chromatophores and pigments

Structure, function and modification of fins

3. Locomotion (5 hrs)

Body shape and musculature

4. Life history of fishes (5 hrs)

Reproduction, reproductive hormones, reproductive behaviour, oviparity, ovoviviparity

Age and growth

Migration

5. Digestive physiology (8 hrs)

Food and feeding

Feeding behaviour

Feeding mechanism

Digestive enzymes

Absorption

6. Circulatory physiology (6 hrs)

Heart

Blood, blood cells, blood pigments and functions of blood

Circulation

7. Respiratory physiology (6 hrs)

Gills and Accessory respiratory organs
Gas transport

8. Excretory and Osmoregulatory physiology (6 hrs)

Excretory organs
Osmoregulation in marine, brackish water and fresh water fishes

9. Endocrine physiology (6 hrs)

Endocrine glands – structure and function
Regulation of endocrine secretion
Crustacean neurosecretory system and its role in reproduction

10. Adaptive physiology (6 hrs)

Deep sea fishes
Cave dwelling fishes
Hill stream fishes

11. Oceanography (15 hrs)

Ecological subdivisions of the sea
Major topographic features of continental shelf, continental slope and ocean floor
Physico-chemical properties of sea water
Ocean currents
Ocean productivity
Coral reefs

12. Brackish water ecology (5 hrs)

Characteristics of brackish and estuarine waters
Estuarine productivity

13. Limnology

Classification of inland waters – ponds, lakes, rivers and reservoirs.
Physico-chemical properties of inland waters

References

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THIRD SEMESTER THEORY
ELECTIVE COURSE -HUMAN GENETICS -1
ZOL3E0904 - CLINICAL GENETICS (90Hours)

Course outcomes (COs)

CO 1: The student will understand the etiology, Prevalence & Frequency of Genetic diseases.
CO 2: Enumerate the applications of PCR and R.DNA technology, Human Biotechnology and Bioinformatics
CO 3: The student will explain the screening of genetic disorders and differential diagnosis
CO 4: Summarize the role of genetic testing, PBLC, banding and cytogenetic techniques
CO 5 : The student characterize the study of genetic diseases and its testing
CO 6: The student learn and appreciate monoclonal antibodies and their applications in various fields of biology

1. Cytogenetics (35 Hrs)

Cell cycle, chromosomal basis of inheritance- Mendelian and Non –Mendelian inheritance in humans- Dominant, recessive, lethal, sex linked, sex influenced, mitochondrial and multifactorial(12 hrs)

Cytogenetic techniques: Routine cytogenetic techniques of PBLC and preparation of stained slides and nomenclature, ISCN. , SCE, MN Banding techniques- C, G, Q, R, Acridine orange, NOR and DAPI (5 hrs)

Specialized techniques: HRB, fragile sites, PCC, Karyotyping, interpretation (3 hrs)

1.4. Chromosome abnormalities and clinical phenotypes. Abnormalities of Chromosome Number- polyploidy, aneuploidy. Factors causing aneuploidy, non-disjunction. Autosomal aneuploid syndromes- trisomy 21, trisomy 18, trisomy 13. Sex chromosome aneuploid syndromes- Turner, Klinefelter, Triple X, XYY. X - inactivation.

Abnormalities of Chromosome Structure: Duplication, deletion, translocation, reciprocal translocation, Robertsonian translocation, microdeletion and syndromes.

Uniparental disomy, Imprinting, ring chromosome, inversion, isochromosome, Chromosome instability syndromes. Spontaneous abortions(15hrs)

2. Medical Genetics (20 Hrs)

Hematological disorders- Hemoglobinopathies, disorders of stasis and

coagulation disorders (3 hrs)
Skeletal disorders: Achondroplasia, Osteogenesis imperfecta (3 hrs)
Neuromuscular disorders-Muscular dystrophies, spinal muscular dystrophy, myotonic dystrophy, neurofibromatosis, tuberous sclerosis, Parkinson‟s disorders, Huntington chorea(5 hrs)
Renal disorders- Renal cystic disorders, disorders of urinary tract, nephritic diseases (2 hrs)
Respiratory disorders-cystic fibrosis, asthma (2 hrs)
Endocrine disorders- thyroid, pancreas, pituitary, gonads (5 hrs)

3. Human Biotechnology (25 Hrs)

Introduction to Biotechnology. (1hr)
Recombinant DNA Technology, construction of chimeric DNA, Recombinant DNA technique for Human diseases, Isolation of cloned genes-copying mRNA to cDNA (5 hrs)
Applications of r-DNA technology, Nucleic acid sequence as diagnostic tool, metabolic engineering, and genetic changes for overproduction of biomolecules such as insulin, interferon and growth hormones(5 hrs)
PCR- types of PCR- RT-PCR, Fluorescent PCR (3hrs)
Primer designing and purification (1hr)
Somatic cell hybridization and monoclonal antibodies (4hrs)

Gene therapy in human-history, different types germ line, zygote and somatic cell gene therapy, SCID(2 hrs)
Signal transduction pathway(4 hrs)

4. Bioinformatics (10 Hrs)

Overview, databanks, techniques of alignment, role of bioinformatics in the analysis of genomic information, genomics, proteomics(5 hrs)
Biological databases - Nucleic acid – GenBank, EMBL, DDBJ. Protein – Swissprot, TreEMBL. Structural – PDB. Submitting sequences to databases – BankIt, SequIn, WebIn, and Sakura. Sequence retrieval by Entrez.(5hrs)

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5. Jack Pastor Nack: Human Molecular Gentics
6. Mahesh ,S. and Vedamurthy: Biotechnology
7. Read Andrew *et al:* New clinical Genetics
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THIRD SEMESTER THEORY ELECTIVE COURSE:
WILDLIFE BIOLOGY-I
ZOL3E0905 - BIODIVERSITY AND BIOTA (90 Hours)

Course outcomes (Cos)

CO1. The student will be familiar with various aspects of our biodiversity.
CO.2. The student will be able to define endemism and hotspots.
CO3. The student will describe the biodiversity of Western Ghats.
CO4. The student develop skills to identify various mammals and birds enlisted in the syllabus.
CO5. The student understand the procedure of studying the biology of birds and animals viz.., their taxonomy, morphology, population status, distribution, feeling &breeding, habits, threads and conservations etc.
CO6. The student gain conceptual knowledge about the various aspects of avian characteristics such as habitat preference, flocking, foraging, competition, courtship, parasitism etc.
CO7. The student uappreciate the importance of vocalization in the birds and their identification
CO8. The student understand peculiarities of birds migrations and able to explain the flyways.
CO9. The student describe the endangered and endemic Indian birds.
CO10.The student describe the economic importance of birds
CO11.The student identify and compare the charactaristics of the endangered and endemic fishes, amphibians and reptiles of Western Ghats.
CO12.Be familiar with the sociobiology of Lion, Elephant and Deer
CO13. The student will be able to describe the territoriality and its function
CO.14. The student explore the Gondwana principle and Satpura hypothesis

1. Introduction (6 hrs)

Biodiversity: Definition
Kinds of biodiversity
Biodiversity hot spots
Endemism
Western Ghats Biodiversity

2. Biology and Taxonomy of Mammals & Birds (60 hrs)

Biology and Taxonomy of the following animals with special emphasis on Western Ghats (Biology should include population status, distribution, feeding and breeding habits, major threats to their survival and conservational significance)

Mammals (30 hrs)

Order: Primates
Apes: Gibbon,
Monkeys: Macaques (Bonnet, Rhesus, Assamese and Lion tailed) Langurs (Common, Capped, Golden,

Nilgiri)Lemurs: Slender Loris and Slow Loris
Order: Carnivora
Cats: Tiger, Lion, Leopard, Fishing cat, Leopard cat, Jungle cat, Indian Wild Dog, Wolf, Jackal, Indian Fox
Otters: Common Otter, Smooth Indian Otter
Bears: Sloth bear, Brown bear, Himalayan black bear, Sun bear Panda: Giant panda, Red panda
Hyaena: Striped hyaena
Civets: Malabar civet, Small Indian civet, Common palm civet
Mongoose: Common mongoose, Small Indian mongoose, striped necked mongoose Order: Artiodactyla
Cervids: Chital, Sambar, Barking deer, Mouse deer.
Bovids: Indian Antelope, Four horned Antelope, Nilgiritahr, Indian bison. Suids: Indian Wild boar.
Order: Proboscidae : Indian Elephant
Order: Perisodactyla : One horned Rhinoceros.
Order: Pholidota : Indian Pangolin
Order: Lagomorpha : Hispid hare
Order: Insectivora : Tree shrew, Hedgehog
Order: Rodentia : Indian Giant squirrel, Grizzled giant squirrel, Porcupine, Flying squirrel, striped palm squirrel
Order: Chiroptera : Indian flying fox, short nosed fruit bat, Indian pipistrella
Order: Cetacea: Gangetic dolphin, Common dolphin, Sperm Whale.
Order: Sirenia: Sea cow

BIRDS (30 hrs)

Habitat preference
Flocking and aggregation.
Foraging behaviour,
Food competition and selection
Courtship and pair selection,
Brood parasitism and cooperative breeding.
Vocalisation and its Role in birds
Flyways and peculiarities of bird migration in the Indian Subcontinent
Avian classification and distribution with special reference to Indian species. Order: Columbiformes: Blue Rock pigeon, Spotted Dove.
Order: Podicipediformes: Little Grebe
Order: Pelecaniformes: Little and Large Cormorant, Darter
Order: Ciconiformes : Pond heron, Large egret, Little egret, Median egret, Grey heron,Purple heron
Order: Ansariformes: Bar headed goose, Lesser whistling teal
Order: Gruiformes: Indian Moorhen, Purple moorhen, White breasted waterhen
Order: Charadriformes: River tern, Red wattled Lapwing, Yellow wattled Lapwing, Black headed gull, Bronze winged jacana, Pheasant tailed jacana.
Order: Falconiformes: Hawks, Vultures.
Order: Cuculiformes: Indian cuckoo, Koel, Crow pheasant
Order: Coraciformes: White breasted kingfisher, Small blue kingfisher, Pied Kingfisher, Brown headed kingfisher, Chestnut headed Bea eater, Small green Bea eater, Hornbill
Order: Pisciformes: Lesser Golden backed woodpecker, Indian golden

backed woodpecker, Small green barbet

Order: Psittaciformes: Rose ringed parakeet, Blossom headed parakeet, Lorikeet Order: Strigiformes: Indian horned owl, Mottled wood owl, Barn owl

Order: Apodiformes: Palm swift

Order: Passeriformes: Black headed Oriole, Golden Oriole, Tree Pie, Drongo, Racket tailed Drongo, Red whiskered Bulbul, Red vented Bulbul, Black headed Babbler, White headed Babbler, Munia, Magpie Robin, Jungle Babbler, Purple Sunbird, Purple rumped sunbird, Indian Roller, Indian Robin, White cheeked Bulbul, Tickell‟s flower pecker, Thick billed flower pecker, Paradise flycatcher.

Globally endangered Indian birds and their classification (At least 20 species).

Endemic Indian birds and endemic bird areas.

Economic importance of birds- beneficial and harmful role.

3. Fishes, Amphibians & Reptiles (10 hrs)

FISHES -Endangered and Endemic fishes of Western Ghats (Brief account with threat to their survival).

AMPHIBIA -Amphibians endemic to Western Ghats (Brief account with threat to their survival)

REPTILES

Order: Crocodilia : Gharial, Estuarine crocodile, Marsh crocodile.

Order: Testudines : Logger headed sea turtle, Green Sea Turtle, Hawk‟s Bill Turtle, Olive Ridley Turtle, Leatherback Sea Turtle.((Brief account with threat to their survival)

Order: Squamata : Indian Monitor Lizards (Brief account only)

Endangered and endemic snakes of Western Ghats (Brief account only)

4. Sociobiology& Territoriality (10 hrs)

Sociobiology of Lion, Elephant and Deer

Territoriality and functions of territory.

