


KANNUR UNIVERSITY

(Abstract)

M.Sc. Applied Zoology Programme under Choice Based Credit Semester System in the University Department- Revised Scheme, Syllabus & Model Question Papers Implemented with effect from 2015 admission- Orders issued.

ACADEMIC 'C' SECTION

U.O. No.Acad/C4/ 5006/2015

Civil Station P.O, Dated, 31-10-2015

- Read: 1. U.O No.Acad/C3/2049/2009 dated 11.10.2010.
2. U.O No.Acad/C3/2049/2009 dated 05.04.2011.
3. Meeting of the Syndicate Sub-Committee held on 16.01.2015.
4. Meeting of the Department Council held on 03.03.2015.
5. Meeting of the Curriculum Committee held on 10.04.2015.
6. U.O No.Acad/C4/14536/2014 dated 29.05.2015.
7. Letter from the Course Director, Dept. of Zoology, Mananthavady Campus, Wayanad
8. Meeting of the Curriculum Committee held on 03.09.2015.

ORDER

1. The Regulations for Post Graduate Programmes under Choice Based Credit Semester System were implemented in the Schools/Departments of the University with effect from 2010 admission as per the paper read (1) above and certain modifications were effected to the same vide paper read (2).
2. The meeting of the Syndicate Sub-Committee recommended to revise the Scheme and Syllabus of all the Post Graduate Programmes in the University Schools/Departments under Choice Based Credit Semester System (CCSS) with effect from 2015 admission vide paper read (3) above.
3. The Department Council vide paper read (4) above has approved the Scheme, Syllabus & Model Question Papers for M.Sc. Applied Zoology Programme under Choice Based Credit Semester System (CCSS) for implementation with effect from 2015 admission.
4. As per the paper read (5) above, the meeting of the Curriculum Committee recommended certain modifications/ additions to the Regulations for Post Graduate Programmes under Choice Based Credit Semester System and the Regulations were modified in the University w.e.f. 2015 admission vide paper read (6).
5. The Course Director, Dept. of Zoology vide paper read (7) above, has forwarded the Scheme, Syllabus & Model Question Papers for M.Sc. Applied Zoology Programme in line with the revised Regulations for Choice Based Credit Semester System for implementation with effect from 2015 admission.

P.T.O.

6. The meeting of the Curriculum Committee held on 03.09.2015 approved the Scheme; Syllabus & Model Question Papers for M.Sc. Applied Zoology Programme under Choice Based Credit Semester System in the Department vide paper read (8)
7. The Vice Chancellor after considering the matter in detail, and in exercise of the powers of the Academic Council conferred under section 11(1) of KU Act 1996, and all other enabling provisions read together with, has accorded sanction to implement the Scheme, Syllabus & Model Question Papers for M.Sc. Applied Zoology Programme under Choice Based Credit Semester System, offered in the University Department, w.e.f 2015 admission, subject to report to the Academic Council.
8. Orders are, therefore, issued accordingly.
9. The revised Scheme, Syllabus and Model Question Papers of M.Sc. Applied Zoology Programme effective from 2015 admission are appended.

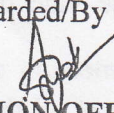
**JOINT REGISTRAR (ACADEMIC)
FOR REGISTRAR**

To
The Course Director, Department of Zoology
Mananthavady Campus, Wayanad

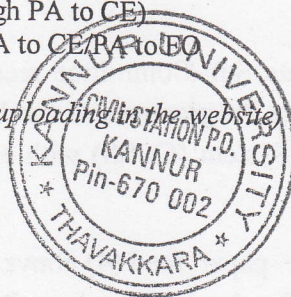
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SECTION OFFICER





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KANNUR UNIVERSITY
DEPARTMENT OF ZOOLOGY

**CURRICULUM AND SYLLABI FOR
M. Sc. APPLIED ZOOLOGY COURSE**

Choice Based Credit and Semester System (CCSS)

(w. e. f. 2015 Admission onwards)

**REGULATIONS, SCHEME AND SYLLABUS FOR M.Sc. APPLIED ZOOLOGY
(BIODIVERSITY: CONSERVATION AND MANAGEMENT)
Effective from 2015 Admission**

1. ELIGIBILITY FOR ADMISSION:

Candidates who have passed and secured at least 55% marks in B.Sc. Zoology (Main) Degree examination of this University or an equivalent examination of any other university are eligible to apply for the M.Sc. Applied Zoology (Biodiversity: Conservation and Management) course. Regulations regarding the reservation of the seats are as per the rules of Government of Kerala/Kannur University. Those who have appeared for the final year examination can also apply; however, they should produce the mark-sheet before the preparation of rank list.

2. ADMISSION PROCEDURE:

Admission to the course shall be based on the marks obtained in the entrance examination conducted by the Department of Zoology.

