

**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	36	5
ZOL1C02- Biophysics and Biostatistics	4	36	5
ZOL1C03- Ecology and Ethology	4	36	5

SECOND SEMESTER- THEORY COURSES

Code No. & Title of the Course	Credits	External Weightage	Internal Weightage
ZOL2C04- Physiology	4	36	5
ZOL2C05- Molecular Biology	4	36	5
ZOL2C06- Systematics and Evolution	4	36	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	36	5
ZOL3C08- Developmental Biology and Endocrinology	4	36	5
ZOL3E09- Entomology 1: Morphology and Taxonomy	4	36	5
ZOL3E09- Environmental Biology 1: Man, Environment & Natural Resources	4	36	5
ZOL3E09- Fishery Science 1: Taxonomy,	4	36	5

Biology, Physiology & Ecology			
ZOL3E09- Human Genetics 1: Clinical Genetics	4	36	5
ZOL3E09- Wildlife Biology 1: Biodiversity & Biota	4	36	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	36	5
ZOL4E11- Entomology II: Anatomy and Physiology	4	36	5
ZOL4E11- Environmental Biology II: Environmental pollution	4	36	5
ZOL4E11- Fishery Science II: Capture & Culture Fisheries	4	36	5
ZOL4E11-- Human Genetics II: Diagnostic Genetics	4	36	5
ZOL4E11- Wildlife Biology II: Wildlife Conservation	4	36	5
ZOL4E12- Entomology III: Agricultural , Medical & Forensic Entomology	4	36	5
ZOL4E12-Environmental Biology III: Environmental Conservation	4	36	5
ZOL4E12-Fishery Science III: Harvesting, Post-harvesting Technology & Marketing	4	36	5
ZOL4E12-Human Genetics III: Cancer Genetics & Genetic Services	4	36	5
ZOL4E12- Wild Life Biology III : Wildlife Management	4	36	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
ZOL4L05- Entomology 1 & II	4	24	5
ZOL4L05-Environmental Biology I & II	4	24	5
ZOL4L05- Fishery Science I & II	4	24	5
ZOL4L05-Human Genetics I & II	4	24	5
ZOL4L05- Wildlife Biology I & II	4	24	5

ZOL4L06- Entomology III	4	24	5
ZOL4L06-Environmental Biology III	4	24	5
ZOL4L06- Fishery Science III	4	24	5
ZOL4L06- Human Genetics III	4	24	5
ZOL4L06- 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 36 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 14 short answer questions with weightage 1 each, 7 short essay questions with weightage 2 each and 2 essay questions with weightage 4 each.
6. Weightage for the external practical examination can be distributed as follows:

With submission Weightage

Major question (1 number)	8
Minor question (2 numbers)	2x5=10
Spotters (2 numbers)	2x1=2
Submission (slides)	2
Record	2
Total	24

Without submission Weightage

Major question (1 number)	8
Minor question (2 numbers)	2x5=10
Spotters (4 numbers)	4x1= 4
Record	2
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 4 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)

Part A. Biochemistry (54 hrs)

Unit - I - Chemistry and functions of Biomolecules

1. Introduction (2 hrs)

1.1 Macromolecules and their subunits

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

2. Carbohydrates (8hrs)

2.1. Classification of carbohydrates with examples-

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

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

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

2.1.4. Biological roles of monosaccharides.

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

2.3.1. Homopolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

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

3. Proteins (6 hrs)

3.1. Amino acids

3.1.1. 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)

3.1.2. Amphoteric properties of amino acids

3.1.3. pK value and Isoelectric point (pI) of amino acids

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

3.2. Structure of protein

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

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

3.2.3. Biological roles of proteins

4. Lipids (5 hrs)

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

4.2. 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

- 4.3. Prostaglandins - Chemical nature and functions.
- 4.4. Fatty acids - definition; essential fatty acids
- 4.5. Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids
- 4.6. Nomenclature of fatty acids - Genevan system

5. Nucleic acids (3 hrs)

- 5.1. Structural organization of DNA (Watson -Crick model)
- 5.2. Structural organization of t-RNA; brief note on micro-RNA
- 5.3. 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 K_m and V_{max} 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)

- 1.1. Glycolysis - (PFK as pacemaker - Hexokinase conformation and change by glucose), Fate of pyruvic acid
- 1.2. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex
- 1.3. Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain
- 1.4. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown .
- 1.5. Pentose phosphate pathway (HMP pathway) and its significance
- 1.6. Uronic acid pathway

2. Amino acid metabolism (4 hrs)

- 2.1. Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine, valine.
- 2.2. Fate of amino acids in the body
- 2.3. Transamination, Decarboxylation and deamination reactions in the biological system.

3. Lipid metabolism (5 hrs)

- 3.1. Oxidation of fatty acids
- 3.2. Biosynthesis of fatty acids
- 3.3. Biosynthesis of cholesterol

4. Nucleic acid metabolism (4 hrs)

- 4.1. Biosynthesis and degradation of purines and pyrimidines

Part B. Cytogenetics (36 hrs)

1. Introduction to Cytogenetics (1 hr)

2. Membrane structure and function . (4 hrs)

- 2.1. Molecular organization of cell membrane - Lipid bilayer and membrane protein. Molecular models of cell membrane.
- 2.2. Cell permeability-osmosis, diffusion, ion channels, active transport, membrane pumps.
- 2.3. Mechanism of sorting and regulation of intracellular transport.
- 2.4. Electrical properties of membranes.
- 2.5. 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)

- 4.1. Structure of chromatin and chromosomes, heterochromatin, euchromatin –unique and repetitive DNA
- 4.2. Chromosomal changes- euploidy, aneuploidy, chromosomal aberrations- Structural alterations- gene mutations- molecular changes- deletion, duplication, translocation, inversion and sister chromatid exchange.
- 4.3. Interrupted genes and gene families.
- 4.4. Concept of gene- Allele, multiple alleles, pseudoallele, complementation tests.
- 4.5. Extrachromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance.

5. Cellular communication (6 hrs)

- 5.1. General principles of cell communication
- 5.2. Cell-cell interactions – cell adhesion and roles of different adhesion molecules

- 5.3. Intercellular attachments- gap junctions, desmosomes, intermediary and tight junctions.
- 5.4. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.
- 5.5. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

6. Cell signaling (8 hrs)

- 6.1. Signal transduction
- 6.2. Concept of cell-signaling
- 6.3. 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
- 6.4. Receptor desensitization
- 6.5. Signaling by nitric oxide, carbon monoxide
- 6.6. Signaling network

7. Apoptosis and its significance (5 hrs)

- 7.1 Necrosis; Programmed and induced cell death
- 7.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis
- 7.3 Regulation of apoptosis - Extracellular and Intracellular
- 7.4 Apoptosis in *Caenorhabditis elegans*, *Drosophila*, mammals and bacterial population
- 7.5 Mechanism of cell death
- 7.6 Genes involved in apoptosis.

References

Biochemistry

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9. Robert H. Tamarin (2002). *Principles of Genetics*, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
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FIRST SEMESTER THEORY

ZOL1C02 - BIOPHYSICS AND BIOSTATISTICS (90 Hours)

Part A. Biophysics (54 hrs)

1. Colloidal System (3 hrs)

- 1.1. Crystalloids and Colloids,
- 1.2. Properties of colloids- Kinetic, optical and electrical properties- Electrosmosis, Cataphoresis, Coagulation.
- 1.3. Forms of colloids, Suspensions and Emulsions, preparation and properties of emulsions.
- 1.4. Biological importance of colloids.

2. Diffusion and Osmosis (4 hrs)

- 2.1. Fick's laws and diffusion coefficient.
- 2.2. Gibb's Donnan equilibrium.
- 2.3. Application of diffusion processes in biology: haemolysis.
- 2.4. Osmosis, Osmotic concentration, Osmotic pressure and osmotic gradient.
- 2.5. Vant Hoff's laws
- 2.6. Electrolytic and ionic balance in biological fluid.

3. PH (2 hrs)

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

4. Bioacoustics (5 hrs)

- 4.1. Characteristics of sound.
- 4.2. Physical basis of hearing.
- 4.3. Physical organization of ear.
- 4.4. Physical aspects of sound transmission in the ear.
- 4.5. Audible sound frequency.
- 4.6. Pitch perception and theories.
- 4.7. Infrasonic and ultrasonic sounds.
- 4.8. Echolocation; receiving and analyzing echoes

5. Radiation Biology (9 hrs)

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

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

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

7. Electrophysiological methods (Brief) (3 hrs)

- 7.1. Single neuron recording.
- 7.2. Patch clamp recording.
- 7.3. ECG.
- 7.4. Brain activity recording.
- 7.5. Lesion and stimulation of brain.
- 7.6. Pharmacological testing.
- 7.7. PET (Positron Emission Tomography), MRI, fMRI, CAT.

8. Principles and applications of (8 hrs)

- 8.1. Fluorescent, Interference, Scanning and Transmission electron microscopes (SEM &TEM) .
- 8.2. Resolving powers of different microscopes.
- 8.3. Different fixation and staining techniques for EM (freeze-etch and freeze fracture methods for EM-image processing methods in microscopy).
- 8.4. Laser and its applications in Biology

9. Separation Techniques (10 hrs)

- 9.1. Chromatography - Different types - Adsorption, Partition and Ion exchange chromatography
 - 9.1.1 Column chromatography
 - 9.1.2 Paper chromatography
 - 9.1.3 Thin- layer chromatography
 - 9.1.4 Gel-filtration.
 - 9.1.5. Gas chromatography,
 - 9.1.6 Affinity chromatography,
 - 9.1.7 HPLC
- 9.2. Electrophoresis
 - 9.2.1 Paper electrophoresis
 - 9.2.2 Disc electrophoresis
 - 9.2.3 PAGE, Two dimensional PAGE, Highvoltage Electrophoresis
- 9.3. Isoelectric focusing.

10. Influence of gravity (3 hrs)

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

11. Nanotechnology (2 hrs)

11.1. Definition

11.2. Nanotechnology and its applications in the field of health care.

11.3. Role of nanotechnology in environmental management.

Part B –Biostatistics (36 hrs)

1. Introduction (2 hrs)

1.1 Biostatistics: Definition,

1.2 Characteristics of Statistics

1.3 Importance and usefulness of statistics

1.4 Limitations of Statistics

2. Data (5 hrs)

2.1. Types of data: classification based on Source of data, Compilation, Variable, Nature .

2.2. Methods of data collection and classification.

2.3. Types of sampling methods.

2.4. Advantages and disadvantages of census and sampling method.

2.5. Class intervals- exclusive and inclusive method

2.6. Frequency curve (types. skewness, kurtosis, ogive)

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

3.1. Mean, (raw data, discrete series and continuous series)

3.2. Standard deviation, Standard error, degree of freedom (raw data, discrete series and continuous series)

3.3. Quartile deviation- Box- whisker plot

4. Probability distributions (4 hrs)

4.1. Basic concepts and definition:

4.2. Laws of probability

4.3. Probability distribution: - Binomial, Poisson and Normal

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

5.1 Difference between parametric and non-parametric statistics;

5.2. Testing of hypothesis

5.3. Errors

5.4. Confidence interval; levels of significance, Critical region;

5.5. Normality test

5.6. t-test, chi-square test, F-test, ANOVA

5.7. Kruskal-Wallis, Mann-Whitney

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

6.1. Types of correlation.

6.2. Methods to measure correlation- Scatter diagram.

6.3. Karlpearson's coefficient of correlation, Spearman's correlation

6.4. Types of regression analysis

6.5. Regression equations

6.6. Difference between regression and correlation analysis

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

7.1. Alpha diversity

Shannon diversity index, Simpsons Dominance index, Pielou's evenness index, Margalef species Richness, Fisher's alpha,

7.2. Beta diversity

Morisita Horn index, Sorenson index, Bray-Curtis similarity

References

Biophysics

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18. Nagini.S (2009)- Instant Biochemistry-Ane Books Ltd.
19. Roy, R.N (1996)-A text book of Biophysics-New central book Agency Calcutta.
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Biostatistics

1. Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
2. Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stoughton, London.
3. Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ika's Publishing House, New Delhi.
5. Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition, New Delhi.
6. Magurran AE. 2004. Measuring Biological Diversity. Blackwell Publishing
7. Stephen W, Looney(2008) Methods in Molecular Biology-Biostatistical Methods Springer International Edition
8. Zar, J.H. (2003) Biostatistical Analysis - Fourth edition. Pearson Education. New Delhi.

