

VIMALA COLLEGE (AUTONOMOUS)

(NAAC Re-accredited(3rd Cycle): A Grade, CGPA-3.50)

Affiliated to University of Calicut



M.Sc. DEGREE PROGRAMME

IN

ZOOLOGY

**Under Credit and Semester System
(CSS)**

SYLLABUS AND SCHEME

(2017 ADMISSION ONWARDS)

**VIMALA COLLEGE
ENGINEERING COLLEGE P O, THRISSUR
KERALA- 680009, INDIA**

CREDIT DISTRIBUTION FOR THEORY COURSES

Semester	Code No. & title of the course	Credits	External weightage	Internal weightage
I	THEORY I Code- VPZO1C01 Biochemistry and Cytogenetics	4	36	5
	THEORY II Code- VPZO1C02 Biophysics & Biostatistics	4	36	5
	THEORY III Code- VPZO1C03 Systematics & Evolution	4	36	5
II	THEORY IV Code- VPZO2C04 Physiology	4	36	5
	THEORY V Code- VPZO2C05 Ecology & Ethology	4	36	5
	THEORY VI Code- VPZO2C06 Developmental biology & Endocrinology	4	36	5
III	THEORY VII Code- VPZO3C07 Molecular Biology	4	36	5
	THEORY VIII - Elective Code- VPZO3E11 Fishery Science I: Taxonomy, Biology, Physiology & Ecology	4	36	5
	THEORY IX Code- VPZO3C08 Immunology	4	36	5
	THEORY X Code- VPZO4C09 Microbiology and Biotechnology	4	36	5

IV	THEORY XI- Elective Code- VPZO4E21 Fishery Science II: Capture & Culture Fisheries	4	36	5
	THEORY XII - Elective Code- VPZO4E31 Fishery Science III: Harvesting, Post-harvesting Technology & Marketing	4	36	5

CREDIT DISTRIBUTION FOR PRACTICAL COURSES/ PROJECT/ VIVA VOCE

Semester	Code No. & title of the Course	Credits	External Weightage	Internal weightage
I & II	PRACTICAL I Code- VPZO2PL1 Biochemistry, Biophysics & Biostatistics	4	24	5
	PRACTICAL II Code- VPZO2PL2 Physiology, Developmental biology & Endocrinology	4	24	5
	PRACTICAL III Code- VPZO2PL3 Systematics, Evolution, Ecology & Ethology	4	24	5
III & IV	PRACTICAL IV Code- VPZO4PL4 Immunology, Cytogenetics Molecular Biology, Microbiology, Biotechnology & Microtechniques	4	24	5
	PRACTICAL V Code- VPZO4PL5 Fishery Science I & II	4	24	5

PRACTICAL VI Code- VPZO4PL6 Fishery Science III	4	24	5
Project work Code- VPZO4PR	4	24	5
Viva –voce Code- VPZO4V	4	24	5

Total number of theory courses - 12
Credit for each theory course - 4
Total credits for theory course – 48

Total number of practical courses - 6
Credit for each practical course - 4
Total credits for practical courses – 24

Credits for Project work - 4
Credits for Viva-voce - 4

Total credits: 80

EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

THEORY

External examination for theory papers will be conducted at the end of the each semester.

1. Weightage for each core and elective theory course shall be 36 for the external examination and 5 for the internal examination.
2. A minimum of two test papers for each course is to be conducted, of which the best performance shall be counted for internal evaluation.
3. Question paper for external evaluation shall contain 14 short answer questions with one weightage each , 7 short essay questions with two weightage each and 2 essay questions with four weightage each.
4. One seminar for each course is compulsory.

PRACTICAL

1. External practical examination for first & second semester practicals shall be conducted at end of second semester and the examination for third and fourth semester practicals at the end of fourth semester. Practical courses of the concerned theory courses shall be conducted during the same semester.
2. Weightage for each external examination of core and elective practical courses shall be 24 and the internal weightage shall be 5.

3. Weightage for the external practical examination can be distributed as follows-

With submission

- Major question (one number) - 8
- Minor question (two numbers) - 5each
- Spotters (two numbers) -1each
- Submission- 2
- Record - 2
- Total: 24**

Without

submission

- Major (one number) - 8
- Minor (two numbers) - 5 each
- Spotters (four numbers) -1 each
- Record - 2
- Total: 24**

4. No submission is required for the practical in elective course.

5. A candidate has to submit the following at the time of practical examination related to Practical IV

Whole mount - 4 numbers

Slides: Histology - 4 numbers

Slides: Histochemistry - 2 numbers (To show the presence of carbohydrate and protein. Control not required)

6. Attested Record is compulsory for appearing in the practical examination. The candidate has to submit the field study / tour reports on the day of Practical III and VI.

PROJECT

1. Students are required to undertake project work on problems pertaining to any topic included in the syllabi, inclusive of the elective course. The research work on the chosen topic shall be carried out by each student under the supervision of a teacher.

2. Two hours per week under practical work may be allotted during the third and fourth semesters for the project work.

3. The report of the research work shall be submitted by each student in the form of a dissertation which shall be submitted for the evaluation a day prior to the date of viva-voce pertaining to the dissertation.

4. 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.

5. Project report should 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.

6. Criteria for the evaluation of dissertations

Sl.No.	Criteria	Weightage
1	Introduction & review of literature	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 student	1
8	Style and neatness of the dissertation	1
9	References	3
	Total	24

7. Criteria for the Viva- voce

Sl.No.	Criteria	Weightage
A. Power point presentation of project work		
B.		
1	Quality and correctness of slides	2
2	Time management	2
3	Way of presentation	2
4	Clarity of presentation	3
5	Communication skill	3
6	Answers to questions	4
	Subtotal	16
C. General Viva-voce		
1	Knowledge of the student	3
2	Communication	2
3	Answers to questions	3
	Subtotal	8
	Grand Total	24

FIRST SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY I - BIOCHEMISTRY AND CYTOGENETICS
Code: VPZO1C01
(90 Hours)

Part A Biochemistry (54 hrs)

Section - A - Chemistry and functions of Biomolecules

Unit 1. Introduction (2 hrs)

1.1 Macromolecules and their subunits

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

Unit 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.

Unit 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 -parallel & antiparallel and B-pleated sheet), random coil conformation, Tertiary structure, Quarternary structure.

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

3.2.3. Biological roles of proteins

Unit 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 - Geneva system

Unit 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

Section - B - 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.

Section - C - 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.

Section - D - Metabolism and biosynthesis of biomolecules

Unit 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

Unit 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.