3. COURSE DETAILS:

- a. Credit and Semester system will be followed for the programme. Credit is the measure to assess the value or relative importance of a course, computed on the basis of the time to be devoted for teaching theory and/or practical. Credit defines the quantum of contents/syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus credits will be assigned on the basis of the number of lectures/tutorials/laboratory works and other forms of learning required completing the course contents in a sixteen-week schedule per semester.
- b. Each student at the time of admission will be assigned to an advisor by the department council. He/she will advise the student about the academic programme and counsel on the choice of course.
- c. The course structure is with core courses and elective courses.
- d. The minimum duration for completion of the two year M.Sc. Applied Zoology (Biodiversity Conservation and Management) is four semesters. The maximum period for completion is 8 semesters.
- e. No regular student shall register for more than 24 credits and less than 12 credits per semester. The duration of the course shall extend to more than two years for the students securing less than 12 credits in a semester.
- f. There shall be a one hour lecture excluding tutorials/seminars and two to three hours of practical work per week for one credit.
- g. The minimum total credits for the successful completion of the course is 80 in which minimum credits required for core course is 60 and minimum for elective course is 12. Those who secure only the minimum credits for core/elective

subject has to supplement the deficiency required for obtaining the minimum total credits required for the successful completion of the programme from the other divisions.

4. EVALUATION:

- a. Evaluation of the students shall be done by the faculty member who teaches the course on the basis of continuous assessment and an end semester examination. The proportion of the distribution of marks among end semester and continuous assessment shall be 60:40.
- b. Continuous assessment includes assignments, seminars, periodic written examination etc. Weightage to the components of the continuous assessment shall be given for all theory papers of the course as follows:

Written test papers	25%
Assignment	10%
Seminars	20%
End semester Viva-voce	25%
Attendance	20%

- c. For the end semester examination each question paper shall consists of three sections: Section A, B and C.
Section A consists of short paragraph answers, 4 to be answered out of 6, each carrying 5 marks.

Section B consists of short essay type questions, 2 to be answered out of 4, each carrying 8 marks.

Section C is consists of essay type questions, 2 to be answered out of 4, each carrying 12 marks.
- d. For the end semester examinations, the duration of a four credit course shall be 3 hours.
- e. The end semester examinations are conducted by a panel of examiners as stipulated by the University in its regulations.
- f. Attendance is compulsory for each course and the minimum requirement for appearing for the end semester examination shall be as per the general regulations of M.Sc. programme.
- g. The list of elective papers is subject to revision, time to time based on requirement.
- h. The syllabus is applicable from 2015 admission onwards.

5. GRADING:

a. An alphabetical grading system shall be adopted for the assessment of student's performance in the course. The grade is based on a six-point scale. The following table gives the range of marks, grade points and the alphabetical grade.

Range of marks%	Grade points	Alphabetical grade
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
Below 50%	0	F

b. A minimum of grade point 5 (Grade C) is needed for the successful completion of the course.

c. Performance of a student at the end of each semester is indicated by the Grade Point Average (GPA) and is calculated by taking the weighted average of grade points of the courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$\text{GPA} = \frac{\text{Sum of (grade points in a course multiplied by its credit)}}{\text{Sum of credits of the courses}}$$

d. The overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above.

e. Approximate percentage of marks can be calculated by $\text{CGPA} \times 10 + 5$.

f. Based on CGPA overall letter grade of the student shall be in the following way.

CGPA	Overall letter grade
8.5 and above	A+
7.5 and above but less than 8.5	A
6.5 and above but less than 7.5	B+
5.5 and above but less than 6.5	B
4.5 and above but less than 5.5	C

g.

Classification	Overall letter grade
First Class with distinction	A+ and A
First Class	B+ and B
Second Class	C

Classification:

h. A student who has failed in a course can reappear for the end-semester examination of the same course along with the next batch to acquire the minimum credits needed for the completion of the course.

SEMESTER WISE DISTRIBUTION OF PAPERS, MARKS, CONTACT HOURS AND CREDITS

First Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
		L	T/S	P	End Sem.	Internal	Total	
	Course details/marks							
ZOOL C 101	Philosophy of Science, History of Biology, Evolution & Phylogeny	4	1	-	60	40	100	4
ZOOL C 102	Chemistry for Biologists	4	1	-	60	40	100	4
ZOOL C 103	Physics for Biologists and Statistics for Biologists	4	1	-	60	40	100	4
ZOOL E 104*	Behavioural Sciences	4	1	-	60	40	100	4
ZOOL E 105*	Wild life Biology	4	1	-	60	40	100	4
ZOOL P 106	Practical – I (Biochemistry)			6	60	40	100	3
ZOOL P 107	Practical – II (Biophysics & Biostatistics)			6	60	40	100	3
	Total				360	240	600	22

*Elective paper – choose either ZOOL E 104 or ZOOL E 105

Second Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
		L	T/S	P	End Sem.	Internal	Total	
	Course details/marks							
ZOOL C 201	Cytogenetics and Molecular Biology	4	1	-	60	40	100	4
ZOOL C 202	Biotechnology & Bioinformatics	4	1	-	60	40	100	4
ZOOL C 203	Comparative Animal Physiology	4	1	-	60	40	100	4
ZOOL C 204	Immunology & Parasitology	4	1	-	60	40	100	4
ZOOL P 205	Practical – III (Cytogenetics, Molecular Biology and Biotechnology)			6	60	40	100	3
ZOOL P 206	Practical – IV (Animal Physiology and Parasitology)			6	60	40	100	3
	Total				360	240	600	22