FIRST SEMESTER THEORY
ZOL1C03 - ECOLOGY AND ETHOLOGY (90 Hours)

Part-A-Ecology (54 hrs)

1. Introduction (3hrs)

- 1.1. Habitat and niche
 - 1.1.1. Concept of habitat and niche
 - 1.1.2. Niche width and overlap
 - 1.1.3. Fundamental and realized niche
 - 1.1.4. Resource partitioning
 - 1.1.5. Character displacement

2. Ecosystem (9 hrs)

- 2.1. Structure and function
- 2.2. Ecosystem energetics
- 2.3. Primary production
- 2.4. Energy flow models
- 2.5. Mineral cycling (CNP)
- 2.6. Trophic levels, Food chain, food web and secondary production
- 2.7. Decomposers and detritivores

3. Population Ecology (7 hrs)

- 3.1. Characteristics of a population
- 3.2. 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
- 3.4. Ground and remote sensing methods
- 3.5. Population growth curves, Life tables, survivorship curves, population regulation, Life history strategies, r and k selection, Demes and dispersal, interdemec extinctions, age structure of populations.
- 3.6. Growth and regulation of human population

4. Species interaction (5 hrs)

- 4.1. Types of interactions, interspecific competition
- 4.2. Herbivory, Carnivory, Pollination, Symbiosis; mutualism, commensalisms and proto co-operation

5. Community Ecology (4 hrs)

- 5.1. Nature of communities.
- 5.2. Characteristics of a biotic community.
- 5.3. Species diversity and latitudinal gradients in diversity.
- 5.4. Edges and ecotones.

6. Ecological succession (4 hrs)

- 6.1. Types, mechanisms ,changes involved in succession .
- 6.2. Concept of climax

7. Biogeography (6 hrs)

7.1. 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)

9.1 Carbon credit, Carbon trading, Blue Carbon

9.2 Green building technology and its ecological importance.

9.3 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)

10.1 Principles of conservation.

10.2 Major approaches to management,

10.3 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)

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

2.2. Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms, super normal stimuli, stimulus filtering.

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

3. Motivating factors (3 hrs)

3.1. General factors in motivation; Studies of motivation in guppies;

3.2. 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-reafferece theory of Von Holst & Mittel Steadt.

8.3-Navigation & migration

9. Parental care – (6 hrs)

9.1. Mating systems, Parental investment and Reproductive Success.

9.2. Development of behavior.

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

10. Evolution and adaptiveness 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 behaviour- mechanism of hormonal action.

References

Ecology

1. Ahluwalia and Sunitha Malhorta-Environmental Science-Ane Books Pvt.Ltd
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3. Archbold, O. W. (1995). Ecology of World Vegetation. New York, NY: Chapman and Hall.
4. Begon, Harper, Townsend- Ecology- Individuals, Populations, and communities- Blackwell Science, Second edition
5. Brewer Richard (1994). The Science of Ecology- Saunders college publishing.
6. Chapman J.L and Reiss.M.J- Ecology principles and applications-Cambridge low price editions
7. Charles J .Krebs- Ecology. The experimental analysis of distribution and abundance .
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9. Dick Neal- Introduction to population Biology- Cambridge University Press
10. Eugene P.Odum- Fundamentals of Ecology- W.B.Saunders Company.
11. Fred, Van Dyke (2003). Conservation biology-foundation concepts, applications-Mc Graw Hill, New Delhi.
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15. Peter.S.(2002). Ecology- Theories and Applications. Prentice Hall of India.
16. Whittaker, Robert H. Communities and Ecosystems New York: MacMillan Publishing Company, Inc., 1975.

Ethology

1. Chris Barnard (2003): Animal Behaviour: Mechanism, Development, Function and Evolution, Publisher: Pearson Education.
2. David McFarland (1999): Animal Behaviour: Psychobiology, Ethology and Evolution, 3rd Edition. Publisher: Pearson Education.
3. David McFarland (2006) A Dictionary of Animal Behaviour. Publisher: Oxford University Press.

4. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
5. Graham Scott (2004) Essential Animal Behaviour. Publisher: Wiley-Blackwell
6. Lenher, P. (1996) Handbook of Ethological methods. Cambridge Univ.Press, Lond.
7. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.
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9. Martin P. and Bateson .P.(2001). Measuring Behaviour – an introductory guide. Cambridge University Press, UK.
10. Scott, J.P. (1972) Animal Behaviour. Publisher: Univ of Chicago.

FIRST SEMESTER PRACTICALS

ZOL2L01 - BIOCHEMISTRY

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
 - 1.1. Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O- Toluidine method)
 - 1.2. 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

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.

References

1. Plummer David, T.(2007). An introduction to practical biochemistry -Tata Mc Graw-Hill, New Delhi.
2. Oser, B.L., (1965) Hawk's Physiological Biochemistry, McGraw Hill Book Co.
3. Sadasivan, S. and Manickam, A., (2005), Biochemical methods, New Age International, New Delhi.
4. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press.
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6. Thimmaiah ,S.K.(2004). Standard methods of Biochemical analysis. Kalyani Publishers, Ludhiana.
7. Sawhney, S.K.and Singh Randhir (2006).Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
8. Winchester.A.M.(1964). Laboratory Manual Genetics. Brownca Publishers, Dubuque,Iowa.
9. Neidharth,F.C. and Beyd, R.F.(1965) Cell Biology- A laboratory text . Burgees Publishing Co.

ZOL2L01 - Biophysics and Biostatistics

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.
3. Gassey, E.J.(1962). Biophysical concepts and mechanics. Van Norstrant Reinhold co.
4. Hoppe, W (1988). Biophysics, Springer Veilag.

5. White, D.C.S.(1974).Biological Physics, Chapman and Hall. London.
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.
2. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
3. Manning, A. (1967). An Introduction to Animal Behaviour. Edward Arnold Pub., London.
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5. Bonnie,J, Plager and Ken Yamkawa (2003). Exploring Animal Behaviour in Laboratory and Field. Academic press.
6. Michael, P.(1984). Ecological methods for field and laboratory investigations. Tata McGraw Hill publishing co.
7. Webber, W.J (1972).Physicochemical Processes for water quality control. Wiley interscience.
8. George,T, Franklin, L. Burton and David, S.H.(2002). Waste water Engineering-Metcalf and Eddy.4th ed. Inc. Tata McGraw Hill publishing co.

SECOND SEMESTER THEORY
ZOL2C04 - PHYSIOLOGY (90 Hours)

1. Nutrition (10 hrs)

- 1.1. Constituents of normal diet and their daily requirements.
- 1.2. Physiological calorie value of food stuffs.
- 1.3. Antioxidant nutrients.
- 1.4. Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation.
- 1.5. The role of hormones and neurotransmitters in the control of gastrointestinal motility.
- 1.6. Energy balance and obesity-causes and consequences.
- 1.7. BMR and its significance.

2. Excretory System (12 hrs)

- 2.1. Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules).
- 2.2. Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus structure, parts and function.
- 2.3. Urine formation (glomerular filtration, tubular reabsorption and tubular secretion)
- 2.4. Regulation of water balance -Mechanism of concentration of urine – Counter Current system (counter current multiplier and counter current exchanger).
- 2.5. Renal regulation of acid- base balance & electrolyte balance.
- 2.6. Structure of urinary bladder, micturition reflex and micturition.
- 2.7. Renal clearance – definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium.

3. Respiratory system (10 hrs)

- 3.1. Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia).
- 3.2. Physiological anatomy and histology of respiratory passage and lungs.
- 3.3. Mechanism of pulmonary ventilation (inspiration & expiration) .
- 3.4. Alveolar ventilation, dead space and its effect on alveolar ventilation.
- 3.5. Role of surfactant in alveolar expansion.
- 3.6. 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).
- 3.7. Exchange of gases- partial pressures involved-lung and tissues.
- 3.8. Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO₂, PCO₂, CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin).
- 3.8. Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

4. Nervous system (21 hrs)

- 4.1. Organisation of human brain.
 - 4.1.1. Cerebrum and cerebral lobe.

- 4.1.2. 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 .
- 4.1.3. Cortical white matter- commissures, association fibers, projection fibers, corpus callosum and fornix, basal nuclei-organisation and function.
- 4.1.4. Brain stem- organisation and function.
- 4.1.5. Cerebellum- structure and function.
- 4.1.6. Diencephalon – organisation and function.
- 4.2. Functional brain systems - Limbic system and reticular formation.
- 4.3. Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.
- 4.4. Diseased states of brain - schizophrenia, Alzheimer's disease, Senile dementia & Parkinson's disease.
- 4.5. Memory- definition, types of memory- short term, intermediate long term and long term memory, consolidation of memory.
- 4.6. PNS and Autonomic nervous system.
- 4.7. Spinal cord – structure.
- 4.8. Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and golgi tendon organ.

5. Special senses (16 hrs)

5.1. Vision:

- 5.1.1. Structure of eyeball
- 5.1.2. Fluid systems of the eye
- 5.1.3. Layers of Retina and photoreceptors (rods & cones)
- 5.1.4. Brief notes on the neuronal cell types and neural circuitry of the retina and visual pathways from retina to visual cortex
- 5.1.5. Image formation
 - 5.1.5.1. Formation of image on the retina.
 - 5.1.5.2. A brief general account of electrophysiology of vision
 - 5.1.5.3. Photochemistry of vision & colour vision

5.2. Taste:

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

5.3. Smell:

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

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

- 6.1.1. Mechanoreceptors and their stimulation
- 6.1.2. Pain receptors and their stimulation

6.1.3. Thermal receptors and their stimulation

7. Cardiovascular system (8hrs)

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

8. Lymphatic System (5 hrs)

- 8.1. Lymph channels of the body.
- 8.2. Composition and formation of lymph.
- 8.3. 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)

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

References

1. Arthur C. Guyton & John E. Hall (2003): Textbook of Medical Physiology, Saunders (An imprint of Elsevier).
2. William F. Ganong (1999): Review of Medical Physiology, Lange Medical Publications (Appleton & Lange).
3. Jain A.K. (2009): Text Book of Physiology (Vol. I & II), Avichal Publishing Company, New Delhi.
4. Deb, A.C. (2002): Fundamentals of Biochemistry (2002): New Central Book Agency (P) LTD, India.
5. Prosser & Brown. (1973). Comparative Animal Physiology. W.B. Saunders and Co.
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8. Jensen D. (1976): Principles of Physiology, Appleton Century Crafts, N.Y.
9. Lonco, G.N. (1993): Physiological Animal Ecology. Longman Scientific and Technical Essex.
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11. Shepherd, G.M: Neurobiology-Principles of Neural Science, E. Kandel & P. Schwartz.
12. Campbell *et al.* (1984): Clinical Physiology, 5th Edn. Blackwell Scientific Publications, Oxford.
13. Pragnelli, C.V & Farhi, L.E. (1989): Physiological function of special Environment- Springer-Verlag, N.Y.
14. Davie IV & Lewid S.M.- Practical Haematology, 6th Edn. Churchill, Livingstone, Edinburgh.