Unit 3. Lipid metabolism (5 hrs)

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

Unit 4. Nucleic acid metabolism (4 hrs)

- 4.1. Biosynthesis and degradation of purines and pyrimidines

References:

1. David L Nelson & Michael M Cox Lehninger, Principles of Biochemistry, VIth edition, (2013) Mac Millan
2. Robert Harper's Biochemistry, (2012) 29th Edition, K. Murray, Daryl K. Granner, Peter, A. Mayes and Victor, W. Rodwell Appleton and Lange, Prentice Hall of India Private limited, New Delhi,
3. Lubert Stryer, (2011) Biochemistry, VIIth edition, W.H. Freeman & Co.
4. Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi, (2007) Outlines of Biochemistry, Vth edition, John Wiley & Sons, Inc.
5. Deb, A.C. (2004) Fundamentals of biochemistry, New Central Book Agency (P) Ltd.
6. Keith Wilson and John Walker (2008) Principles and techniques of Biochemistry and Molecular biology - 6th edn, Cambridge University Press
7. Voet, D. and Voet, J.G. & Pratt (2012). Principles of Biochemistry, John Wiley & sons .
8. Zubay, G (1997). Biochemistry, Mc Graw – Hill Publications
10. Devlin, T.M. (2010). A Text of Biochemistry with clinical correlations, John Wiley & sons.
9. Lehninger, A. L. (2008). Principles of Biochemistry. (5th edn). CBS Publishers and Distributors, New Delhi.
10. Mathews, H. R., Freeland, R. and Miesfeld, R. L. (1997). Biochemistry: A Short Course – Wiley- Liss, Inc. NY.
11. Mary, K. Campbell (1995) Biochemistry. II Ed. Harcourt Brace and Co. Florida.
12. Murray, Robert, Granner, K. and Harper, Daryl K. (2006). Harper's Illustrated Biochemistry. Mc Graw-Hill, New York.

- 13.. Nelson, D. L. Cox, M. M. and Lehninger, A. L. (2007). Principles of Biochemistry, 4th Ed. Freeman and Co, NY.
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- 15 Zubay, G. L., Parson, W. W. and Vance, D. E. (1995). Principles of Biochemistry, Brown Publishers, England

Part B. Cytogenetics (36 hrs)

Unit 1. Introduction to cytogenetics. (1 hr)

Unit 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.

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

Nucleus, mitochondria, golgi complex, lysosomes, endoplasmic reticulum , ribosomes, peroxisomes and cytoskeleton.

Unit 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.

Unit 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.

Unit 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

Unit 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:

1. Becker, W. M., Reece, J. B. and Poenie, M. F. (1999; 2000). The World of the Cell, 4th edition, Benjamin/Cummings Publishing Co.
2. Benjamin Lewin (2008). Genes IX. Jones & Bartlett Learning Publishers, New York.
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5. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York.
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7. Peter Snustad, D. and Michael J. Simmons (2000). Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
8. Purves W. K., Orians G. H. and Heller H. C. (1995). Life: The Science of Biology, 4th Edition. Sinauer Associates, Sunderland.
9. Robert H. Tamarin (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New Delhi.
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11. Watson J. D., Hopkins N. H., Roberts, J. W., Steits, J. A. and Weiner, A. M. (1987). Molecular Biology of the Gene 4th Edition. The Benjamin Cumming Publishing Company. Menlo Park, California.

FIRST SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY II- BIOPHYSICS AND BIostatISTICS
Code: VPZO1C02
(90 Hours)

SECTION A: BIOPHYSICS (55 hrs)

Unit 1. Matter and mechanics of cells (3 hrs)

- 1.1 Colloids, properties of colloids, forms of colloids, Brownian movement and Tyndall Phenomena

Unit 2. Diffusion and Osmosis (5 hrs)

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

Unit 3. pH (2 hrs)

- 3.1 Dissociation of water
- 3.2 Dissociation of a weak acid
- 3.3 Henderson Hasselbalch equation
- 3.4 Buffers
- 3.5 pH meter
- 3.6 pH value calculation

Unit 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 reception and theories
- 4.7 Infrasonic and ultrasonic sounds

Unit 5. Radiation Biology (9 hrs)

- 5.1 Properties of different types of radio isotopes normally used in biology, their detection and measurement, incorporation of radioisotopes in biological tissues and cells
- 5.2 Molecular imaging of radioactive material, safety guidelines
- 5.3 Biological effects of radiations
- 5.4 Radiation protection and therapy, nuclear medicine
- 5.5 Applications of tracer techniques- radiation dosimetry, radioactive isotopes, ionizing radiations, radiation detectors (GM Counter, Liquid Scintillation Counter)
- 5.6 Autoradiography

Unit 6. Biophysical methods (Brief account) (5 hrs)

- 6.1 Analysis of biomolecules- using UV / visible fluorescence, circular dichroism
- 6.2 NMR and Electron Spin Resonance (ESR) spectroscopy
- 6.3 Structure determination using X-ray diffraction and NMR, analysis using light scattering
- 6.4 Different types of mass spectrometry and surface plasma resonance methods

Unit 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, f MRI, CAT

Unit 8. Principles and applications (8 hrs)

- 8.1 Microscopy (Fluorescent, interference, confocal -scanning and transmission electron microscopes), resolving powers of different microscopes
- 8.2 Different fixation and staining techniques for EM (freeze-etch & freeze fracture methods)
- 8.3 Image processing methods in microscopy
- 8.4 Laser and its applications in biology

Unit 9. Separation Techniques (10 hrs)

- 9.1 Chromatography (adsorption, partition and ion-exchange chromatography, column, paper, thin-layer, gel-filtration, gas chromatography, affinity chromatography, HPLC)
- 9.2 Electrophoresis (paper, disc, PAGE, two dimensional PAGE, high voltage and Immunoelectrophoresis)
- 9.3 Isoelectric focusing
- 9.4 Flow cytometry

Unit 10. Influence of gravity (3 hrs)

- 10.1 Human body posture in the gravitational field
- 10.2 Influence of G force
- 10.3 Force of centrifugal acceleration, importance in 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

Unit 11. Nanotechnology (2 hrs)

- 11.1 Definition
- 11.2 Nanotechnology and its applications in the field of health care
- 11.3 Roles of nanotechnology in environmental management

SECTION B: BIOSTATISTICS (35 hrs)**Unit 1. Introduction (2 hrs)**

- 1.1 Biostatistics- definition, terms, applications
- 1.2 Role of biostatistics in modern research.