5. Principles & Hypothesis (4 hrs)

Gondwana principle

Satpura Hypothesis

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13. Salim Ali and Ripley (1983): Handbook of birds of India and Pakistan (2nd Ed.) Oxford University Press.
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15. Singh, Samar (1987): Conserving India‟s Natural Heritage. Nataraj Pulblication.
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THIRD SEMESTER PRACTICALS

ZOL4L04 - IMMUNOLOGY

Course outcomes

CO 1 Students may gain a thorough knowledge regarding the immune components and production of antiserum in animals
CO 2 The student gain hands on training on various immunotechniques
CO3 Students are expected to demonstrate proficiency in Practical immunology in order to satisfactorily complete the course. In addition, the extent of a student's mastery of these objectives, will help guide the course evaluation and grade.Laboratory sessions throughout the Immunology course will help to integrate theory and practical skills meaning the students learn about all aspects of the field and develop strong transferable skills, both in and out of the lab.

1. Study of cells of immune system.
2. Histology of organs of immune system.
3. Bleeding of animals and preparation of serum.
4. Separation of lymphocytes.
5. Demonstration of agglutination reaction.
6. Immunoelectrophoresis.
7. Demonstration of ELISA technique.
8. Production of antibodies.
9. Preparation of antiserum.
10. Titration of antiserum.

References

1. Talwar, G.P. and Gupta, S.K.(2002). A hand book of practical and clinical immunobiology. 2nd ed. CBS Publishers, India.
2. Wilson.K. and Walker,J. (1995). Practical Biochemistry- Principles and Techniques. Cambridge University Press.

THIRD SEMESTER PRACTICALS

ZOL4L04- Developmental Biology & Endocrinology

Course outcomes

CO1: The student gain knowledge about the identification of different developmental stages of frog.
CO2: The student will identify common larval forms.
CO3: The student gain skills in the vital staining technique.
CO4: The student will be able to perform the whole mount preparation of different developmental stages of chick embryo.
CO5: The student will be trained to do the mounting of various larval forms.
CO6: The student learn the stages of insect development.
CO7: The student compare morphological and histological details of different types of placenta in mammals.
CO8. The student appreciate the effects of hormones in amphibian metamorphosis.

1. Induced ovulation in fish.
2. Identification of different developmental stages of frog - Egg, blastula, gastrula, neurula, tadpole external gill and internal gill stage.
3. Vital staining of chick embryo.
4. Preparation of temporary/permanent whole mounts of chick embryo of the following stages to study the extent of development of the circulatory and nervous system in detail in 20, 24, 33, 48 & 72 hours of incubation.
5. Tracing the development of stained parts. Candling, identification of blastoderm, window preparation - staining using stained agar strips and following the development.
6. Preparation of stained temporary/permanent mounts of larvae.
7. Experimental analysis of insect development - Drosophila.
8. Regeneration studies in frog tadpole tail.
9. Demonstration of sperm of rat/calotes/frog.
10. Morphological and histological studies of different types of placenta in mammals.
11. Hormones in Amphibian metamorphosis - Thyroxine/Iodine solution.
12. Culture of early chick embryo in vitro.
13. Study of invertebrate/vertebrate larval forms (minimum 7).
14. Observation of the mid-sagittal sections and cross sections of the chick embryo through head/ heart region of 24, 48 & 56 hours of incubation.

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1. Adamstone, E. B. and Waldo Shumway (1954). 3 Ed. A Laboratory Manual of Vertebrate Embryology. John Wiley & Sons, Inc.
2. Roberts Rugh (1961). Laboratory Manual of Vertebrate Embryology. Indian Ed., Allied Pacific Pvt. Ltd.
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4. Zarrow, M. X., Yochim, J. M., Mc Carthy, T. L. and Sanborn, R. C. (1964).
5. Experimental Endocrinology: A source book of basic Techniques. Academic Press, New

York.
6. Thomas, J. A. (1996). Endocrine methods. Academic press, New York.
7. Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.

THIRD SEMESTER PRACTICALS ELECTIVE

COURSE- ENTOMOLOGY -I

ZOL4L0501 - MORPHOLOGY & TAXONOMY

Course outcomes

CO1 . The student will develop skills in the procedures of collection, preservation, spreading,
and curation of insects for scientific studies.
CO7. The student explore the anatomy of insects through dissections.

1. Study of the sclerites of head and thorax of different Orders of insects: Grasshopper,
   Cockroach, Housefly, Honeybee.
2. Study of the different types of antennae- prepare permanent slides of at least 5 types of antennae (To be submitted during practical examination) .
3. Adaptive radiation of pterygote mouth parts (Adult & Larval)
4. Adaptive radiation of pterygote legs- prepare permanent slides of at least 5 types of legs.
5. Wings: their shape variation in the venation of pterygote wings.
6. Study of different types of genitalia.
7. Mounting of stinging apparatus – Honeybee
8. Morphological studies of different castes of social insects- Honeybee, Ants and Termites
9. Studies of (a) Honey bee and hives (b) Termitarium and termites.
10. Dissection of alimentary canal and associated glands- Oryctes grub, Iphita and Cricket
11. Dissection of reproductive system in insects- Iphita, Cockroach and grasshopper.
12. Dissection of nervous system- Oryctes grub, Iphita and Cricket.
13. Dissection of stomatogastric nervous system (oesophageal, sympathetic, single recurrent nerve and paired recurrent nerves in Cockroach.
14. Preparation of dichotomous keys of the following orders up to families. Each order should contain a minimum of 5 species: Orthoptera, Hemiptera, Hymenoptera, Lepidoptera and Coleoptera.

References

1. Borror, D.J. and Delong, D. H. (1964). An Introduction to the study of Insects. Holt Reineheart and Winston, New York.
2. Pedigo, L.P.(1996).Entomology and Pest Management Practice. Hall India Pvt. Ltd, New Delhi.
3. Mani. M.S. (1962). General Entomology. Oxford and IBH, New Delhi.
4. Nair, K.K., Ananthakrishnan, T.N. and David, B.V. (1976). General and applied Entomology. Tata Mc Graw Hill , New Delhi.

THIRD SEMESTER PRACTICALS ELECTIVE

COURSE: ENVIRONMENTAL BIOLOGY –I

ZOL4L0502 - AIR POLLUTION, RADIATION BIOLOGY AND HEAVY METALS

Course outcomes

CO 1 The student acquire practical knowledge regarding air samplers
CO2 The student gain knowledge regarding the analysis of pollutants in air and effluents

A. AIR POLLUTION

I. Air samplers – Simple, Handy and High volume air samplers.

II. Monitoring of the following pollutants in ambient and polluted air:

1. Dust fall
2. Suspended particulate matter
3. Sulphation rate using lead peroxide candle.
4. Sulphur dioxide
5. Nitrogen dioxide
6. Ammonia

III. Study on the effect of SO2 on vegetation

B. RADIATION BIOLOGY

1. Demonstration of UV induced lipid peroxidation in tissue homogenates
2. Effect of Vitamin E on UV induced lipid peroxidation

C. HEAVY METALS

I. Estimation of the following metals in effluent and sediment samples

2. Zinc- Zincon method
3. Chromium (Hexavalent) - Diphenylcarbazide method

References

1. Aery, N.C.-Manual of Environmental Analysis- Ane Books Pvt.Ltd
2. Greenberg *et al*-Methods for the examination of water and waste water-APHA publishers Washington D.C.
3. Indian standard methods for measurement of air pollution-ISI - New Delhi
4. Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi
5. Michael –Ecological methods for field and Lab investigations-Tata Mc Graw-Hill
6. Sawyer and Mc Carty-Chemistry for environmental engineering –Mc Graw Hill Publisher.

THIRD SEMESTER PRACTICALS ELECTIVE

COURSE - FISHERY SCIENCE - I

ZOL4L0503 - TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY

Course outcomes

CO1. The student will identify common and local fishes
CO2. The student attain skills in dissection of various organ systems of fishes
CO3. The student gain skills in the determination of haemoglobin, urea, amylase, lipase, proteases in fshes

1. Identification of common and local fishes
2. Dissection of accessory respiratory organs
3. Dissection of urinogenital system
4. Dissection of arterial system
5. Mounting of internal ear
6. Study of different types of scales
7. Determination of haemoglobin content in fish blood
8. Determination of amylase, protease and lipase activities in different parts of alimentary canal of fish
9. Determination of rate of ammonia and urea excretion in fishes.
10. Age determination of fishes using scales and otolith.

THIRD SEMESTER PRACTICAL ELECTIVE

COURSE -HUMAN GENETICS PAPER 1

ZOL4L0504 - CLINICAL GENETICS

Course ourcomes

CO 1 The student demonstrate PBLC culture studies
CO 2 The student evaluate the techniques of lymphocyteculture,banding techniques - G banding, C banding, NOR banding in disease diagnostics.
CO3 To demonstrate the hematological disorders by analyzing thebleeding time, clotting time, Prothrombin time.
CO 4 The student will explain the organ System and its importance.

1. Sterilization, medium preparation.
2. Peripheral blood lymphocyte culture.
3. Banding - G banding, C banding, NOR banding.
4. Karyotyping and reporting- Normal, Down, Edward, Klinefelter, Patau, Turner.
5. Experiments with Spectrophotometer- blood urea, serum creatinine, BUN.
6. Study of hematological disorders- Bleeding time, Clotting time, Prothrombin time.
7. Detections of HbF, HbA.
8. Study of organ system diseases by charts, photographs etc.- Thalassemia, Hemophilia, DMD, Neurofibromatosis, Huntington‟s chorea, Pituitary

dwarfism, Congenital adrenal hyperplasia.

THIRD SEMESTER PRACTICALS ELECTIVE

COURSE: WILDLIFE BIOLOGY-I

ZOL4L0505 - BIODIVERSITY AND BIODATA

1. Dissections.
   A) Arterial system of bird (Pigeon/quail/chicken)
   B) Flight muscles.
   C) Perching mechanism - pigeon
2. Examination and identification of poisonous and non poisonous snakes
3. Examination and identification of different types of feathers.
4. Examination and identification of horns and antlers.
5. Examination and identification of scales of reptiles, birds, and modified hairs of pangolin and porcupine.
6. Mapping distribution of bird fauna and identification of distinct biotic regions.
7 Scats / pellet analysis – significance (Population estimation).
8. Study of the dental formula of various mammals.
9. Study of mammal necropsy procedures
10. Spotters: Pug marks, teeth like lophodont, carnassial dentition, nest of birds, Hair of mammals, feathers, spines, nails, claws, horns, antlers, and other item related to wildlife biology.

FOURTH SEMESTER THEORY

ZOL4C10-BIOTECHNOLOGY&MICROBIOLOGY (90 hours)

Part - A. BIOTECHNOLOGY (54 Hrs)

Course Outcomes (COs)

CO1. The student learn the features of various types of cloning vectors
CO2. The student explore different steps involved in molecular cloning
CO3. The student will describe the techniques involved in the production of molecular probes, Genomic and CDNA library
CO4. The student evaluate and compare various types of PCR techniques
CO5. The student will analyze techniques involved in isolation, sequencing and synthesis of genes
CO6. The student explore and appreciate the applications of biotechnology in animal health care, agriculture and environmental protection.
CO7. The student get falimial with the biotechnological techniques involved in animal cell tissue culture, gene silencing and cloning.
CO8. The student ethical and social implications of biotechnology
CO9. The student understand taxonomy, structure, nutrition, growth of various microbes
CO10. The student analyze various types of microbial diseases and its control measures,
CO11. The student appreciates beneficial effects of microbes.

1. Introduction (1 hr)

Definition, branches, scope and importance

2. Vectors (5 hrs)

Cloning vectors –

Plasmids: pBR322 and pUC
Phages: λgt10 and M13 vector
Cosmids: general features
Phagemids: general features
Viruses: SV40 and CaMV

Transposones; Ac transposon and Ds transposon of Maize, P-element of *Drosophila*

Artificial chromosomes: BAC, YAC and MAC.

Shuttle vectors: applications and example

Expression vectors: mention commonly used promoters in expressionvectors (Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter of CaMV, Polyhedrin promoter from Baculovirus

3. Different steps involved in *in vivo* cloning (3hrs)

Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use of linkers)

Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization

Amplification – Multiplication, Expression, and integration of the DNA insert in host genome

4. Molecular probes (3 hrs)

Production
Labelling
Applications
FISH, McFISH and GISH

5. Genomic and cDNA library (4 hrs)

Construction

Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity.(Refer unit 4-Molecular Biotechnology by Glick and Pasternak-ASM press)

Blotting techniques- Southern blot, Northern blot, Western blot, Dot blot and Slot blot.