SECOND SEMESTER
ZOL2C05 - MOLECULAR BIOLOGY (90 Hrs)

1. DNA replication (11 Hrs)

- 1.1. Semidiscontinuous synthesis-Okazaki fragments
- 1.2. Replication origin and replication fork
- 1.3. Unit of replication, extra chromosomal replicon of bacterial Ti plasmid
- 1.4. Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase;
- 1.5. Fidelity of replication
- 1.6. Replication of the ends of eukaryotic chromosome – role of telomerase
- 1.7. Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ -model.
- 1.8. Inhibitors of DNA replication – Methotrexate and Fluorodeoxyuridylate

2. Safeguard systems of DNA (5 Hrs)

- 2.1. Restriction: significance, role and features of Type I, II & III restriction enzymes
- 2.2. Modification: enzymes and significance
- 2.3. Repair:
 - 2.3.1. Major kinds of damage to DNA and causes
 - 2.3.2. Repair mechanisms: Direct reversal, Mismatch repair, Excision repair, Recombination repair, SOS response

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

- 3.1. Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA
- 3.2. Transcription in prokaryotes and eukaryotes
 - 3.2.1. Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites
 - 3.2.2. Transcription factors; Transcription activators and repressors
- 3.3. Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions
- 3.4. Post transcriptional modification of RNA
 - 3.4.1. Capping
 - 3.4.2. Polyadenylation
 - 3.4.3. Splicing
- 3.5. RNA editing: site specific deamination and role of gRNAs
- 3.6. mRNA transport

4. Genetic code (5 Hrs)

- 4.1. Characteristics of genetic code
- 4.2. Start codons and stop codons
- 4.3. Degeneracy of the code: Wobble hypothesis and isoacceptor tRNAs
- 4.4. Special features of the genetic code in mitochondria, mitochondrial tRNA
- 4.5. Variations in the genetic code in *Mycoplasma* and *Tetrahymena*
- 4.6. Point mutations that alter genetic code (missense, nonsense & frameshift)

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

- 5.1. Structure

5.2. Composition; Reconstitution experiments

5.3. Active centres

5.4. Biogenesis of ribosome in eukaryotes

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

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

6.2. Aminoacyl tRNA synthetases & initiation, elongation and termination factors

6.3. Translational proof-reading

6.4. Differences in protein synthesis between prokaryotes and eukaryotes

6.5. Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin

6.6. 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)

7.1. Regulation of gene expression in Phages – alternate patterns of gene expression for control of lytic and lysogenic cycle in λ phage

7.2. Regulation of gene expression in bacteria – basic features of tryptophan, arabinose and galactose operons

7.3. Regulation of gene expression in eukaryotes –

7.3.1. Role of chromatin in regulating gene expression

7.3.2. Activation and repression of transcription

7.3.3. Regulation of translation by gene arrangement

7.3.4. Regulation of translation by alternate pathways of transcript splicing

7.3.5. Antisense RNA strategies for regulating gene expression

7.3.6. si RNA and mi RNA in regulation

8. Eukaryotic genome: (5 Hrs)

8.1. Special features of eukaryotic genome

8.2. Features, components and reassociation kinetics of Unique, Moderately repetitive and Highly repetitive DNA

8.3. Junk DNA, Satellite DNA and Selfish DNA

8.4. Cot value and complexity of genome

8.5. Organisation of human genome (brief account)

9. Interrupted genes (4 Hrs)

9.1. Definition and explanation

9.2. Organisation and special features of interrupted genes

9.3. Evolution of interrupted genes

10. Gene families: (6 Hrs)

10.1. Definition and concept

10.2. Classification with example

10.2.1. Simple multigene family - organisation of rRNA gene in *Xenopus*

10.2.2. Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in *Drosophila*

10.2.3. Developmentally controlled complex multigene family e.g., globin gene

10.2.3.1. Globin genes and its products

- 10.2.3.2. Organisation of globin genes and its expression in Man
- 10.2.3.3. Evolution of globin genes
- 10.2.4. Concept of an evolutionary clock
- 10.2.5. Pseudogenes
- 11. Transposable genetic elements - Transposons (6 Hrs)**
 - 11.1. Definition, features and types
 - 11.2. Transposition and mechanism
 - 11.3. Transposons in bacteria
 - 11.3.1. IS elements
 - 11.3.2. Tn family
 - 11.3.3. Mu phage as a transposable element
 - 11.4. Transposons in eukaryotes
 - 11.4.1. SINE, Alu family; LINE, L1
 - 11.4.2. P elements in *Drosophila*
 - 11.4.3. Transposons in Maize
 - 11.5. Retroviruses and transposition
- 12. Molecular mechanisms involved in recombination of DNA: (5 Hrs)**
 - 12.1. Genetic recombination – types with example
 - 12.1.1. Site specific recombination
 - 12.1.2. Non-homologous recombination
 - 12.1.3. Homologous recombination
 - 12.2. Molecular mechanism involved in homologous recombination of DNA in eukaryotes- Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion
 - 12.3. Role of Rec A protein in genetic recombination
- 13. Microbial genetics (5 Hrs)**
 - 13.1. Prokaryotic genome- *Escherichia coli* genome – basic features
 - 13.2. Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumoniae*), conjugation and sexduction, transduction
 - 13.3. Brief note on mapping genes by interrupted mating (in bacteria)
- 14. Organelle genome (4 Hrs)**
 - 14.1. Chloroplast genome: special features
 - 14.2. Mitochondrial genome
 - 14.2.1. Special features of yeast mitochondrial genome, petite mutants
 - 14.2.2. Special features of human mitochondrial genome.
- 15. Cancer (5 Hrs)**
 - 15.1. Genetic rearrangements in progenitor cells, oncogenes, protooncogenes and tumour suppressor genes
 - 15.2. Virus-induced cancer
 - 15.3. Alteration of cell cycle regulation in cancer
 - 15.4. Interaction of cancer cells with normal cells
 - 15.5. New therapeutic interventions of uncontrolled cell growth (immunotherapy and gene therapy).

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SECOND SEMESTER

ZOL2C06 - SYSTEMATICS AND EVOLUTION (90 Hours)

Part –A: Systematics (54 Hrs)

I. Introduction (1 hr)

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

2.1 Levels of Taxonomy

(a) Alpha, Beta and Gamma taxonomy

2.2 Importance and applications of taxonomy

2.3 Goals of taxonomy

2.4 Definition of systematics

2.5 Definition of classification

3. Species (4 hrs)

3.1 Monotypic species

3.2 Polytypic species

3.3 Ecospecies and Cenospecies

3.4 Morphospecies

3.5 Super species

3.6 Species as a Population Complex

4. Species Concepts (6 hrs)

4.1 Typological Species Concept

4.2 Nominalistic Species Concept

4.3 Biological Species Concept

4.4 Evolutionary Species Concept

4.5 Difficulties in the application of the biological species concept

5. Classification (7 hrs)

5.1 Uses of Classification

5.2 Purpose of Classification

5.3 Theories of Classification

(a) Essentialism (b) Nominalism (c) Empiricism (d) Cladism (e) Evolutionary Classification

5.4 Hierarchy of Categories

5.5 The objectives of classification

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

6.1 Taxonomic collections: Types of collections, Value of Collection

6.2 Purpose of scientific collection

6.3 Preservation of Specimens

6.4 Labeling

6.5 Curating of collections

6.6 Curating of types

6.7 Identification- Methods of identification

6.8 Use of keys, types of keys.

6.9 Merits and demerits of different keys

6.9.1 Description and publication

7. Taxonomic Characters (6 hrs)

7.1 Nature of taxonomic characters

7.2 Taxonomic characters and adaptation

7.3 Kinds of taxonomic characters

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

7.4 Taxonomic characters and classification

7.5 Taxonomic characters and evolution

7.6 Functions of taxonomic characters

8. Zoological Nomenclature (6 hrs)

8.1 Brief History of nomenclature

8.2 International Code of Zoological Nomenclature

8.3 The nature of scientific names

8.4 Species and infraspecies names

8.5 Gender of generic names

8.6 Synonyms and Homonyms

8.7 The Law of Priority

8.8 Rejection of names

8.9 Type method and different kinds of types

9. Newer trends in systematics (4 hrs)

9.1 DNA Bar coding

9.2 Molecular systematics

9.3 Chemo taxonomy and serotaxonomy

9.4 Cytotaxonomy

9.5 Numerical taxonomy

9.6 Cladistics

10. Ethics related to taxonomic publications (4 hrs)

10.1 Authorship of taxonomic papers

10.2 Correspondence

10.3 Suppression of data

10.4 Undesirable features of taxonomic papers

10.5 Taxonomist and user communities

11. Taxonomic impediments (4 hrs)

11.1 Impediments in taxonomic collections and maintenance

11.2 Shortage of man power

11.3 Lack of funding for taxonomic research

11.4 Lack of training and library facilities

11.5 Impediments in publishing taxonomic work

11.6 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)

1.1 Mechanism of natural selection- directional, disruptive and stabilizing selection

1.2 Natural selection in islands

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

2 The Mechanisms (7 hrs)

- 2.1 Population genetics- populations, gene pool, gene frequency, Hardy-Weinberg law, founder principle, bottleneck effect and genetic drift as factors in evolution
- 2.2 Evidence for evolution: DNA evidence, fossil evidence, embryological evidence, geological evidence, evolution in action, imperfection of evolution
- 2.3 Co-evolution: microevolution, macroevolution, convergent evolution (homoplasy), divergent (parallel) evolution

3 Tempo of evolution (5hrs)

- 3.1 Gradualism Vs punctuated equilibrium
- 3.2 Anagenesis Vs Cladogenesis

4 Molecular evolutions (8 hrs)

- 4.1 Neutral theory of molecular evolution
- 4.2 Molecular divergence
- 4.3 Molecular drive
- 4.4 Molecular clocks, genetic equidistance, human mitochondrial molecular clock
- 4.5 Phylogenetic relationships- Homology, homologous sequence of proteins and DNA, orthologous and paralogous evolution, nucleotide sequence analysis

5 Evolutionary trends (9 hrs)

- 5.1 Biochemical evolution- Collapse of orthogenesis
- 5.2 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
- 5.3 Can evolution explain language? Communication, speech, language and self awareness in primates.

References

Part -A Systematics

1. David.M.H, Craig Mortiz and Barbara K.M (1996) Molecular Systematics. Sinauer Associates, Inc
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Part- B Evolution

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SECOND SEMESTER PRACTICALS

ZOL2L02 – PHYSIOLOGY

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
3. Schmidt-Nielsen, K. (1997), Animal Physiology, adaptation and environment, Cambridge University Press.
4. Dounersberger, Anne.B.Lesak, Anne,C and Timmons, Maichael,J.(1992).A laboratory Text Book Of Anatomy and Physiology. 5th ed. D.C.Heath & Co.

ZOL2L02- MOLECULAR BIOLOGY

1. Estimation of DNA by Diphenyl Amine method
2. Estimation of RNA by Orcinol method
3. Estimation of Protein by Lowry's 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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1. Brown, T.A. (1998): Molecular biology Lab Fax. Vol. 1 and 2, Academic press
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

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)

1. Introduction (1 hour)

2. Hematopoiesis (7 hours)

- 2.1. Hematopoiesis – Lymphoid and myeloid lineages.
- 2.2. Hematopoietic growth factors.
- 2.3. Genes that regulate hematopoiesis.
- 2.4. Regulation of hematopoiesis.
- 2.5. B- Lymphocytes, T- lymphocytes and Antigen presenting cells.

3. Antigens (8 hours)

- 3.1. Immunogenicity, Antigenicity.
- 3.2. Factors that influence immunogenicity.
- 3.3. Adjuvants.
- 3.4. Haptens.
- 3.5. Epitopes.
- 3.6. Properties of B-cell and T- cell epitopes.

4. Immunoglobulins (Antibodies) (10 hours)

- 4.1. Structure and function of Antibody molecules.
- 4.2. Generation of Antibody diversity.
- 4.3. Immunoglobulin gene.
- 4.4. Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotype.
- 4.5. B-cell receptor (BCR).
- 4.6. Monoclonal Antibodies.
- 4.7. Production of Monoclonal Antibodies (Hybridoma technology).
- 4.8. Clinical uses of Monoclonal Antibodies.
- 4.9. Antibody Engineering.

5. Antigen Antibody interactions (10 hours)

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

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

- 6.1. Humoral immunity.
- 6.2. Cellular immunity.
- 6.3. T- Cell receptor, TCR-CD3 complex.
- 6.4. Activation, maturation and differentiation of B-Cells.
- 6.5. Activation, maturation and differentiation of T- Cells.

7. Immune effector mechanism. (7 hours)

- 7.1. Cytokines.
- 7.2. Properties of cytokines.

- 7.3. Cytokine antagonists.
- 7.4. Cytokine secretion by TH1 and TH2-cells.
- 7.5. Cytokine related diseases. (a) Bacterial septic- shock (b) chaga's disease) (c) lymphoid and myeloid cancers.
- 7.6. Therapeutic uses of cytokines.
- 7.7. Toll- like receptors.
- 8. The Complement system. (6 hours)**
 - 8.1. The complement components.
 - 8.2. The functions of complement components.
 - 8.3. Complement activation (a) Classical pathway (b) Alternate pathway (c) Lectin pathway.
 - 8.4. Regulation of complement system.
 - 8.5. Biological consequences of complement activation.
 - 8.6. Complement deficiencies.
- 9. Major Histocompatibility Complex (MHC) (8 hours).**
 - 9.1. General organization and inheritance of MHC.
 - 9.2. MHC molecules and genes.
 - 9.3. Cellular distribution of MHC.
 - 9.4. Antigen- processing and presentation- Exogenous and Endogenous pathways.
 - 9.5. Presentation of non- peptide antigens.
- 10. Transplantation immunology (8 hours)**
 - 10.1. Auto graft, Allograft, Isograft and xenograft
 - 10.2. Immunological basis of graft rejection.
 - 10.3. Role of cell- mediated responses.
 - 10.4. Transplantation antigens.
 - 10.5. General immune suppressive therapy.
- 11. Hypersensitivity Reactions. (5 hours)**
 - 11.1. Allergens.
 - 11.2. IgE- mediated (type- I) hypersensitivity.
 - 11.3. Antibody- mediated cytotoxic (type- II) hypersensitivity.
 - 11.4. Immune complex- mediated (type- III) hypersensitivity.
 - 11.5. TDTH- mediated (type- IV) hypersensitivity
- 12. Vaccines. (5 hours)**
 - 12.1. Active and passive immunization.
 - 12.2. Whole organism vaccines.
 - 12.3. Recombinant vector vaccines.
 - 12.4. DNA vaccines.
 - 12.5. Synthetic peptide vaccines.
 - 12.6. Multivalent vaccines.
- 13. Immunity and malnutrition and immune deficiency diseases. (6 hours)**
 - 13.1. Immunity and malnutrition.
 - 13.2. Primary immune deficiency diseases. (a)Burton's disease (b) Di-George syndrome and SCID.
 - 13.3. Secondary immune deficiency - AIDS.