Unit 2. Data collection (7 hrs)

- 2.1 Types of data- Primary, secondary, qualitative, quantitative
- 2.2 Methods of data collection and classification- types of sampling methods, advantages and disadvantages of census and sampling method
- 2.3 Classification of data- tabulation, methods of classification, class intervals (exclusive and inclusive method)
- 2.4 Diagrammatic and graphical presentation of data- Bar diagram (types), pie diagram, histograms, frequency polygon, frequency curve (skewness, kurtosis, ogive)

Unit 3. Statistical Methods (8 hrs)

- 3.1 Measures of central tendency and dispersal - mean, median, mode, quartile
- 3.2 Range, mean deviation, Quartiles deviation, variance, standard deviation, standard error, degree of freedom

Unit 4. Statistical Inference (7 hrs)

- 4.1 Difference between parametric and non-parametric statistics
- 4.2 Testing of hypothesis
- 4.3 Errors
- 4.4 Confidence interval, levels of significance, critical region
- 4.5 Normality test
- 4.6 t-test, chi-square test, F-test, ANOVA
- 4.7 Kruskal-Wallis, Mann-Whitney

Unit 5. Correlation and Regression (7 hrs)

- 5.1 Types of correlation
- 5.2 Methods to measure correlation- scatter diagram, Karlpearson's coefficient of correlation, Spearman's correlation
- 5.3 Types of regression analysis
- 5.4 Regression equations
- 5.5 Difference between regression and correlation analysis

Unit 6. Probability distributions (4 hrs)

- 6.1 Basic concepts and definition:
- 6.2 Laws of probability
- 6.3 Probability distribution (Binomial, poisson and normal)

REFERENCES

Biophysics

1. Ackerman E. (1962) Biophysical Science, Prentice Hall Inc.
2. Alonso A. and Arrondo J.L.R (2006) Advanced techniques in Biophysics, Springer
3. Alok Srivastava and Ipsita Roy (2009) Bio-Nano- Geo Sciences- The future challenge, Ane Books Ltd.
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18. Srivastava P.K (2006) Elementary Biophysics: An introduction, Narosa publishing house, New Delhi.
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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 Stongtton, London.
3. Campell R.C. (1978) Statistics for biologists, Blacker and Sons Publishers, Bombay.
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FIRST SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY III- SYSTEMATICS AND EVOLUTION
Code: VPZO1C03
(90 Hours)

SECTION A: SYSTEMATICS (45 hours)

Unit 1. Definition and basic concepts in Systematics and Taxonomy (4 hrs)

- 1.1 Historical resume of systematics
- 1.2 Levels of taxonomy - Alpha, Beta, Gamma
- 1.3 Importance and application of Taxonomy
- 1.4 Goals of taxonomy

Unit 2. Classification (4 hrs)

- 2.1 Practice of classification, purpose of classification
- 2.2 Use of classification- storage of data, recovery of data
- 2.3 Theories of biological classification, hierarchy of categories
- 2.4 Types of classification- evolutionary & phylogenetic classification, typological classification, phonetic classification, omnispersive classification, horizontal and vertical classification
- 2.5 Components of classification

Unit 3. Taxonomic procedure (8 hrs)

- 3.1 Taxonomic collections- types of collections, value of collections, types of Museum collections
- 3.2 Curation- preservation of collection in field and laboratory
- 3.3 Recording of field data, storage of collection, labelling and cataloguing of collections
- 3.4 Identification- methods of identification, use of keys, kinds of keys, their merits and demerits
- 3.5 Taxonomic descriptions, presentation of findings
- 3.6 Kinds of taxonomic publications, ecological publication and their difference

Unit 4. Species concepts (7 hrs)

- 4.1 Species category- different species concepts- typological, Nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological species concepts)
- 4.2 Taxonomic diversity within species, different kinds of species, sub species and other infra specific categories, hybrids

Unit 5. Taxonomic character (4 hrs)

- 5.1 Different kinds of taxonomic characters
- 5.2 Functions of taxonomic characters
- 5.3 Taxonomic characters and classification
- 5.4 Taxonomic characters and evolution

Unit 6. Zoological nomenclature (5 hrs)

- 6.1 International Code of Zoological Nomenclature, development of Code of Zoological

Nomenclature: its operative principles, interpretation and application of important rules in the formation of scientific names of various taxa

6.2 Principle of priority, homonymy and synonymy

6.3 Type method and its significance, different kinds of types in descriptive taxonomy

Unit 7. Newer trends in systematic (4 hrs)

7.1 Chemo and serotaxonomy

7.2 Cytotaxonomy

7.3 Numerical taxonomy

7.4 Cladistics

7.5 Molecular systematic

7.6 DNA bar coding vs traditional taxonomy

Unit 8. Ethics in taxonomy (5 hrs)

8.1 Ethics related to collections

Credit

Lending and borrowing of specimens

Loan of material

Exchange of materials

Collaboration and co-operation with co-workers

Use of language

8.2 Ethics related to taxonomic publications

Authorship of taxonomic papers

Correspondence

Suppression of data

Undesirable features of taxonomic papers

8.3 Taxonomists and user communities

Unit 9. Taxonomic impediments (4 hrs)

9.1 Impediments to build up taxonomic collections and maintenance

9.2 Shortage of man power

9.3 Lack of funding for taxonomic research

9.4 Lack of training in taxonomy

9.5 Lack of library facilities

9.6 Impediments in publishing taxonomic work

9.7 Solutions to overcome the impediments

International co-operation, development of taxonomic centres

9.8 Need for efficient international networking

9.9 The desired end product

SECTION B: EVOLUTION (45 hrs)

Unit 1. 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 sex characteristics, sexy son hypothesis, good genes hypothesis

Unit 2. The Mechanisms (10 hrs)

2.1 Population genetics – populations, gene pool, gene frequency, Hardy-Weinberg law,

founder principle, bottleneck effect and genetic drift as factors in speciation.

2.2 Isolating mechanisms- Prezygotic and Postzygotic isolating mechanisms

2.3 Speciation-allopatric, peripatric, parapatric, heteropatric, sympatric speciation, ecotypes

2.4 Co-evolution, Microevolution, Macroevolution, convergent (homoplasy), divergent and parallel evolution

Unit 3. Tempo of evolution (8 hrs)

3.1 Gradualism vs punctuated equilibrium

3.2 Anagenesis vs Cladogenesis

Unit 4. Molecular evolution (10 hrs)

4.1 Neutral theory of molecular evolution, molecular divergence, molecular drive

4.2 Molecular clocks, genetic equidistance, human mitochondrial molecular clock

4.3 Phylogenetic relationships- homology, orthologous, paralogous, parsimony, homologous sequences of protein and DNA analysis, nucleotide sequence analysis, DNA bar coding vs traditional taxonomy

Unit 5. Evolutionary trends (10 hrs)

5.1 Biochemical evolution- RNA world hypothesis, collapse of Orthogenesis, Evo-Devo, heterochrony, heterotopy, heterometry and heterotypy

5.2 Stages in primate evolution- *Homo*, dry and wet nosed primates, prosimians and simians, humans, African origin for modern humans. Y-chromosomal Adam- mitochondrial Eve

5.3 Communication, speech, language and self awareness in primates

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SECOND SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY IV- PHYSIOLOGY
Code: VPZO2C04
(90 Hours)

