CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

IRINJALAKUDA, THRISSUR - PIN 680 125

DEGREE OF
MASTER OF SCIENCE
(CHOICE BASED CREDIT AND SEMESTER SYSTEM)

UNDER THE

FACULTY OF SCIENCE

SYLLABUS

(FOR THE STUDENTS ADMITTED FROM THE ACADEMIC YEAR 2014 – 15 ONWARDS)

BOARD OF STUDIES IN ZOOLOGY(PG)

IRINJALAKUDA, THRISSUR - PIN 680 125

KERALA

CURRICULUM AND SYLLABI FOR
M.Sc. ZOOLOGY Course under
Choice Based Credit Semester
System (CBCSS)

FIRST SEMESTER

Theory Courses

Code No. & Title of the Course	Credits	External marks	Internal marks	Total
ZO ICT 01- Biochemistry	4	75	25	100
ZO ICT-02-Biophysics and Biostatistics	4	75	25	100
ZO ICT-03-Systematics and Evolution	4	75	25	100
Total	12	225	75	300

Practical Courses

Code No. & Title of the Course	Credits	External marks	Internal marks	Total
ZO ICP 01- Biochemistry	2	75	25	100
ZOICP-02-Biophysics Biostatistics and Systematics	2	75	25	100
Total	4	150	50	200

ZO - Zoology
I - I semester
CT - Course Theory
CP - Course Practical

THEORY
ZO-1CT-01 - BIOCHEMISTRY

Unit - I – Chemistry and functions of Biomolecules

(90 hours)

1. **Introduction** **(2 hr)**

1.1. Macromolecules and their subunits

1.2. Chemical bonds of biomolecules

2. Carbohydrates (12 hr)

2.1. Monosaccharides

2.1.1. Classification with examples–

2.1.2. Structure of glucose, fructose, galactose, mannose and ribose

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

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

2.1.5. Mutarotation

2.1.6. Reactions – Oxidation (by acids, metal hydroxides and H_2O_2), dehydration (by acid) and reduction (by alkali), reactions with alanine and phenyl hydrazine

2.1.7. Derivatives – ascorbic acid, acetal and hemiacetal, ketal and hemiketal, glycocosides – glycosidic bond and deoxyribose

2.1.8. Biological roles of monosaccharides

2.2. Disaccharides

2.2.1. Structure and biological roles of Maltose, Sucrose, Lactose, Cellobiose and Trehalose

2.2.2. Biosynthesis of trehalose and lactose

2.3. Polysaccharides

2.3.1. Hompolysaccharides – Structure and biological roles of cellulose, starch, glycogen, inulin and chitin

2.3.2. Mode of action of amylase on homopolysaccharides (starch and glycogen)

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

3. Proteins (9 hr)

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. p*K* 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 (α-helix –parallel & antiparallel and β pleated sheet), random coil conformation, Tertiary structure, Quarternary structure.

3.2.2. Brief note on protein domains, motifs, folds and Ramachandran plot.Biological roles of proteins

4. Lipids (8 hr)

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

4.2. Brief account of the chemistry of sterols, terpenes and carotenoids.

4.3. Acid number, saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids

4.4. 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

4.5. Prostaglandins – Chemical nature and functions.

4.6. Fatty acids – definition; essential fatty acids

4.7. Classification with examples– Saturated, unsaturated, hydroxyl and cyclic fatty acids

4.8. Nomenclature of fatty acids – Genevan system

5. Nucleic acids (5 hr)

5.1. Structure of nitrogen bases and nucleotides

5.2. Structural organization of DNA (Watson –Crick model)

5.3. Characteristic features of A-, B- C- and Z-DNA

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

5.5. Biological roles of nucleotides and nucleic acids

Unit - II – Enzymes (15 hr)

1. Classification- (I.U.B. system)
2. Specificity of enzyme action
3. Mechanism of enzyme action: Formation of enzyme substrate complex- Gibbs free energy of activation; Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Electrostatic, hydrogen and Van der Waal's bonds in Enzyme-substrate complex.
4. Enzyme kinetics - Michaelis-Menten equation – derivation; significance of K_m and V_{max} Values.
5. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction.
6. Enzyme inhibition – Competitive, non-competitive and uncompetitive inhibition (distinguish kinetically), suicide inhibition and feedback inhibition
7. Allosteric enzymes – positive and negative modulators
8. Iso-enzyme and ribozyme
9. Vitamins as conenzymes
10. Factors influencing enzyme action

Unit - III – Bioenergetics (5 hr)

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 (**15 hr**)
   1.1. Glycolysis – (PFK as pacemaker – Hexokinase conformation and change by glucose), Fate of pyruvic acid
   1.2. Metabolism of 2, 3 DPG as regulator of oxygen transport
   1.3. Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex
   1.4. Electron transport system and oxidative phosphorylation; Redox porential, Chemiosmotic hypothesis; inhibitors of electron transport chain
   1.5. Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown
   1.6. Pentosephosphate pathway (HMP pathway)
2. Amino acid metabolism (5 **hr**)
   2.1. Biosynthesis and degradation of amino acids – glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine
3. Lipid metabolism (**8 hr**)
   3.1. Oxidation of fatty acids
   3.2. Biosynthesis of fatty acids
   3.3. Biosynthesis of cholesterol
4. Nucleic acid metabolism (**6 hr**)
   4.1. Biosynthesis and degradation of purines and pyramidines

References:

1. Lenhninger, A.L. (2008), Principles of Biochemistry, Vth edition, CBS publishers and distributors, Delhi
2. Robert Harper's Biochemistry, (1996) 24th 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 Stayer,(latest) Biochemistry, II edition, W.H. Freeman & Co. NY
4. Oser, B.L, (1965) Hawk's Physiological Biochemistry, Mc Graw Hill Book Co.
5. Eric E. Conn, Paul K. Stumpf, George Bruening, Roy H. Doi, (latest) Outlines of Biochemistry, Vth edition, John Wiley & Sons, Inc, (2007).
6. Deb, A.C.(2004) Fundamentals of biochemistry, New Central Book Agency (P) Ltd.
7. Keith Wilson and John Walker (2008) Principles and techniques of Biochemistry and Molecular biology – 6th edn, Cambridge University Press
8. Voet, D. and Voet, J.G. (2004), Biochemistry, John Wiley & Sons
9. Zubay, G (latest .), Biochemistry, Maxwell Macmillan International
10. Devlin,T.M. (2006), A Text of Biochemistry with clinical correlations, John Wiley & Sons

ZO-1CT-02-BIOPHYSICS AND BIOSTATISTICS

(90 Hours)

Section-A-Biophysics (55 Hours)

1- Matter and mechanics of cells **3 hr**

1--Colloids, properties of colloids, forms of colloids,

Brownian movement and Tyndall phenomena

2- –Diffusion and Osmosis 5 hr

2.1- - Fick's law and diffusion coefficient.

2.3- Gibb's Donnan equilibrium

2.4- Application of diffusion processes in biology: haemolysis.

2.5 -Vant Hoff's laws

2.6-Osmotic concentration, Osmotic pressure and osmotic gradient

2.7- Electrosmosis.

2.8 -Electrolytic and ionic balance in biological fluid

3 –P^H 2 hr

3.1. Dissociation of water

3.2. Dissociation of a weak acid

3.3. Henderson Hasselbalch equation

3.4. Buffers, pH meter

3.5. pH value calculation.

4 – Bioacoustics 5 hr

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

4.8 Echolocation; receiving and analyzing echoes

5 -Radiation Biology 9 hr

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

6 - Biophysical methods (Brief account) 5 hr

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

7- Electrophysiological methods (Brief) 3 hr

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.

8 -Principles and applications of 8 hr

8.1-Microscopy (Fluorescent, Interference , confocal -scanning and transmission electron microscopes

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 hr

9.1- Chromatography (Adsorption, Partition, and ion-exchange chromatography ,Column, Paper ,Thin-layer ,Gel-filtration, Gas chromatography, Affinity, HPLC)

9.2-Electrophoresis-(Paper, Disc, PAGE, Two dimensional PAGE, High voltage and Immunoelectrophoresis.