Chromosome walking

6. Polymerase Chain Reaction (3 hrs)

Basic PCR – raw materials and steps involved

Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and R Real Time PCR

Applications of PCR in Biotechnology and genetic engineering

7. Molecular markers: detection and applications (3 hrs)

RFLP
AFLP
RAPD
Minisatellites (VNTR)
Microsatellites (SSR)
SNPs

8. Isolation, sequencing and synthesis of genes (3 hrs)

Isolation (for specific proteins and tissue specific proteins)
DNA sequencing – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method.
Synthesis of gene-Chemical synthesis of tRNA gene, Synthesis of gene from mRNA, Gene synthesis machines

9. Transfection methods and transgenic animals (3 hrs)

Definition, Methods - Electroporation, DNA micro injection, Calcium phosphate precipitation, Dextran mediated transfer, shot gun method, virus mediated, lipofection method, engineered embryonic stem cell method
Transgenic animals for human welfare

10 . Biotechnology - Animal and human health care (4 hrs)

Vaccines
Disease diagnosis
Gene therapy
Transplantation of bone marrow, artificial skin,
Antenatal diagnosis
DNA finger printing
Forensic medicine

11 *In vitro* fertilization (3 hrs)

In vitro fertilization and embryo transfer in human
In vitro fertilization and embryo transfer in live stock

12 Animal cell and tissue culture (3 hrs)

Culture media – natural and artificial
Culture methods – primary explantation techniques, various methods of cell and tissue culture
Tissue and organ culture

13 Gene Silencing techniques (2 hrs)

Antisence RNA
RNAi
Gene knockouts and Knock out mouse

14 Cloning- (2 hrs)

Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) –
Advantages and disadvantages of cloning

15 Environmental biotechnology (3 hrs)

Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring.
Restoration of degraded lands - reforestation using micro propagation, development of stress tolerant plants

16 Agricultural Biotechnology (3 hrs)

Biofertilizers
Insect pest control (Pheromones, hormone mimics & analogues)
Biopesticides (Baculovirus, *Bacillus thuringiensis*, NPV)

17. Intellectual property rights (3 hr)

Intellectual property protection,
Patents, copy right, trade secrets, trademarks
GATT and TRIPS, patenting of biological materials,
International co-operation, obligation with patent applications,

implications of patenting- current issues

18. The ethical and social implications - (3 hrs)

Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants- Animals and ethics-

Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology

Social acceptance of biotechnology-Transgenic crops - Social acceptance of medical biotechnology- Acceptance of GM crops for food and pharmaceutical production, Social acceptance of Industrial biotechnology.

Part-B-MICROBIOLOGY (36 Hours)

1. Introduction- (1 hr)

History and scope of microbiology

Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.

2. Microbial Taxonomy and Phylogeny (3 hrs)

Major characteristics (classic and molecular)

Numerical taxonomy

Taxonomic ranks

Phylogenetic studies

Phenetic classification

Bergey's Manuel (mention major groups)

3. Bacterial cell structure and function (5 hrs)

Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid

Bacterial cell wall Peptidoglycan - structure-

Gram positive and gram negative cell wall- Mechanism of gram staining

Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility

4. Microbial nutrition (4 hrs)

Nutritional requirements,

Nutritional types (Auto, Hetero, Chemo, Phototrophs & Obligate parasites)

Culture media and types of media.

Mixed microbial population and pure cultures.

5. Microbial growth (4 hrs)

Growth curve -synchronous growth

Continuous culture

Influence of environmental factors on growth

Measurement of growth

Measurement of cell numbers- Petroff, Hassuer counting Chamber,

Spread plate and pour plate techniques

Measurement of cell mass-Turbidity and microbial mass measurement

6. Utilization of energy (3hrs)

Biosynthetic process-peptidoglycan synthesis, amino acid synthesis,

Non synthetic processes -Bacterial motility and transport of nutrients.(biochemical reactions not required).

7. Viruses (3 hrs)

General structural properties

Types: DNA viruses, RNA viruses, and enveloped viruses

8. Microbial diseases (4 hrs)

Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.

Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS

Fungal diseases- Candidiasis

9. Control of microorganisms (4 hrs)

Disinfectants; A - physical- Heat, filtration and radiation. B- Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.

Antibiotics- Penicillin, Cephalosporins, Chloramphenicol, Tetracyclines

Microbial drug resistance.

10. Microbial fermentation (2 hrs)

Lactic acid fermentation - Homolactic and heterolactic fermenters, Mention dairy products

-cheese and yogurt

Alcoholic fermentation.

11. Environmental microbiology (3 hrs)

Microbiological analysis of drinking water.

Microbial Bioremediation

Biogas plant.

References

Part- A- Biotechnology

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2. Bernard R. Glick and Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press Washington D.C.
3. Charles Hardin (2008): Cloning, Gene expression, and Protein purification-Experimental procedures and process rationale - Oxford University Press.
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Applications of Recombinant DNA.

Part B- Microbiology

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FOURTH SEMESTER ELECTIVE COURSE- ENTOMOLOGY-II

ZOL4E1101- ANATOMY AND PHYSIOLOGY (90 Hours)

Course outcomes

CO1. The student explore the physiological systems of insects.
CO2. The student gain ability to explain the anatomy of insects.
CO3. The student compare embryonic and post embryonic development of insects.
CO4. The student explore various methods of locomotion of insects.
CO 5. The student explore physiology and biochemistry of insects through different laboratory experiments.
CO 6 The student gain hands on experience on the preparation of taxonomic keys, enabling to identify and classify insects.
CO7. The student explore diversity of insects in their natural habitat by various field visits.

1. The Integument (6 hrs)

Histology-basic components
Chemical and physical properties
Moulting and sclerotisation
Hormonal control and function

2. Nutrition (5 hrs)

Nutritional requirement- water, minerals, vitamins, carbohydrates, proteins, fatty acids, sterols, nucleic acids, inorganic salts and micro-organisms.

Nutrition and growth, development, reproduction

3. Digestion and Assimilation (8 hrs)

Anatomy and histology of gut
Digestive enzymes – carbohydrases, proteases, lipases
Physiology of digestion
Digestion of wood, keratin, wax and silk
Extra intestinal digestion.
Role of microbiota in digestion

4. Circulatory system (8 hrs)

Cellular elements in haemolymph
Composition of haemolymph
Dorsal vessels, accessory pumping sinuses and diaphragm
Heart beat rate and control of heart beat
Course of circulation of haemolymph

5. Excretory system (6 hrs)

Malpighian tubules-anatomy & histology - Hemipteran, Coleopteran and Lepidopteran types
Physiology of excretion
Dietary problems - salt and water balance- control
Nitrogenous excretion-synthesis of uric acid, formation of excreta

6. Ventilatory system (6 hrs)

Structure of trachea, tracheole, air-sacs, spiracles
Types of ventilatory process - passive, active and bulk flow
Respiratory pigments
Cyclic release of carbondioxide and nervous control of ventilation
Ventilation in aquatic insects, endoparasitic insects and during moulting

7. Nervous system (14 hrs)

Anatomy and histology of brain, ganglia and nerves
Reception and transmission of stimuli, production and control of nerve impulses and transmission.
Sense organs - anatomy, histology and physiology of mechanoreceptors - tactile senses, proprioceptors, sound perception, chemoreceptors, photoreceptors, thermoreceptors and hygroreceptors
Sound production and light production.

8. Muscular system (8 hrs)

Histomorphology of muscles, skeletal muscles, visceral muscles
Neuromuscular junctions
Excitation of muscle fibres, activation of muscle fibres, role of fast and slow axons
Muscle development and maintenance

9. Endocrine and exocrine glands (8 hrs)

Histomorphology of neurosecretory cells and endocrine glands (corpora cardiaca, corpora allata and Prothoracic glands)
Hormones and their functions
Mechanism of hormone action
Pheromones and their function

10. Reproductive system and morphogenesis (9 hrs)

Development of primordial germ cells
Reproductive system- structure-male and female
Fertilization and oviposition
Formation of blastoderm and extraembryonic membranes
Sex determination and parthenogenesis

11. Embryogenesis (6 hrs)

Differentiation of germ layers
Segmentation, appendage formation, organogenesis
Polyembryony, paedogenesis, viviparity, oviparity, eclosion,
Postembryonic development-hatching, larval development and control, polyphenism, diapause.

12. Locomotion (6 hrs)

Terrestrial and aquatic, basic stricture of a leg
Maintenance of stance and patterns of movements
Patterns of aquatic movements
Structure of wings, modifications, mechanism of wing movement
Aerodynamics and control of wing beat.

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FOURTH SEMESTER ELECTIVE COURSE -ENVIRONMENTAL BIOLOGY-II

ZOL4E1102 - ENVIRONMENTAL POLLUTION (90 Hrs)

Course outcomes (COs)

CO1. Acquire in depth knowledge about the common pollutants in our environment and their interactions with ecosystem components
CO2. Perform qualitative and quantitative analysis of various primary and secondary pollutants in the environment
CO3. Gain insight on the multi-dimensional impact produced by various pollutants on health, environment and materials of the ecosystem.
CO4. Apply appropriate abatement techniques for various air, water and terrestrial pollutants present in the ecosystem
CO5. Comprehend the rules and regulations implemented by various governmental institutions

1: AIR POLLUTION (35 hrs)

Primary air pollutants: occurrence, sources and sinks of the following pollutants: (a) compounds of carbon, (b) compounds of sulphur, (c) compounds of nitrogen, (d) gaseous halogens, (e) ozone, (f) mercury, (g) particulate matter

Sampling of air using sampling train and orifice flow meter

Method of sampling and monitoring of the following gaseous air pollutants (Two methods for each pollutant)

(a) Oxides of Carbon, Hydrocarbons

(b) SO2, H2S, Mercaptans

(c) Oxides of Nitrogen, Ammonia

(d) Ozone

Sampling sizing of Particulate matter. Sample collection - settlement, filtration, particle count, evaluation by optical microscopy, particle size analysis - projected diameter and statistical diameter (Ferete's diameter and Martin's diameter).

Interaction of air pollutants in the atmosphere. Secondary pollutants: photochemical smog, acid rain, and green house effect,

Effect of air pollution:

(a) On materials, buildings, metals etc.

(b) On vegetation

(c)On weather and atmospheric conditions

(d) On human health- a brief survey of major air pollution episodes.

Air pollution- abatement technology, basic principles of design and working of: (e) Bag filters (b) Inertial collection- cyclones (c) Electrostatic precipitators (d) Scrubbers (e) Adsorption (f) Device for controlling automobile emissions

Noise pollution-sources, effects and abatement.

2: WATER POLLUTION (40 hrs)

Organic pollution: (a) Origin and sources of organic pollutants,

biodegradable and non- biodegradable- Domestic, Agricultural and Industrial sources.

(b) Biochemical oxygen demand (BOD) - Kinetics of BOD tests- rate constant and its importance- Method of estimation

(c) Chemical Oxygen Demand (COD) - Importance and method of estimation

(d) Effects of organic pollution on aquatic systems, saprobicity system and indicator species. Importance in pollution assessment.

Eutrophication- natural and cultural sources and effects.

Biocides: Classification and types of Biocides- Fungicides, Pyrethroids and pesticides. Effects of Biocides, Biological magnification, Toxic effects on non target organisms- hazards to man.

Heavy metals sources and effects of the following in the ecosystem and human population

(a) Mercury - Inorganic and organic mercury compounds - Bioconversion of inorganic and organic mercury

(b) Cadmium - itai - itai disease

(c) Lead - Plumbism

(d) Lesser metals - copper, zinc, selenium, chromium, molybdenum, beryllium and thallium.

Thermal pollution-sources, effects- cooling towers as control measures.

Oil spills-sources effects and control.

Hazards of Radioactive materials in the environment Biological effects of ionizing, radiations, nuclear waste disposal.