Unit 1. Nutrition (12 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 Digestion of carbohydrate, protein & lipids, brief note on the role of salivary glands, liver, pancreas and intestinal glands in digestion
- 1.5 Absorption of carbohydrates, lipids, amino acids, water, electrolytes, vitamins & minerals
- 1.6 Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation
- 1.7 The role of hormones and neurotransmitters in the control of gastrointestinal motility
- 1.8 Energy balance and obesity, causes and consequences
- 1.9 BMR and its significance

Unit 2. Excretory system (12 hrs)

- 2.1 Introduction- brief description of different types of excretory organs in different animal groups
- 2.2 Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus- structure, parts and function
- 2.3 Urine formation (glomerular filtration, tubular re-absorption 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
- 2.6 Composition (normal & abnormal) and characteristics of urine
- 2.7 Physiology of micturition
- 2.8 Renal clearance – definition, concept and significance, clearance value of urea, creatinine, phosphate, potassium, chloride and sodium

Unit 3. Respiratory system (13 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
- 3.8 Transport of gases -transport of oxygen and carbon dioxide
Oxygen dissociation curve - factors affecting binding of oxygen to haemoglobin (pO_2 , pCO_2 , CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin)
- 3.9 Neural and chemical regulation of respiration

Unit 4. Nervous system (18 hrs)

4.1 Introduction- basic details of neurons and action potential

4.2 Gross neuroanatomy of the brain (histology & neural pathway not expected)

Cerebral cortex -motor cortex, mention functional areas (including specialized areas) and their motor functions

Cerebral cortex- Association areas, their sub areas and their functions, Wernicke's area and its intellectual function

Memory – definition, types of memory (positive and negative memory), brief note on the mechanism of short term, intermediate long term and long term memory, consolidation of memory

Brain stem – list the components (medulla, pons, mesencephalon, reticular and vestibular nuclei) and functions

Cerebellum- mention parts and functions

Basal ganglia – mention components and functions

Limbic system; structure and functions (emotion and motivation)

4.3 Gross neuroanatomy of the spinal cord

Spinal cord - structural organization

Reflex action – reflex arc, muscle spindle, golgi tendon organ

Types of reflexes- monosynaptic reflex (Muscle stretch reflex, negative stretch reflex), polysynaptic reflex (withdrawal reflex)

4.4 Diseased states of brain – brief description of epilepsy, depression, schizophrenia,

Alzheimer's disease, senile dementia & Parkinson's disease

Unit 5. Special senses (13 hrs)

5.1 Vision

Structure of eyeball

Fluid systems of the eye

Layers of Retina and photoreceptors (rods & cones)

Brief notes on the neuronal cell types and neural circuitry of the retina and visual pathways from retina to visual cortex Image formation, formation of image on the retina, brief general account of electrophysiology of vision, photochemistry of vision & colour vision, problems related to vision

5.2 Taste, primary sensations of taste (agents and site of sensation)

Taste buds (location, structure, receptors and nerve supply)

physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS)

5.3 Smell, olfactory membrane and receptor cells

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

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

6.1 Mechanoreceptors and their stimulation

6.2 Pain receptors and their stimulation

6.3 Thermal receptors and their stimulation

Unit 7. Cardiovascular system (8 hrs)

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 ECG – Principle and application
- 7.7 Neural and chemical regulation of heart function
- 7.8 Blood volume and blood pressure
- 7.9 Physiological anatomy of coronary blood flow, coronary blood flow and its control
- 7.10 Ischemic heart disease – mention causes and example

Unit 8. Lymphatic system (5hrs)

- 8.1 Lymph channels of the body
- 8.2 Composition and formation of lymph
- 8.3 Functions of lymph and lymphatic system including role in controlling interstitial fluid, protein concentration, interstitial fluid volume and interstitial fluid pressure

Unit 9. Environmental physiology (5hrs)

- 9.1 Thermoregulation
Comfort zone, normal body temperatures (oral, skin & core), heat production & heat loss, factors affecting body temperature, lethal temperature
- 9.2 Temperature regulating mechanisms (hot & cold), mention the role of hypothalamus, thyroid and adrenal glands
- 9.3 Acclimatization

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SECOND SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY V: ECOLOGY AND ETHOLOGY
Code: VPZO2C05
(90 Hours)

SECTION A: ECOLOGY (65 hrs)

Unit 1. Natural history of Indian subcontinent (3 hrs)

- 1.1 Major habitat types of the subcontinent
- 1.2 Geographic origin and migration of species
- 1.3 Seasonality of the subcontinent
- 1.4 Resistance and resilience stability
- 1.5 Gaia hypothesis

Unit 2. Habitat and niche (3 hrs)

- 2.1 Concept of habitat and niche
- 2.2 Niche width and overlap
- 2.3 Fundamental and realized niche
- 2.4 Resource partitioning
- 2.5 Character displacement

Unit 3. Ecosystem (9 hrs)

- 3.1 Structure and function
- 3.2 Ecosystem energetics
- 3.3 Primary production
- 3.4 Energy flow models
- 3.5 Mineral cycling (CNP)
- 3.6 Trophic levels, food chain, food web and secondary production.
- 3.7 Decomposers and detritivores
- 3.8 Structure and function of some Indian ecosystems-
Terrestrial- major forest types in India with their features, grassland, desert
Fresh water, marine, coral reef, estuarine, wetland and mangrove ecosystems

Unit 4. Population Ecology (7 hrs)

- 4.1 Characteristics of a population
- 4.2 Methods of estimating population density of animals, ranging patterns through direct, indirect and remote observations
- 4.3 Sampling methods in the study of behaviour, habitat characterization
- 4.4 Ground and remote sensing methods
- 4.5 Population growth curves, life tables, survivorship curves, population regulation, life history strategies, r and k selection, demes and dispersal, interdemic extinctions, age structure of populations
- 4.6 Growth and regulation of human population

Unit 5. Species interaction (6 hrs)

- 5.1 Types of interactions, interspecific competition
- 5.2 Herbivory, carnivory, pollination, symbiosis, mutualism, commensalisms and proto-co-Operation

Unit 6. Community Ecology (7 hrs)

6.1 Nature of communities

6.2 Characteristics of a biotic community

6.3 Species diversity and its measurements

Alpha diversity- Simpson's Diversity Index -Shannon index -Fisher's Alpha- Rarefaction,
Beta diversity –Sorensen's similarity index-Whittaker's measure

Gamma diversity –Guild and its functioning in the community

6.4 Latitudinal gradients in diversity

6.5 Edges and ecotones

Unit 7. Ecological succession (4 hrs)

7.1 Types, mechanisms

7.2 Changes involved in succession

7.3 Concept of climax

Unit 8. Biogeography (6 hrs)

8.1 Major terrestrial biomes:

Tropical rain Forest, grassland, desert, chaparral, temperate deciduous forest, temperate boreal forest, tundra, savanna

Unit 9. Theory of island biogeography (4 hrs)