Third Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
		L	T/S	P	End Sem.	Internal	Total	
	Course details/marks							
ZOOL C 301	Developmental Biology	4	1	-	60	40	100	4
ZOOL C 302	Ecology	4	1	-	60	40	100	4
ZOOL C 303	Conservation Biology – I	4	1	-	60	40	100	4
ZOOL C 304	Conservation Biology - II	4	1	-	60	40	100	4
ZOOL P 305	Practical – V (Developmental Biology)			6	60	40	100	3
ZOOL P 306	Practical –VI (Ecology and Conservation Biology)			6	60	40	100	3
	Total				360	240	600	22

Fourth Semester

Paper No	Title of Paper	Contact Hrs/Week			Marks			Credits
		L	T/S	P	End Sem.	Internal	Total	
	Course details/marks							
ZOOL E 401*	Research Methodology – Concepts & Methods	4	1	-	60	40	100	4
ZOOL E 402*	Biosystematics & Taxonomy	4	1	-	60	40	100	4
ZOOL E 403*	Fisheries Biology	4	1	-	60	40	100	4
ZOOL C 404	Project				120	80	200	12
	Total	--	--	-	180	120	400	20

*Elective paper - choose any two (ZOOL E 401, ZOOL E 402, ZOOL E 403)

PROJECT WORK

The main objective of introducing a project work in the curriculum is that the student who completes this course should get hands on experience in independent research work in the field of biodiversity conservation and management. He/she should equip himself/herself to face challenges in Conservation Biology and should be able to provide trained manpower in the field.

A topic in the optional subject – Biodiversity: Conservation and Management shall be assigned to each student. The research work related to this topic will be carried out by each student under the supervision of a teacher. The report of the findings shall be submitted by each student in the form of a dissertation which shall be submitted for evaluation a day prior to the date of viva voce examination of the fourth semester. A declaration by the student to the effect that the dissertation submitted by him/her has not previously 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.

CURRICULUM AND SYLLABI FOR APPLIED ZOOLOGY

I SEMESTER

- ZOOL C 101 - Philosophy of Science, History of Biology, Evolution & Phylogeny
- ZOOL C 102 - Chemistry for Biologists
- ZOOL C 103 - Physics for Biologists & Statistics for Biologists
- ZOOL E 104* - Behavioral Sciences
- ZOOL E 105* - Wild Life Biology
- ZOOL P 106 - Practical I (Biochemistry)
- ZOOL P 107 - Practical II (Biophysics & Biostatistics)

II SEMESTER

- ZOOL C 201 - Cytogenetics and Molecular Biology
- ZOOL C 202 - Biotechnology and Bioinformatics
- ZOOL C 203 - Comparative Animal Physiology
- ZOOL C 204 - Immunology and Parasitology
- ZOOL P 205 - Practical III (Cytogenetics, Molecular Biology and Biotechnology)
- ZOOL P 206 - Practical IV (Animal Physiology and Parasitology)

III SEMESTER

- ZOOL C 301 - Developmental Biology
- ZOOL C 302 - Ecology
- ZOOL C 303 - Conservation Biology – I
- ZOOL C 304 - Conservation Biology – II
- ZOOL P 305 - Practical V (Developmental Biology)
- ZOOL P 306 - Practical VI (Ecology and Conservation Biology)

IV SEMESTER

- ZOOL E 401* - Research Methodology – concepts and methods
- ZOOL E 402* - Biosystematics & Taxonomy
- ZOOL E 403* - Fisheries Biology
- ZOOL C 404 - Project Work

*elective paper

**ZOOL C 101 - PHILOSOPHY OF SCIENCE, HISTORY OF
BIOLOGY, EVOLUTION & PHYLOGENY**

90 hrs

A. Philosophy of science

1. What is Science?

- 1.1 Origins of modern science.
- 1.2 Philosophy of Science- definition, scope.
- 1.3 Science and pseudo-science.

2. Scientific Reasoning

- 2.1 Deduction and induction
- 2.2 Hume's problem
- 2.3 Probability and induction

3. Scientific Change and Scientific Revolutions

- 3.1 Logical positivist philosophy of science
- 3.2 The structure of scientific revolutions
- 3.3 Incommensurability and theory ladenness of data

4. Science and its Critics

- 4.1 Scientism.
- 4.2 Science and religion
- 4.3 Is Science value free?

B. History of biology

1. An account on history of science

- 1.1 Ancient Greek philosophers.

2. History of biology:

- 2.1 Seventeenth century:
 - 2.1.1 Anatomists
 - 2.1.2 Microscopists
- 2.2 Eighteenth century:
 - 2.2.1 Great chain of being
 - 2.2.2 Carl Linnaeus

- 2.2.3 Lamarck
- 2.2.4 Precursors to modern evolutionary theory.

- 2.3 Nineteenth century
 - 2.3.1 Birth of associations and societies to promote science
 - 2.3.2 Charles Darwin
 - 2.3.2.1 Pre-Darwinian evolution
 - 2.3.2.2 Origin of species
 - 2.3.3 The emergence of biological disciplines
 - 2.3.3.1 Experimental physiology
 - 2.3.3.2 Cell theory; cell pathology; germ theory.

- 2.4 History of Biology during twentieth century:
 - 2.4.1 First half of 20th century
 - 2.4.1.1 Growth of microbiology and biochemistry
 - 2.4.1.2 Genetics and heredity
 - 2.4.2 Second half of 20th century
 - 2.4.2.1 The architects of life - proteins, DNA and RNA
 - 2.4.2.2 The origins and borderlines of life
 - 2.4.2.3 Growth of genetic engineering
 - 2.4.2.4 Growth of Biotechnology
 - 2.4.2.5 Growth of Genomics
 - 2.4.2.6 Growth of Recombinant DNA.