9.3. Isoelectric focusing.

9.4-Flow cytometry

10. Influence of gravity 3 hr

10.1-Human body posture in the gravitational field

10.2- Influence of G force

10.3- Force 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-Nanotechnolgy 2 hr

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 Hours)

1. Introduction 2 hr

1.1 Biostatistics: Definition, Terms, Applications, Role of biostatistics in modern research.

2. Data collection: 7 hr

2.1 Types of data:

- Primary, secondary, qualitative, quantitative

2.2 Methods of data collection and classification:-

Types of sampling method-

Advantages and disadvantages of census and sampling method,

Classification of data, Tabulation

Methods of classification

Class intervals- exclusive and inclusive method

2.3 Diagrammatic and graphical presentation of data

Bar diagram – (types), Pie diagram, Histograms, Frequency polygon

Frequency curve (types. skewness, kurtosis, ogive)

3. Statistical Methods: Measures of central tendency and dispersal **8 hr**

3.1. Mean, median, mode, quartile

3.2 Range, Mean deviation, Quartiles deviation, variance, Standard deviation, Standard error, degree of freedom

4. Probability distributions 4 hr

4.1. Basic concepts and definition:

4.2. Laws of probability

4.3. Probability distribution: -

Binomial, Poisson and Normal

5. Statistical inference 7 hr 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

6. Kruskal-Wallis, Mann-Whitney

7. Correlation and Regression 7 hr

6.1. Types of correlation

6.2. Methods to measure correlation

Scatter diagram

Karlpearson's coefficient of correlation

Spearman's correlation

6.3. Types of regression analysis

6.4. Regression equations

6.5. Difference between regression and correlation analysis

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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5. Bengt Nolting (2006), Methods in modern Biophysics, Springer.
6. Daniel, M (2002), Basic Biophysics for Biologists. Agro Botanics, Bikaner
7. Das, D. (1991) Biophysics and Biophysical Chemistry, Academic Publishers Calcutta.
8. Ernster, L (1985), Bioenergetics, Elsevier, New York.
9. Frank H. Stephenson (2006)- Calculations for Molecular Biology and Biotechnology- A guide to Mathematics in the laboratory-Academic Press- An imprint of Elsevier.
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11. Keith Wilson and John Walker (2008), Principles and techniques of Biochemistry and Molecular biology – 6th edn, Cambridge University Press
12. Marshall, A.G. (1978) Biophysical Chemistry, Principles, Techniques and Applications- John Wiley and Sons NewYork
13. Mohan P. Arora-(2007), Biophysics –Himalaya Publishing House.
14. Muralidharan.V.S. and Subramania, A (2010)- Nanoscience and Technology- Ane Books Ltd.
15. Narayan, P (2000) Essentials of Biophysics. New age international
16. Nagini.S (2009)- Instant Biochemistry-Ane Books Ltd.

17. Roy, R.N(1996)-A text book of Biophysics-New central book Agency Calcutta.

18. Srivastava, P.K (2006)-Elementary Biophysics, An introduction. Narosa publishing house New Delhi

19. Viswanathan. B(2009)-Nano Materials- Narosa Publishing House.

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.

4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ikas Publishing House, New Delhi.

5. Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition New Delhi

6.Stephen W,Looney(2008) Methods in Molecular Biology-Biostatistical Methods- Springer International Edition

7. Zar, J.H.(2003) Biostatistical Analysis - Fourth edition. Pearson Education. Delhi.

ZO-1CT-03 - SYSTEMATICS AND EVOLUTION

Section A. Systematics (45 hours) **(90 hours)**

Definition and basic concepts in Systematics and Taxonomy **4Hr** Historical resume of systematics

1.1 Levels of Taxonomy

Alpha, beta, gamma taxonomy

1.2 Place, importance and applications of taxonomy

1.3 Goals of taxonomy

2. Classification 4Hr

2.1 Practise 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, omnispective classification, horizontal and vertical classification

2.5 Components of classification

3. Taxonomic procedure 8 Hr

3.1. Taxonomic collections- types of collections, value of 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

3.4.1. Use of keys- kinds of keys, their merits and demerits

3.5. Taxonomic descriptions: presentation of findings

3.6. Kinds of taxonomic publications

3.6.1. Taxonomic and ecological publication and their difference

4. Species concepts 7 Hr

4.1. Species category- different species concepts: typological, Nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological species concepts)

4.2. Taxonomic diversity with in species, different kinds of species, sub species and other infra specific categories, hybrids.

5. Taxonomic characters 4 Hr

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

6. Zoological nomenclature 5 Hr

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

6.2.1 Homonymy and Synonymy

6.3Type method and its significance

6.3.1 Different kinds of types in descriptive taxonomy

7. Newer trends in systematics 4 Hr

7.1 Chemo and serotaxonomy

7.2 Cytotaxonomy

7.3 Numerical taxonomy

7.4 Cladistics

7.5. Molecular systematics

7.6 DNA bar coding *vs* traditional taxonomy

8. Ethics in taxonomy 3 Hr

8.1 Ethics related to collections

8.1.1 credit

8.1.2 Lending and borrowing of specimens

8.1.3 Loan of material

8.1.4 Exchange of materials

8.1.5 Collaboration and co-operation with co-workers

8.1.6 Use of language

8.2 .Ethics related to taxonomic publications **2 Hr**

8.2.1 Authorship of taxonomic papers

8.2.2 Correspondence

8.2.3 Suppression of data

8.2.4 Undesirable features of taxonomic papers

8.3 Taxonomists and user communities

9. Taxonimic impediments 4 Hr

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

9.7.1 International co-operation

9,7.2 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 hr

1. Mechanism of natural selection - directional, disruptive and stabilizing selection
2. Natural selection in Islands.
3. Sexual selection; Intrasexual and intersexual selection-secondary sex characteristics-sexy son hypothesis-good genes hypothesis.

Unit 2. **The Mechanisms**: 10 hr

1. Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law,, founder principle, bottleneck effect and genetic drift as factors in speciation.
2. Isolating mechanisms-*Prezygotic* and *Postzygotic isolating mechanisms;* speciation-allopatric-peripartric-parapatric-heteropatric- sympatric speciation;ecotypes.
3. Co-evolution; Microevolution, Macroevolution. Convergent (homoplasy) –divergent-parallel evolution.

Unit 3. **Tempo of evolution** 8 hr

1. Gradualism Vs punctuated equilibrium.
2. Anagenesis Vs Cladogenesis.

Unit 4. **Molecular evolution** : 10 hr

1. Neutral theory of molecular evolution; molecular divergence; molecular drive.
2. Molecular clocks- genetic equidistance- human mitochondrial molecular clock.
3. Phylogenetic relationships- Homology; Homologous sequences of proteins and DNA - orthologous and paralogous; parsimony analysis; nucleotide sequence analysis; DNA bar coding *vs* traditional taxonomy.

Unit 5. **Evolutionary trends** 10 hr

1. Biochemical evolution- Collapse of Orthogenesis.
2. Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians-humans and the African apes - African origin for modern humans. Y-chromosomal Adam- mitochondrial Eve.
3. Communication, speech, language and self awareness in primates.