9.1 Theory, influencing factors

9.2 Applications in conservation biology

9.3 Species-area relationship -single large or several small (SLOSS)

9.4 Development of habitat corridors

Unit 10. Biogeographical zones of India (4 hrs)

10.1 Trans Himalayan zone

10.2 Himalayan zone

10.3 Desert zone

10.4 Semiarid zone

10.5 Western Ghats zone

10.6 Deccan plateau zone

10.7 Gangetic plain zone

10.8 North east zone

10.9 Coastal zone

10.10 Islands present near the shore line

Unit 11. Applied ecology (8 hrs)

11.1 Environmental pollution (air, water, terrestrial and noise pollution)-
causes and consequences

11.2 Global environmental change (global warming and ozone layer depletion), climate change

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

11.4 Biodiversity management approaches- *Ex situ* and *in situ* conservation strategies

Unit 12. Conservation Biology (4 hrs)

12.1 Principles of conservation

12.2 Major approaches to management with reference to Indian case studies on conservation & management strategy (concepts of project tiger, biosphere reserves)

SECTION B: ETHOLOGY (25 hrs)

Unit 1. Introduction (4 hrs)

1.1 Ethology as different from the other schools studying animal behaviour like behaviourism
Behaviour as a reaction to stimuli - sign stimuli, social releasers

1.2 Ethograms, super normal stimuli, stimulus filtering

Unit 2. Motivating factors (5 hrs)

2.1 General factors in motivation, studies of motivation in guppies

2.2 Mating systems-parental investment and reproductive success

Unit 3. Conflict behaviour (3 hrs)

3.1 Stress-displacement activities, ritualization

Unit 4. Instinct behaviour and reflex action (2 hrs)

Neural basis of sleep and arousal

Unit 5. Adaptiveness of behavior (2 hrs)

J.P.Scotts categories of behaviour

Unit 6. External stimulus - circadian rhythms (3 hrs)

Unit 7. Parental care -Social behaviour (3 hrs)

Termites

Primates (Macaque, Langurs)

Unit 8. Evolution of behaviour (3 hrs)

Altruism, kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour, domestication and behavioural changes

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SECOND SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY VI: DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY
Code : VPZO2C06
(90 Hours)

SECTION A: DEVELOPMENTAL BIOLOGY (55 hrs)

Unit 1. Introduction- Basic concepts of development (7 hrs)

- 1.1 Potency
- 1.2 Commitment
- 1.3 Specification - autonomous, conditional
- 1.4 Induction
- 1.5 Competence
- 1.6 Determination and differentiation
- 1.7 Morphogenetic gradients

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

- 2.1 Production of gametes
- 2.2 Cell surface molecules in sperm-egg recognition in animals
- 2.3 Zygote formation
- 2.4 Cleavage and blastula formation
- 2.5 Embryonic fields
- 2.6 Gastrulation and formation of germ layers in amphibia

Unit 3. Embryogenesis and Organogenesis (10 hrs)

- 3.1 Axis formation in amphibians - primary embryonic induction
- 3.2 Anterior posterior patterning in Amphibians - Hox code hypothesis
- 3.3 Anterior posterior patterning in Drosophila - gap genes, bicoid gradient, segmentation genes, pair rule genes, homeotic selector genes, realistor genes
- 3.4 Dorsoventral patterning and left right patterning - dorsal protein gradient in Drosophila
- 3.6 Limb development in chick
- 3.7 Insect wings and legs
- 3.8 Vulva formation in *Caenorhabditis elegans*

Unit 4. Cellular and Molecular basis of development (10 hrs)

- 4.1 Cellular interactions during development
Epithelial - mesenchymal interactions, paracrine factors, RTK pathway, JAK-STAT pathway, cell death pathways
- 4.2 Cellular interactions concerned in fertilization
- 4.3 Cellular changes during blastulation and gastrulation
- 4.4 Cellular interactions in organogenesis
- 4.5 Molecular basis of cellular differentiation - cadherins

Unit 5. Genetic basis of development (7 hrs)

- 5.1 Differential gene expression
Promoters, transcription factors, silencers, DNA methylation, insulators, dosage compensation, differential RNA processing
- 5.2 Models of cell differentiation

5.3 Reversibility of patterns of gene activity

Unit 6. Metamorphosis, Regeneration and Aging (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 – cellular and extra cellular aging, causes, wear and tear, oxidative damage, mitochondrial genome damage, genetically programmed aging

Unit 7. Environmental regulation of animal development (4 hrs)

- 7.1 Environmental regulation of normal development – types of polyphenism
sex determination in *Bonellia*, primary and secondary sex determination, environmental sex determination
- 7.2 Environmental disruptions of normal development (Teratogenesis)
Teratogenic agents - Alcohol, retinoic acid, bisphenol, heavy metals, pathogen
- 7.3 Environmental oestrogens

SECTION B: ENDOCRINOLOGY (35 hrs)

Unit 1. Endocrine glands and their hormones (Brief account) (3 hrs)

- 1.1 Hormone secreting 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 Physiological roles of hormones
- 1.5 Control of hormone secretion

Unit 2. General mechanisms of Hormonal action (5 hrs)

- 2.1 Cell signalling
- 2.2 Receptors and transducers, types of receptors, regulation of receptor number, receptor activation
- 2.3 Second messengers of hormone action, receptor signal transduction
- 2.4 Eicosanoids and hormone action

Unit 3. Endocrine glands (15 hrs)

Structure, physiological functions and control of secretion of their hormones and pathophysiology of

- 3.1 Hypothalamus
- 3.2 Hypophysis
- 3.3 Thyroid
- 3.4 Parathyroid
- 3.5 Adrenal
- 3.6 Pancreas

Unit 4. Hormones and male reproductive physiology (3 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

Unit 5. Hormones and female reproductive physiology (6 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

Unit 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

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THIRD SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY VII- MOLECULAR BIOLOGY
Code: VPZO3C07
(90 Hours)

Unit 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

Unit 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

Unit 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

Unit 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)

Unit 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

Unit 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

Unit 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

Unit 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)

Unit 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

Unit 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

Unit 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

Unit 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

Unit 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)

Unit 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.