B. Evolution & phylogeny:

1. Introduction

- 1.1 What is evolution
- 1.2 Darwin's evolutionary theory
- 1.3 Evolution theories after Darwin
- 1.4 The evolutionary synthesis

2. Paleontology and evolutionary history

- 2.1 The evolutionary time scale: Major events in the evolutionary time scale
- 2.2 Phylogenetic gradualism and punctuated equilibrium.
- 2.3 Micro evolution and macro evolution

3. Variations

- 3.1 Variation : The Foundation of Evolution
- 3.2 Sources of phenotypic variations
- 3.3 Principles of genetic variations in populations
- 3.4 Frequencies of alleles and genotypes
- 3.5 The Hardy-Weinberg Principle and its significance in evolution
- 3.6 Genetic variation in natural populations
 - 3.6.1 Inbreeding depression and heterosis
 - 3.6.2 Genetic drift
- 3.7 Variations at Molecular level
- 3.8 Variation among populations
 - 3.8.1 Patterns of geographic variations

- 3.8.2 Kinds of geographically variable characters
- 3.9 Variation in Quantitative traits
 - 3.1.1 Heritability
- 3.10 Genotype – environment interactions
 - 3.10.1 Phenotypic plasticity
- 4 The Evolution of Biological Diversity**
 - 4.1 Patterns of origination and extinction
 - 4.1.1 Causes of extinction
 - 4.1.2 Origination and diversification.
- 5 Molecular population genetics**
 - 5.1 Patterns of change in nucleotide and amino acid sequences
 - 5.2 Emergence of Non-Darwinism-Neutral Hypothesis.
 - 5.3 Concepts of neutral evolution
- 6 Genetics of Speciation**
 - 6.1 Isolation
 - 6.1.1 Patterns and mechanisms
 - 6.1.2 Genetic basis of reproductive isolation
 - 6.2 Modes of speciation
 - 6.2.1 Allopatric, parapatric and sympatric
 - 6.2.2 Polyploidy and recombinational speciation
- 7 Species, Phylogeny and Classification**
 - 7.1 Species concepts
 - 7.2 Phylogeny
 - 7.3 Homology
 - 7.4 Convergence and Parallelism
 - 7.5 Phylogenetic trees
 - 7.6 Cladistics
- 8 Molecular Evolution**
 - 8.1 Molecular divergence and molecular clocks
 - 8.2 Origin of new genes and proteins

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ZOOL C 102 CHEMISTRY FOR BIOLOGISTS

90 hrs

1. Introduction:

- 1.1. Biochemistry and organisation of cells.
- 1.2. Molecular logic of life.
- 1.3. Chemical unity and biological diversity.
- 1.4. Biopolymers.
- 1.5. The physical roots of the biochemical world.

2. Bioenergetics & oxidative metabolism:

- 2.1 Laws of thermodynamics in biological system entropy, enthalpy, and concept of free energy.
- 2.2 High-energy compounds; role of ATP in the biological system.

3. Carbohydrates:

- 3.1 Structure of monosaccharides, disaccharides, oligosaccharides and polysaccharides (chitin, bacterial cell wall and glycogen).
- 3.2 Physical and chemical properties of monosaccharides.
- 3.3 Glycolysis; fate of pyruvate; gluconeogenesis; HMP pathway; glycogenolysis; glycogenesis.
- 3.4 Regulation of glycogen synthesis and breakdown.
- 3.5 Citric acid cycle; electron transport chain; oxidative phosphorylation; redox potential; chemi-osmotic hypothesis; uncouplers; inhibitors of electron transport chain.

4. Lipids:

- 4.1 Classification of lipids, classification of fatty acids.
- 4.2 Physical and chemical properties of lipids.
- 4.3 Structural lipids in membranes; sphingolipids in biological recognition.

- 4.4 Oxidation of fatty acids (saturated, unsaturated and odd carbon). Ketone bodies;
 - 4.5 Biosynthesis of fatty acids; biosynthesis and degradation of cholesterol.
 - 6.6 Prostaglandins.
5. **Amino acids and proteins:**
 - 5.1 Structure of different amino acids in proteins. Physical and chemical properties of amino acids. Peptide bonds; Zwitter ions.
 - 5.2 Metabolism of amino acids; transamination, decarboxylation and deamination reactions in the biological system; inborn errors in metabolism.
 - 5.3 Classification of proteins; glycoproteins and proteoglycans
 - 5.4 Structure of proteins; Ramachandran plot
 - 5.5 Nitrogen excretion and urea cycle.
 6. **Enzymes:**
 - 6.1 Introduction
 - 6.2 Classification and nomenclature
 - 6.3 Specificity, various factors influencing velocity of enzyme catalysed reactions
 - 6.4 Michaelis-Menten equation & Kinetics
 - 6.5 Line weaver-Burk plot
 - 6.6 Enzyme inhibition-reversible and irreversible (competitive and non-competitive) with examples. Enzyme inhibition in the treatment of AIDS
 - 6.7 Regulatory enzymes-Allosteric enzymes
 - 6.8 Zymogens, isozymes
 7. **Nucleic acids:**
 - 7.1 Chemistry, biosynthesis and degradation of nucleic acids
 - 7.2 Structure of DNA and RNA.
 8. **Vitamins:**
 - 8.1 Chemical nature and functions of vitamins
 - 8.2 Role of B-complex vitamins as coenzymes.