References:

A. Systematics:

1. David, M. H, Craig Moritz and Barbara K. M. (1996) Molecular Systematics. Sinauer Associates, Inc.
2. David, M. S. (2009) DNA barcoding will frequently fail in complicated groups: an example in wild potatoes. American Journal of Botany 96(6): 1177–1189.Downloadable from www.vcru.wisc.edu/spoonerlab/.../BarCodes%20and%20Wild%20Potatoes.pdf
3. Kapoor, V.C (1998) Theory and practise of animal taxonomy. Oxford & IBH ,Publi., Co. New Delhi
4. Kipling, W. W; Brent, D.M. and Quentin, D. W. (2005) The Perils of DNA Barcoding and the Need for Integrative Taxonomy**.** *Syst. Biol.* 54(5):844–851,Downloadable from *sysbio.oxfordjournals.org/cgi/reprint/54/5/844.pdf*
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B: Evolution

1. Coyne, J.A. and Allen, O.H. (2004) Speciation. Sinauer Associates Inc., Massachusetts, USA.

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3. David, M. S. (2009) DNA barcoding will frequently fail in complicated groups: an example in wild potatoes. American Journal of Botany 96(6): 1177–1189.Downloadable from www.vcru.wisc.edu/spoonerlab/.../BarCodes%20and%20Wild%20Potatoes.pdf
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7. Motoo Kimura (1983) The neutral theory of molecular evolution. Cambridge University Press.
8. Roderick D.M, Page and Edward, C. H. (2000) Molecular Evolution: A Phylogenetic Approach: Blackwell science.
9. Strikberger, M.W. (2005) Evolution, Jones and Bartett Publishers, London.

PRACTICALS

ZO ICP 01- 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-Toludine 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

References:

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.

ZOICP02-Biophysics, Biostatistics and Systematics

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 ($KMnO_4$)
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 poison 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.

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; minimum ten sets from the identified specimens.

Evolution

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

Reference

John T (2002) Practical statistics for environmental and biological scientists john wiley and sons.

UNIVERSITY OF CALICUT
CURRICULUM AND SYLLABI FOR M.Sc. ZOOLOGY PROGRAMME
(CHOICE BASED CREDIT SEMESTER SYSTEM)

SECOND SEMESTER

CODE NO. AND TITLE OF THE COURSE	CREDITS	EXTERNAL WEIGHTAGE	INTERNAL WEIGHTAGE
ZO 2 CT 04 - PHYSIOLOGY	4	36	5
ZO 2 CT 05 – ECOLOGY & ETHOLOGY	4	36	5
ZO 2 CT 06 – DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY	4	36	5
ZO 2 CP 01 – BIOCHEMISTRY, BIOPHYSICS & BIOSTATISTICS	4	24	5
ZO 2 CP 02 – PHYSIOLOGY, DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY	4	24	5
ZO 2 CP 03 – SYSTEMATICS, EVOLUTION, ECOLOGY & ETHOLOGY	4	24	5

SECOND SEMESTER M. Sc. ZOOLOGY (CSS) DEGREE PROGRAMME
ZO- 2- CT- 04 - PHYSIOLOGY
(90 Hours)

1. Nutrition: 12hrs

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 and minerals in GIT
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 (Ref. 4)

2. Excretory system: 12hrs

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 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
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

3. Respiratory system: 13hrs

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
3.8.1 Transport of oxygen and carbon dioxide
3.8.2 Oxygen dissociation curve – factors affecting binding of oxygen to

haemoglobin (PO_2, PCO_2 ,CO, pH, body temperature, diphosphoglyceric acid level, faetal haemoglobin and also myoglobin)

3.9 Neural and chemical regulation of respiration

4. Nervous system 18hrs

4.1. Introduction: Basic details of neurons and action potential

4.2. Gross neuroanatomy of the brain (histology & neural pathway not expected unless otherwise specified)

4.2.1. Cerebral cortex- Motor cortex: mention functional areas (including specialized areas) and their motor functions

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

4.2.3. 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

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

4.2.5. Cerebellum- mention parts and functions

4.2.6. Basal ganglia – mention components and functions

4.2.7. Limbic system; structure and functions (emotion and motivation)

4.3. Gross neuroanatomy of the spinal cord

4.3.1. Spinal cord - structural organization

4.3.2. Reflex action – reflex arc, muscle spindle, Golgi tendon organ

4.3.3. Types of reflexes- monosynaptic reflex (e.g., Muscle stretch reflex, negative stretch reflex), polysynaptic reflex (e.g., withdrawal reflex)

4.4. Diseased states of brain – brief description of epilepsy, depression, schizophrenia, Alzheimer's disease, Senile dementia & Parkinson's disease

5. Special senses 13hrs

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 circuitary 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. 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

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 of in controlling interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure

9. Environmental physiology **5hrs**

9.1. Thermoregulation

9.1.1. Comfort zone, normal body temperatures (oral, skin & core), heat production & heat loss, factors affecting body temperature, lethal temperature

9.1.2. Temperature regulating mechanisms (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, Comparative Animal Physiology
6. William S. Hoar, Comparative Animal Physiology

7 Kunt-Schmidt-Nielsen: Animal Physiology, Adaptation and Environment.
8 Jensen D. (1976): Principles of Physiology, Appleton Century Crafts, N.Y.
9 Lonco, G.N. (1993): Physiological Animal Ecology. Longman Scientific and Techhnical, Essex.
10 Caer BL-Haw's Physiological chemistry, 14th Edn. Tata McGraw Hill Pub. Co. New Delhi.
11 Shepherd, G.M: Neurobiology-Principles of Neural Science, E. Kandel & P. Schwartz.
12 Campbell *et al*. (1984): Clinical Physiology, 5th Edn. Blackwall 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 MSc ZOOLOGY (CSS) DEGREE PROGRAMME

ZO- 2- CT- 05 - ECOLOGY AND ETHOLOGY

(90 Hours)

Part-A-ECOLOGY 65 hrs

1- Natural history of Indian subcontinent: 3 hrs

1.1. Major habitat types of the subcontinent

1.2. Geographic origins and migrations of species

1.3. Seasonality of the subcontinent

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

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.

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.

5 -Species interactions- 6 hrs

5.1. Types of interactions, interspecific competition

5.2 Herbivory, Carnivory, Pollination, Symbiosis;-mutualism, commensalisms and protoco-operation

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 –

6.4. Latitudinal gradients in diversity,

6.5. Edges and ecotones.

7 -Ecological succession- 4 hrs

7.1. Types, mechanisms

7.2. Changes involved in succession

7.3. Concept of climax

8 -Biogeography- 6 hrs

8.1. 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

9 -Theory of island biogeography- 4 hrs

9.1. Theory – Influencing factors –

9.2 Applications in conservation biology- species-area relationship -single large or several small (SLOSS) - development of habitat corridors-

10 -Biogeographical zones of India 4hrs

(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.

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)

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

11.4. Biodiversity management approaches- Exsitu and insitu conservation strategies.

12- Conservation Biology-

12.1. Principles of conservation

12.2. Major approaches to management,

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

REFERENCES

1. Ahluwalia and sunitha malhorta-Environmental Science-Ane Books Pvt.Ltd
2. Allan Beebi and Anne Maria Brennan-2006- First Ecology-Ecological principles and environmental issues-Oxford university press
3. Archbold, O. W. *Ecology of World Vegetation*. New York, NY: Chapman and Hall, 1995.
4. Begon,Harper,Townsend- Ecology-Individuals,Populations,and communities-Blackwell Science,Second edition
5. Brewer Richard-The Science of Ecology-Saunders college publishing
6. Chapman J.L and Reiss.M.J- Ecology principles and applications-Cambridge law price editions
7. Charles J .Krebs- Ecology .The experimental analysis of distribution and abundance
8. David Quammen. 1997. The Song of the Dodo: Island Biogeography in an Age of Extinctions. Scribner. ISBN 0-684-82712-3
9. Dick Neal- Introduction to population Biology- Cambridge University Press
10. Eugene P.Odum- Fundamentals of Ecology- W.B.Saunders Company
11. MacArthur, R. H. and Wilson, E. O. 1967. The Theory of Island Biogeography. Princeton, N.J.: Princeton University Press.
12. Magurran, A. E. 2004. *Measuring biological diversity*. Oxford: Blackwell Publishing. ISBN 0-632-05633-9
13. May and Mc Lean- Theoretical Ecology principles and applications-Oxford university press
14. Whittaker, Robert H. Communities and Ecosystems New York: MacMillan Publishing

Company, Inc., 1975.