- 13.4. Transmission of HIV.
- 13.5. Vaccines to prevent AIDS.
- 13.6. Autoimmunity (systemic and organ specific brief)

References

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2. Abdul K Abbas and Andrew H. Lichtman (2003). Cellular and Molecular Immunity (fifth edition, Elsevier Science, USA).
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THIRD SEMESTER THEORY

ZOL3C08–DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY (90 Hours)

Part- A - DEVELOPMENTAL BIOLOGY (54hrs)

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

- 1.1. Cell fate, potency, determination and differentiation.
- 1.2 Commitment
- 1.3. Specification - autonomous, conditional, syncytial .
- 1.4. Genomic equivalence and cytoplasmic determinants
- 1.5. Morphogenetic gradients
- 1.6. Genomic Imprinting
- 1.7. 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)

- 2.1. Production of gametes- Spermatogenesis and Oogenesis, Ultra structure of gametes
- 2.2 Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals)
- 2.3 Zygote formation-
 - 2.3.1. Encounter of sperm and egg
 - 2.3.2. Capacitation
 - 2.3.3. Acrosome reaction
 - 2.3.4. Activation of ovum
 - 2.3.5 Amphimixis
 - 2.3.6. Prevention of Polyspermy (Fast block and Slow block)
- 2.4 Cleavage and blastula formation
- 2.5 Gastrulation and formation of germ layers in amphibia
- 2.6 Embryonic fields

3. Embryogenesis and Organogenesis (10 hrs)

- 3.1 Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center, primary embryonic induction, mechanism of axis formation
- 3.2 Anterior posterior patterning in Amphibians - Hox code hypothesis
- 3.3 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
- 3.4 Dorso- ventral patterning in *Drosophila*- dorsal protein gradient
- 3.5. 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
- 3.6. Insect wings and legs formation
- 3.7. Vulva formation in *Caenorhabditis elegans*.
- 3.8. Eye lens induction.

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

- 4.1. Induction and competence- cascade of induction- reciprocal and sequential inductive events, instructive and permissive interactions.
- 4.2. Epithelial- Mesenchymal interactions- paracrine factors - The Hedhog family, The Wnt family, Juxtacrine signaling and cell patterning, notch pathway.
- 4.3. Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis.
- 4.5. Molecular basis of cellular differentiation – Cadherins.

5. Genetic basis of development (8 hrs)

- 5.1. Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcription factors, Silencers and Insulators.
- 5.2. Differential RNA processing- X chromosome inactivation- dosage compensation.
- 5.3. 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.
- 5.4. Post translational regulation of gene expression.
- 5.5. Models of cell differentiation- hematopoiesis, myogenesis, differentiation of neural crest cells.
- 5.6. Reversibility of patterns of gene activity-cell fusion, transdifferentiation.

6. Metamorphosis, Regeneration and Ageing (7 hrs)

- 6.1. Metamorphosis in Amphibians and Insects and their hormonal control
- 6.2. Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration
- 6.3. 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)

- 7.1 Environmental regulation of normal development - types of polyphenism
- 7.2 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
- 7.3. Environmental oestrogens.
- 7.4. 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)

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

1.6. Physiological roles of hormones.

2. General mechanisms of Hormonal action (5 hrs)

2.1. Hormone Receptors and transducers;

2.1.1. Types of receptors- G protein coupled receptors, steroid receptors and nitric oxide receptors,

2.1.2. Regulation of receptor number, receptor activation

2.2. Second messengers of hormone action- cAMP, cGMP, inositol triphosphate, diacylglycerol ,

2.3. Receptor signal transduction

2.4. Eicosanoids and hormone action

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

3.1. Hypothalamus

3.2. Hypophysis

3.3. Thyroid

3.4. Parathyroid

3.5. Adrenal

3.6. Pancreas

4. Hormones and male reproductive physiology (7 hrs)

4.1. Synthesis, chemistry, and metabolism of androgens

4.2. Endocrine control of testicular function

4.3. Physiological roles of androgens and estrogens

4.4. Pathophysiology

5. Hormones and female reproductive physiology (3 hrs)

5.1. Synthesis, chemistry, and metabolism of Ovarian steroid hormones

5.2. Physiological roles of Ovarian steroid hormones

5.3. Hormonal regulation of female monthly rhythm

5.4. Hormonal factors in pregnancy, parturition and lactation

6. Neurohormones (3 hrs)

6.1. Gases as neural messengers

6.2. Endorphins- physiological roles, mechanism of action and pathophysiology

6.3. Brain hormones and behaviour

6.4. Neuroendocrine pathophysiology

References

Developmental biology

1. Balinsky, B. I.(1981). An introduction to Embryology. Holt Saunders, Philadelphia
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3. Deuchar, E. M. Cellular interactions in animal development.
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6. Hopper, A. S. & N. H. Hart. Foundation of animal development.
7. Lash, J & J. R. Whittaker. Concepts of development.
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Endocrinology

1. Bentley, P. J. (1998). Comparative vertebrate endocrinology. 3rd ed. Cambridge University Press
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3. Bolander, F. F. (2006). Molecular endocrinology, Academic press, New Delhi.
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6. Harris, G. W. (1995). Neural control of the pituitary gland, Edward Arnold, London.
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9. Prakash Lohr. Hormones and human health
10. Nelson R. J. Introduction to behavioral endocrinology
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THIRD SEMESTER THEORY
ELECTIVE COURSE- ENTOMOLOGY-I
ZOL3E09 -MORPHOLOGY AND TAXONOMY (90 Hours)

1. Introduction (5 hrs)

- 1.1. Origin and evolution of insects: Ancestry of insects based on fossil studies. Phylogeny of insects: Atelocerata hypothesis, Pancrustacea theory. Mention phylogenomics studies.
- 1.2. Fossil insects. Mention extinct orders: Archodonata, Blattoptera, Coxoptera, Diaphanopteroidea, Glosselytroidea, Meganisoptera, Megaseoptera, Miomoptera, Monura, Palaeodictyoptera, Protelytroptera, Protodiptera, Protorthoptera and Titanoptera.

2. Insect classification (31 hrs)

- 2.1. Introduction to classification of insects. Mention Apterygota, Exopterygota, Endopterygota, Hemimetaboly and Holometaboly. **(1 hr)**
- 2.2. **Apterygota:** Diagnostic characteristics, biology and economic importance of the following Orders: Collembola, Protura, Diplura, Archeognata (Microcoryphia) and Thysanura. Locomotion in Collembola. **(3 hrs)**
- 2.3. **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 damselflies, mouthparts of naiads, mating behavior.
 3. Isoptera- Castes, Termitarium, economic importance.
 4. Phasmida.
 5. Blattaria- Mention economic importance and important species.
 6. Mantodea & Mantophasmatodea.
 7. Orthoptera- Families: Acrididae, Tettigoniidae, 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. Dermoptera- Sexual dimorphism and parental care.
 13. Plecoptera.
 14. Embioptera.
 15. Zoraptera.
- 2.4. **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, Cerambycidae, Lampyridae, Chrysomelidae, Elateridae, Meloidae. Mention cantharidin and bioluminescence.
2. Lepidoptera. Butterflies and Moths. Families: Noctuidae, Sphingidae, Saturnidae, Pyralidae, Papilionidae, Nymphalidae, Hesperidae, Pieridae, Lycaenidae, Geometridae .Migration in butterflies; Butterfly farming; Silk moths.
3. Hymenoptera: Families: Vespidae, Sphecidae, Megachilidae, Apidae, Eumenidae, Xylocopidae, Formicidae, Evaniae, 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, Simuliidae, 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)

3.1. Segmentation and division of the body

3.2. General morphology of the Head

3.2.1. Opisthognathous, hypognathous and prognathous –

3.2.2. Head segmentation- theories about the segmentation of the head

3.2.3. Head skeleton- different sutures and sclerites –

3.2.4. Tentorium –

3.2.5. Modification in head capsules –

3.2.6. Cephalic appendages –

3.2.6.1. Antenna: structure, function & types

3.2.6.2. Gnathal appendages: types, structure & function

3.2.6.3. Mouth parts of insects

3.2.7. Cervix

3.3. Thorax

3.3.1. Thoracic segmentation

3.3.2. Thoracic skeleton

3.3.3. Endothorax

3.3.4. Thoracic appendages

3.3.4.1. Modifications of thoracic legs

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

3.4. Abdomen

- 3.4.1. Segmentation
- 3.4.2. Skeletal composition
- 3.4.3. Pregenital and post genital segments
- 3.4.4. Abdominal appendages
- 3.5. External genitalia: male and female
- 4. Ecology and Behaviour (18 hrs)**
- 4.1. Aquatic insects
 - 4.1.1. Factors influencing the aquatic life
 - 4.1.2. Food capture; modifications
 - 4.1.3. Respiration in semi-aquatic and in truly aquatic insects
 - 4.1.4. Oviposition methods
 - 4.1.5. Anchorage, locomotion
 - 4.1.6. Adaptations of swimming forms
- 4.2. Gall forming insects:
 - 4.2.1. Definition and features
 - 4.2.2. Formation, economic importance
 - 4.2.3. Common gall pests
 - 4.2.4. Extent of gall making habits
 - 4.2.5. Gall as dwelling place, the position of gall
 - 4.2.6. Classification of galls by Orders
 - 4.2.7. Adaptation for the gall making habits
 - 4.2.8. Origin and types of galls (open & closed)
 - 4.2.9. Physiology of gall formation
- 4.3. Leaf mining insects
 - 4.3.1. Definition and identification
 - 4.3.2. Forms of leaf mines, economic importance
 - 4.3.3. Extent of the leaf mining habits
 - 4.3.4. Feeding habits and frass disposal
 - 4.3.5. Ecological aspects of leaf mining
- 4.4. Insect-plant interdependence (co-evolution)
- 4.5. Social insects – social organisation
- 4.6. Caste differentiation
- 4.7. Aspects of social behaviour with reference to honey bee, termite and ant
- 4.8. Communication – acoustic, visual, tactile and chemical method (pheromones)
- 4.9. Adaptations of parasitic and predatory insects

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18. https://en.wikipedia.org/wiki/Category:Extinct_insect_orders (Extinct insect orders)
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THIRD SEMESTER THEORY
ELECTIVE COURSE - ENVIRONMENTAL BIOLOGY- I
ZOL3E09 - MAN, ENVIRONMENT & NATURAL RESOURCES (90 hours)

1. Weather and climate (15 hrs)

- 1.1. Atmosphere- structure and composition; Local winds: Sea and land breezes; Polar easterlies, Westerlies; Trade winds;
- 1.2. Indian and African Monsoon;
- 1.3. Inversions: temperature or thermal inversions- causes –consequences –subsidence inversion;
- 1.4. 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)

- 2.1. External factors: solar radiation- Plate tectonics - Milankovitch Theory – Orbital eccentricity - obliquity- axial precession.
- 2.2. 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
- 2.3. Global climate changes – causes and consequences.
- 2.4. Physical evidence for climatic change – Historical and archaeological evidence-Glaciers – Vegetation -Ice cores – Dendroclimatology- Pollen analysis-Sea level change

3. Human population (10 hrs)

- 3.1. 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 -
- 3.3. Current trends in global population with reference to developed and developing countries
- 3.4. Population explosion –Baby boom –History of population growth Projections Of population growth
Demographic transition, Carrying capacity – Human population in India

4. Ecosystem (25 hrs)

- 4.1. Ecosystems-a) types, natural & artificial, agroecosystems, city ecosystems and Spacecraft ecosystems
- 4.2. Functions of Ecosystems-
- 4.3. Ecological energetics - Fixation and utilization of energy-
- 4.4. Primary production, factors affecting & measurements of primary production,
- 4.5. Ecological efficiencies- ratios within and between trophic levels,
- 4.6. Lindmann's work, Single channel, Y shaped and universal energy flow models.