Carcinogens in the environment

(a) Polycyclic aromatic hydrocarbons (b) Nitrosamines (c) Inorganic carcinogens-Asbestos, Metal dust (d)Carcinogens in food: Artificial sweeteners, disodium benzoate and other additives.

Water pollution abatement technology:

(a) Primary, secondary and tertiary treatment systems (b) Principles of design and operation of (1)screens (2) Grit chambers (3) Sedimentation tanks (4) Oxidation ponds and (5) algal pond.

Design and operation of biological treatment systems:

(1) Aerated lagoons (2) Activated sludge process (3) Trickling filters (4) sludge digest.

Sewage and sewage treatment: composition, bacteriology of sewage treatment, stabilisation- properties of sewage, categories of sewage, use of effluents in irrigation

3. TERRESTRIAL POLLUTION (15 hrs)

Solid waste- garbage, rubbish, ashes, debris, street litter, agricultural waste, mining waste, industrial waste, e-waste etc.

Problems of solid waste disposal, consequences of solid pollution- Love canal episode as an example.

Solid waste disposal methods: Sanitary land fill, plasma gasification, deep well injection, incineration, recycling biogas

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FOURTH SEMESTER ELECTIVE COURSE- FISHERY SCIENCE- II

ZOL4E1103 - CAPTURE AND CULTURE FISHERIES (90 Hours)

Course outcomes (COs)

CO1: The student explore on the capture fishery from different water resources in India including marine, estuarine and freshwater systems.
CO2: The student compare different types of aquaculture practices in India and abroad.
CO3: The student evaluate the pond design, pond construction, water quality management, feed and transportation requirements in aquaculture.
CO4: The student develop knowledge about the basic reproductive biology of fishes and induced breeding practices in aquaculture.
CO5: The student gain skills in the preparation and maintenance of aquarium.
CO6: The student analyze the major diseases encountered in aquaculture.
CO7: The student gain an idea to control of weeds, pests and predators in aquaculture.
CO8: The student learn and appreciate integrated fish farming.
CO4: The student study the identification of larval stages of shrimps, prawns and fishes.
CO5: The student study the gut content analysis in fishes.
CO6: The student get an idea to identify ecto and endoparasitesof fishes.

1. Introduction to Capture and Culture fisheries (10 hrs)

Marine fisheries - Crustaceans, Molluscans and fin fishes
Shrimps, Crabs and Lobsters Mussels, Oysters and Cephalopods, Sardine, Mackerel, Bombay duck, Pomfretes, Ribbon fishes and Tuna

2. Freshwater fisheries (5 hrs)

Major river systems and fisheries
Lakes and reservoir fishery

3. Estuarine fisheries (5 hrs)

Major estuaries and fisheries

4. Aquaculture (5 hrs)

History of aquaculture, scope and definition, importance of aquaculture, present state of aquaculture, future prospectus
Classification of aquaculture practices

5. Design and construction of aqua farms and hatcheries (5 hrs)

Pond design and construction
Farm design and layout
Pond preparation
Cage farms
Pens and enclosures
Design and construction of hatcheries

6. Transportation and acclimatization (3 hrs)

7. Nutrition and feeds (3 hrs)

Feeding habits and food utilization
Live feeds
Artificial feeds

8. Water quality management (3 hrs)

Water quality parameters
Techniques for monitoring
Strategies for monitoring

9. Fertilizers and chemicals in aquaculture (2 hrs)

10. Reproduction and genetic selection (10 hrs)

Reproductive cycles
Control of reproduction
Induced breeding
Use of hormone analogues
Cryo-preservation of gametes
Sex reversal
Genetic selection and hybridization

11. Control of weeds, pests and predators in aquaculture (2 hrs)

12. Aquaculture practices (25 hrs)

Integrated fish farming - paddy cum fish culture, duck cum fish culture, pig cum fish culture
Polyculture
Culture of shrimps
Culture of prawns
Culture of crabs
Culture of edible oysters, pearl oysters and mussels
Culture of sea weeds
Culture of fresh water fishes - Indian major carps and exotic carps
Culture of cold water fishes - trout and mahaseer

Culture of brackish water fishes - mullets, milk fish and *Etroplus*

13. Preparation and maintenance of aquarium (5 hrs)

Types of aquaria
Preparation and maintenance
Equipments
Water chemistry
Aquarium fishes and plants

14. Pathology (7 hrs)

Major fish diseases - viral, bacterial, fungal
Protozoan infections
Control and treatment.

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FOURTH SEMESTER ELECTIVE COURSE-HUMAN GENETICS

-II ZOL4E1104- DIAGNOSTIC GENETICS (90 Hours)

Course outcomes (COs)

CO 1 : The student explain human birth defects
CO 2: The student will analyze the importance of Multifactorial inheritance in
genetic disorders and life style diseases.
CO 3: The student will evaluate the treatment of genetic disorders
CO 4: The student will analyze reproductive genetics & techniques like ART, IVF, IUI and PGD
CO 5: The student will learn and appreciate prenatal diagnostics & current studies
CO 6: The student learn and acquire knowledge about DNA fingerprinting, FISH, Linkage analysis Gene sequencing studies.

1. Biochemical Genetics (25 hrs)

Inborn errors of metabolism -Definition and mode of inheritance
Disorders of carbohydrate metabolism- Galactosemia, essential fructosuria, fructose intolerance, glycogen storage disorders Mucopolysaccharides
Diseases of amino acid metabolism- Phenylketonuria, tyrosinosis, alkaptonuria, albinism, maple syrup urine disease, homocystinuria and histidinuria
Disorders of lipid metabolism- Tay Sach's disease, Goucher's disease
Disorders of nucleic acid metabolism- Primary gout, Leish nyhan syndrome
Mineral metabolism disorders- Wilson disease, Menkes disease
Disorders of porphyrins - inherited porphyrias
Peroxisomal disorders - Zellweger syndrome, X linked adrenoleucodystrophy

2. Developmental Genetics (25 hrs)

Human embryo development- Cleavage, 2 cells, 4 cells, 8 cells, 16 cells, 32 cells, Morula,Blastula, Gastrula, Organogenesis
Gonadial differentiation
Placental types, implantation,developmental features of human foetus- first lunar month to tenth lunar month First, second and third trimester
Formation of extra embryonic tissue
Study of human birth defects-Syndromology, Dysmorphology, Neural tube defect, Anencephaly, Meningocele, Spina bifida, Herlequin icthyosis

3. Reproductive Genetics (5 hrs)

Spermatogenesis, oogenesis
Computer Assisted Semen Analysis (CASA).
Assisted Reproductive Techniques (ART) IUI, IVF, ICSI, ZIFT, GIFT
Pre-implantation Genetic Diagnosis (PGD)

4. Molecular Diagnosis (15 hrs)

DNA fingerprinting.
Linkage analysis - RFLP, blotting techniques (southern, northern and western)
Gene sequencing Probes- Preparation and classification, in-situ hybridization, FISH, mFISH, fiber FISH, application of FISH.
CGH, SKY, Micro array, Microchips, Comet assay

5. Prenatal Diagnosis. (20 hrs)

Historical perspective
Non-invasive techniques- Ultrasonography, foetal MRI
Invasive techniques- Amniocentesis, chorionic villus sampling sampling, foetal skin sampling,
Chromosome analysis, metabolic disorders, DNA Analysis
Current knowledge of prenataly diagnosed genetic disorders, haemoglobinopathies, coagulation disorders.
Treatment of genetic disorders

References

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FOURTH SEMESTER ELECTIVE COURSE: WILDLIFE BIOLOGY- II

ZOL4E1105 - WILDLIFE CONSERVATION (90 Hours)

Course objectives (Cos)

CO1. The student get a holistic view of Wildlife conservation in India
CO2. The student explore the scope and history of wildlife
CO3. The student identify various types of wildlife habitats such as forest, grasslands, mangroves and sacred grooves.
CO3. The student analyze the importance of *in-situ* and *ex-situ* conservation methods
CO4. The student value different tribal groups in Kerala and their roles in forest management and eco-development projects
CO5. The student compare protected areas in Kerala, India and Worldwide
CO6. The student clearly evaluate the laws and regulations related to wildlifein India
CO7. The student acquire knowledge regarding the features of Red data book
CO8. The student will able describe various conservation schemes in India for wildlife such as project Tiger, Project elephant.
CO7. The student will appreciate the efforts taken by Government and voluntary organizations for wildlife protection
CO8. The student appreciate ecological principles of conservation and ecotourism in India.

1. Conservation - Scope and History (8 hrs)

History of conservation in India- Status of wildlife in India (Past and Present)
Values of Wildlife - conservation values & ethics
Causes of depletion of Wildlife resources - habitat loss, construction of dams, collection for trophies, hunting, poisoning, poaching and other developmental activities.
Why conserve? The ecological, genetic, economic and Philosophic reasoning.
Man and Wildlife conflict - crop depredation, cattle lifting, human encounters
case studies in Kerala (Brief account only), control and management.

2. Wildlife Habitat (14 hrs)

Forest types - classification by Champion & Seth, mention major plant species of Indian forests.
(a) deforestation - reasons for deforestation- shifting cultivation, illicit felling and encroachment, grazing and lopping, forest fire, industrial development, mining, plant diseases, insect pest, human settlements.
(b). Afforestation & Reforestation.
Grasslands, Mangroves and Sacred groves (Mention conservation and management)
Forestry (Social, Production, Plantation and Protection)
Hydel projects and their impacts (mention habitat fragmentation, loss of forest corridors & isolation of Wildlife population), case studies in Kerala.
In Situ and Ex situ conservation (Gene banking, conservation and exchange)
National River Conservation Programme (NRCP)

3. Tribals and Wildlife (4 hrs)

Tribal groups in Kerala
Role of tribals in Wildlife conservation - Joint Forest Management
Ecodevelopment Projects

4. Exotic and pet animals (4 hrs)

Introduction of Exotic animals (Flora and Fauna) in India: Principles and problems
Illegal Wildlife Trade and Pet Trade in India- Major trade centres, routes and related issues.

5. Protected Areas (18 hrs)

National parks and Sanctuaries: Important National Parks and Sanctuaries in India with special importance to Kerala - characteristics features, importance, declaration, formation, management, protection and administration.
Marine Sanctuaries and National Parks of India: Gulf of Mannar,
Gulf of Kutch & Andaman.
Important Bird Sanctuaries of India: Bharatpur, Ranganathittoo,Thatekkad and Vedan Thangal.

Man and Biosphere reserves (MAB) in India - concept, importance, ecological features and management (Brief Account). Nilgiri biosphere reserve (NBR) and Agastyavanam Biosphere reserve. Mention other biosphere reserves in India.

6. Wildlife - Laws and Regulation (5 hrs)

Wildlife administration and legislation: administrative set up (central and state level), statutory bodies,
Wildlife Protection Act -1972 with its latest amendments.
Indian Forest act (Brief Account only).

7. Red Data Book (3 hrs)

Red data book on animals.
IUCN criteria and definition regarding extinct (EX), extinct in the wild (EW), critically endangered (CD), low risk (LR), data deficient (DD) & not evaluated animals (NE). The problems in the application of criteria in the wild.

8. Government and Voluntary Organizations (10 hrs)

Role of Government and voluntary organization in wildlife conservation (IBWL, IUCN, ICF, WWF, BNHS, WPS, MNHS, TRAFFIC, CITES, NBA etc.)
Environmental Education and UN conferences on Environmental Issues
Resource depletion and Sustainable development
Earth Summit and World summit

9. Conservation Schemes (15 hrs)

Project Tiger
Project Hangul
Crocodile breeding project

Gir Lion Project
Project Sangai
Project Elephant
Sea turtle project
Snow Leopard Project.

10. Ecological Principles of Conservation (5 hrs)

Concept of minimum viable area
Minimum viable population
Compression hypothesis
Stable limit cycle
Fragmentation and isolation of habitats - role of corridors
Environmental and demographic stochasticity
Effective population size.
Genetic isolation (Island Biogeography theory) and genetic viability

11. Ecotourism (4 hrs)

Tourism and Wildlife - Importance of Tourism in Wildlife conservation - tourism requirements, visitor impact, visitor management - control and safety rules.

Ecotourism, role of ecotourism in sustainable development.