Part B. ETHOLOGY 25 hrs

Unit 1. Introduction

1.1 Ethology as different from the other schools studying animal behaviour like behaviourism. 1hr

1.2 Behaviour as a reaction to stimuli - sign stimuli, social releasers, Ethograms , super normal stimuli, stimulus filtering. 2hrs

Unit 2. Motivating factors 3hrs

2.1 General factors in motivation; Studies of motivation in guppies;

2.2 mating systems-parental investment and reproductive success

Unit 3. Conflict behaviour- stress-displacement activities- Ritualization. 2hrs

Unit 4. Instinctive behaviour & reflex action, neural basis of sleep and arousal --Learning. 3hrs

Unit 5. Adaptiveness of behaviour JP Scotts categories of behaviour. 3hrs

Unit 6. External stimulus - circadian rhythms 3hrs -

6.1- Proximate and Ultimate factors 6.2-Types of orientation-reafference theory of Von Holst & Mittel Stadt.

6.3-Navigation & migration

Unit 7. Parental care -Social behaviour of termites & Primates- 4hrs

Unit 8. Evolution of behaviour-Altruism, Kin selection, inclusive fitness, selfish gene theory, cultural transmission of behaviour; domestication and behavioural changes. 4hrs

References

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.
8. Manning, A. and Dwakins, M.S. (1995) An Introduction to Animal Behaviour. Cambridge Univ. Press, Lond.
9. Scott, J.P. (1972) Animal Behaviour. Publisher**:** Univ of Chicago

SECOND SEMESTER M. Sc. ZOOLOGY(CSS) DEGREE PROGRAMME

ZO 2 CT 06 - DEVELOPMENTAL BIOLOGY & ENDOCRINOLOGY

(90 Hours)

Part- A - DEVELOPMENTAL BIOLOGY (55 hrs)

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

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: (10hrs)

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 (10hrs)

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
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: (10hrs)

4.1 Cellular interactions during development
Epithelial - mesenchymal interactions, paracrine factors, RTK 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: (7hrs)

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: (7hrs)

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 8. Environmental regulation of animal development: (4hrs)

8.1 Environmental regulation of normal development – types of polyphenism
Sex determination in *Bonellia*; primary and secondary sex determination, environmental sex determination

8.2 Environmental disruptions of normal development (Teratogenesis)
Teratogenic agents - Alcohol, retinoic acid, bisphenol, heavy metals, pathogen

8.3 Environmental oestrogens

References – Developmental biology

1. Balinsky, B. I. An introduction to Embryology.
2. Berril, N. J. Developmental biology.
3. Deuchar, E. M. Cellular interactions in animal development.
4. Gilbert, S. F. Developmental Biology. Sinauer Associate, 8th edition
5. Hodge, R. Developmental Biology: From a Cell to an Organism.
6. Hopper, A. S. & N. H. Hart. Foundation of animal development.
7. Lash, J & J. R. Whittaker. Concepts of development.
8. Muller, W. A. Developmental biology. Springer.
9. Snustad, D. P., J. M. Simmons & J. B. Jenkins. Principles of Genetics.
Wolpert, L. Principles of Development. Oxford university press, 2nd edition

Part B Endocrinology (35 Hours)

Unit 1. Endocrine glands and their Hormones (Brief account)

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. Physical characteristics of hormones – latency,post-secretory modification and half-life

1.4. Synthesis and delivery of hormones- storage, secretion and transportation.

1.5. Physiological roles of hormones.

1.6. Control of hormone secretion. (3 Hours)

Unit 2. General mechanisms of Hormonal action

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 (5 Hours)

Unit 3. Anatomy of endocrine glands; structure, physiological functions, and control of secretion of their hormones and pathophysiology.

3.1. Hypothalamus
3.2. Hypophysis
3.3. Thyroid
3.4. Parathyroid

3.5. Adrenal
3.6. Pancreas (15hours)

Unit 4. Hormones and male reproductive physiology

4.1. Synthesis, chemistry, and metabolism of androgens
4.2. Endocrine control of testicular function
Physiological roles of androgens and estrogens
4.3.
4.4. Pathophysiology (3 Hours)

Unit 5. Hormones and female reproductive physiology

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 Hours)

Unit 6. Neurohormones

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 (3 Hours)

References - Endocrinology

1. Bentley, P. J. Comparative vertebrate endocrinology
2. Bern, H. A. Text book of comparative endocrinology
3. Bolander, F. F. 2006. *Molecular endocrinology*, Academic press, New Delhi.
4. Ganong, W. F. 2005. *Review of medical physiology*, Mc Graw Hill, New Delhi.
5. Hadley, M. E. 2000. *Endocrinology*, Pearson education, Inc., New Delhi.
6. Harris, G. W. 1995. *Neural control of the pituitary gland*, Edward Arnold, London.
7. Hazelwood, R. 1990. *The endocrine pancreas*, EnglewoodCliffs, Prentice Hall, NJ.
8. Horrbin, D. F. Essentials of Biochemistry, endocrinology and nutrition.
9. Prakash Lohr. Hormones and human health
10. Nelson R. J. Introduction to behavioural endocrinology
11. Norris D. O. 2005. Vertebrate endocrinology.
12. Vinzen, G. Et al, 1992. Adrenal cortical steroid hormones, EnglewoodCliffs, Prentice Hall, NJ.
13. 13.

SECOND SEMESTER

PRACTICALS

ZO 2 CP 02 – 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 O_2 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)Blood: clotting time, bleeding time, rouleaux formation, preparation of haemin crystals.
12. Enumeration of RBCs in human blood.
13. Determination of lactic acid in muscle tissue.
14. Differential count of human WBCs
15. Haematocrit and ESR of human blood.
16. WBC total count

References

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

ZO 2 CP 02 - 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.
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.

Reference for Practicals

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. (19964). 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.

ZO- 2- CP- 03 - ECOLOGY AND ETHOLOGY

Ecology Practicals

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 and 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 termitorium / 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 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.

Reference for Practicals

1- NC Aerry 2010– A manual of environmental analysis . Ane books private limited.

Ethology Practicals

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.

References:

1. Goodenough, J; McGuire B. and Robert, W. (1993) Perspectives on Animal Behaviour. John Wiley and Sons, Lond.
2. Manning, A. (1967) An Introduction to Animal Behaviour. Edward Arnold Pub., London.

MODEL QUESTION PAPER

SECOND SEMESTER M. Sc. ZOOLOGY (CSS) DEGREE EXAMINATION

ZO 2 CT 04: PHYSIOLOGY

Time: Three hours Maximum weightage: 36

I. Answer **all fourteen** questions (Weightage – 1)

1. What is physiological calorie value? Give the calorie value of carbohydrate, protein and lipid.
2. Define and give the normal values of tidal volume and inspiratory reserve volume.
3. Name 4 antioxidant nutrients
4. List the different layers of retina.
5. Mention the association areas of cerebral cortex.
6. What are surfactants? Mention their function.
7. Define renal clearance. Give the clearance value of urea, creatinine and phosphate
8. Write short note on dead space.
9. Give the methods of transportation of oxygen in blood
10. Chloride shift
11. What is organ of Corti? What is its function?
12. Comment on Wernicke's area.
13. Comment on intestinal motility
14. What is basal ganglia? What is its major function?