- 4.7. Place of man in the food chain, Human expropriation of primary production, Nutrient cycling, selection, diversity, decomposition and stability.
- 4.8. Development of ecosystems, Types and factors controlling, changes in the trends of ecological attributes,
- 4.9. Relevance of ecosystem development concept to human ecology and evolution of ecosystems
- 4.10. Human impact on ecosystems, Human settlements, Human cultural evolution, Environmental crisis,
- 4.11. Environmental protection and sustainable development, Creating sustainable cities suburbs and towns,
- 4.12. Meeting human needs while protecting the environment.

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

- 5.1. Natural resources-Renewable and nonrenewable natural resources.
- 5.2. Depletion of natural resources and its effects.
- 5.3. Aquaculture. Economically important crustaceans, mussels, oysters, clams and sea weeds.(Brief)
- 5.4. Fishery resources of Kerala with special reference to fresh water ornamental species.
- 5.5. Marine products - Food value of fish, Fish meal, fish body oil, Fish liver oil, Fish maw and other products.
- 5.6. Forest products -major and minor products of both plant and animal origin.
- 5.7. Economically important insects and their products-Honey, Lac and Silk.
- 5.8. Plantation crops, and their products and uses (Tea, coffee, Rubber, Coconut, Cashew nut, Cardamom).
- 5.9. Mineral resources with special reference to India. Over exploitation and environmental problems citing case studies from India.
- 5.10. 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
- 5.11. Energy resources
- 5.12. Conventional energy sources (coal, Oil and natural gas and oil shale)
- 5.13. Non conventional energy sources -solar energy, wind energy, geothermal energy, hydropower, biomass, biogas, Tidal energy, Energy from waste, Hydrogen, and Nuclear energy.
- 5.14. Energy crisis.

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THIRD SEMESTER THEORY

ELECTIVE COURSE - FISHERY SCIENCE - I

ZOL3E09 –TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY (90 Hours)

1. Fish Taxonomy (10 hrs)

- 1.1. Fundamentals of fish taxonomy
- 1.2. 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, Heteropneustidae, 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)

- 2.1. Exoskeleton
- 2.2. Skin and scales
- 2.3. Colouration
- 2.4. Chromatophores and pigments
- 2.5. Structure, function and modification of fins

3. Locomotion (5 hrs)

- 3.1. Body shape and musculature

4. Life history of fishes (5 hrs)

- 4.1. Reproduction, reproductive hormones, reproductive behaviour, oviparity, ovoviviparity
- 4.2. Age and growth
- 4.3. Migration

5. Digestive physiology (8 hrs)

- 5.1. Food and feeding
- 5.2. Feeding behaviour
- 5.3. Feeding mechanism
- 5.4. Digestive enzymes
- 5.5. Absorption

6. Circulatory physiology (6 hrs)

- 6.1. Heart
- 6.2. Blood, blood cells, blood pigments and functions of blood
- 6.3. Circulation

7. Respiratory physiology (6 hrs)

- 7.1. Gills and Accessory respiratory organs
- 7.2. Gas transport

8. Excretory and Osmoregulatory physiology (6 hrs)

- 8.1. Excretory organs

8.2. Osmoregulation in marine, brackish water and fresh water fishes

9. Endocrine physiology (6 hrs)

9.1. Endocrine glands – structure and function

9.2. Regulation of endocrine secretion

9.3. Crustacean neurosecretory system and its role in reproduction

10. Adaptive physiology (6 hrs)

10.1. Deep sea fishes

10.2. Cave dwelling fishes

10.3. Hill stream fishes

11. Oceanography (15 hrs)

11.1. Ecological subdivisions of the sea

11.2. Major topographic features of continental shelf, continental slope and ocean floor

11.3. Physico-chemical properties of sea water

11.4. Ocean currents

11.5. Ocean productivity

11.6. Coral reefs

12. Brackish water ecology (5 hrs)

12.1. Characteristics of brackish and estuarine waters

12.2. Estuarine productivity

13. Limnology

13.1. Classification of inland waters – ponds, lakes, rivers and reservoirs.

13.2. Physico-chemical properties of inland waters

References

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THIRD SEMESTER THEORY
ELECTIVE COURSE –HUMAN GENETICS -1
ZOL3E09 - CLINICAL GENETICS (90Hours)

1. Cytogenetics (35 Hrs)

- 1.1 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)
- 1.2 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)
- 1.3 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)

- 2.1 Hematological disorders- Hemoglobinopathies, disorders of stasis and coagulation disorders (3 hrs)
- 2.2 Skeletal disorders: Achondroplasia, Osteogenesis imperfecta (3 hrs)
- 2.3 Neuromuscular disorders-Muscular dystrophies, spinal muscular dystrophy, myotonic dystrophy, neurofibromatosis, tuberous sclerosis, Parkinson"s disorders, Huntington chorea (5 hrs)
- 2.4 Renal disorders- Renal cystic disorders, disorders of urinary tract, nephritic diseases (2 hrs)
- 2.5 Respiratory disorders-cystic fibrosis, asthma (2 hrs)
- 2.6 Endocrine disorders- thyroid, pancreas, pituitary, gonads (5 hrs)

3. Human Biotechnology (25 Hrs)

- 3.1 Introduction to Biotechnology. (1hr)
- 3.2. Recombinant DNA Technology, construction of chimeric DNA, Recombinant DNA technique for Human diseases, Isolation of cloned genes-copying mRNA to cDNA (5 hrs)
- 3.3 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)
- 3.4. PCR- types of PCR- RT-PCR, Fluorescent PCR (3hrs)
- 3.5. Primer designing and purification (1hr)
- 3.6. Somatic cell hybridization and monoclonal antibodies (4hrs)

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

4. Bioinformatics (10 Hrs)

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

References

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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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9. Gardner Mc Kinley *et al*: Chromosome abnormalities and genetic counselling.
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THIRD SEMESTER THEORY
ELECTIVE COURSE: WILDLIFE BIOLOGY-I
ZOL3E09 - BIODIVERSITY AND BIOTA (90 Hours)

1. Introduction (6 hrs)

- 1.1. Biodiversity: Definition
- 1.2. Kinds of biodiversity
- 1.3. Biodiversity hot spots
- 1.4. Endemism
- 1.5. 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)

2.1. 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

2.2. BIRDS (30 hrs)

2.2.1. Habitat preference

2.2.2. Flocking and aggregation.

2.2.3. Foraging behaviour,

2.2.4. Food competition and selection

2.2.5. Courtship and pair selection,

2.2.6. Brood parasitism and cooperative breeding.

2.2.7. Vocalisation and its Role in birds

2.2.8. Flyways and peculiarities of bird migration in the Indian Subcontinent

2.2.9. 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: Ciconiiformes : 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: Charadriiformes: 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: Coraciiformes: White breasted kingfisher, Small blue kingfisher, Pied Kingfisher, Brown headed kingfisher, Chestnut headed Beaeater, Small green Beaeater, 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.

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

2.2.11. Endemic Indian birds and endemic bird areas.

2.2.12. Economic importance of birds- beneficial and harmful role.

3. Fishes, Amphibians & Reptiles (10 hrs)

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

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

3.3 REPTILES

Order: Crocodylia : 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)

4.1 Sociobiology of Lion, Elephant and Deer

4.2 Territoriality and functions of territory.

5. Principles & Hypothesis (4 hrs)

5.1 Gondwana principle

5.2 Satpura Hypothesis

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16. Sukumar, R. (1989): Asian Elephant. Cambridge University Press.
17. Trothy, J.B. Boyle and Boontawee.(1995). Measuring and monitoring Biodiversity in Tropical and Temperate Forest. Centre for International forestry Research, Bogor, Indonesia.

THIRD SEMESTER PRACTICALS

ZOL4L04 – IMMUNOLOGY

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

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.

References

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.
3. Browden, L. W., Erikson, C. A., and Jeffery, R. W. (1991). Developmental Biology. Ed., Saunders College Publi., Philadelphia.
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

ZOL4L05 - MORPHOLOGY & TAXONOMY

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., Ananthkrishnan, 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

ZOL4L05 - AIR POLLUTION, RADIATION BIOLOGY AND HEAVY METALS

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

ZOL4L05 - TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY

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
ZOL4L05 - CLINICAL GENETICS

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
ZOL4L05 - 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)

1. Introduction (1 hr)

Definition, branches, scope and importance

2. Vectors (5 hrs)

2.1. Cloning vectors –

2.1.1. Plasmids: pBR322 and pUC

2.1.2. Phages: λ gt10 and M13 vector

2.1.3. Cosmids: general features

2.1.4. Phagemids: general features

2.1.5. Viruses: SV40 and CaMV

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

2.1.7. Artificial chromosomes: BAC, YAC and MAC.

2.2. Shuttle vectors: applications and example

2.3. Expression vectors: mention commonly used promoters in expression vectors (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)

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

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

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

4. Molecular probes (3 hrs)

4.1. Production

4.2. Labelling

4.3. Applications

4.4. FISH, McFISH and GISH

5. Genomic and cDNA library (4 hrs)

5.1. Construction

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

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

5.4. Chromosome walking

6. Polymerase Chain Reaction (3 hrs)

6.1. Basic PCR – raw materials and steps involved

6.2. Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR

6.3. Applications of PCR in Biotechnology and genetic engineering

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

- 7.1. RFLP
- 7.2. AFLP
- 7.3. RAPD
- 7.4. Minisatellites (VNTR)
- 7.5. Microsatellites (SSR)
- 7.6. SNPs

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

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

9. Transfection methods and transgenic animals (3 hrs)

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

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

- 10.1. Vaccines
- 10.2. Disease diagnosis
- 10.3. Gene therapy
- 10.4. Transplantation of bone marrow, artificial skin,
- 10.5. Antenatal diagnosis
- 10.6. DNA finger printing
- 10.7. Forensic medicine

11. *In vitro* fertilization (3 hrs)

- 11.1. *In vitro* fertilization and embryo transfer in human
- 11.2. *In vitro* fertilization and embryo transfer in live stock

12. Animal cell and tissue culture (3 hrs)

- 12.1. Culture media – natural and artificial
- 12.2. Culture methods – primary explantation techniques, various methods of cell and tissue culture
- 12.3. Tissue and organ culture

13. Gene Silencing techniques (2 hrs)

- 13.1. Antisense RNA
- 13.2. RNAi
- 13.3. Gene knockouts and Knock out mouse

14. Cloning- (2 hrs)

- 14.1. Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning) –
- 14.2. Advantages and disadvantages of cloning

15. Environmental biotechnology (3 hrs)

- 15.1. Pollution control – cleaner technologies, toxic site reclamation, removal of oil spill, reducing of pesticides and fertilizers, biosensors, biomonitoring.
- 15.2. Restoration of degraded lands - reforestation using micro propagation, development of stress tolerant plants
- 16. Agricultural Biotechnology (3 hrs)**
 - 16.1. Biofertilizers
 - 16.2. Insect pest control (Pheromones, hormone mimics & analogues)
 - 16.3. Biopesticides (Baculovirus, *Bacillus thuringiensis*, NPV)
- 16. Intellectual property rights (3 hr)**
 - 16.1. Intellectual property protection,
 - 16.2. Patents, copy right, trade secrets, trademarks
 - 16.3. GATT and TRIPS, patenting of biological materials,
 - 16.4. International co-operation, obligation with patent applications, implications of patenting-current issues
- 17. The ethical and social implications - (3 hrs)**
 - 17.1. Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants- Animals and ethics-
 - 17.2. Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology
 - 17.3. 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)**
 - 1.1 History and scope of microbiology
 - 1.2 Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.
- 2. Microbial Taxonomy and Phylogeny (3 hrs)**
 - 2.1. Major characteristics (classic and molecular)
 - 2.2. Numerical taxonomy
 - 2.3. Taxonomic ranks
 - 2.4. Phylogenetic studies
 - 2.5. Phenetic classification
 - 2.6. Bergey's Manuel (mention major groups)
- 3. Bacterial cell structure and function (5 hrs)**
 - 3.2. Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid
 - 3.3. Bacterial cell wall Peptidoglycan - structure-
 - 3.4. Gram positive and gram negative cell wall- Mechanism of gram staining
 - 3.5. Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility
- 4. Microbial nutrition (4 hrs)**
 - 4.1. Nutritional requirements,

- 4.2. Nutritional types (Auto, Hetero, Chemo, Phototrophs & Obligate parasites)
- 4.3. Culture media and types of media.
- 4.4. Mixed microbial population and pure cultures.
- 5. Microbial growth (4 hrs)**
 - 5.1. Growth curve -synchronous growth
 - 5.2. Continuous culture
 - 5.3. Influence of environmental factors on growth
 - 5.4. Measurement of growth
 - 5.5. Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques
 - 5.6. Measurement of cell mass-Turbidity and microbial mass measurement
- 6. Utilization of energy (3hrs)**
 - 6.1. Biosynthetic process-peptidoglycan synthesis, amino acid synthesis,
 - 6.2. Non synthetic processes -Bacterial motility and transport of nutrients.(biochemical reactions not required).
- 7. Viruses (3 hrs)**
 - 7.1. General structural properties
 - 7.2. Types: DNA viruses, RNA viruses, and enveloped viruses
- 8. Microbial diseases (4 hrs)**
 - 8.1. Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.
 - 8.2. Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS
 - 8.3. Fungal diseases- Candidiasis
- 9. Control of microorganisms (4 hrs)**
 - 9.1. Disinfectants; A - physical- Heat, filtration and radiation. B- Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
 - 9.2. Antibiotics- Penicillin, Cephalosporins, Chloramphenicol, Tetracyclines
 - 9.3. Microbial drug resistance.
- 10. Microbial fermentation (2 hrs)**
 - 10.1. Lactic acid fermentation - Homolactic and heterolactic fermenters, Mention dairy products -cheese and yogurt
 - 10.2. Alcoholic fermentation.
- 11. Environmental microbiology (3 hrs)**
 - 11.1 Microbiological analysis of drinking water.
 - 11.2. Microbial Bioremediation
 - 11.3. Biogas plant.