Unit 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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THIRD SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY VIII- ELECTIVE
FISHERY SCIENCE-I
TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY
Code: VPZO3E11
(90 Hours)

SECTION A: TAXONOMY (5 hrs)

Unit 1. Fish Taxonomy (5 hrs)

1.1 Classification and distribution of economically important fin fishes

SECTION B: FISH BIOLOGY (20 hrs)

Unit 1. Integument (10 hrs)

- 1.1 Exoskeleton
- 1.2 Skin and scales
- 1.3 Colouration
- 1.4 Chromatophores and pigments
- 1.5 Structure, function and modification of fins

Unit 2. Locomotion (5 hr)

- 2.1 Body shape and musculature
- 2.2 Mechanism of propulsion- forces
- 2.3 Types of locomotion

Unit 3. Life history of fishes (5 hrs)

- 3.1 Reproduction, reproductive hormones, reproductive behaviour, oviparity, ovoviviparity
- 3.2 Age and growth
- 3.3 Migration

SECTION C: PHYSIOLOGY (40 hrs)

Unit 1. Digestive physiology (10 hrs)

- 1.1 Food and feeding
- 1.2 Feeding behaviour
- 1.3 Feeding mechanism
- 1.4 Digestive enzymes
- 1.5 Absorption

Unit 2. Circulatory physiology (6 hrs)

- 2.1 Heart
- 2.2 Blood, blood cells, blood pigments and functions of blood
- 2.3 Circulation

Unit 3. Respiratory physiology (6 hrs)

- 3.1 Gills and accessory respiratory organs
- 3.2 Gas transport

Unit 4. Excretory and osmoregulatory physiology (6 hrs)

- 4.1 Excretory organs
- 4.2 Osmoregulation in marine, brackish water and fresh water fishes

Unit 5. Endocrine physiology (6 hrs)

- 5.1 Endocrine glands – structure and function
- 5.2 Regulation of endocrine secretion
- 5.3 Crustacean neurosecretory system and their role in reproduction

Unit 6. Adaptive physiology (6 hrs)

- 6.1 Deep sea fishes
- 6.2 Cave dwelling fishes
- 6.3 Hill stream fishes

SECTION D: ECOLOGY (25 hrs)

Unit 1. Oceanography (15 hrs)

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

Unit 2. Brackish water ecology (5 hrs)

- 2.1 Characteristics of brackish and estuarine waters
- 2.2 Estuarine productivity

Unit 3. Limnology (5 hrs)

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

THIRD SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY IX- IMMUNOLOGY
Code: VPZO4C08
(90 Hours)

Unit 1. Introduction (6 hrs)

- 1.1 Innate and adaptive immunity
- 1.2 Cells and organs of the immune system
- 1.3 Antigens, antigenicity, immunogenicity and haptens
- 1.4 Factors influencing immunogenicity

Unit 2. Antibodies (14 hrs)

- 2.1 Structure and functions of antibody molecules
- 2.2 Generation of antibody diversity
- 2.3 Monoclonal antibodies - Hybridoma technology and applications
- 2.4 Antibody engineering

Unit 3. Antigen-Antibody Interactions (16 hrs)

- 3.1 Strength of antigen antibody interactions
- 3.2 Cross reactivity, precipitation reactions, agglutination reactions
- 3.3 Immunotechniques - ELISA, RIA, Western Blot, Immunoprecipitation, Immunofluorescence microscopy, Flow cytometry

Unit 4. Generation of B cell & T cell response (12 hrs)

- 4.1 Humoral & cell mediated response
- 4.2 B & T cell receptors and CD3 Complex
- 4.3 Properties of B cell & T cell epitopes
- 4.4 Activation and differentiation of B and T cells

Unit 5. Immune effector mechanisms (12 hrs)

- 5.1 Cytokines & antagonists
- 5.2 Complement System- components & functions
- 5.3 Complement activation and regulations (classical, alternate and lectin pathways)
- 5.4 Toll –like receptors
- 5.5 Cell mediated effector functions
- 5.6 Inflammation & hypersensitivity

Unit 6. Major Histocompatibility Complex (MHC) (10 hrs)

- 6.1 General organisation and inheritance of MHC
- 6.2 MHC genes & molecules
- 6.3 Cellular distribution of MHC molecules
- 6.4 MHC and immune response
- 6.5 Antigen processing and presentation –Endogenous and Exogenous pathways
Presentation of non peptide bacterial antigens

Unit 7. Immune system in health and diseases (20 hrs)

- 7.1 Immune responses in bacterial (tuberculosis) parasitic (malaria) and viral (HIV) infections

- 7.2 Autoimmune diseases (organ specific and systemic)
- 7.3 Primary Immunodeficiency diseases -Bruton's disease, Di-George Syndrome & Severe combined immunodeficiency (SCID)
- 7.4 Secondary immunodeficiency diseases -AIDS (origin, means of infection, course of infection, structure and types of HIV, viral multiplication, mutation, diagnosis, antiretroviral therapy and AIDS vaccine)
- 7.5 Vaccines –Recombinant , DNA vaccines, synthetic peptide vaccines and multivalent vaccines

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**FOURTH SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY X- MICROBIOLOGY & BIOTECHNOLOGY**

Code: VPZO4C09

(90 Hours)

SECTION A: MICROBIOLOGY (45 Hours)

1. Introduction (3 hrs)

- 1.1 History and scope of microbiology
- 1.2 Spontaneous generation concept
- 1.3 Recognition of the role of microbes in diseases
- 1.4 Composition of the microbial world
- 1.5 Turning points in microbial research
- 1.6 Microorganisms and the evolution of the earth
- 1.7 Modern age of microbiology

Unit 2. Microbial taxonomy and phylogeny (4 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 Manual (mention major groups)

Unit 3. Bacterial cell structure and function (6 hrs)

- 3.1 Plasma membrane and internal system - cytomatrix, inclusions, ribosomes, nucleoid
- 3.2 Bacterial cell wall –peptidoglycan, structure
- 3.3 Gram positive and gram negative cell wall- mechanism of gram staining
- 3.4 Components external to cell wall- pili and fimbriae, capsule and slime layers
- 3.5 Flagella and motility

Unit 4. Microbial nutrition (3 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

Unit 5. Microbial growth (5 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, Hauser counting Chamber, Spread plate and pour plate techniques
- 5.6 Measurement of cell mass-turbidity and microbial mass measurements

Unit 6. Utilization of energy (4 hrs)

- 6.1 Biosynthetic process-
Peptidoglycan synthesis, amino acid synthesis, non synthetic processes
- 6.2 Bacterial motility and transport of nutrients

Unit 7. Viruses (4 hrs)

7.1 General structural properties

7.2 Types- DNA viruses, RNA viruses, and enveloped viruses

Unit 8. Microbial diseases (4 hrs)

8.1 Human diseases caused by bacteria- *Streptococcal* diseases, typhoid, cholera, tetanus, leprosy, tuberculosis and Pneumonia

8.2 Human diseases caused by viruses - AIDS, small pox, rabies, measles, swine flu, bird flu, SARS

8.3 Fungal diseases- candidiasis

Unit 9. Control of microorganisms (5 hrs)

9.1 Disinfectants-

Physical- heat, filtration and radiation

Chemical agents - phenol and phenolic compounds, alcohols, halogens and aldehydes

9.2 Antibiotics- Penicillin's, Cephalosporins, Chloramphenicol, Tetracyclines

9.3 Microbial drug resistance

Unit 10. Microbial fermentation (4 hrs)