Chemistry for biologists

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24. Pattabhiraman, T. N 2008. Laboratory manual and Practical Biochemistry (4th ed). All India Publ.
25. Rober K murrey, Daryl K Granner, Victor W Rodwell, 2006. Harpers Illustrated Biochemistry (27th ed) Mc Graw Hill.
26. S P Singh, 2007. A Text Book of Biochemistry (4th ed) CBS.
27. Stryer, L. (1995) Biochemistry, IV Ed. Freeman & Co., NY.
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29. Westhead, D.R., and Parish, J.H (1998) *Instant Notes* in Biochemistry, Bios Scientific Publishers Ltd., U.K.
30. L Veerakumari, 2007, Biochemistry, MJP Publishers.
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ZOOL C 103 - PHYSICS FOR BIOLOGISTS AND STATISTICS FOR BIOLOGISTS

90 hrs

A. Physics for Biologists:

1. Biophysical methods:

- 1.1 Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy.
- 1.2 Structure determination using X-ray diffraction and NMR, analysis using light scattering;
- 1.3 Different types of mass spectrometry and surface plasma resonance methods.
- 1.4 Laser and its application in Biology

2. Radiation biology:

- 2.1 Properties of different types of radioisotopes normally used in biology, their detection and measurement.
 - 2.1.1 Autoradiography,
 - 2.1.2 G.M. counter
 - 2.1.3 Incorporation of radioisotopes in biological tissues and cells
 - 2.1.4 Applications of tracer techniques.
 - 2.1.5 Radiation protection and therapy; safety guidelines.

3. Bioacoustics:

- 3.1 Physical basis of hearing
 - 3.1.1 Physical aspects of sound transmission in the ear;
 - 3.1.2 Echocardiography
 - 3.1.3 Ultrasonography.

4. Biophysics of vision:

- 4.1 Eye as an optical instrument;
 - 4.1.1 formation of image.

5. Electrophysiological methods:

- 5.1 Single neuron recording
- 5.2 Patch clamp recording
- 5.3 ECG
- 5.4 EEG
- 5.5 PET
- 5.6 MRI
- 5.7 CAT

6. Biophysical methods and their applications:

- 6.1 Microscopy
 - 6.1.1 Bright field
 - 6.1.2 Phase contrast
 - 6.1.3 Fluorescence
 - 6.1.4 SEM
 - 6.1.5 TEM
 - 6.1.6 STEM
- 6.2 Colorimetry;
- 6.3 Spectrophotometry
- 6.4 Flow cytometry
- 6.5 Gel-filtration
- 6.6 TLC
- 6.7 HPLC
- 6.8 Gel electrophoresis
- 6.9 Centrifugation
 - 6.9.1 Differential
 - 6.9.2 Density gradient
 - 6.9.3 Ultracentrifugation.

B. Statistics for biologists:

1. **Introduction:**
 - 1.1. Data
 - 1.2. Collection of Data
 - 1.3. Classification of data
 - 1.4. Tabulation of data
2. **Diagrammatic and graphical presentation of data:**
 - 2.1 Bar diagram
 - 2.2 Pie diagram
 - 2.3 Histogram
 - 2.4 Frequency polygon
 - 2.5 Frequency curve
3. **Measures of central tendency:**
 - 3.1 Mean
 - 3.2 Median
 - 3.3 Mode.
4. **Measures of dispersion:**
 - 4.1 Range
 - 4.2 Mean deviation
 - 4.3 Standard deviation
 - 4.4 Quartile deviation
5. **Probability:**
 - 5.1. Basic concepts
 - 5.2. Laws of probability
 - 5.3. Probability distributions
 - 5.3.1. Binomial distribution
 - 5.3.2. Poisson distribution
 - 5.3.3. Normal distribution
6. **Statistical inference:**
 - 6.1. Testing of hypothesis
 - 6.1.1. Null and alternate hypotheses
 - 6.2. Testing of significance
 - 6.2.1. Z-test
 - 6.2.2. *t*-test
 - 6.2.3. X^2 test
7. **Analysis of variance (ANOVA):**
 - 7.1. One way analysis
 - 7.2. Two way analysis

8. Correlation analysis

- 8.1. Kinds of correlation
- 8.2. Pearson coefficient of correlation
- 8.3. Scatter plots

9. Regression analysis

- 9.1. Regression equations
- 9.2. Regression lines

REFERENCES

Physics for biologists

1. Cotterill Rodney (2004). Biophysics: an Introduction. Wiley student edition
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ZOOL E 104 - BEHAVIORAL SCIENCES 90 hrs

1. Introduction:

- 1.1 Approaches and methods in study of behavior
 - 1.1.1 Studies in laboratory
 - 1.1.1.1 Neuroanatomical or lesion or ablation technique
 - 1.1.1.2 Neurophysiological technique
 - 1.1.1.3 Neurochemical technique
 - 1.1.2 Studies in wild
 - 1.1.2.1 Methods of location of animals
 - 1.1.2.2 Methods of identification and naming of animals
 - 1.1.2.3 Methods of observation of behavior patterns of animals
- 1.2 Proximate and ultimate causes of behaviour