(14 x 1 = 14)

II. Answer any **seven** questions (Weightage – 2)

15. What is BMR? What is its significance?
16. Enlist the normal and abnormal constituents of urine.
17. Distinguish between slow wave sleep and REM sleep.
18. Write notes on Parkinson's disease
19. Write the principle and applications of ECG
20. What are the major causes of obesity?
21. Give an account of factors causing shift of oxygen dissociation curve.
22. What is memory? Explain the physiology of short term and long term memory.
23. Composition of lymph
24. Give short note on pain receptors and their stimulation

(7 x 2 = 14)

III. Answer any two questions: (weightage-4)

25. Describe the mechanism of pulmonary ventilation. Add a note on the neural and chemical regulation of respiration **.**

26. Describe the formation of urine.
27. Present an account of the functional areas of motor cortex and their motor functions.
28. Explain the taste buds and physiology of taste. (2x4=8)

SECOND SEMESTER M.SC ZOOLOGY (CSS) DEGREE EXAMINATION ZO 2 CT 05-

ECOLOGY AND ETHOLOGY

Time: Three Hours **Weightage: 36**

I. Short Answer type (10 questions from ecology and 4 from ethology)

Number of questions to be answered:14 **Weightage :1x14=14**

1-Describe any four characteristic features of population?
2-Explain the term ecological succession, types, sere and climax.
3-What is symbiosis, mention the types with examples
4-What is primary production, describe three important points.
5-what is decomposition, mention decomposers, detritivores with suitable examples.
6-Describe four features of grasslands.
7-Distinguish between lentic and lotic systems with examples.
8-Describe four major causes of water pollution.
9-What is carnivory, mention three important points.
10-What is meant by niche ,distinguish between fundamental and realized niche and niche width.
11- Explain Klinotaxis with example
12- Sign stimulus with examples
13- Describe Selfish gene theory,
14- Define Ethograms give a suitable example

11-Short Essay type(Seven questions from Ecology and 3 from ethology) Number of questions to be answered is seven out of ten. Weightage:7x2=14

15- Describe the biogeographic zones of India
16- What are the aims and objectives of Project Tiger
17-Describe the mechanism of Ecological succession.
18-What is herbivory, mention plant defences against herbivory.
19-Describe ecotone and edge effect.
20-Explain the features of Savanna biome
21-Explain ex situ conservation strategies.
22-What is life table , mention its significance
23- Describe circadian rhythm
24- Explain ritualization.

III-Essay type(Three questions from Ecology and one from Ethology)
No.of questions to be answered is two out of four. **Weightage: 2x4=8**

25- Write an essay on biotic divisions of the sea with its major fauna and adaptations.
26-What is biotic community,Explain its characteristics with examples.
27-Explain the term biodiversity,describe alpha,beta,and gamma diversity,and methods of measuring diversity
28-Describe motivation and importance of guppies in the study of motivation.

SECOND SEMESTER M.SC ZOOLOGY (CSS) DEGREE EXAMINATION ZO 2 CT 06-DEVELOPMENTAL BIOLOGY AND ENDOCRINOLOGY

Time:Three Hours **Weightage:36**

I. Short Answer type (9 questions from Developmental biology and 5 from Endocrinology)
Number of questions to be answered:14 **Weightage :1x14=14**
1. Primary sex determination
2. Explain embryonic fields
3. Grey crescent?
4. RTK pathway
5. Morula
6. Induction
7. Realistor gene
8. DNA methylation

9. Epimorphic regeneration
10. Glucagon
11. ADH
12. Calcitonin
13. Pineal gland
14. Oxytocin

II- Short Essay type (6 questions from Developmental biology and 4 from Endocrinology)
Number of questions to be answered is seven out of ten. Weightage:7x2=14

15. Describe the cellular interactions in organogenesis
16. Different types of regeneration
17. Differentiate between determination and differentiation
18. Hox code hypothesis
19. What is dorsoventral partitioning?
20. Explain cortical reaction
21. Explain the physiological role of ovarian steroid hormones.
22. What is endorphins? Explain its physiological role.
23. Explain the physical characteristics of hormones.
24. Hormonal factors in pregnancy.

III- Essay type (3 questions from Developmental biology and 1 from Endocrinology)
No. of questions to be answered is two out of four.
Weightage:2x4=8

25. Write an essay on metamorphosis in Amphibians and their hormonal control
26. Explain limb development in chick
27. Explain different types of cleavages and blastulas
28. Give an account on adrenocortical hormones.

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA
CURRICULUM AND SYLLABI FOR M. Sc. ZOOLOGY
(CREDIT SEMESTER SYSTEM)
THIRD SEMESTER – THEORY COURSES

Code number &Title of the course	Credits	External Weightage	Internal Weightage
ZO 3 **CT** 07 - Cell & Molecular Biology	4	36	5
ZO 3 **ET** 08 - Fishery Biology I: Taxonomy, Biology, Physiology & Ecology	4	36	5
ZO 3 **ET** 09 - Fishery Biology II: Capture & Culture Fisheries	4	36	5

ZO- Zoology **CT- Core Theory** **ET- Elective Theory**

Practical courses of the concerned theory courses shall be conducted during the same semester. However, external examination shall be conducted at the end of fourth semester only.

FOURTH SEMESTER – THEORY COURSES

ZO- Zoology CT- Core Theory ET- Elective The

Code number & Title of the course	Credits	External Weightage	Internal Weightage
ZO 4 **CT** 10 – Immunology	4	36	5
ZO 4 **CT** 11 - Microbiology and Biotechnology	4	36	5
ZO 4 **ET** 12 - Fishery Biology III: Harvesting, Post-harvesting Technology & Marketing	4	36	5

THIRD AND FOURTH SEMESTER – CORE & ELECTIVE PRACTICAL COURSES

ZO- Zoology CP- Core Practical EP- Elective Practical

1. TOTAL CREDITS - 80

Code number & Title of the course	Credts	External Weightage	Internal Weightage
ZO 4 **CP** 04 – Cell & Molecular Biology, Immunology, Microbiology, Biotechnology & Micro techniques II	4	24	5
ZO 4 **EP** 05 - Fishery Biology I & II	4	24	5
ZO 4 **EP** 06 - Fishery Biology III	4	24	5
PROJECT WORK	4	24	5
VIVA-VOCE	4	24	5

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**

Project work: Credits - **8** (**4** credits for dissertation and **4** credits for viva-voce)
(Project report / dissertation shall be presented by Power point software)

2. Practical Examination shall be conducted at end of second and fourth semester.
3. Two hours per week under practical work may be allotted during the third and fourth semesters for the project work.
4. 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 submitted for the evaluation a day prior to the date of viva- voce pertaining to the dissertation. 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. Weightage for each core and elective theory course shall be 36 for the external examination and 5 for the internal theory examination.
6. Weightage for each external core and elective practical course shall be 24 for the external examination and 5 for the internal core and elective practical examination.
7. Theory examination question paper shall contain 14 short answer questions with weightage 1each , 7 short essay questions with weightage 2 each and 2 essay questions with weghtage 4 each.
8. Weightage for the external practical examination can be distributed as follows-

With submission **Without submission**

Major question (one number)-Weightage 8 Major (one number) - Weightage 8 Minor

question (two numbers)	, ,	2x5= 10	Minor (two numbers)	)	,,	2x5 = 10	Spotters (two (four numbers) ,,
Submission			2x1= 2	Spotters Record			4x1 = 4 ,, 2
Record	,,	2					
Total		**24**		**Total**			**24**

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

10. A candidate has to submit the following at the time of practical examination related to ZO 4 CP 04

    Whole mount : 4 numbers

    Slides: Histology : 4 numbers

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

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

12. 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.

13. A minimum of two test papers for each course have to be conducted of which the best performance shall be counted for internal evaluation in each semester.