10.1 Lactic fermentation - homolactic and heterolactic fermenters

10.2 Dairy products cheese, Yogurt, kefir (brief)

10.2 Alcoholic fermentation- alcoholic beverages

Unit 11. Environmental microbiology (3 hrs)

11.1 Aquatic microbes

11.2 Microbiological analysis of drinking water

11.3 Waste water- microbial characteristics and treatment

11.4 Microbial Bioremediation- microbial fouling and corrosion

11.5 Biogas plants

SECTION B: BIOTECHNOLOGY (45 hrs)

Unit 1. Introduction (1 hr)

1.1 Definition, scope and importance

1.2 Branches

Unit 2. Genetic engineering (4 hrs)

2.1 Cloning vectors – properties of a good cloning vector

2.2 Types of vectors -

Plasmids - pBR322, pBR327, pUC

Phages - lambda phage, M13

Cosmids, Phagemids, viruses, BAC, YAC and MAC

2.3 Shuttle vectors and expression vectors

2.4 Enzymes for r DNA technology- restriction enzymes and ligases

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

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

Unit 4. Molecular probes (2 hrs)

4.1 Production

4.2 Labelling

4.3 Applications

Unit 5. Genomic and cDNA library (4 hrs)

5.1 Construction

5.2 Screening by - DNA hybridization, immunological assay, protein activity

5.3 Blotting techniques - Southern blot, northern blot, western blot, dot blot and slot blot

5.4 FISH and GISH, chromosome walking

Unit 6. Polymerase Chain Reaction (2 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

Unit 7. Molecular markers (brief notes) (3 hrs)

7.1 RFLP

7.2 AFLP

7.3 RAPD

7.4 Minisatellites (VNTR)

7.5 Microsatellites (SSR)

7.6 SNPs

Unit 8. Isolation, sequencing and synthesis of genes (4 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

Unit 9. Transfection methods and transgenic animals (3 hrs)

9.1 Definition, methods of transfection - 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

Unit 10. Biotechnology - animal and human health care (3 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

Unit 11. *In vitro* fertilization (2 hrs)

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

Unit 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

Unit 13. Gene Silencing techniques (2 hrs)

- 13.1 Antisense RNA
- 13.2 RNAi

Unit 14. Cloning (2 hrs)

- 14.1 Cloning procedures (adult DNA cloning, therapeutic cloning, embryo cloning) –
- 14.2 Advantages and disadvantages of cloning

Unit 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

Unit 16. Intellectual property rights (2 hr)

- 16.1 Intellectual property protection
- 16.2 Patents, copy right, trade secrets, trademarks
- 16.3 GATT and TRIPS, patenting of biological materials, Geographical indicators
- 16.4 International co-operation, obligation with patent applications, implications of patenting-current issues

Unit 17. Ethical and social implications (2 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
- 17.3 Human genome alterations by biotechnology
- 17.4 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

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Screening by - DNA hybridization, immunological assay, protein activity (Refer unit 4- Molecular Biotechnology by Glick and Pasternak-ASM press)
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FOURTH SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY XI- ELECTIVE
FISHERY SCIENCE- II
CAPTURE AND CULTURE FISHERIES
Code: VPZO4E21
(90 Hours)

Unit 1. Introduction to capture and culture fisheries (10 hrs)

1.1 Marine fisheries –

Crustaceans, molluscs, fin fishes, shrimps, crabs, lobsters, mussels, oysters cephalopods, sardine, mackerel, Bombay duck, pomfrets, ribbon fishes and Tuna

Unit 2. Freshwater fisheries (5 hrs)

2.1 Major river systems and fisheries

2.2 Lakes and reservoir fisheries

Unit 3. Estuarine fisheries (6 hrs)

3.1 Major estuaries and fisheries

Unit 4. Aquaculture (5 hrs)

4.1 History of aquaculture, scope and definition

4.2 Importance of aquaculture, present state of aquaculture, future prospectus

4.3 Classification of aquaculture practices

Unit 5. Design and construction of aqua farms and hatcheries (7 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

Unit 6. Transportation and acclimatization (3 hrs)

Unit 7. Nutrition and feeds (3 hrs)

7.1 Feeding habits and food utilization

7.2 Live feeds

7.3 Artificial feeds

Unit 8. Water quality management (3 hrs)

8.1 Water quality parameters

8.2 Techniques for monitoring

8.3 Strategies for monitoring

Unit 9. Fertilizers and chemicals in aquaculture (2 hrs)

Unit 10. Reproduction and genetic selection (11 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

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

Unit 12. Aquaculture practices (21 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*
- 12.11 Culture of Holothuria

Unit 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

Unit 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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FOURTH SEMESTER M.Sc ZOOLOGY PROGRAMME
THEORY XII- ELECTIVE
FISHERY SCIENCE-III
HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING
Code: VPZO4E31
(90 Hours)

SECTIONA: HARVESTING & POST HARVESTING TECHNOLOGY (84 hrs)

Unit 1. Commercial fishing method (2 hr)

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

Unit 2. Crafts and gears for harvesting (21 hrs)

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

Unit 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

Unit 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

Unit 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

Unit 7. Preservation and processing techniques (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

Unit 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 deveined (PD), peeled and undeveined (PUD), head-less shrimps (HI), head on shrimps (HON)
- 8.3 Grades of shrimps
- 8.4 Cooked shrimps
- 8.5 IQF shrimp

Unit 9. Processing of lobsters (3 hrs)

- 9.1 Commercially important lobsters of India
- 9.2 Processing lobsters into different varieties of products
- 9.3 Grades of packing

Unit 10. Processing of cephalopods (3 hrs)

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

Unit 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

Unit 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

Unit 13. Fish processing plant and cold storage (2 hrs)

- 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

Unit 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)

Unit 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

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

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

SECTION B: FISHERY MANAGEMENT & INTERNATIONAL MARKETING (6 hrs)

Unit 1. Fishery management (2 hrs)

- 1.1. Marketing of fish in India
- 1.2. Fisherman and fisherman co-operatives

Unit 2. International marketing (4 hrs)

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

REFERENCES

1. K. K. Balachandran (2001) Post-harvest Technology of Fish and Fish Products, Daya Books.
2. Sreekrishna Y., Latha Shenoy (2001) Fishing gear and craft technology, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research.
3. Fishing gears and methods <http://www.fao.org/fishery/topic/1617/en>.
4. Yadav, B.N. 2006) Fish and fisheries, 2nd edition. Daya Publishing house, NewDelhi.
5. Uma Kant Srivastava *et. al.* (1985) Inland fish marketing in India- Riverine system, Volume 5, Indian Institute of Management, Ahmedabad series, Concept Publishing company, NewDelhi.
6. Bensam P. (1999) Development of marine fisheries science in India, Daya Publishing house, NewDelhi.
7. Srivastava U.K. (1980) Fisheries development in India, Concept Publishing Co., New Delhi.
8. Rao, P S. (1983) Fishery economics and management in India, Pioneer Medical Publications, Delhi.