References

Part- A- Biotechnology

1. Alphey - DNA sequencing-Bios Scientific publishers-
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.
4. Chatterji, A.K.(2007). Introduction to environmental biotechnology-Prentice Hall of India
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge University press.
6. Dale. J.W. and Malcom von Scantz. From genes to genome- Concepts and Applications of DNA Technology
7. Dominic, W.C. Wong-The ABCs of gene cloning-Springer international edition
8. Dubey, R.C. -A text book of biotechnology-S. Chand & Co.
9. Emmanuel. C., Rev. Fr. Ignacimuthu. S. and Vincent. S. Applied Genetics: Recent Trends and Techniques, MJP Publishers, Chennai
10. Gupta. P.K. -Elements of biotechnology-Rastogi publications.
11. Singh, B.D.(2002).Biotechnology-Kalyani publishers.
12. Sobti, R.C. and Suparna, S. Pachauri-Essentials of Biotechnology-Ane Books Pvt. Ltd.
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15. Alberts,B., Bray, D., Lewis, J., Raff., M, Roberts, K. And Watson, J.D. (2000). Molecular Biology of the cell. Garland Science, New York.
16. Brown .T.A. (2002).Genomes II ed. John Wiley and Sons, New York.
17. Freshney, Ian R.(2006). Culture of Animal Cell. 5thed. Wiley-Liss Publications.
18. Glick,B.R.and Pasternak, J.J.(1998). Molecular Biotechnology-Principles and Applications of Recombinant DNA.

Part B- Microbiology

1. Gandhi-Microbiology and Immunology notes and cases-Blackwell publishing
2. Hans G. Schlegel (2008): General Microbiology-Cambridge low price editions.
3. Chakraborty.P.A.(2009). Text Book of Microbiology. New Central Book Agency. New Delhi.
4. Arora, D.R. and Arora, B.(2008).Text Book of Microbiology. CBS Publishers& distributors. New Delhi.
5. Mansi. Fermentation, Microbiology and Biotechnology-Taylor and Francis
6. Pelczar, M.J, Chan, E.C.S. and Krieg, N.R.(1998)-Microbiology-TMH edition
7. Prescott, L.M., Harley, J. P. and Klein. D.A. (2008). Microbiology. 7th ed. McGraw- Hill Inc. New York.
8. Rao, A.S. - Introduction to microbiology-Prentice Hall of India.
9. Ingraham, J.L. and Ingraham, C.A.(2000).Microbiology. 2nd ed.Brooks/Cole-Thomson Learning, MA, USA.
10. Harvey, R.A.and Champe, P.A.(2001). Microbiology.Lippincott, Williams and Wilkins.
11. Harma, R. and Kanika,J.(2009). Manual of Microbiology.Tools and Techniques.Ane Books Pvt. Ltd, New Delhi.
12. Madigan, M.T., Martinko,J.M.and Parker, J.(2000).Biology of Micro organisms. Prentice Hall International Inc.
13. Talase, Park, Kathelee, N. and Talaro, Arthur.(2002).Foundations of Microbiology. McGraw Hill Higher Education, New York.
14. Wheelis, Mark (2010). Principles of Modern Microbiology. Jones and Barlett Publishers, New York.

FOURTH SEMESTER ELECTIVE COURSE- ENTOMOLOGY – II
ZOL4E11- ANATOMY AND PHYSIOLOGY (90 Hours)

1. The Integument (6 hrs)

- 1.1. Histology-basic components
- 1.2. Chemical and physical properties
- 1.3. Moulting and sclerotisation
- 1.4. Hormonal control and function

2. Nutrition (5 hrs)

- 2.1. Nutritional requirement- water, minerals, vitamins, carbohydrates, proteins, fatty acids, sterols, nucleic acids, inorganic salts and micro-organisms.
- 2.2. Nutrition and growth, development, reproduction

3. Digestion and Assimilation (8 hrs)

- 3.1. Anatomy and histology of gut
- 3.2. Digestive enzymes – carbohydrases, proteases, lipases
- 3.3. Physiology of digestion
- 3.4. Digestion of wood, keratin, wax and silk
- 3.5. Extra intestinal digestion.
- 3.6. Role of microbiota in digestion

4. Circulatory system (8 hrs)

- 4.1. Cellular elements in haemolymph
- 4.2. Composition of haemolymph
- 4.3. Dorsal vessels, accessory pumping sinuses and diaphragm
- 4.4. Heart beat rate and control of heart beat
- 4.5. Course of circulation of haemolymph

5. Excretory system (6 hrs)

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

6. Ventilatory system (6 hrs)

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

7. Nervous system (14 hrs)

- 7.1. Anatomy and histology of brain, ganglia and nerves
- 7.2. Reception and transmission of stimuli, production and control of nerve impulses and transmission.

7.3. Sense organs - anatomy, histology and physiology of mechanoreceptors - tactile senses, proprioceptors, sound perception, chemoreceptors, photoreceptors, thermoreceptors and hygroreceptors

7.4. Sound production and light production.

8. Muscular system (8 hrs)

8.1. Histomorphology of muscles, skeletal muscles, visceral muscles

8.2. Neuromuscular junctions

8.3. Excitation of muscle fibres, activation of muscle fibres, role of fast and slow axons

8.4. Muscle development and maintenance

9. Endocrine and exocrine glands (8 hrs)

9.1. Histomorphology of neurosecretory cells and endocrine glands (corpora cardiaca, corpora allata and Prothoracic glands)

9.2. Hormones and their functions

9.3. Mechanism of hormone action

9.4. Pheromones and their function

10. Reproductive system and morphogenesis (9 hrs)

10.1. Development of primordial germ cells

10.2. Reproductive system- structure-male and female

10.3. Fertilization and oviposition

10.4. Formation of blastoderm and extraembryonic membranes

10.5. Sex determination and parthenogenesis

11. Embryogenesis (6 hrs)

11.1. Differentiation of germ layers

11.2. Segmentation, appendage formation, organogenesis

11.3. Polyembryony, paedogenesis, viviparity, oviparity, eclosion,

11.4. Postembryonic development-hatching, larval development and control, polyphenism, diapause.

12. Locomotion (6 hrs)

12.1. Terrestrial and aquatic, basic structure of a leg

12.2. Maintenance of stance and patterns of movements

12.3. Patterns of aquatic movements

12.4. Structure of wings, modifications, mechanism of wing movement

12.5. Aerodynamics and control of wing beat.

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FOURTH SEMESTER ELECTIVE COURSE –ENVIRONMENTAL BIOLOGY-II

ZOL4E11 - ENVIRONMENTAL POLLUTION (90 Hrs)

1: AIR POLLUTION (35 hrs)

- 1.1 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
- 1.2 Sampling of air using sampling train and orifice flow meter
- 1.3 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
- 1.4 Sampling sizing of Particulate matter. Sample collection - settlement, filtration, particle count, evaluation by optical microscopy, particle size analysis - projected diameter and statistical diameter (Feret's diameter and Martin's diameter).
- 1.5 Interaction of air pollutants in the atmosphere. Secondary pollutants: photochemical smog, acid rain, and green house effect,
- 1.6 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.
- 1.7 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
- 1.8 Noise pollution-sources, effects and abatement.

2: WATER POLLUTION (40 hrs)

- 2.1. 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.
- 2.2. Eutrophication- natural and cultural sources and effects.
- 2.3. Biocides: Classification and types of Biocides- Fungicides, Pyrethroids and pesticides. Effects of Biocides, Biological magnification, Toxic effects on non target organisms- hazards to man.
- 2.4. 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.
- 2.5. Thermal pollution-sources, effects- cooling towers as control measures.
- 2.6. Oil spills-sources effects and control.
- 2.7. Hazards of Radioactive materials in the environment Biological effects of ionizing, radiations, nuclear waste disposal.
- 2.8. 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.
- 2.9. 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.
- 2.10. Design and operation of biological treatment systems: (1) Aerated lagoons (2) Activated sludge process (3) Trickling filters (4) sludge digest.
- 2.11 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)

- 3.1 Solid waste- garbage, rubbish, ashes, debris, street litter, agricultural waste, mining waste, industrial waste, e-waste etc.
- 3.2 Problems of solid waste disposal, consequences of solid pollution- Love canal episode as an example.
- 3.3 Solid waste disposal methods: Sanitary land fill, plasma gasification, deep well injection, incineration, recycling biogas

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11. Irewarth Horn, An introduction to climate- Mac Graw-Hill
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FOURTH SEMESTER ELECTIVE COURSE- FISHERY SCIENCE- II
ZOL4E11 - CAPTURE AND CULTURE FISHERIES (90 Hours)

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

- 1.1. Marine fisheries - Crustaceans, Molluscs and fin fishes
Shrimps, Crabs and Lobsters, Mussels, Oysters and Cephalopods, Sardine, Mackerel, Bombay duck, Pomfrets, Ribbon fishes and Tuna

2. Freshwater fisheries (5 hrs)

- 2.1. Major river systems and fisheries
2.2. Lakes and reservoir fishery

3. Estuarine fisheries (5 hrs)

- 3.1. Major estuaries and fisheries

4. Aquaculture (5 hrs)

- 4.1. History of aquaculture, scope and definition, importance of aquaculture, present state of aquaculture, future prospectus
4.2. Classification of aquaculture practices

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

- 5.1. Pond design and construction
5.2. Farm design and layout
5.3. Pond preparation
5.4. Cage farms
5.5. Pens and enclosures
5.6. Design and construction of hatcheries

6. Transportation and acclimatization (3 hrs)

7. Nutrition and feeds (3 hrs)

- 7.1. Feeding habits and food utilization
7.2. Live feeds
7.3. Artificial feeds

8. Water quality management (3 hrs)

- 8.1. Water quality parameters
8.2. Techniques for monitoring
8.3. Strategies for monitoring

9. Fertilizers and chemicals in aquaculture (2 hrs)

10. Reproduction and genetic selection (10 hrs)

- 10.1. Reproductive cycles

- 10.2. Control of reproduction
- 10.3. Induced breeding
- 10.4. Use of hormone analogues
- 10.5. Cryo-preservation of gametes
- 10.6. Sex reversal
- 10.7. Genetic selection and hybridization

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

12. Aquaculture practices (25 hrs)

- 12.1. Integrated fish farming - paddy cum fish culture, duck cum fish culture, pig cum fish culture
- 12.2. Polyculture
- 12.3. Culture of shrimps
- 12.4. Culture of prawns
- 12.5. Culture of crabs
- 12.6. Culture of edible oysters, pearl oysters and mussels
- 12.7. Culture of sea weeds
- 12.8. Culture of fresh water fishes - Indian major carps and exotic carps
- 12.9. Culture of cold water fishes - trout and mahaseer
- 12.10. Culture of brackish water fishes - mullets, milk fish and *Etroplus*

13. Preparation and maintenance of aquarium (5 hrs)

- 13.1. Types of aquaria
- 13.2. Preparation and maintenance
- 13.3. Equipments
- 13.4. Water chemistry
- 13.5. Aquarium fishes and plants

14. Pathology (7 hrs)

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

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2. T. V. R. Pillay [Ed.].(1972). Coastal Aquaculture in the Indo Pacific Region, FAO.
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FOURTH SEMESTER ELECTIVE COURSE-HUMAN GENETICS –II

ZOL4E11- DIAGNOSTIC GENETICS (90 Hours)

1. Biochemical Genetics (25 hrs)

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

2. Developmental Genetics (25 hrs)

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

3. Reproductive Genetics (5 hrs)

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

4. Molecular Diagnosis (15 hrs)

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

5. Prenatal Diagnosis. (20 hrs)

- 5.1 Historical perspective
- 5.2 Non-invasive techniques- Ultrasonography, foetal MRI

- 5.3 Invasive techniques- Amniocentesis, chorionic villus sampling, foetal skin sampling,
- 5.4 Chromosome analysis, metabolic disorders, DNA Analysis
- 5.5. Current knowledge of prenataly diagnosed genetic disorders, haemoglobinopathies, coagulation disorders.
- 5.6 Treatment of genetic disorders

References

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12. Sushama Bai, S: Clinical evaluation of Newborn Infants and Children
13. Tomarin Robert, H: Principles of Genetics
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16. Weatherall, D.J. and Clegg. (1981): The Thalassaemia Syndromes (Ed.3).