14. One seminar for each course is compulsory.

15. 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	Weightage

A. Presentation of project work- (POWER POINT Presentation)

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**

B. General V**iva-voce**:

7. Knowledge of the student
8. Communications
9. Answers to questions

THIRD SEMESTER
ZO 3 CT 07 - CELL AND MOLECULAR BIOLOGY (90 Hours)

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 replicons
1.4. Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase; Fidelity of replication
1.5. Replication of the ends of eukaryotic chromosome – role of telomerase
1.6. Models of DNA replication –Rolling circle model and looped rolling circle model, D-loop model, θ-model
1.7. 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 (9 hrs)

3.1. Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA
3.2. Initiation, elongation and termination of transcription
3.3. Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites
3.4. Transcription factors; Transcription activators and repressors
3.5. Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions
3.6. Post transcriptional modification of RNA
  3.6.1. Capping
  3.6.2. Polyadenylation
  3.6.3. Splicing
3.7. RNA editing: site specific deamination and role of gRNAs
3.8. 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 *Mycoplsma* and *Tetrahymena*
4.6. Point mutations that alter genetic code (missense, nonsense & frameshift)
4.7. Suppressor mutation, suppressor genes & suppressor tRNA

5. Ribosome: The site of protein synthesis: (5 hrs)

5.1. Composition, topography, active centres and biogenesis of ribosome
5.2. Experiments to understand Composition, topography, active centres and biogenesis of ribosome
  5.2.1. Composition; Reconstitution experiments, r-protein mutants
  5.2.2. Topography; Methods to study ribosome structure- Immune electron microscopy, cross linking
  5.2.3. Active centres; affinity labelling
  5.2.4. Biogenesis; anucleolate mutants in *Xenopus laevis*

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 eukaryote – 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: (8 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
10.2.3.4. Concept of an evolutionary clock
10.2.3.5. 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 : (4 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- Structural organisation of *Escherichia coli*

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

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

14. Organelle genome: (4 hrs)

14.1. Extranuclear genes and maternal inheritance

14.2. Chloroplast genome: special features

14.3. Mitochondrial genome
- 14.3.1. Special features of yeast mitochondrial genome, petite mutants
- 14.3.2. 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. Cancer and the cell cycle

15.4. Cancer and apoptosis

15.5. Interaction of cancer cells with normal cells

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

References:

1. Attwood T.K, Parry-Smith D.J. (2003): Introduction to Bioinformatics. Pearson Education
2. Benjamin Lewin (2004): Genes, Vol. VIII, Pearson Prentice Hall, Singapore
3. Brown, T.A. (2006): Genomes 3.Garland Science, New York.
4. Elliott, W. H and Elliott, D. C. (1997): Advanced molecular Biology, Viva Books, New Delhi
5. Freifelder, D. (2003): Molecular Biology, Narosa Publishing House, New Delhi

6. Gupta, P. K. (2005): Cell and molecular Biology, Rastogi Publications, New Delhi
7. Kothekar, V. (2004): Introduction to Bioinformatics. DHRUV Publications, Delhi.
8. Kumar, H. D. (2001): Molecular Biology, Vikas publications, New Delhi
9. Malacinski, G. M. (2005): Essentials of Molecular Biology, Narosa Publishing House, New Delhi
10. Mayers, R.A (Ed) (1995). Molecular Biology and Biotechnology: A Comprehensive Desk Reference.VCH Publishers, Inc., New York
11. Russel, P. J. (2009): Cell and Molecular Biology, Cengage learning
12. Tropp, B. E. (2008): Molecular Biology, Jones and Bartlet.
13. Veer Bal Rastogi (2008): Fundamentals of Molecular Biology, Ane Books India
14. Watson, J. D. (1998): Molecular Biology of the gene, Benjamin Publishing house
15. Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R.. (2006). Molecular Biology of the Gene, Pearson Education.

ELECTIVE COURSE - FISHERY BIOLOGY-I

ZO 3 ET 08 –TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY (90 Hours)

1. Fish Taxonomy **(5 hrs)**

1.1. Classification and distribution of economically important fin fishes

2. Integument **(10 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
3.2. Mechanism of propulsion

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 **(10 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 their 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 (5 hrs)

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

References:

THIRD SEMESTER
ELECTIVE COURSE- FISHERY BIOLOGY - II

ZO 3 ET 09 - CAPTURE AND CULTURE FISHERIES (90 Hours)

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

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

2. Freshwater fisheries **(5 hrs)**

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 practises

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 games
10.6. Sex reversal
10.7. Genetic selection and hybridization

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

12. Aquaculture practises **(20 hrs)**

12.1. Integrated fish farming - paddy cum fish culture, duck cum fishculture, 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

References:

FOURTH SEMESTER

ZO 4 CT 10 – IMMUNOLOGY (90 Hours)

1. Introduction (6 hrs)

1.1. Innate and adaptive immunity
1.2. Cells and organs of the immune system
1.3. Antigens, Antigenecity, immunogenecity and Haptens
1.4. Factors influencing immunogenicity

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

3. Antigen-Antibody Interactions (16 hrs)

3.1. Strength of Antigen Antibody Interactions
3.2. Cross reactivity, precipitation reactions ,agglutination reactions

3.3. Immunotechniques -Detection of molecules using ELISA, RIA, Western Blot, Immunoprecipitaion, Immunofluorence microscopy, Flowcytometry.

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

5. Immune effector Mechanisms (12 hrs)

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

6. Major Histocompatability 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. Antigen processing and presentation –Endogenous and Exogenous pathways. Presentation of non peptide bacterial antigens.

7. Immune system in Health and Diseases (20 hrs)

7.1. Immune responses during 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). Orgin,means of infection, course of infection, structure and types of HIV, viral multiplication, mutation, diagnosis, antiretroviral therapy and AIDS vaccine.
7.5. Vaccines –Recombinant Vector, DNA vaccines, synthetic peptide vaccines and multivalent vaccines

References:

1. Adul K Abbas and Andrew H Lichtman (2003).Cellular and Molecular Immunity (fifth edition).Elsevier Science,USA.
2. Carpenter. Immunology and Serology
3. Das Gupta, Modern Immunology
4. Godkar, P.B. (1998): A Text Book of Medical Laboratory Technology, Bhalani Bhalani Publishing House Mumbai

5. Hay & Hudson -Practical Immunology.
6. Janis Kuby (1997): Immunology. WH Freeman,New York
7. Joshi. K. R and Osamo N.O (1994). Immunology.Agro Bios Publishers,Jodhpurr
8. Peter Parham (2004).The immune System (2nd Edition), Garlands, New York
9. Roit, Essentials of Immunology.
10. Shetty. N (1993) Immunology Wiley Eastern Ltd, New Delhi
11. Weir-Hand book of Experimental Immunology(Volume 1,2&3).

ZO 4 CT 11- MICROBIOLOGY & BIOTECHNOLOGY (90 hours)

Part-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 micro biology

2. Microbial Taxonomy and Phylogeny (4 Hrs)

1. Major characteristics (classic and molecular)
2. Numerical taxonomy
3. Taxonomic ranks
4. Phylogenetic studies
5. Phenetic classification
6. Bergey's Manu**el (mention major groups)**

3. Bacterial cell structure and function (6 hrs)

1. Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid
2. Bacterial cell wall Peptidoglycan - structure-
3. Gram positive and gram negative cell wall- Mechanism of gram staining
4. Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility

4. Microbial nutrition (3 hrs)

1. Nutritional requirements,
2. Nutritional types (Auto, Hetero, Chemo, Phototrophs & obligate parasites)
3. Culture media and types of media-Mixed microbial population and pure cultures

5. Microbial growth (5 hrs)

1. Growth curve -synchronous growth
2. Continuous culture
3. Influence of environmental factors on growth

4. Measurement of growth
5. Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques
6. Measurement of cell mass-Turbidity and microbial mass measurements

6. Utilization of energy (4 hrs)

6.1. Biosynthetic process-peptidoglycan synthesis, amino acid synthesis, Non synthetic processes -Bacterial motility and transport of nutrients

7. Viruses (4 hrs)

1. General structural properties
2. Types: DNA viruses, RNA viruses, and enveloped viruses

8. Microbial diseases (4 hrs)

1. Human diseases caused by bacteria- Strepto ccoccal diseases, Typhoid, Cholera, tetanus, Leprosy, tuberculosis and Pneumonia.
2. Human diseases caused by viruses- AIDS, Small pox, Rabies, Measles, Swine Flu, Bird flu, SARS
3. Fungal diseases- Candidiasis

9. Control of microorganisms (5 hrs)

1. Disinfectants; A - physical- Heat, filtration and radiation
   B-Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes.
2. Antibiotics- Penicillin's, Cephalosporins, Chloramphenicol, Tetracyclines
3. Microbial drug resistance

10. Microbial fermentation (4 hrs)

1. Lactic fermentation Homolactic and heterolactic fermenters, Mention dairy products ,cheese, Yogurt, kefir etc
2. Alcoholic fermentation-Alcoholic beverages

11. Environmental microbiology (3 hrs)

1. Aquatic microbes
2. Microbiological analysis of drinking water
3. Waste water- microbial characteristics and treatment
4. Microbial Bioremediation
5. Biogas plants.