2 Instinctive and learning behaviours

- 2.1 Instinctive behavior: Fixed action pattern, sign stimuli and releasers as triggers. Types of sign stimuli, Ritualization.
- 2.2 Learning : Categories of learning, habituation, classical conditioning, operant conditioning, latent learning, insight learning, learning sets, social learning, imprinting, trial and error

3 Physiology of behaviour:

- 3.1 Neural basis of behavior
 - 3.1.1 Brain and behavior
 - 3.1.2 Role of nervous system upon reflexes
- 3.2 Hormones and behavior
 - 3.2.1 Basic categories of hormones related to animal behavior
 - 3.2.1.1 Activational or releaser hormones
 - 3.2.1.2 Organizational hormones
 - 3.2.2 Groups of hormones controlling animal behaviour
 - 3.2.2.1 Primary or direct producers of behaviour
 - 3.2.2.2 Secondary or indirect producers of behaviour
 - 3.2.3 Hormonal impact on various behavioural patterns

4 Biological clocks

- 4.1 Types of biological clocks
 - 4.1.1 Circannual clocks
 - 4.1.2 Circatidal clocks
 - 4.1.3 Circalunar or Circasynodic clocks
 - 4.1.4 Semilunar or Circasyzygic Clocks
 - 4.1.5 Circadian clocks
- 4.2 Theories for the mechanism of the biological clock

5 Genetics of behaviour

- 5.1 Hybridization
- 5.2 Single or multiple gene effect
- 5.3 Gene mutations which influence behavior
- 5.4 Relationship between genes and environment in control of behaviour

6 Biological Communication

- 6.1 Components of communication system
- 6.2 Signals in communication system
- 6.3 Types of communication systems
 - 6.3.1 Chemical communication
 - 6.3.2 Visual communication
 - 6.3.3 Auditory communication
 - 6.3.4 Tactile communication
 - 6.3.5 Electrical communication
 - 6.3.6 Complex communication systems

7 Reflex and complex behaviours

- 7.1 Latency, after discharge, summation, warm up, fatigue, inhibition, feedback regulation

8 Sociobiology

- 8.1 Types of social groups, Social dominance
- 8.2 Migration
 - 8.2.1 Bird Migration
 - 8.2.1.1 Types of migration

- 8.2.1.2 Causes of migration
 - 8.2.1.3 Classification based on migratory status
 - 8.2.1.4 Orientation and navigation in migration
 - 8.2.1.5 Conditional strategy hypothesis of migration
- 8.2.2 Fish migration
 - 8.2.2.1 Types of migration based on causes
 - 8.2.2.2 Classification migratory fishes
 - 8.2.2.3 Factors influencing migration
- 8.3 Cooperation
 - 8.3.1 Paths to co-operation
 - 8.3.1.1 Kin selection
 - 8.3.1.2 Reciprocity
 - 8.3.1.3 Byproduct mutualism
 - 8.3.1.4 Group selection
 - 8.3.2 Range of co-operative behavior
 - 8.3.2.1 Helping in the birthing process
 - 8.3.2.2 Social grooming
 - 8.3.2.3 Group hunting
 - 8.3.2.4 Nest raiding
 - 8.3.3 Interspecific co-operation
 - 8.3.4 Role of Altruism and reciprocal altruism in co-operation
- 8.4 Territoriality
 - 8.4.1 Territory
 - 8.4.2 Size of territory
 - 8.4.3 Territory and foraging
 - 8.4.4 Territory and breeding
 - 8.4.5 Territory and learning
 - 8.4.6 Interspecific territoriality
 - 8.4.7 Economy of territoriality
 - 8.4.8 Functions of territoriality
- 8.5 Aggression
 - 8.5.1 Types of aggression
 - 8.5.2 Intraspecific aggression
 - 8.5.3 Interspecific aggression
 - 8.5.4 Causes of aggression
 - 8.5.5 Game theory models of aggression
 - 8.5.6 Hawk-dove game model
 - 8.5.7 The war of attrition model
 - 8.5.8 Sequential assessment model
- 8.6 Foraging
 - 8.6.1 Foraging strategies
 - 8.6.2 Learning and Foraging
 - 8.6.3 Optimal Foraging Theory
- 8.7 Antipredation
 - 8.7.1 Different methods of antipredatory behaviour
 - 8.7.2 Learning and antipredator behaviour
 - 8.7.3 Inter-population differences in antipredator behaviour

9 Sexual Behavior

- 9.1 Sexual selection
- 9.2 Mating systems
- 9.3 Monogamy
- 9.4 Polygamy
- 9.5 Promiscuity

10. Parental Care:

- 10.1 Parts of parental care
 - 10.1.1 Care before birth
 - 10.1.2 Care after birth
 - 10.1.3 Early parental care
- 10.2 General features of parental behavior
- 10.3 Factors affecting parental care
- 10.4 Types of parental care
- 10.5 Care and attachment
- 10.6 Parent –offspring conflict

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ZOOL E 105 WILD LIFE BIOLOGY