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FOURTH SEMESTER THEORY ELECTIVE

COURSE-ENTOMOLOGY-III

ZOL4E1201- AGRICULTURAL, MEDICAL & FORENSICENTOMOLOGY

(90 Hours)

Course outcomes (COs)

CO1. The student explore insect pests and types of damage done by insects to plants , pest surveillance and forecasting of pest outbreak.
CO2. The student identify and evaluate insect pests attacking agricultural crops, their biology,
damage , and control measures.
CO3. The student will appreciate Concepts of Economic levels.
CO4. The student explore insect vectors of human diseases and their control.
CO5. The student learn about the principles of insects pest management including
ecological based pest management and chemical control.
CO6. The student gain skills in various equipments for insecticide application.
CO7. The student evaluate the use of insecticides and its impact on wild life and human health
and insecticide resistance.

1: Insect Pests (10 Hrs)

Types of damage to plants by insects (Injury by chewing insects, piercing and sucking insects, internal feeders, subterranean insects, to stored products and indirect effect of feeding)

Classification of insect pests (Regular pests, Occasional pests, Seasonal pests, persistant pests, sporadic pests, major pests, minor pests, potential pests, key pests)

Causes for insect assuming pest status

Concepts of Economic levels, Economic injury levels, Economic threshold level

Pest surveillance and forecasting pest outbreak

Estimation of damage caused by insects to crops

2: Insect pests of crops (20 Hrs)

Identification, life history, damage and control of major pests of:

Paddy (17 major pests including stem borers, army worm, rice thrips, gall midge, mealy bug, BPH, green & white leaf hoppers, rice caseworm, rice leaf roller, rice hispa, rice earhead bug, root weevil, rice grass hoppers)

Sugarcane (Major pests including shoot, internode & top borers, white grub, leaf hopper, sugarcane scale, mealy bug, whiteflies, Termites, Black winged bug)

Cotton (Major pests - Aphid, leaf hopper, thrips, whitefly, Pink spotted and American boll worms, stem weevil, Red and Dusky cotton bugs, leaf roller)

Coconut (7 pests - Rhinoceros beetle, red palm weevil, black-headed caterpillar, white grub, Scale insect, Lace wing bug, coconut skipper)

Pulses (8 pests - Gram pod borer, plume moth, red gram pod fly, pod borer, spotted pod borer, Blue butterflies, bean aphid, white fly)

Common vegetables

Brinjal (shoot & fruit borer, stem borer, spotted leaf beetle, grey weevil, Pumbkin beetle)

Tomato (serpentine leaf miner, fruit borer)

Gourds (fruiflies, snake gourd semilooprer, spotted beetle, Pumbkin beetle)

Bhendi (Earias, leaf hopper, Red cotton bug, Grampod borer)

Cruciferous vegetables (diamond black moth, cabbage borer, leaf webber, Cabbage green semilooper ,Cabbage aphid)

Fruit trees

Mango (hopper, flower webber, Leaf webber, gall midges, Nut weevil, stem borer, red tree ant)

Cashew (tree borers, Hairy caterpillar, Tea mosquito bug, Apoderus, Leaf miner)

Banana (rhizome weevil, banana aphid, spittle bug)

Citrus (Fruit sucking moth, citrus butterfly)

Spices

Pepper (pollu beetle, shoot borer, Marginal gall thrips)

Cardamom (cardamom thrips, rhizome borer, cardamom whitefly, hairy caterpillars, *Eupterote* and *Pericallia*)

Turmeric and Ginger (Leaf roller, shoot borer)

Identification, nature of damage & control of Insect pests of Stored Products: rice weevil, sweet potato weevil, leser grain borer, tobacco beetle, drug store beetle, pulse beetle, Angoumois grain moth, potato tuber moth, Red flour beetle, rice moth)

3: Principles of Insect pest management (15 Hrs)

Ecology based pest management

Prophylactic methods

Curative or direct methods

Cultural methods

Mechanical methods

Physical methods

Legal methods

Biological control

History of biological control, Ecological basis of biological control.

Natural enemies (Parasites, Parasitoids, Predators), Feasibility of biocontrol.

Applied biological control (Conservation and Enhancement, Importation and Colonization, Mass culture and release).

Importance of systematics, Advantages and disadvantages of biological control.

Important biocontrol projects undertaken in India by employing parasites and predators.

Autocidal control- Sterile male technique and other methods, Chemosterilants, Methods of sterilization, Application, Dynamics, Advantages and disadvantages. Examples of autocidal control.

Insect growth regulators (IGRs) – Brief note on Insect growth hormones and mimics (**J**H mimic & ecdysone agonists) and chitin synthesis inhibitors as insect control agents,

Behavioural (pheromonal) control- (Brief note on Trail, Alarm, Aggregation and sex pheromones and the behaiour produced, Mode of application, Pest management with pheromones, Advantages and disadvantages, Examples).

Insect attractants: definition, types of attractants, applications in insect pest mangement, examples, advantages and disadvantages.

Insect repellents: definition, desirable features of good repellent, types of repellents, applications in insect pest management, examples, advantages and disadvantages.

Insect antifeedants: definition, examples, applications in insect pest management, advantages and disadvantages

Microbial control of crop pests by employing Bacteria, Virus and Fungi Classification of entomophagus Bacteria, Virus, Fungi, Mode of action, formulation, Application, Examples

Integrated Pest Management- Definition, IPM in Agroecosystem, Kinds of pest, (Key pests, Occassional pests, Potential pests, Migrant pests) Establishing the need to take action, Guidelines for developing IPM, Tactics in IPM, IPM of Rice

Unit 4: Chemical Control (20 Hrs)

Insecticide formulation (Brief note on Emulsifiable concentrates, Watermiscible liquids, Wettable powders, Water soluble powders, Oil solutions, Flowable powders, Aerosoles, Granulars, Fumigants, Ultra-low volume concentrates, Fogging concentrates, Dusts, Poison bates and Slow release insecticides)

Classification of insecticides.

Based on mode of entry.

Based on mode of action.

Based on chemical nature

Chemistry, toxicology & mode of action of following class of insecticides; mention examples for each class.

Synthetic Organic compounds.

Organochlorine insecticides.

DDT.

BHC.

Cyclodiene group (special reference to endosulfan; examples: heptachlor, aldrin).

Organophosphorous insecticides (examples: TEPP, Dichloros, monocrotophos, parathion).

Carbamates (special mention of carbofuran; examples: Carbaryl, aprocarb)

Inorganic compounds as insecticides - arsenic compounds, fluorides, sulphur compounds

Fumigants – definition, examples, methods of fumigation, hazards of fumigation,advantages and precautions

Botanical insecticides- chemical properties, mode of action and toxicity of the following: Nicotine, Rotenone, Pyrethrum and Neem

Synthetic pyrethroids – definition, uses as insecticides, mode of action (examples: Pyrethrin, allethrin)

Insecticide synergists – definition, types of synergism, mode of action &

examples

5. Insecticides and Environment (10 hrs)

Insecticide resistance -Genetic, Physiological and biochemical mechanism
Pesticides and the environment- its impact on wildlife and human health
Microbial and environmental degradation of pesticides

6. Medical entomology (10 hrs)

Insect vectors of human diseases and their biology: (Malaria, Lymhatic filariasis, Dengue, Chikungunya, Zika, Yellow fever, West Nile virus, River Blindness, African sleeping sickness, American sleeping sickness, Kala Azar, Plague, Typhus): Mosquitoes (*Anopheles*, *Aedes*, *Culex*, *Mansonia*); Sand fly, Flea, Assassin bug, Black fly, Tse Tse fly, Head louse.
Mosquito control- Larval and adult control-Chemical, Biological and environmental.
Insects related to Myasis
Poisonous insects: Bees, wasps and ants- Anaphylaxis.
Maggot therapy (Use of maggots in treatment.

7. Forensic Entomology (5 hrs)

Introduction to Forensic entomology
Insects used in forensic entomology (Dipterans and coleopterans)
Succession of insect fauna on a cadaver.
Methods of forensic entomology: Detection of time of death, mode of death and place of death. Case histories (at least 3).
Forensic entomology in India.

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FOURTH SEMESTER THEORY

ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III

ZOL4E1202 - ENVIRONMENTAL CONSERVATION (90 Hours)

Course Outcome (COs)

CO1. The student gain knowledge on the important approaches and practices in biodiversity conservation and management.
CO2. The student evaluate ecological, evolutionary, economical importance of various biodiversity components
CO3. Develop skills in planning management of bioresources
CO4. The student develops appreciation of the major conservation strategies &programmes implemented by national and international agencies and their role in biodiversity conservation
CO5. The student will be able to dentify and categorise organisms based on the degree of threat and under the need for their conservation
CO6. Acquire insight towards and environmental friendly and sutainable life

1. Habitat Conservation (25 hrs)

Forest Ecology
Major vegetation types - dry and moist deciduous, semi evergreen, evergreen, and montane evergreen forests
Tropical rain forests; geography, climate; precipitation; features of plants-leaves, root, bark.
Shola forests (Cloud forests) ; global distribution; fog precipitation; cloud stripping; water shed function; fauna; vegetation.
Montane shola grass land matrix Mangroves
Deforestation and its consequences
Need for scientific management and conservation of forests
Social forestry and agro forestry
Habitat destruction, Fragmentation and Degradation, causes and consequences
Wetlands and waterfowl conservation
Ramsar convention aims and objectives, Ramsar sites in Kerala
Coastal zone management
Special features of CRZ
Coastal Zone Management plan and its objectives
Categorization of the Coastal Zone; „Setback line": Coastal Zone Management
Indicative list of ecologically sensitive areas (ESA)
Coral reefs: list of major coral reefs; conservation problems
Ocean acidification; Ocean Warming and Coral Bleaching;
Coral tourism; water pollution; sedimentation; coral mining;

2. Biodiversity conservation (20 hrs)

The richness of biodiversity

The importance of biodiversity (Direct and indirect values)
Reasons for high species diversity in the tropics.
Biodiversity of India
The threatened biodiversity with special reference to critically endangered vertebrates from India.
Loss of biological diversity and Causes of extinction.
Endemism
Keystone species and Keystone resources–
Exotic species introductions, invasive species, disease and over exploitations
Global hotspots - hotspots in India,- Western ghats and Sreelanka, Indo Burma, and Eastern Himalayas.
Biological control and Integrated Pest Management.
Organic farming and its importance

3. Strategies of conservation (20 hrs)

Concept of minimum viable area and minimum viable population
National Parks, aims and objectives -Briefly mention the important national parks in India with special reference to Kerala (Eravikulam, Silent valley, Mathikettan chola, Anamudi chola and Pambadum chola National parks from Kerala)
Sanctuaries-Major sanctuaries in India and mention the sanctuaries in Kerala.
Biosphere Reserves –Their aims and objectives, briefly mention them-with special reference to Kerala
Conservation strategies at the global level-Role of World conservation union, CITES, WWF and other international conventions and protocols
IUCN categories of threatened animals and red data book.
Wildlife management in India; Role of Government and non governmental agencies. Briefly mention wildlife protection act 1972 and its amendments and schedules
Endangered species -strategies of conservation with special reference to India - Project Tiger, Project Elephant, Project hangul, Operation Rhino. Crocodile breeding project, Project Sangai, Gir lion project, Himalayan Musk deer project.
Ex situ conservation -Zoo, Aquarium, Seed bank, Gene bank, Pollen bank etc.
In situ conservation.- National parks, sanctuaries, Biosphere reserves, community reserves and other protected areas.
Traditional Ecological Knowledge (TEK)-
Introduction and need for its conservation
Economic benefits
Social implications-sacred groves, sacred landscape, sacred species
TEK and sustainable development.

4. Environmental Impact (25 Hrs)

Aims and uses of preparing Environmental Impact Statement (EIS)
Aims and objectives of Environmental Impact Assessment (EIA),
Environmental management systems-ISO-14000 standards
Cost benefit analysis of environmental protection incorporating, environmental costs and benefits of designing projects.

Development and displacement of rural communities, ethical and socio - economic problems, Disappearing culture and traditions, Impact on environment. Urban environment and new problems.