FOURTH SEMESTER ELECTIVE COURSE: WILDLIFE BIOLOGY- II
ZOL4E11 - WILDLIFE CONSERVATION (90 Hours)

1. Conservation - Scope and History (8 hrs)

- 1.1 History of conservation in India- Status of wildlife in India (Past and Present)
- 1.2 Values of Wildlife - conservation values & ethics
- 1.3 Causes of depletion of Wildlife resources - habitat loss, construction of dams, collection for trophies, hunting, poisoning, poaching and other developmental activities.
- 1.4 Why conserve? The ecological, genetic, economic and Philosophic reasoning.
- 1.5. 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)

- 2.1 Forest types - classification by Champion & Seth, mention major plant species of Indian forests.
- 2.2 (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.
- 2.3 Grasslands, Mangroves and Sacred groves (Mention conservation and management)
- 2.4 Forestry (Social, Production, Plantation and Protection)
- 2.5 Hydel projects and their impacts (mention habitat fragmentation, loss of forest corridors & isolation of Wildlife population), case studies in Kerala.
- 2.6 In Situ and Ex situ conservation (Gene banking, conservation and exchange)
- 2.7 National River Conservation Programme (NRCP)

3. Tribals and Wildlife (4 hrs)

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

4. Exotic and pet animals (4 hrs)

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

5. Protected Areas (18 hrs)

- 1.1 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.
- 1.2 Marine Sanctuaries and National Parks of India: Gulf of Mannar, Gulf of Kutch & Andaman.
- 1.3 Important Bird Sanctuaries of India: Bharatpur, Ranganathittoo, Thatekkad and Vedan Thangal.

5.4. 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)

6.1 Wildlife administration and legislation: administrative set up (central and state level), statutory bodies,

6.2. Wildlife Protection Act -1972 with its latest amendments.

6.3. Indian Forest act (Brief Account only).

7. Red Data Book (3 hrs)

7.1 Red data book on animals.

7.2 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)

8.1 Role of Government and voluntary organization in wildlife conservation (IBWL, IUCN, ICF, WWF, BNHS, WPS, MNHS, TRAFFIC, CITES, NBA etc.)

8.2 Environmental Education and UN conferences on Environmental Issues

8.3 Resource depletion and Sustainable development

8.4 Earth Summit and World summit

9. Conservation Schemes (15 hrs)

9.1 Project Tiger

9.2 Project Hangul

9.3 Crocodile breeding project

9.4 Gir Lion Project

9.5 Project Sangai

9.6 Project Elephant

9.7 Sea turtle project

9.8 Snow Leopard Project.

10. Ecological Principles of Conservation (5 hrs)

10.1 Concept of minimum viable area

10.2 Minimum viable population

10.3 Compression hypothesis

10.4 Stable limit cycle

10.5 Fragmentation and isolation of habitats - role of corridors

10.6 Environmental and demographic stochasticity

10.7 Effective population size.

10.8 Genetic isolation (Island Biogeography theory) and genetic viability

11. Ecotourism (4 hrs)

- 11.1 Tourism and Wildlife - Importance of Tourism in Wildlife conservation - tourism requirements, visitor impact, visitor management - control and safety rules.
- 11.2 Ecotourism, role of ecotourism in sustainable development.

References

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FOURTH SEMESTER THEORY
ELECTIVE COURSE-ENTOMOLOGY-III
ZOL4E12- AGRICULTURAL, MEDICAL & FORENSIC ENTOMOLOGY
(90 Hours)

1: Insect Pests (10 Hrs)

- 1.1. 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)
- 1.2. Classification of insect pests (Regular pests, Occasional pests, Seasonal pests, persistent pests, sporadic pests, major pests, minor pests, potential pests, key pests)
- 1.3. Causes for insect assuming pest status
- 1.4. Concepts of Economic levels, Economic injury levels, Economic threshold level
- 1.5. Pest surveillance and forecasting pest outbreak
- 1.6. Estimation of damage caused by insects to crops

2: Insect pests of crops (20 Hrs)

- 2.1. Identification, life history, damage and control of major pests of:
 - 2.1.1. **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)
 - 2.1.2. **Sugarcane** (Major pests including shoot, internode & top borers, white grub, leaf hopper, sugarcane scale, mealy bug, whiteflies, Termites, Black winged bug)
 - 2.1.3. **Cotton** (Major pests - Aphid, leaf hopper, thrips, whitefly, Pink spotted and American boll worms, stem weevil, Red and Dusky cotton bugs, leaf roller)
 - 2.1.4. **Coconut** (7 pests - Rhinoceros beetle, red palm weevil, black-headed caterpillar, white grub, Scale insect, Lace wing bug, coconut skipper)
 - 2.1.5. **Pulses** (8 pests - Gram pod borer, plume moth, red gram pod fly, pod borer, spotted pod borer, Blue butterflies, bean aphid, white fly)
 - 2.1.6. **Common vegetables**
 - 2.1.6.1. **Brinjal** (shoot & fruit borer, stem borer, spotted leaf beetle, grey weevil, Pumbkin beetle)
 - 2.1.6.2. **Tomato** (serpentine leaf miner, fruit borer)
 - 2.1.6.3. **Gourds** (fruitflies, snake gourd semilooper, spotted beetle, Pumbkin beetle)
 - 2.1.6.4. **Bhendi** (Earias, leaf hopper, Red cotton bug, Grampod borer)
 - 2.1.6.5. **Cruciferous vegetables** (diamond black moth, cabbage borer, leaf webber, Cabbage green semilooper, Cabbage aphid)
 - 2.1.7. **Fruit trees**
 - 2.1.7.1. **Mango** (hopper, flower webber, Leaf webber, gall midges, Nut weevil, stem borer, red tree ant)
 - 2.1.7.2. **Cashew** (tree borers, Hairy caterpillar, Tea mosquito bug, Apoderus, Leaf miner)
 - 2.1.7.3. **Banana** (rhizome weevil, banana aphid, spittle bug)

- 2.1.7.4. **Citrus** (Fruit sucking moth, citrus butterfly)
- 2.1.8. **Spices**
 - 2.1.8.1. **Pepper** (pollu beetle, shoot borer, Marginal gall thrips)
 - 2.1.8.2. **.Cardamom** (cardamom thrips, rhizome borer, cardamom whitefly, hairy caterpillars, *Eupterote* and *Pericallia*)
 - 2.1.8.3. **Turmeric and Ginger** (Leaf roller, shoot borer)
- 2.2. Identification, nature of damage & control of Insect pests of Stored Products: rice weevil, sweet potato weevil, lesser 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

- 3.1. Prophylactic methods
- 3.2. Curative or direct methods
 - 3.2.1. Cultural methods
 - 3.2.2. Mechanical methods
 - 3.2.3. Physical methods
 - 3.2.4. Legal methods
- 3.3. **Biological control**
 - 3.3.1. History of biological control, Ecological basis of biological control.
 - 3.3.2. Natural enemies (Parasites, Parasitoids, Predators), Feasibility of biocontrol.
 - 3.3.3. Applied biological control (Conservation and Enhancement, Importation and Colonization, Mass culture and release).
 - 3.3.4. Importance of systematics, Advantages and disadvantages of biological control.
 - 3.3.5. Important biocontrol projects undertaken in India by employing parasites and predators.
- 3.4. **Autocidal control**- Sterile male technique and other methods, Chemosterilants, Methods of sterilization, Application, Dynamics, Advantages and disadvantages. Examples of autocidal control.
- 3.5. **Insect growth regulators (IGRs)** – Brief note on Insect growth hormones and mimics (JH mimic & ecdysone agonists) and chitin synthesis inhibitors as insect control agents,
- 3.6. **Behavioural (pheromonal) control**- (Brief note on Trail, Alarm, Aggregation and sex pheromones and the behaviour produced, Mode of application, Pest management with pheromones, Advantages and disadvantages, Examples).
- 3.7. **Insect attractants**: definition, types of attractants, applications in insect pest mangement, examples, advantages and disadvantages.
- 3.8. **Insect repellents**: definition, desirable features of good repellent, types of repellents, applications in insect pest management, examples, advantages and disadvantages.
- 3.9 **Insect antifeedants**: definition, examples, applications in insect pest management, advantages and disadvantages
- 3.10. **Microbial control** of crop pests by employing Bacteria, Virus and Fungi Classification of entomophagus Bacteria, Virus, Fungi, Mode of action, formulation, Application, Examples

3.11. **Integrated Pest Management**- Definition, IPM in Agroecosystem, Kinds of pest, (Key pests, Occasional 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)

- 4.1. 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 baits and Slow release insecticides)
- 4.2. Classification of insecticides.
 - 4.2.1. Based on mode of entry.
 - 4.2.2. Based on mode of action.
 - 4.2.3. Based on chemical nature
- 4.3. Chemistry, toxicology & mode of action of following class of insecticides; mention examples for each class.
 - 4.3.1. Synthetic Organic compounds.
 - 4.3.1.1. Organochlorine insecticides.
 - 4.3.1.1.1. DDT.
 - 4.3.1.1.2. BHC.
 - 4.3.1.1.3. Cyclohexane group (special reference to endosulfan; examples: heptachlor, aldrin).
 - 4.3.1.2. Organophosphorous insecticides (examples: TEPP, Dichloros, monocrotophos, parathion).
 - 4.3.1.3. Carbamates (special mention of carbofuran; examples: Carbaryl, aprocarb)
 - 4.4. Inorganic compounds as insecticides - arsenic compounds, fluorides, sulphur compounds
 - 4.5. Fumigants – definition, examples, methods of fumigation, hazards of fumigation, advantages and precautions
 - 4.6. Botanical insecticides- chemical properties, mode of action and toxicity of the following: Nicotine, Rotenone, Pyrethrum and Neem
 - 4.7. Synthetic pyrethroids – definition, uses as insecticides, mode of action (examples: Pyrethrin, allethrin)
 - 4.8. Insecticide synergists – definition, types of synergism, mode of action & examples

5. Insecticides and Environment (10 hrs)

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

6. Medical entomology (10 hrs)

- 6.1. Insect vectors of human diseases and their biology: (Malaria, Lymphatic 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.
- 6.2. Mosquito control- Larval and adult control-Chemical, Biological and environmental.

- 6.3. Insects related to Myiasis
- 6.4. Poisonous insects: Bees, wasps and ants- Anaphylaxis.
- 6.5. Maggot therapy (Use of maggots in treatment.

7. Forensic Entomology (5 hrs)

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

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Agricultural Entomology

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Medical entomology

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2. Jeremy Farrar et al (2015). Manson's Tropical Diseases, 23rd Edition. Elsevier. Pp. 1552
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Forensic Entomology

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2. Sumodan P.K. (2002). Insect Detectives. *Resonance*.
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FOURTH SEMESTER THEORY
ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III
ZOL4E12 - ENVIRONMENTAL CONSERVATION (90 Hours)

1. Habitat Conservation (25 hrs)

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

2. Biodiversity conservation (20 hrs)

- 2.1. The richness of biodiversity
- 2.2. The importance of biodiversity (Direct and indirect values)
- 2.3. Reasons for high species diversity in the tropics.
- 2.4. Biodiversity of India
- 2.5. The threatened biodiversity with special reference to critically endangered vertebrates from India.
- 2.6. Loss of biological diversity and Causes of extinction.
- 2.7. Endemism
- 2.8. Keystone species and Keystone resources–
- 2.9. Exotic species introductions, invasive species, disease and over exploitations
- 2.10. Global hotspots - hotspots in India,- Western ghats and Sreelanka, Indo Burma, and Eastern Himalayas.