Part-B-BIOTECHNOLOGY (45 Hrs)

1. Introduction (1 hr)

Definition, branches, scope and importance

2. Genetic engineering (4 hrs)

2.1. Cloning vectors –

2.1.1. Properties of a good cloning vector

2.1.2. Types - plasmids (pBR322, pBR 327, pUC); phages (lambda phage, M13); cosmids, Phagemids, viruses, BAC, YAC and MAC.

2.2. Shuttle vectors and expression vectors

2.3. Enzymes for r DNA technology- Restriction enzymes and ligases

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 (2 hrs)

4.1. Production

4.2. Labelling

4.3. Applications

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, FISH and GISH, Chromosome walking

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

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

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)

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
2. Transgenic animals for human welfare

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

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

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. Antisence RNA
13.2. RNAi
13.3. Gene knockouts

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. 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,
16.4. International co-operation, obligation with patent applications, implications of patenting-current issues

17. The 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-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

References:

1. Alphey - DNA sequencing-Bios Scientific publishers-
2. Bernard R. Glick & 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. -Introduction to environmental biotechnology-Prentice Hall of India
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge University press.
6. Dominic, W.C. Wong-The ABCs of gene cloning-Springer international edition
7. Dubey, R.C. -A text book of biotechnology-S. Chand & Co.
8. Gupta. P.K. -Elements of biotechnology-Rastogi publications.
9. Singh, B.D.-Biotechnology-Kalyani publishers.
10. Sobti, R.C. & Suparna, S .Pachauri-Essentials of Biotechnology-Ane Books Pvt.Ltd.
11. Wilson & Walker (2008): Principles and techniques of Biochemistry and Molecular biology- Cambridge low price editions.

Part- Microbiology

12. Gandhi-Microbiology and Immunology notes and cases-Blackwell publishing
13. Hans G. Schlegel (2008): General Microbiology-Cambridge low price editions
14. Kanika Sharma-Manual of microbiology tools and techniques-Ane's student edition-Ane books Pvt. Ltd
15. Monica Cheesbrough - District laboratory practice in tropical countries, Part I and II - Cambridge low price editions
16. Mansi- Fermentation,Microbiology and Biotechnology-Taylor and Francis
17. Pelczar, M.J, Reid, R.D. & Chan, E.C.S-Microbiology-TMH edition
18. Prescot, Harley and Klein- Microbiolgy, IV th ed. McGraw-Hill
19. Rao, A.S.-Introduction to microbiology-Prentice Hall of India.
20. Tortora, Funke and Case - Microbiology : An Introduction Eight edition- pearson education, Veerbala Rastogi-Fundamentals of Molecular biology-Ane books
21. Wise-Bioinstrumentation and Biosensors-Taylor and Francis.

ELECTIVE COURSE - FISHERY BIOLOGY – III

ZO 4 ET 12 – HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING (90 hrs)

PART-I. HARVESTING

1. Commercial fishing method **(1 hr)**

1. Brief history of commercial fishing
2. 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

8.6. Processing of lobsters (3 hrs)
Commercially important lobsters of India
8.7. Pre and processing lobsters into different varieties of products
8.8. Grades of packing

9. Processing of cephalopods (3 hrs)

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

10. Processing of fish (4 hrs)

10.1. Commercially important fishes of India
10.2. Fish filleting
10.3. Surimi
10.4. IWP products, grades for fish products

11. Fishery by-products (9 hrs)

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

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

12.1. 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
12.2. Requirements for registration with MPEDA, approval of processing plant by FIA allotment code

13. Quality control (7 hrs)

13.1. Fundamental aspects of quality
13.2. Major quality problems in sea foods

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

14. Packing and export of seafood (4 hrs)

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

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

15.1. Objectives and activities of the following institutions (very brief) – CIFT, CMFRI, CIRNET, NIO, FSI, CIBA, FIA, MPEDA
15.2. Objectives of fishery extension
15.3. Qualities for fishery extension workers
15.4. Organizations of extension programs

Part- III- FISHERY MANAGEMENT AND INTERNATIONAL MARKETING

16. Fishery management (2 hrs)

16.1. Marketing of fish in India
16.2. Fisherman and fisherman co-operatives

17. International marketing (4 hrs)

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

FOURTH SEMESTER PRACTICALS

ZO 4 CP O4 – CELL & MOLECULAR BIOLOGY, IMMUNOLOGY, MICROBIOLOGY, BIOTECHNOLOGY AND MICROTECHNIQUES

ZO 4 CP O4 - CELL & MOLECULAR BIOLOGY

(Practical classes to be conducted during third semester)

1. Estimation of DNA by Diphenyl Amine method
2. Estimation of RNA by Orcinol method
3. Estimation of Protein by Lowry' method.

4. Cell fractionation and Differential Centrifugation to isolate mitochondria,nuclei and nucleolus.
5. Isolation of RNA fromYeast.
5. Isolation of plasmid DNA.
6. Isolation of genomic DNA.
7. Isolation of DNA fromLiver/Spleen/Thymus.
8. Maintenance of E.coli.culture(shake and surface cultures) and quantitave evaluation (number of cells/ml)of a given sample of culture by dilution and plating.
9. Preparation of salivary gland ,polytene chromosome from drosophila larva.
10. Dosophila banding technique and Karyotyping.
11. Grass hopper – (testes –squash preparation) to study various meiotic stages

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

ZO 4 CP 04 - IMMUNOLOGY

(Practical classes to be conducted during fourth semester)

1. Study of cells of immune system.
2. Histology of organs of immune system.
3. Bleeding of animals and preparation of serum.
4. Seperation 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

ZO 4 CP 04 – MICROBIOLOGY

(Practical classes to be conducted during fourth semester

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. Preperation of media and sterilization.eg: Nutrient agar, mac conkey agar, sterilizationby wet anddry heat, disinfection.
7. Cultivation of yeast and molds
8. Isolation of pure colonies of bacteria.
9. Growth curve of yeast - monitoring progress of microbial culture.
10. Bacteriological analysis of water e.g., fecal pollutants.
11. Anaerobic culturing.
12. Antibiotic sensitivity test.

ZO 4 CP 04 – BIOTECHNOLOGY
(Practical classes to be conducted during fourth semester)

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.

ZO 4 CP 04 - MICROTECHNIQUE AND HISTOCHEMISTRY
(Practical classes to be conducted during fourth semester)

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. and Russel, D.W. (2001): Molecular cloning: A laboratory Manual. CSHL Press, New York.

PRACTICALS
ELECTIVE COURSE - FISHERY BIOLOGY - I
ZO 4 EP 05 – TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY
(Practical classes to be conducted during third semester)

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

PRACTICALS
ELECTIVE COURSE- FISHERY BIOLOGY - II ZO EP 05 - CAPTURE AND CULTURE FISHERIES
(Practical classes to be conducted during third semester)

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 H_2S
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

PRACTICALS
ELECTIVE COURSE – FISHERY BIOLOGY - III
ZO 4 EP 06 – 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\d 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.

MODEL QUESTION PAPERS

THIRD SEMESTER M. Sc. DEGREE EXAMINATION (CSS)
Zoology
ZO 3 CT 07 – CELL AND MOLECULAR BIOLOGY

Time: Three hours Maximum weightage: 36

I. Answer **all fourteen** questions (**Weightage – 1**)

1. Distinguish between monocistronic and polycistronic mRNA.
2. Name two non-sense codons and their common names.
3. Enlist the rRNAs of eukaryotic ribosome
4. Name two antibiotics as translational inhibitors. Mention their action.
5. What are chaperones? Mention their role in post-translationalmodification.
6. Distinguish between minisatellite and microsatellite.
7. What is site specific recombination? Cite example.
8. Distinguish between transduction and transformation.
9. What is a promoter site? Mention 3 consensus sequences of eukaryotic promoter site.
10. Comment on start codons
11. What is gRNA? What is its function?
12. Give short note on supressor tRNA
13. What is affinity labeling? What is its application in ribosome studies?
14. What are petite mutants? Name the petite mutants of Yeast.