Ecotourism - Importance of Ecotourism, visitor impact, visitor management, control and safety rules – threats to local culture, ecolodges. Economic & Ecological effects of ecotourism

Restoration of ecology and degraded rural landscape- Illustrate with case studies from India.

Environmental protection movements – Global, national, and local, historical, present social pressure group agencies like Green and Chipco movement, Narmada Bachao

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FOURTH SEMESTER THEORY ELECTIVE

COURSE - FISHERY SCIENCE – III

ZOL4E1203 - HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING (90 hrs)

Course outcomes (COs)

CO 1	The student will gain knowledge about commercial fishing methods.
CO 2	The student compare different crafts and gears of fish harvesting.
CO 3	Appreciate chemical composition and nutritional value of fishes.
CO 4	The student will gain knowledge regarding the post mortem changes associated with fish muscle and various types of spoilage mechanisms.
CO 5	Gain handling skills in harvested fish and different methods/techniques of fish preservation.
CO 6	The student will learn about the processing of fishes, shrimps, cephalopods and lobsters.
CO 7	The student will appreciate the various uses of fish by products.
CO 8	Will explore the opportunities in national and international marketing of fish.

PART- I. HARVESTING

1. Commercial fishing method (1 hr)

Brief history of commercial fishing
Introduction to materials for construction of nets and ropes

2. Crafts and gears for harvesting (21 hrs)

Towed or dragged gear
Bottom trawling
Beam trawl
Otter trawl
Side trawling
Stern trawling
Bottom pair trawling
Mid water (pelagic) trawling
Targeted and selective trawling
Turtle excluder device (TED)
Dredging
Encircling gear
Beach seining
Purse seining
Seine nesting
Static gear
Gill nets
Trap nets
Long lines
Pots and traps
Other gears
Squid jigging

Net fishing
Harpooning
Fish aggregating devices (FAD)
Echo-sounder and sonar
Catch per unit effort and economic consideration of vessel operations.
Onboard handling and processing

Part-II- POST HARVEST TECHNOLOGY

3. Chemical composition of fish (2 hrs)

Chemical composition of fish muscle
Significance of proteins and lipids
Nutritive value of fish muscle over red meat

4. Post-mortem changes in fish muscle (4 hrs)

Pre-rigor mortis and post mortem changes
Physical and biochemical changes associated with the post mortem changes
Importance of post mortem changes in fish processing
Problems associated with post mortem changes and solutions

5. Fish spoilage mechanisms (4 hrs)

Microbial spoilage
Enzymatic spoilage
Biochemical spoilage

6. Handling of fresh fish (3 hrs)

Icing and icing methods
Different types of ice - block ice, flake ice and dry ice
Handling - on board chilling and use of refrigerated sea water (RSW)
Fish landing platforms
Hygienic handling of fish on board and on shore

7. Methods (Techniques) of processing/preservation and their products (10 hrs)

Drying
Salting
Smoking
Freezing - plate freezers, blast freezers and individual quick freezing (IQF)
Battered and breaded products
Accelerated freeze drying (AFD)
Immersion freezing and cryogenic freezing
Canning
Irradiation
Assessment of capacity of plate, blast and IQF freezers

8. Processing of shrimps (3 hrs)

Commercially important prawns and shrimps of India
Pre-processing of prawns and shrimps into different varieties - peeled and devined (PD), peeled and undevined (PUD), head-less shrimps (HI), head on shrimps (HON)

Grades of shrimps
Cooked shrimps
IQF shrimp

9. Processing of lobsters (3 hrs)

Commercially important lobsters of India
Pre and processing lobsters into different varieties of products
Grades of packing

10. Processing of cephalopods (3 hrs)

Commercially important cephalopods (squids and cuttlefish) of India
Pre-processing of cephalopods into different varieties
Grades of packing

11. Processing of fish (4 hrs)

Commercially important fishes of India
Fish filleting
Surimi
IWP products, grades for fish products

12. Fishery by-products (9 hrs)

Body oil, liver oil and sauces
Shark fins, fin rays, fish maws/isinglass
Fish silage, chitin and chitosan
Fermented fishery products

13. Fish processing plant and cold storage (2 hr)

The pre-processing and processing plant, cold storage – general conditions relating to premises ,building, equipment, general conditions of hygienic of plant and workers, conditions of storage of frozen products Requirements for registration with MPEDA, approval of processing plant by FIA allotment code

14. Quality control (7 hrs)

Fundamental aspects of quality
Major quality problems in sea foods
Quality of water and ice-chlorination and use of UV rays
Microbiology
Microbial hazards of sea foods - *E. coli*, *Salmonella*, *V. cholerae*, *Staphylococcus*
Inspection systems
Brief introduction to the quality control concepts of HACCP, ISO and IQM (total quality management)

15. Packing and export of seafood (4 hrs)

Methods of packing of various sea food products for export
Identification marks
In house stuffing and transport in refrigerated containers

16. Fishery education, research, development and export promotion agencies (3 hrs)

Objectives and activities of the following institutions (very brief)

– CIFT, CMFRI, CIRNET, NIO, FSI, CIBA, FIA, MPEDA
Objectives of fishery extension
Qualities for fishery extension workers
Organizations of extension programs

Part- III- FISHERY MANAGEMENT AND INTERNATIONAL MARKETING

17. Fishery management (2 hrs)

Marketing of fish in India
Fisherman and fisherman co-operatives

18. International marketing (4 hrs)

Scope and importance.
Major sea food products and markets of India.
Documents required for export - letter of credit, invoice, bill of landing etc.
Buyers and buyers agents
Trade promotion
Role of trade promotion offices and embassies
Seafood trade fairs
Trade promotion visits
Value added products and its marketing.

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FOURTH SEMESTER THEORY

ELECTIVE COURSE - HUMAN GENETICS -III

ZOL4E1204 - CANCER GENETICS AND GENETIC SERVICES (90 Hrs)

Course outcomes (COs)

CO 1: The evaluate the malformations, neural tube defects, maternal age effects, infertility problems and genetics of cancer
CO 2: The student define cancer cell characteristics, modes of cancer, types and cell signaling in cancer
CO 3: The student develop ideas and regulation of Cancer and cell transformations
CO 4: The student evaluate tumor progression, angiogenesis and metastasis
CO 5: The student develop career in genetics and provide awareness to society and research
CO 6: The student introduce cancer and environmental influence
CO 7: The student evaluate treatment methods and its efficacy
CO 8 : The student define the role of a genetic councilor.

1. Cancer Genetics (30 hrs)

Genetic basis of cancer: Neoplasms, Tumorogenesis, Apoptosis(2 hrs)
Classification, diagnosis, prognosis, treatment
Leukemia- ALL,CLL, AML,CML, Philadelphia chromosome, bcr-abl gene fusion, PML- RARA gene fusion(4 hrs)
Solid tumours: Breast cancer, prostate cancer, retinoblastoma, osteosarcoma, Two hit hypothesis(5 hrs)
Reticulo-endothelial system: lymphomas- Burkitt, Non- Hodgkin lymphoma, Multiple myeloma(3 hrs)
Oncogene families: Cancer causing genes,Tumor suppresser genes, Protooncogene, DNA repair gene. Mechanism of oncogene expression, over expression of oncogenes, cellular oncogene producers.(8 hrs)
Telomeres and Telomerases- Introduction and function of telomeres and telomerases, steps involved, DNA repair and damage. Regulation of telomere length, genetic disorders and telomeres (Progeria, Ataxia Telangiectia)(3 hrs)
Genomic instability and cancer.Mutation rates in normal and neoplastic cells, mutation and genomic instability, common DNA damaging agents (environmental, chemical, physical, biological).Chemotherapy and

mechanism of anticancer drugs.(5 hrs)

2. Genetic Counseling (15 hrs)

Definition, Indication for genetic counseling, Steps in genetic counseling (5 hrs)

Premarital genetic counseling(3 hrs)

Psychological aspects of genetic counseling, Special considerations in genetic counseling(4 hrs)

Pre-natal counseling and Population screening(3 hrs)

3. Genetic engineering (10 hrs)

Introduction- Molecular tools of genetic engineering(1 hr)

Vectors- methods of gene transfer(2 hrs)

Gene cloning strategies- DNA amplification, Gene libraries, site `directed mutagenesis, and protein engineering- manipulation of gene expression in host .(4 hrs)

Basic techniques in genetic engineerin (2 hrs)

Agarose gel electrophoresis, Counter clamped homogenous electric field electrophoresis (CHEF), PAGE, SDS – PAGE(1 hr)

4. Gene Mapping and cloning (5 hrs)

Physical mapping, gene mapping, linkage analysis, recombination frequencies, LOD score, linkage equilibrium, linkage disequilibrium(2 hrs)

Human Genome Project: Objectives, achievements and applications

Positional cloning, Sequence tagged sites, Genomic library.(2 hrs)

Chromosome walking, chromosome jumping(1 hr)

5. Ethics (10 hrs)

Medical ethics in India and Abroad(2 hrs)

Organ banks, human cloning, genetic registries(2 hrs)

IVF ethics(3 hrs)

PND act, MTP act(2 hrs)

ELSI of new genetics(1 hr)

6 Immunogenetics (5 hrs)

MaMjor Histocompatibility Complexes - General organization of MHC and disease association.(1 hr)

Blood group system- Genetics of ABO and Rh factor, Rh incompatibility (1 hr)

Immune system in health and diseases-Immune response to infectious disease, Primary and secondary deficiencies, autoimmunity, SCID, Wiskott Aldrich syndrome, Agamaglobulinemia(3 hrs)

7. Radiation Genetics (5 hrs)

Biological effect of radiation, dosimetry 2hrs

Radiation sensitizers, radio protectors and other factors. Radiation protection – radiation safety, maximum permissible doses. Clinical applications of radiation biology – in therapeutic radiology, diagnostic radiology and nuclear medicine.(3 hrs)

8. Population Genetics (10 hrs)

Twin studies (1 hr)

Dermatoglyphics- qualitative and quantitative parameters. Dermatoglyphics in medical disorders(2 hrs)

Epidemiology- descriptive and analytical methods(3 hrs)

Hardy Weinberg equilibrium- Properties of equilibrium populations

Selection favouring and against heterozygotes(2 hrs)

Non random mating in human populations- consequences of inbreeding,Genetic load (2 hrs)

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9. Kilbey *et al*.(1984). Handbook of Mutagenicity test procedures. Elsevier , Amsterdam.
10. Venitt, S and Parry, J.M. (1984). Mutagenicity testing- A practical approach, IRL Press.
11. Umadevi. P, Nagarathnam. A and Satish Rao. B.S.(2000). Introduction to radiation biology. Churchill Livingstone, Pvt. Ltd., New Delhi.
12. Tubiana. M, Dutereix. J, and Wambersie. A .(1990). Introduction to Radiobiology. Taylor & Francis, London, NY.
13. Obe. G and Natarajan. A.T. (1994). Chromosomal Alterations – Origin and significance, springer – verlag, Berlin, Heidelberg.
14. A.E.H. Emery and D.L. Rimoin: Principles and Practice of Medial Genetics, Vol. III, Churchill Livingston,
15. Kowles Richard: Solving Problems in Genetics
16. Banerlee Pranab Kumar: Problems in Genetics, Mol. Genetics and evolutionary Genetics
17. Xion Jin: Essential Bioinformatics
18. Harper Joyee C: PreimplantationGeneticDiagnosis.
19. Harper Peter S: Practical Genetic Counseling

FOURTH SEMESTER THEORY ELECTIVE

COURSE: WILDLIFE BIOLOGY – III

ZOL4E1205- WILDLIFE MANAGEMENT (90 Hours)

Course outcomes

CO1. The student will describe various concepts, principles, policies and laws related with wildlife management
CO2. The student get a holistic view of habitat and able to understand how HEP, HIS and EIA are used in habitat management.
CO3. The student relate herbivory, frugivory and carnivory with selection and patterns of habitat utilization in wild animals.
CO4. The student be familiar with various aspects of fire, pollution and environmental sanitation with wildlife management
CO5. The student get an in-depth knowledge about vegetation profile.
CO6. The student be familiar with various types of population estimation, capturing and marking techniques used by wildlife management authorities.
CO7. The student learn about the age and sex determination techniques in birds and animals.
CO8. The student get knowledge about the modern methods of wildlife study
CO9. The student compare the methods of food habit analysis of wild animals
CO10.The student will learn to develop a holistic approach on the various aspects of prey predator management in wildlife management
CO11. The student gain knowledge in wetland and zoo management
CO12. To be familiar with various wild animal diseases and their management

1. Wildlife Management (5 hrs)

Concepts and Principles
Policies and laws in wildlife management

2. Habitat and management (18 hrs)

Components of habitat (Physical and Biological), Mention different types of habitats.
Habitat Evaluation Procedures (HEP).
Habitat Suitability Index (HSI)
Environmental Impact Assessment (EIA).
Concept of herbivory, frugivory and carnivory (predation).
Food selection and patterns of habitat utilization.
Forest and fire: Impacts of fire on vegetation succession, effects of fire on soil, forest development and wildlife, Fire prevention, fire detected system, fire control and suppression procedures in India and developed nations.
Impacts of pollution on forest and wildlife, Environmental sanitation.
Vegetation profile: Techniques for estimation of plant abundance, frequency, dominance and importance value index, Preparation of vegetation profile, various techniques for assessment of vegetation cover

3. Wildlife population estimation (12 hrs)

Direct Count: - Total count, Drive count, Time area counts and transect Count- Indirect Count: - Call count, Track count and Pellet count/dungcount

Abundance estimation techniques for mammals, birds, reptiles and amphibians.