**FIRST AND SECOND SEMESTER M.Sc ZOOLOGY PROGRAMME
PRACTICAL I -BIOCHEMISTRY, BIOPHYSICS AND BIOSTATISTICS**

Code: VPZO2PL1

(Practical classes to be conducted during first semester)

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
 - a) Estimation of blood glucose by colorimetric method (Somogy-Nelson method/ O- Toluidine method)
 - b) 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 monoxime 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

BIOPHYSICS

1. pH meter and measurement of pH
2. Paper chromatography of amino acids, mixtures, identification of unknown amino acids and sugars
3. Gel filtration chromatography (Separation of starch from glucose)
4. Thin layer chromatography of amino acids and sugars
5. Serum electrophoresis
7. Determination of absorption coefficient and concentration of unknown solutions by calibration curve using a coloured solution
8. Absorption spectrum of a coloured solution (KMnO₄)
9. 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
3. Graphic presentation of population distribution in the form of histogram, frequency polygon and frequency curve
4. Computation of measures of central dispersion anthropometric data of school children
5. Simulation of binomial and poisson distributions
6. Estimation of mean number of children per family in the university campus
7. Estimation of population of planktons
8. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA
9. Regression analysis and correlation analysis of a data of heights and weight of a group of students
10. Data analysis by SPSS

REFERENCES

Biochemistry

1. Plummer David, T.(latest) 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
5. Jayaraman, J.(latest.) Laboratory Manual in Biochemistry, Wiley Eastern Ltd.

**FIRST AND SECOND SEMESTER M.Sc ZOOLOGY PROGRAMME
PRACTICAL II - PHYSIOLOGY, DEVELOPMENTAL BIOLOGY AND
ENDOCRINOLOGY**

Code: VPZO2PL2

(Practical classes to be conducted during second semester)

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 graphs
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

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 - 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

Physiology

1. Oser B. L., 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

Developmental biology & endocrinology

1. Adamstone, E. B. & 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., & Jeffery, R. W. (1991). Developmental Biology. 3 Ed., Saunders College Publi., Philadelphia.
4. Zarrow, M. X., Yochim, J. M., Mc Carthy, T. L. & Sanborn, R. C. (1996). Experimental Endocrinology: A source book of basic Techniques. Academic Press, New York.
5. Thomas, J. A. (1996). Endocrine methods. Academic press, New York.
6. Humason, G. L. (1962). Animal Tissue techniques. W. H. Freeman & Co.

FIRST AND SECOND SEMESTER M.Sc ZOOLOGY PROGRAMME
PRACTICAL III- SYSTEMATICS, EVOLUTION, ECOLOGY AND ETHOLOGY
Code: VPZO2PL3
(Practical classes to be conducted during first & second semesters)

SYSTEMATICS

1. Collection, preservation and curation of specimens
2. Identification of 15 specimens (fishes/insects/any other) upto family/ generic / species level
3. Preparation of dichotomous (simple bracket) keys- minimum ten sets of identified specimen

EVOLUTION

1. Exercises in convergent evolution
2. Exercises in divergent evolution

ECOLOGY

1. Identification, qualitative and quantitative estimation of marine plankton
2. Estimation of BOD in polluted water sample
3. Estimation of COD in water sample
4. Estimation of salinity, phosphates, chlorides, silicates and nitrates in water samples
5. Separation and identification of soil arthropods using Berlese funnel
6. Determination of moisture content of soil sample
7. Determination of water holding capacity of soil sample
8. Testing the transparency of water using Secchi disc
9. Determination of primary productivity in pond water using light and dark bottle
10. Study of termitarium / ant colony
11. 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)
- 12- **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 should 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.

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. Study of circadian rhythm
3. Chemo reception and behaviour in flies –finding the tarsal threshold for sugar
4. Behavioural reaction to moisture and light using isopods

REFERENCE

1. John T (2002) Practical statistics for environmental and biological scientists john wiley and sons
2. NC Aerry 2010– A manual of environmental analysis . Ane books private limited
3. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
4. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.

**THIRD & FOURTH SEMESTER MSC ZOOLOGY PROGRAMME
PRACTICAL IV –IMMUNOLOGY, CYTOGENETICS, MOLECULAR BIOLOGY,
MICROBIOLOGY, BIOTECHNOLOGY AND MICROTCHNIQUES**

Code: VPZO4PL4

(Practical classes to be conducted during third and fourth semesters)

MOLECULAR BIOLOGY

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

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. Immuno Electrophoresis
7. Demonstration of ELISA technique
8. Production of antibodies
9. Preparation of antiserum
10. Titration of antiserum

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.

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. Phosphate activity of milk
5. Microbial filters and their application
6. Preparation of media and sterilization -
Nutrient agar, Mac conkey agar, sterilization by wet and dry heat, disinfection
7. Cultivation of yeast and moulds
8. Isolation of pure colonies of bacteria
9. Growth curve of yeast - monitoring progress of microbial culture
10. Bacteriological analysis of water - faecal pollutants
11. Anaerobic culturing
12. Antibiotic sensitivity test

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

MICROTECHNIQUES 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. 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
4. Ausubel, F.M., Brent 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.
5. Sambrook, J. and Russel, D.W. (2001): Molecular cloning: A laboratory Manual. CSHL

THIRD & FOURTH SEMESTER M.Sc ZOOLOGY PROGRAMME
PRACTICAL V- FISHERY BIOLOGY I & II
TAXONOMY, BIOLOGY, PHYSIOLOGY, ECOLOGY, CAPTURE AND CULTURE
FISHERIES

Code : VPZO4PL5

(Practical classes to be conducted during third semester)

1. Identification of common and local fishes
2. Dissection of accessory respiratory organs
3. Dissection of urino-genital 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

CAPTURE AND CULTURE FISHERIES

1. Demonstration of induced breeding in fishes
2. Estimation of fecundity
3. Identification and study of ecto and endoparasites in fishes
4. Study of gut content analysis in fishes
5. Study and maintenance of fresh water aquarium
6. Determination of water and soil pH
7. Studies on texture of soil
8. Test for H₂S
9. Test for Alkalinity
10. Test for salinity
11. Determination of water transparency
12. Determination of Ammonia, Nitrogen, Phosphorus and Free calcium carbonate
13. Identification of culturable species of shrimps, prawns and fishes
14. Identification of larval stages of shrimps, prawns and fishes

THIRD & FOURTH SEMESTER M.Sc ZOOLOGY PROGRAMME
PRACTICAL VI - FISHERY BIOLOGY III
HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING
Code : VPZO4PL6
(Practical classes to be conducted during fourth semester)

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 by-products
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, NIFPHAT
Fish hatcheries, fish landing centers, boat building yards, aqua-farms

The field reports with dated signature of the teacher concerned and duly certified should be submitted at the time of examination.