90 hrs

1. Introduction

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

2. Biology and Taxonomy of Mammals & Birds

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

2.1. Mammals

Order Primates

- Apes: Gibbon
- Monkeys: Macaques (Bonnet, Rhesus, Assamese and Lion tailed)
- Langurs (Common, Capped, Golden, Nilgiri)
- Lemurs: Slender Loris and Slow Loris

Order Carnivora

- Cats: Tiger, Lion, Leopard, Fishing cat, Leopard cat, Jungle cat, Indian Wild Dog, Wolf, Jackal, Indian Fox
- Otters: Common Otter, Smooth Indian Otter
- Bears: Sloth bear, Brown bear, Himalayan black bear, Sun bear
- Panda: Giant panda, Red panda
- Hyena: Striped hyaena
- Civets: Malabar civet, Small Indian civet, Common palm civet
- Mongoose: Common mongoose, Small Indian mongoose, striped necked mongoose

Order Artiodactyla

- Cervids: Chital, Sambar, Barking deer, Mouse deer.
- Bovids: Indian Antelope, Four horned Antelope, Nilgiri tahr, Indian bison.
- Suids: Indian Wild boar.

Order Proboscidae Indian Elephant

Order Perisodactyla One horned Rhinoceros.

Order Pholidota Indian Pangolin

Order Lagomorpha Hispid hare

Order Insectivora Tree shrew, Hedgehog

Order Rodentia Indian Giant squirrel, Grizzled giant squirrel, Porcupine, Flying squirrel, striped palm squirrel

Order Chiroptera Indian flying fox, Short nosed fruit bat, Indian pipistrella
Order Cetacea Gangetic dolphin, Common dolphin, Sperm Whale.
Order Sirenia Sea cow

2.2. Birds

2.2.1. Habitat preference
2.2.2. Flocking and aggregation.
2.2.3. Foraging behaviour,
2.2.4. Food competition and selection
2.2.5. Courtship and pair selection,
2.2.6. Brood parasitism and cooperative breeding.
2.2.7. Vocalisation and its Role in birds
2.2.8. Flyways and peculiarities of bird migration in the Indian Subcontinent
2.2.9. Avian classification and distribution with special reference to Indian species.

Order Columbiformes Blue Rock pigeon, Spotted Dove.

Order Podicipediformes Little Grebe

Order Pelecaniformes Little and Large Cormorant, Darter

Order Ciconiformes Pond heron, Large egret, Little egret, Median egret, Grey heron, Purple heron

Order Ansariformes Bar headed goose, Lesser whistling teal

Order Gruiformes Indian Moorhen, Purple moorhen, White breasted waterhen

Order Charadriiformes River tern, Red wattled Lapwing, Yellow wattled Lapwing, Black headed gull, Bronze winged jacana, Pheasant tailed jacana.

Order Falconiformes Hawks, Vultures.

Order Gruiformes Indian cuckoo, Koel, Crow pheasant

Order Coraciiformes White breasted kingfisher, Small blue kingfisher, Pied kingfisher, Brown headed kingfisher, Chestnut headed Beaeater, Small green Beaeater, Hornbills

Order Pisciformes Lesser Golden backed woodpecker, Indian golden backed woodpecker, Small green barbet

Order Psittaciformes Rose ringed parakeet, Blossom headed parakeet, Lorikeet

Order Strigiformes Indian horned owl, Mottled wood owl, Barn owl

Order Apodiformes Palm swift

Order Passeriformes Black headed Oriole, Golden Oriole, Tree Pie, Drongo, Racket tailed Drongo, Red whiskered Bulbul, Red vented Bulbul, Black headed Babbler, White headed Babbler, Munia, Magpie Robin, Jungle Babbler, Purple sunbird, Purple rumped sunbird, Indian Roller, Indian Robin, White cheeked Bulbul,

Tickell's flower pecker, Thick billed flower pecker, Paradise flycatcher.

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

2.2.11. Endemic Indian birds and endemic bird areas.

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

3. Fishes, Amphibians & Reptiles

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

3.2 Amphibia: Amphibians endemic to Western Ghats (Brief account with threat to their survival)

3.3 Reptiles

Order Crocrodilia Gharial, Estuarine crocodile, Marsh crocodile.

Order Testudines Logger headed sea turtle, Green Sea Turtle, Hawk's Bill Turtle, Olive

Ridley Turtle, Leatherback Sea Turtle. (Brief account with threat to their survival)

Order Squamata Indian Monitor Lizards (Brief account only)

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

4. Sociobiology & Territoriality

4.1 Sociobiology of Lion, Elephant and Deer

4.2 Territoriality and functions of territory.

5. Principles & Hypothesis

5.1 Gondwana principle

5.2 Satpura Hypothesis

References:

1. Aaron, N.M. (1973): Wildlife ecology. W.H. Freeman Co. San Francisco, USA.
2. Alfred, J.R.S., Das, A.K. and Sanyal, A. K. (1998): Faunal diversity in India, ZSI Calcutta
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6. Induchoodan (2004): Keralathile Pakshikal (Malayalam) - IVth Edn. Kerala Sahitya, Academy, Thrissur.
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16. Sukumar, R. (1989): Asian Elephant. Cambridge Univ. Press
17. Trothy, J.B. Boyle and Boontawee – Measuring and monitoring Biodiversity in Tropical and Temperate Forest. Centre for International forestry Research, Bogor, Indonesia