Capturing and Marking Techniques: - Live trapping of birds and Mammals, Chemical immobilization, methods of marking captured birds and mammals, Peterson or Lincoln Index method.

Determination of Age and sex in animals and birds

4. Modern Methods of Wildlife study (15 hrs)

Wildlife photography: Still and Videography, recording of calls, study of animal evidences.

Remote sensing, GIS, Radar in wildlife research.

Radio telemetry: Importance, scope and methodology

Genetics in wildlife management- Pedigree analysis and karyotyping techniques

5. Food habit analysis (8 hrs)

Sampling method: Direct and indirect methods, qualitative and quantitative methods

Kinds of study materials, preservation and analytical procedures.

6. Prey predator management (5 hrs)

Foraging behaviour, optimal foraging theory, group foraging, depredation, forage poisoning

7. Wetland Management (10 hrs)

Study of Waterfowl, waterfowl management, Habitat manipulation, food production, water development and cover improvement.

Management of Indian Cranes. Endangered and Non-endangered crane, crane conservation, migration, impact of pollution on wetland birds. Conventions related to Wetland management.

Ramsar sites in India, Conventions on wetlands

Pheasants and Pheasant management- Pheasants of Himachal Pradesh, Pheasantry.

8. Zoo management (10 hrs)

Basic consideration for designing a modern zoo,

Functions of a modern zoo,

Zoo layout and exhibition of animals,

Zoo services

Zoo sanitation

Captive breeding,

Safari parks

Moonlit zoo

9. Healthcare and disease management (7 hrs)

Disease monitoring and control, surveillance of disease.
Viral, bacterial, ricketsial, mycoplasmal, and protozoan disease.
Nutritional deficiency disease, worm infestation and related disease, Zoonosis.

References

1. Aaron, N.M. (1973): Wildlife ecology. W.H. Freeman Co. San Francisco, USA.
2. Abbassi and Ramaswami (1999): Biotechnological methods of pollution.
3. Barret, E.C and Anton Micallef (1991): Remote Sensing for Hazard Monitoring and Disaster Assessment, Taylor and Francis, London.
4. Canter, L.W. and Graw, M.C.(1996). Environmental Impact Assessment, Hill publication, New York.
5. Chang Kang, Tsung. (2002): Introduction to Geographic information system.Tata McGraw-Hill Publishing Company Limited. New Delhi
6. Choudary, Suahant and Malik, Pradeep. A guide to chemical Restraint of WildAnimals. Nataraj Publishers, Dehradun
7. Dasman R.F. (1964): Wildlife biology, John Wiley and Sons, New York.
8. Giles R.H. Jr. (Ed) (1984): Wildlife management techniques-3rd Edition, the wildlife society, Washington D.C.
9. Gopal, Rajesh (1992): Fundamentals of Wildlife Management, Justice Home,Allahabad, India.
10. Hosetti, B.B. (1997): Concepts in Wildlife Management, Daya Publishing House, Delhi.
11. Lilleand, T.M, and Kieffer, R.W. Remote Sensing and image Interpretation. John Wiley and Sons.
12. Negi, S.S. (1993): Biodiversity and its conservation in India. Indus Publishing Co., New Delhi.
13. Negi, S.S. (2007). Manual for Wildlife Management in India.
14. Robert, G.H. (1978): Wildlife management. W.H. Freeman and Co., San Francisco, USA.
15. Robinson W.L and Eric G. Bolen (1984): Wildlife ecology and management. Mac Millen Publishing Co. New York.
16. Rodgers W.A (1991): Techniques for wildlife census in India.
17. Sabbins, F.E., Freeman.(1959). Remote sensing: Principles and Applications.
18. Saharia V.B. (1982): Wildlife of India
19. Samar Singh .(1986).Natural heritage
20. Sanayal, Ram Bramha (1995): A Handbook of the Management of Animals in Captivity.
21. Schaller (1978): The deer and Tiger.
22. Sharma B.K. and Kaur, H. (1996): Environmental chemistry. Goel Publishing House, Meerut.
23. Sharma, B.D. (1999): Indian wildlife resources: Ecology and development. Daya publishing House, Delhi.
24. Singh, S.K (2005): Textbook of Wildlife Management. IBDC.Lucknow
25. Singh, Samar (1987): Conserving India‟s Natural Heritage. Nataraj Pulblication.
26. Teague R.D. (Ed), (1980): A manual of wildlife ecology
27. Conservation, The wildlife society Washington D.C.
28. Tikkader (1994): Threatened animals of India.
29. WII.(1983). A Guide to chemical restraints of wild animals.Technical report II.

FOURTH SEMESTER PRACTICALS
ZOL4L04 -BIOTECHNOLOGY

Course outcomes

CO1 The student secure hands own training to isolate plasmid DNA and RNA from bacteria and other tissues
CO2 The student know how to separate DNA /RNA by electrophoresis
CO3 The student acquire practical knowledge to work with PCR machiene in order to amplify DNA and experience on cell immobilization

1. Isolation of plasmid DNA.
2. Isolation of total RNA from tissues
3. Separation of DNA by electrophoresis.
4. Bacterial transformation.
5. PCR
6. Cell immobilization.

ZOL4L04 - MICROBIOLOGY

Course outcomes

CO1. The student gather hands own experience in isolation, staining and counting of bacteria
CO2. The student gain better knowledge regarding various sterilization tecgniques and bacterial culture

1. Selective isolation and enumeration of bacteria.
2. Bacterial staining technique
    a. Simple staining of bacteria.
    b. Negative staining
    c. Hanging drop technique.
    d. Gram staining.
    e. Endospore staining.
3. Turbidity test for contamination of milk.
4. Preparation of media and sterilization.eg: Nutrient agar, mac conkey agar,
5. Cultivation of yeast and molds
6. Bacteriological analysis of water e.g., fecal pollutants.
7. Antibiotic sensitivity test.
8. Maintenance of *E. coli* culture (shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.

ZOL4L04 - MICROTECHNIQUE AND HISTOCHEMISTRY

Course Outcomes

CO 1 The student attian skills in Tissue fixation and staining
CO 2 Student will demonstrate the differential staining

1. Preparation of stained and unstained whole –mounts.
2. Identification of the various tissues of animals in serial sections prepared using nuclear and cytoplasmic stains.
3. Processing a few types of tissues for the histochemical staining-Staining of serial sections to show the presence of
    a) Carbohydrates by PAS method
    b) Proteins by Mercuric bromophenol blue method
    c) Fats by Sudan Black B method
    d) DNA by Feulgen Technique.

Submission:

Stained/unstained Whole mounts – 4 numbers
Double stained serial histology slides- 4 numbers
Histochemical slides - 2 numbers

References

1. Ausubel, F.M., Brebt R, Kingston, R.E., Moore, D. D., Seidman, J. G., Smith, J.A. and Struht, K. (2002): Short protocols in Molecular Biology. John Wiley & Sons, Inc.
2. Sambrook, J. & Russel, D.W.(2001): Molecular cloning: A laboratory Manual. CSHL Press, NY
3. Kannan, N.(2003). Lab Manual in General Microbiology. Panima Publishing Company,India.
4. Cappuccino,J.G. and Sherman,N. (2007). Microbiology-A laboratory Manual Benjamin- Cummings Publishing Company.USA.

FOURTH SEMESTER PRACTICALS

ELECTIVE COURSE- ENTOMOLOGY II

ZOL4L0501 - ANATOMY AND PHYSIOLOGY

Course outcomes

1. The will be trained on the physiology and biochemistry of insects through different laboratory experiments.
2. The student gain hands on experience on the preparation of taxonomic keys, enabling to identify and classify insects.
3. The student will appreciate the diversity of insects in their natural habitat by various field visits.

classes to be conducted during third semester)

1. Haemocytes: Staining and Identification of haemolymph in various insects using Giemsa/Wrights/ BPB stain.
2. Estimation of total haemolymph proteins.
3. Dye Transport: Estimation of Dyes such as Indigo, carmine or neutral red transported by Malpighian Tubules.
4. Identification of at least 3 amino acids in haemolymph by paper chromatography.
5. Estimation of digestive carbohydrates in the alimentary canal of insect.
6. Survey of digestive enzymes- Amylases, invertases, proteases and lipases in Cockroach/Dragon flies.
7. Estimation of glucose content in the insect haemolymph from different orders.
8. Preparation of key for the identification insects.

FIELD WORK REPORT-

Field study shall be conducted to observe the insects in their natural environment. A detailed field report shall be submitted by each student which includes the observation of insects in their natural habitat like forest, scrub jungle, grass lands, water bodies, sandy areas, litter, and so on with the procedure adopted. (Students are expected to be familiar with the procedure of insect collection, preservation, spreading and curation using using freely available insects). The field report with the dated signature of the teacher concerned and duly certified shall be submitted at the time of practical examination along with the practical record. No marks shall be awarded for the record without field report.

(Students need not submit collections)

ELECTIVE COURSE- ENTOMOLOGY III
ZOL4L0601 - AGRICULTURAL, MEDICAL AND FORENSIC ENTOMOLOGY

Course outcomes

CO8. The student will explore the insect pests attacking various agricultural crops by field observation identification and collection.
CO9. The student will evaluate the insects pests of man and domestic animals through field visits.
CO10. The student gain experience of techniques for laboratory rearing of Insect pests and understanding of their life histories
CO11. The student gain skills on laboratory rearing of parasitoids, and predators by visit to their breeding stations.
CO12. The student will compare various insecticide appliances and their application in the field.
CO13. The student will be exposed to industrial entomology by visit to bee keeping stations and sericulture institutes
CO14. The student will explore the toxicological studies on insects by visit to toxicological labs

1. Field observation, identification and collection of insect pest of paddy, coconut, sugarcane, cotton, pulses, vegetables, fruit trees spices and forest trees.
2. Field observation, identification and collection of insect pest of Man and domestic animals
3. Field observation, identification and collection of insect damages to crops
4. Study of life histories of insect pests
5. Laboratory rearing of insect pests (any two)
6. Observation of laboratory rearing of Parasitoids and Predators
7. Identification of insecticide appliances
8. Field study of insecticide application
9. Field study to observe and collect insect pollinators, parasitoids and predators, scavengers and weed killers
10. Estimation of LD 50 values for some insect pests

Field report- Each student shall submit a field report consisting of the areas visited like paddy fields, coconut groves, sugarcane fields, cotton fields, fields of pulses and vegetables, fruits, parasitoids and predator breeding stations, beekeeping stations, sericulture institutes, Toxicology laboratories etc.

(The field report with the dated signature of the teacher concerned and duly certified shall be submitted at the time of practical examination along with practical record. No marks shall be awarded for the record without field report).