(14 x 1 = 14)

II. Answer any **seven** questions (**Weightage – 2**)

15. Explain psuedogenes.
16. Describe the rolling circle model of DNA replication.
17. Write short note on posttranscriptional modification of RNA.
18. Explain wobble hypothesis.
19. Compare translation in eukaryotes and prokaryotes.
20. Describe the basic features of tryptophan operon.
21. What is siRNA and miRNA? What are their roles in regulating geneexpression?
22. What is cot ½? How it is related to complexity of the genome?
23. What is a complex multigene family? Explain the organization of histone gene in sea urchin.
24. Human mitochondrial genome.

(7 x 2 = 14)

III. Answer any **two** questions (**Weightage – 4**)

25. Give an account of semiconservative method of replication. Add a brief note on the enzymes and protein involved in DNA replication.
26. Write an essay on the organization of interrupted genes and their evolution.
27. Describe the various methods of DNA repair.
28. (a) What are transposons? Give an account of the mechanism of transposition, and transposons in eukaryotes and prokaryotes.

(2 x 4 = 8)

THIRD SEMESTER M. Sc. DEGREE EXAMINATION (CSS)
Zoology
ELECTIVE COURSE - FISHERY SCIENCE-I
ZO 3 ET 08 - TAXONOMY, BIOLOGY, PHYSIOLOGY & ECOLOGY

Time: Three hours **Maximum weightage: 36**

I. Answer all *fourteen* questions (weightage-1)

1. Comment on physiological colour changes in fishes.
2. What is ultim-branchial organ?
3. List the different types of scales seen in fishes.
4. What is neurohypophysis? Mention its function.
5. Define deep sea trenches and give examples.
6. What is EEZ?
7. Comment on upwelling.
8. What is coral reef?
9. What is thermocline?
10. Comment on diadromus migration.
11. What is ovoviviparity? Give its evolutionary significance.
12. What is continental slope?
13. Give scientific names of four economically important fishes.
14. Comment on digestive enzymes in fishes.

II. Answer any *seven* questions (Weightage - 2) (14 x 1 = 14)

1. Comment on the functions of blood
2. Give the names and functions of reproductive hormones
3. Write in brief, crustacean neurosecretory system and their role in reproduction
4. Write notes on excretion in lung fishes
5. Describe briefly the accessory respiratory organs in fishes
6. Comment on benthic divisions of sea
7. What are the peculiarities of Piscian circulation
8. Write briefly on mechanism of propulsion
9. Describe in brief age and growth of fish
10. Comment on mud banks

III. Answer any two questions (Weightage - 4) (7 x 2 = 14)

11. Describe osmoregulation in marine fishes.
12. Explain the factors affecting primary production in ocean.
13. Explain briefly the ocean currents.
14. Describe the adaptations of cave dwelling fishes.

(2x4=8)

THIRD SEMESTER M. Sc. DEGREE EXAMINATION (CSS)

Zoology

ELECTIVE COURSE - FISHERY SCIENCE-II ZO 3

ET 09 - CAPTURE AND CULTURE FISHERIES

Time: Three hours **Maximum weightage: 36**

I. Answer all *fourteen* questions **(weightage - 1)**

1. Define integrated fish culture with examples
2. List four bacterial fish diseases
3. Write short notes on sex reversal
4. Methods of fish seed transport
5. Cryopreservation of gametes
6. Cage farming
7. Comment on hormone analogues
8. Four uses of sea weeds
9. Distinguish between Penaeid and Non-Penaeid prawns
10. Feeding and breeding habits of Pomfrets
11. Viviparous ornamental fishes
12. Aquarium plants
13. Crab fattening
14. Ployculture

II. Answer any *seven* questions **(Weightage - 2)** (14 x 1 = 14)

15. Write notes on induced breeding in fishes.
16. What are the major symptoms of Dropsy? What are the control measures?
17. Give an account on water quality parameters.
18. How will you prepare an artificial feed?
19. Major river systems and fisheries of south India.
20. Write an account on hybridization in aquaculture.
21. Protozoan infections.
22. Preparation and maintenance of freshwater aquarium.
23. Design and construction of hatcheries.
24. Classification of aquaculture practices.

(7 x 2= 14)

III. Answer any two questions **(Weightage – 4)**

25. Write an account on present status and future prospects of aquaculture in India
26. Describe the biology of oil sardine and mackerel
27. Discuss the steps involved in the culture of fresh water prawns and write notes on their commercial significance
28. Write an account on culture of brackish water fishes

(2 x 4 = 8)

FOURTH SEMESTER M.Sc. DEGREE EXAMINATION (CSS)

Zoology

ZO 4 CT 11 - MICROBIOLOGY & BIOTECHNOLOGY

Time: Three Hours Maximum Weightage : 36

I. Answer the following :- **(Weightage – 1)**

(Seven questions from Microbiology & Seven from Biotechnology)

1. What are plasmids? Mention their features.

2. Distinguish between YAC and MAC
3. What are linkers?
4. Explain blue white selection method.
5. Describe FISH technique.
6. What is *in vitro* fertilization?
7. What are GATT and TRIPS?
8. Describe gram staining.
9. Distinguish between spread plate and pour plate techniques.
10. Describe microbial drug resistance.
11. Write notes on major fungal diseases.
12. Explain the structure of bacterial cell wall.
13. Describe Bergey's scheme of classification.
14. Describe various types of media used for the culture of microbes.

(14 x 1 =14 Weightage)

II. Answer any seven of the following :-
(Five questions from Microbiology& five from Biotechnology)

15. Explain the advantages of cloning technique.
16. Describe the features of Knockout mouse.
17. Explain DNA finger printing.
18. What are molecular markers? Describe any two of them.
19. What are molecular probes? Explain its uses.
20. What are antibiotics? Mention their role in disease treatment.
21. What are disinfectants? Classify them.
22. Describe the major diseases caused by Bacteria.
23. Describe the general structure and properties of viruses.
24. Write notes on influence of environmental factors on growth of microbes.

(7 x 2 = 14 Weightage)

Answer any two of the following
(Two questions from Microbiology & two from Biotechnology)

25. What is PCR? Describe the types and its applications.
26. Describe the role of Biotechnology in pollution control.
27. Write an essay on human diseases caused by viruses.
28. Write an essay on microbial fermentation and the products.

(2 x 4 = 8 Weightage)

FOUTH SEMESTER M. Sc. DEGREE EXAMINATION
(CSS)
Zoology
ELECTIVE COURSE – FISHERY SCIENCE - III
ZO 4 ET 12- HARVESTING, POST HARVESTING TECHNOLOGY AND MARKETING

Time: Three hours Maximum Weightage: 36

I. Answer **all fourteen** questions **(Weightage – 1)**

1. What is TED? Give the importance of it.
2. Different types of fishing traps.
3. Comment on FAD.

4. Targetted and selective trawling.
5. What are encircling gears? Give examples.
6. Gear materials.
7. Different types of ice.
8. Battered and breaded products.
9. Irradiation.
10. Grades of shrimps.
11. Activities of CMFRI.
12. Surumi.
13. Value added products.
14. Fermented and fishery products.

(14x1 = 14)

II. Answer **any seven** questions **(Weightage – 2)**

15. Squid jigging.
16. Ecosounder and sonar.
17. On board handling and processing.
18. Chemical composition of fish.
19. Different types of freezers.
20. Processing of Cephalopods.
21. Fundamental aspects of quality.
22. Methods of packing of various seafood products for export.
23. Fishermen cooperataives.
24. Sea food trade fairs.

(7 x 2 = 14)

III. Answer **any two** questions **(Weightage – 4)**

25. Write an account on fishery bi product.
26. Fundamental aspects of quality control problems of sea food.
27. Give an account on the various crafts and gears operated in inland waters.
28. Describe the various methods of fish preservation and processing techniques.

(2 x 4 = 8)