2.11. Biological control and Integrated Pest Management.

2.12. Organic farming and its importance

3. Strategies of conservation (20 hrs)

3.1. Concept of minimum viable area and minimum viable population

3.2. 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)

3.3. Sanctuaries-Major sanctuaries in India and mention the sanctuaries in Kerala.

3.4. Biosphere Reserves –Their aims and objectives, briefly mention them-with special reference to Kerala

3.5. Conservation strategies at the global level-Role of World conservation union, CITES, WWF and other international conventions and protocols

3.6. IUCN categories of threatened animals and red data book.

3.7. Wildlife management in India; Role of Government and non governmental agencies. Briefly mention wildlife protection act 1972 and its amendments and schedules

3.8. 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.

3.9. Ex situ conservation -Zoo, Aquarium, Seed bank, Gene bank, Pollen bank etc.

3.10. In situ conservation.- National parks, sanctuaries, Biosphere reserves, community reserves and other protected areas.

3.11. Traditional Ecological Knowledge (TEK)-

3.11.1. Introduction and need for its conservation

3.11.2. Economic benefits

3.11.3. Social implications-sacred groves, sacred landscape, sacred species

3.11.4. TEK and sustainable development.

4. Environmental Impact (25 Hrs)

4.1. Aims and uses of preparing Environmental Impact Statement (EIS)

4.2. Aims and objectives of Environmental Impact Assessment (EIA),

4.3. Environmental management systems-ISO-14000 standards

4.4. Cost benefit analysis of environmental protection incorporating, environmental costs and benefits of designing projects.

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

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

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

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

References

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FOURTH SEMESTER THEORY
ELECTIVE COURSE - FISHERY SCIENCE – III
ZOL4E12 – HARVESTING, POST HARVESTING TECHNOLOGY AND
MARKETING (90 hrs)

PART- I. HARVESTING

1. Commercial fishing method (1 hr)

- 1.2. Brief history of commercial fishing
- 1.3. Introduction to materials for construction of nets and ropes

2. Crafts and gears for harvesting (21 hrs)

- 2.1. Towed or dragged gear
 - 2.1.1. Bottom trawling
 - 2.1.2. Beam trawl
 - 2.1.3. Otter trawl
 - 2.1.4. Side trawling
 - 2.1.5. Stern trawling
 - 2.1.6. Bottom pair trawling
 - 2.1.7. Mid water (pelagic) trawling
 - 2.1.8. Targeted and selective trawling
 - 2.1.9. Turtle excluder device (TED)
 - 2.1.10. Dredging
- 2.2. Encircling gear
 - 2.2.1. Beach seining
 - 2.2.2. Purse seining
 - 2.2.3. Seine nesting
- 2.3. Static gear
 - 2.3.1. Gill nets
 - 2.3.2. Trap nets
 - 2.3.3. Long lines
 - 2.3.4. Pots and traps
- 2.4. Other gears
 - 2.4.1. Squid jigging
 - 2.4.2. Net fishing
 - 2.4.3. Harpooning
- 2.5. Fish aggregating devices (FAD)
- 2.6. Echo-sounder and sonar
- 2.7. Catch per unit effort and economic consideration of vessel operations.
- 2.8 Onboard handling and processing

Part-II- POST HARVEST TECHNOLOGY

3. Chemical composition of fish (2 hrs)

- 3.1. Chemical composition of fish muscle
- 3.2. Significance of proteins and lipids
- 3.3. Nutritive value of fish muscle over red meat

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

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

5. Fish spoilage mechanisms (4 hrs)

- 5.1. Microbial spoilage
- 5.2. Enzymatic spoilage
- 5.3. Biochemical spoilage

6. Handling of fresh fish (3 hrs)

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

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

- 7.1. Drying
- 7.2. Salting
- 7.3. Smoking
- 7.4. Freezing - plate freezers, blast freezers and individual quick freezing (IQF)
- 7.5. Battered and breaded products
- 7.6. Accelerated freeze drying (AFD)
- 7.7. Immersion freezing and cryogenic freezing
- 7.8. Canning
- 7.9. Irradiation
- 7.10. Assessment of capacity of plate, blast and IQF freezers

8. Processing of shrimps (3 hrs)

- 8.1. Commercially important prawns and shrimps of India
- 8.2. 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)
- 8.3. Grades of shrimps
- 8.4. Cooked shrimps
- 8.5. IQF shrimp

9. Processing of lobsters (3 hrs)

- 9.1. Commercially important lobsters of India
- 9.2. Pre and processing lobsters into different varieties of products
- 9.3. Grades of packing

10. Processing of cephalopods (3 hrs)

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

11. Processing of fish (4 hrs)

- 11.1. Commercially important fishes of India
- 11.2. Fish filleting
- 11.3. Surimi
- 11.4. IWP products, grades for fish products

12. Fishery by-products (9 hrs)

- 12.1. Body oil, liver oil and sauces
- 12.2. Shark fins, fin rays, fish maws/isinglass
- 12.3. Fish silage, chitin and chitosan
- 12.4. Fermented fishery products

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

- 13.1. 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
- 13.2. Requirements for registration with MPEDA, approval of processing plant by FIA allotment code

14. Quality control (7 hrs)

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

15. Packing and export of seafood (4 hrs)

- 15.1. Methods of packing of various sea food products for export
- 15.2. Identification marks
- 15.3. In house stuffing and transport in refrigerated containers

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

- 16.1. Objectives and activities of the following institutions (very brief) – CIFT, CMFRI, CIRNET, NIO, FSI, CIBA, FIA, MPEDA
- 16.2. Objectives of fishery extension
- 16.3. Qualities for fishery extension workers
- 16.4. Organizations of extension programs

Part- III- FISHERY MANAGEMENT AND INTERNATIONAL MARKETING

17. Fishery management (2 hrs)

- 17.1. Marketing of fish in India
- 17.2. Fisherman and fisherman co-operatives

18. International marketing (4 hrs)

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

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FOURTH SEMESTER THEORY
ELECTIVE COURSE - HUMAN GENETICS –III
ZOL4E12 – CANCER GENETICS AND GENETIC SERVICES (90 Hrs)

1. Cancer Genetics (30 hrs)

- 1.1 Genetic basis of cancer: Neoplasms, Tumorigenesis, Apoptosis (2 hrs)
 Classification, diagnosis, prognosis, treatment
- 1.2 Leukemia- ALL, CLL, AML, CML, Philadelphia chromosome, bcr-abl gene fusion, PML-RARA gene fusion (4 hrs)
- 1.3 Solid tumours: Breast cancer, prostate cancer, retinoblastoma, osteosarcoma, Two hit hypothesis (5 hrs)
- 1.4 Reticulo-endothelial system: lymphomas- Burkitt, Non- Hodgkin lymphoma, Multiple myeloma (3 hrs)
- 1.5 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)
- 1.6 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)
- 1.7. 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)

- 2.1 Definition, Indication for genetic counseling, Steps in genetic counseling (5 hrs)
- 2.1 Premarital genetic counseling (3 hrs)
- 2.2 Psychological aspects of genetic counseling, Special considerations in genetic counseling (4 hrs)
- 2.3 Pre-natal counseling and Population screening (3 hrs)

3. Genetic engineering (10 hrs)

- 3.1 Introduction- Molecular tools of genetic engineering (1 hr)
- 3.2 Vectors- methods of gene transfer (2 hrs)
- 3.3 Gene cloning strategies- DNA amplification, Gene libraries, site `directed mutagenesis, and protein engineering- manipulation of gene expression in host . (4 hrs)
- 3.4. Basic techniques in genetic engineering (2 hrs)
- 3.5. Agarose gel electrophoresis, Counter clamped homogenous electric field electrophoresis (CHEF), PAGE, SDS – PAGE (1 hr)

4. Gene Mapping and cloning (5 hrs)

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

4.2 Human Genome Project: Objectives, achievements and applications Positional cloning, Sequence tagged sites, Genomic library. (2 hrs)

4.3 Chromosome walking, chromosome jumping (1 hr)

5. Ethics (10 hrs)

5.1 Medical ethics in India and Abroad (2 hrs)

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

5.3 IVF ethics (3 hrs)

5.4 PND act, MTP act (2 hrs)

5.5 ELSI of new genetics (1 hr)

6 Immunogenetics (5 hrs)

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

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

6.3 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)

7.1 Biological effect of radiation, dosimetry 2hrs

7.2 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)

8.1 Twin studies (1 hr)

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

8.3 Epidemiology- descriptive and analytical methods (3 hrs)

8.4 Hardy Weinberg equilibrium- Properties of equilibrium populations Selection favouring and against heterozygotes (2 hrs)

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

References

1. Brown, T. A. (1995). Gene Cloning –3rd Ed, Chapman and Hall publications.
2. Primrose, S., Twyman, R. and Old, B. (2001)-. Principles of Gene manipulation 6th Edition Blackwell Scientific Publication.
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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: Preimplantation GeneticDiagnosis.
19. Harper Peter S: Practical Genetic Counseling

FOURTH SEMESTER THEORY
ELECTIVE COURSE: WILDLIFE BIOLOGY - III
ZOL4E12- WILDLIFE MANAGEMENT (90 Hours)

1. Wildlife Management (5 hrs)

1. Concepts and Principles
2. Policies and laws in wildlife management

2. Habitat and management (18 hrs)

- 2.1. Components of habitat (Physical and Biological), Mention different types of habitats.
- 2.2. Habitat Evaluation Procedures (HEP).
- 2.3. Habitat Suitability Index (HSI)
- 2.4. Environmental Impact Assessment (EIA).
- 2.5. Concept of herbivory, frugivory and carnivory (predation).
- 2.6. Food selection and patterns of habitat utilization.
- 2.7. 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.
- 2.8. Impacts of pollution on forest and wildlife, Environmental sanitation.
- 2.9 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)

- 3.1. Direct Count: - Total count, Drive count, Time area counts and transect Count- Indirect Count: - Call count, Track count and Pellet count/dungcount
- 3.2. Abundance estimation techniques for mammals, birds, reptiles and amphibians.
- 3.3. Capturing and Marking Techniques: - Live trapping of birds and Mammals, Chemical immobilization, methods of marking captured birds and mammals, Peterson or Lincoln Index method.
- 3.4. Determination of Age and sex in animals and birds

4. Modern Methods of Wildlife study (15 hrs)

- 4.1 Wildlife photography: Still and Videography, recording of calls, study of animal evidences.
- 4.2 Remote sensing, GIS, Radar in wildlife research.
- 4.3 Radio telemetry: Importance, scope and methodology
- 4.4 Genetics in wildlife management- Pedigree analysis and karyotyping techniques

5. Food habit analysis (8 hrs)

- 5.1 Sampling method: Direct and indirect methods, qualitative and quantitative methods
- 5.2. Kinds of study materials, preservation and analytical procedures.

6. Prey predator management (5 hrs)

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

7. Wetland Management (10 hrs)

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

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

7.3. Ramsar sites in India, Conventions on wetlands

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

8. Zoo management (10 hrs)

8.1. Basic consideration for designing a modern zoo,

8.2. Functions of a modern zoo,

8.3. Zoo layout and exhibition of animals,

8.4. Zoo services

8.5. Zoo sanitation

8.6. Captive breeding,

8.7. Safari parks

8.8. Moonlit zoo

9. Healthcare and disease management (7 hrs)

9.1 Disease monitoring and control, surveillance of disease.

9.2 Viral, bacterial, rickettsial, mycoplasmal, and protozoan disease.

9.3 Nutritional deficiency disease, worm infestation and related disease, Zoonosis.

References

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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
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8. Giles R.H. Jr. (Ed) (1984): Wildlife management techniques-3rd Edition, the wildlife society, Washington D.C.
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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.

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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 Publblication.
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

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

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

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 III
ZOL4L06 - AGRICULTURAL, MEDICAL AND FORENSIC ENTOMOLOGY

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. Cm Cambridge 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 ILaboratory.
6. Trigunayat,M.M.(2002).A Manual of practical Entomology. Scientific Publishings. Jodhpur.

FOURTH SEMESTER PRACTICALS
ELECTIVE COURSE: ENVIRONMENTAL BIOLOGY-III
ZOL4L06 – SOIL AND SEDIMENT ANALYSIS

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– III
ZOL4L06 – HARVESTING POST HARVESTING TECHNOLOGY
AND MARKETING**

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.

FOURTH SEMESTER PRACTICALS ELECTIVE COURSE - HUMAN GENETICS – III ZOL4L06 - CANCER GENETICS AND GENETIC SERVICES

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.

FOURTH SEMESTER PRACTICALS ELECTIVE COURSE: WILDLIFE BIOLOGY-III ZOL4L06 -WILD LIFE MANAGEMENT

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. Quadrant 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.