References

1. Atwal, A.S. (1988).Agricultural pests of India and South East Asia. Kalyani Publishers, New Delhi.
2. Kottle, D.S,(1995). Medical and Veterinary Entomology. CAB International.
3. Mike Service.(2008).Medical Entomology for students. 4thed. Cmambridge University Press, U K .
4. Thacker, J.R.M.(2002). An Introduction to Arthropod Pest control. Cambridge

University Press.
5. Tonapi, G.T.(1994).Experimental Entomology. An aid to Field and lLaboratory.
6. Trigunayat,M.M.(2002).A Manual of practical Entomology. Scientific Publishings. Jodhpur.

FOURTH SEMESTER PRACTICALS

ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-II

ZOL4L0502: WATER POLLUTION

Course Outcomes

CO1. Students will attain skills in the determination of various parametres such as dissolved solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammonia nitrogen, nitrite nitrogen and sulphate in waste water samples.

(Practical classes to be conducted during Fourth semester)

Waste water characterization - determination of the following parameters in waste water samples

1. Turbidity - Nephlo meter or Secchi disc method
2. Odour
3. Dissolved solids - gravimetric method
4. Suspended methods - gravimetric method
5. Dissolved oxygen (modified Winkler method)
6. Biochemical oxygen demand - Dilution method
7. Chemical oxygen demand - Dichromate digestion
8. Ammonia nitrogen - Indophenol blue method
9. Nitrite nitrogen - Azo dye method
10. Nitrate nitrogen -Phenol disulphonic acid method
11. Sulphate
12. Inorganic phosphates - APHA method
13. Hardness EDTA titration Method
14. Residual chlorine
15. Species diversity indices and indicator species
16. Primary production
    a) Light and dark bottle method b) b) Chlorophyll method.

ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III

ZOL4L0602 - SOIL AND SEDIMENT ANALYSIS

Course Outcomes

CO1	The student develop skill for Soil and Sediment Analysis
CO2	The student gain indeapth knowledge regarding environmental pathogens and their bioassays

A. Soil and Sediment Analysis

1. Collection and Preservation
2. Redox potential.
3. Alkalinity
4. PH
5. Exchangeable calcium and magnesium
6. Sodium and potassium
7. Available phosphorous.
8. Ammonia Nitrogen
9. Chlorides
10. Organic Matter –Walkley Black Method
11. Sulphates

B. Environmental Microbiology

12. Standard plate count of soil and water samples
13. MPN of total coliforms
14. MPN of fecal coliforms

C. Bioassay Studies and Insecticides

15. Fish/Daphnia bioassay test to find out the toxicity of heavy metals/pesticides
16. Calculation of LC50 or TLm
17. Determination of the concentration of the following insecticides in water: a) DDT b) Methyl parathion
18. Inhibition of acetylcholine esterase by organophosphates/ carbamate insecticides (demonstration only)

References

1. Aery, A.C.-Manual of Environmental Analysis- Ane Books Pvt. Ltd
2. Greenberg,*et.al.*Methods for the examination of water and waste water-APHA publishers Washington D.C.
3. Indian standard methods for measurement of air pollution-ISI – New Delhi
4. Indian standard method of sampling and test for industrial effluents Part III-ISI New Delhi
5. Michael –Ecological methods for field and Lab investigations-Tata Mc Graw- Hill
6. Sawyer and Mc Carty-Chemistry for environmental engineering –Mc Graw Hill Publishers
7. Trivedi and Goel-Practical methods in Ecology and Environmental Sciences- Environmental publications Kara.

FOURTH SEMESTER PRACTICALS
ELECTIVE COURSE - FISHERY SCIENCE- II
ZOL4L0503 CAPTURE AND CULTURE FISHERIES

Course Outcomes

CO1: The student learn the maintenance of fresh water aquarium.
CO2: The student study the water and soil parameters to set up an aquarium.
CO3: The student get an idea about the identification of culturable species of shrimps, prawns and fishes.
CO4: The student lern to identify larval stages of shrimps, prawns and fishes.
CO5: To study the gut content analysis in fishes.
CO6: To get an idea to identify ecto and endoparasites of fishes.

1. Demonstration of induced breeding in fishes
2. Estimation of fecundity
3. Identification and study of ecto and endoparasites in fishes
4. Study of gut content analysis in fishes
5. Study and maintenance of fresh water aquarium
6. Determination of water and soil p^H
7. Studies of texture of soil
8. Test for H_2S
9. Test for alkalinity
10. Test for salinity
11. Determination of water transparency
12. Determination of Ammonia, Nitrogen, Phosphorous and free Calcium carbonate
13. Identification of culturable species of shrimps, prawns and fishes
14. Identification of larval stages of shrimps, prawns and fishes

ELECTIVE COURSE - FISHERY SCIENCE- III
ZOL4L0603 - HARVESTING POST HARVESTING TECHNOLOGY AND MARKETING

Course Outcomes

CO 1 The student learn the identification of fishing crafts and gears.
CO 2 The student know the processing of commercially important fin fishes and shell fishes.
CO 3 The student identify different fishery byproducts.
CO 4 The student lern the laboratory technique to detect pathogenic bacteria of public health importance.
CO 5 The student learn the scoring key to identify different stages of fish spoilage.
CO 6 The students learn various physic-chemical parameters of fish muscle.
CO 7 The student learn canning and refrigeration fish and fish by products.

1. Identification of fishing craft, gears and gear material from models, drawings and photographs
2. Study of processing of commercially important fin fishes and shell fishes.
3. Identification of different fishery byproducts
4. Identification of different mechanisms used in fish processing.
5. Staining of bacteria
6. Preparation of culture media
7. Study of bacterial culture
8. Laboratory technique to detect pathogenic bacteria of public health, significance of *E. coli*, *Salmonella*, and *Staphylococcus*
9. Preparation of scoring key to identify different stages of fish spoilage
10. Estimation of ash and water content of fish muscle
11. Estimation of total amino acid in fish muscle
12. Estimation of trimethyl amine
13. Extraction of liver and body oil
14. Study of canning and refrigeration

Study Tour

A study tour not less than ten days duration (Need not be at a stretch) to fishery research institutes such as CIFT, CMFRI, CIFNET, IFP, etc, fish hatcheries, fish landing centers, boat building yards, aqua-farms etc. The field reports with dated signature of the teacher concerned and duly certified should be submitted at the time of examination.

ELECTIVE COURSE - HUMAN GENETICS – II
ZOL4L0504 DIAGNOSTIC GENETICS

Course Outcomes

CO 1:	To demonstrate clinical tests for inborn errors of Metabolism
CO 2:	To analyze biochemical estimations; Serum cholesterol, TG, HDL etc..
CO 3:	To demonstrate developmental features of human foetus
CO 4:	To Characterize birth defects and its effect.

(Practical classes to be conducted during third semester)

1. Clinical tests for inborn errors of metabolism
2. Urine spot test for Mucopolysaccharides

Urine spot test for Cystinuria and Homocystinuria

3. Lysosomal Enzyme assays (Arylsulfatase A and B)
4. Estimation of serum cholesterol, proteins, triglycerides, lipids
5. Stages of human development-

   (Demonstration with video of with slides, models or charts, vists to labs Cleavage, 2 cells, 4 cells, 8 cells,16 cells, 32 cells,

   Morula, Blstula, Gatrula, Organogenesis
6. Developmental features of human fetus- first lunar month to tenth lunar month
7. Human birth defects-Spina bifida, Meningocele, neural tube defect
8. ART- IVF, ICSI, GIFT, ZIFT, Semen analysis
9. PGD- FISH, PCR based analysis
10. Amniocentesis, CVS - demo by video

References:

1. Devlin, T.M. (1994): Text book of Biochemistry with clinical correlations (3rd edn.).
2. Emery, A.E.H. and Rimoin, D.L. (1983): Principles and Practice of Medial Genetics, Vol. II, Churchill Livingston, Chap.99.
3. Weatherall, D.J. and Clegg. (1981): The Thalassaemia Syndromes (Ed.3).

ELECTIVE COURSE - HUMAN GENETICS – III
ZOL4L0604 - CANCER GENETICS AND GENETIC SERVICES
Course outcomes

CO 1: The student will evaluate Blood grouping and cross matching
CO 2: The student learn the preparation and identification techniques of human DNA analysis
CO 3: The students lern about dermatoglyphics and its role in genetical studies
CO 4: The student will identify pros and cones of genetic counseling
CO 5: The student will summarize gene frequency and its role in inheritance
CO 6: The student demonstrate technique awareness & its role in Molecular studies.

1. Problems in genetic counseling
2. Agarose gel electrophoresis
3. Preparation of human genomic DNA
4. Blood grouping and cross matching
5. Experiments with PCR
6. Estimation of CA/MN on cells
7. SCE, Micro Nucleus Assay
8. Study of Ph1 chromosome, FISH in genetics, bcr-abl gene fusion, PMLRARA fusion
9. Qualitative and quantitative analysis of Ig,. ELISA, Western blotting.
10. Experiments with ELISA Reader- FSH, LH, T3,T4,TSH, Testosterone
11. Study of radiation induced chromosomal aberrations
12. Study of dermatoglyphic features
13. Calculation of gene frequencies of dominant and recessive autosomal alleles.

ELECTIVE COURSE - WILDLIFE BIOLOGY-II
ZOL4L0505 WILD LIFE CONSERVATION
Course outcomes

CO1. The student attain skills in taxidermic procedures
CO2. The student attain skills in the identification of parasites in brds and mammals
CO3. The student identify endangered animals
CO4. The student attain skills in the identification of calls of local birds

1. Taxidermic procedures – Skinning, curing of a common bird (Pigeon / Quail).
2. Pterylography and comparison (Pigeon/ Quail)
3. Study of ecto and endo parasites of locally available bird and mammal
4. Hair sample analysis.
5. Identification of Fresh water fishes, Reptiles, Endangered amphibians, birds and mammals. Good quality photographs may be used for the purpose
6. Identification and interpretation of calls of local birds (from recorded cassettes).
7. Recording of zoo diseases and control measures, management of zoo animals.
8. Remote sensing (Photographic interpretation)
9. Typical vertebra of a bird, reptile and mammal
10. Spotters: Ecto and Endo parasites, bones of characteristic

importance in the skull of crocodile, snake, dog, monkey and other items relevant to wildlife biology.

ELECTIVE COURSE: WILDLIFE BIOLOGY-III
ZOL4L0605 -WILD LIFE MANAGEMENT

Course outcomes

CO1. The student attain skill in doing the qualitative estimation of digestive enzymes of the gut of a herbivore (rat)
CO2. The student practice morph metric analysis and understand the importance of morphometry in wildlife research and systematics
CO3. The student gain knowledge about the quantitative estimation of uric acid in birds or reptiles
CO4. The student will be familiar with major feet and beak modifications present in birds
CO5. The student will demonstrate the method of age determination by the teeth of mammals
CO6. The student gain practice in measuring temperature, light, rainfall, humidity, transpiration and wind speed by using appropriate equipment
CO7. The student will familiar with Berlese funnel method and understand the procedure of quantitative and qualitative analysis of soil fauna.
CO8. The student will be able to demonstrate the procedure of population estimation using the line transect method and quadrate sampling method

1. Qualitative analysis of digestive enzymes of the gut. (Herbivores/ Carnivores/Omnivores).
2. Measurements (Morphometry) for systematic study. Total length, body length, tail length, various dimensions of the skull etc. of mammals, birds, reptiles, amphibians and fishes.
3. Quantitative estimation of uric acid in birds and reptiles.
4. Identifying features of the beaks and feet of common birds. Students are expected to identify from photographs / Xerox.
5. Assessment of the age of mammals using their teeth.
6. Measurement of temperature, light, rainfall, humidity, transpiration and wind speed.
7. Collection and quantitative and qualitative analysis of soil fauna.
8. Territory mapping. Quadrate sampling, Line transect, Line intersect, Point prime methods of population study. Pellet counting for deer population of elephant dung in a sanctuary.
9. Spotters: Various item related to wildlife biology.

Study Tour

A study tour of not less than 10 days duration (need not to be at a stretch) to sanctuaries, National Parks, Zoos, Research Institutes and other places of ecological importance. The field report with the dated signature of the teacher concerned and duly certified should submit at the time of examination. Slides should be submitted at the time of examination during IV semester.