ZOOL P 106 - PRACTICAL I (BIOCHEMISTRY)

1. Quantitative estimation of carbohydrates :
 - a. Estimation of blood glucose by colorimetric methods (Nelson-Somoyi or Arsenomolybdate or by Folin-Wu method).
 - b. Estimation of total carbohydrate by phenol-sulphuric acid method.
2. Quantitative estimation of proteins:
 - a. Estimation of serum proteins by colorimetric method (Biuret method).
 - b. Estimation of total proteins from liver by Lowry's method.
 - c. Isolation of casein from milk.
3. Quantitative estimation of lipids
 - a. Estimation of serum cholesterol by Ferric chloride or Carr-Dreker method.
 - b. Saponification value of fat.
 - c. Estimation of total lipids in the serum (using phosphovanillin method).
4. Enzyme assays
 - a. Determination of salivary amylase activity-effect of substrate concentration.
 - b. Determination of salivary amylase activity - effect of pH.
5. Buffers and pH:
 - a. Comparison of the capacities of two buffers of the same pH.

ZOOL P 107 - PRACTICAL II (BIOPHYSICS & BIOSTATISTICS)

Biophysics

1. Absorption spectrum of potassium permanganate.
2. Determination of absorption coefficient and concentration of unknown solutions by calibration as well as by absorption coefficient.
3. Separation of mixtures of sugars and amino acids by paper/thin layer chromatography.
4. Micrometry
5. Phase contrast microscope, camera Lucida, Photomicrography equipment.
6. Determination of coefficient of viscosity.
7. Determination of pH of various biological fluids using pH meter.

Biostatistics

1. Preparation of frequency distribution for the data of a group of people according to height.
2. Diagrammatic presentation of census data in Kerala in the form of bar diagrams and pie diagrams.
3. Graphic presentation of a population distribution according to age in the form of histogram, frequency polygon and frequency curve.
4. Computation of measures of central tendency and dispersion in anthropometric data of school children.

5. Simulation of binomial and poisson distributions.
6. Estimation of population of birds in the University campus.
7. Design an experiment for the comparison of efficacy of diets of different types animals by the method of ANOVA.
8. Regression analysis and correlation analysis of a data of heights and weights of a group of students.
9. Estimation of organisms in water by Dilution Method.

II SEMESTER

ZOOL C 201 - CYTOGENETICS AND MOLECULAR BIOLOGY 90 hrs

A. Cytogenetics:

1. Membrane systems of cell:

1.1 Plasma membrane:

- 1.11 Structure and function of plasma membrane
- 1.12 Molecular models of plasma membrane structure
- 1.13 Movement of substances across cell membranes (diffusion, active transport and pumps).

1.2 Cytomembrane systems:

- 1.21 Structure, function and membrane trafficking
- 1.22 Endoplasmic reticulum
- 1.23 Golgi complex
- 1.24 Types of vesicle transport and their functions
- 1.25 Cellular uptake of particles and macromolecules

2. Cellular energy transactions:

- 2.1 Role of mitochondria and chloroplasts.

3. Signal transduction

- 3.1 The basic elements of cell signaling systems.
- 3.2 G protein coupled receptors and their second messengers
- 3.3 Protein- Tyrosine phosphorelation as a mechanism for signal transduction.
- 3.4 The role of calcium as an intracellular messenger

4. Cell Cycle Mechanisms:

- 4.1 Genetic regulation of cell division in yeast and eukaryotes
- 4.2 Molecular basis of cellular check points
- 4.3 Molecular basis of Neoplasia.

5. Human cytogenetics:

- 5.1 Numerical and structural abnormalities of human chromosomes–syndromes
- 5.2 Gene mutations
- 5.3 Chromosome based heritable diseases in humans (Haemophilia, colour blindness)

6. **Microbial genetics:**
 - 6.1 Bacterial transformation, transduction, conjugation and bacterial chromosome.
 - 6.2 Bacteriophages: structure and morphology of T₄ and lambda phages.
7. **Transposable genetic elements:**
 - 7.1. Genetic instability and the discovery of transposable elements
 - 7.2. Transposons in bacteria
 - 7.1.1 IS elements, the Tn family
 - 7.1.2 Mu phage as a transposable element
 - 7.2 Transposons in eukaryotes
 - 7.2.1 Controlling elements in maize
 - 7.2.2 P elements in *Drosophila*;
 - 7.3 Retroposon type transposition
 - 7.3.1 Yeast Ty elements
 - 7.3.2 Alu family
 - 7.4 Retroviruses and transposition
8. **Apoptosis:**
 - 8.1 Intrinsic pathway of apoptosis
 - 8.2 Extrinsic pathway of apoptosis

B. Molecular biology:

1. **Genes and genomes:**
 - 1.1 Genomes of prokaryotes and eukaryotes
 - 1.2 Organelle genomes
 - 1.3 Evolution of genomes.
2. **Characteristic features of eukaryotic genome:**
 - 3.1 Chromosomal content and C-value paradox
 - 3.2 Unique, moderately repetitive and highly repetitive DNA sequences
 - 3.3 Reassociation kinetics of the above types of DNA
 - 3.4 Cot value and complexity of the genome
3. **Chemistry and Structure of nucleic acids:**
 - 3.1 Topology of nucleic acids
 - 3.2 Supercoiling and topoisomerases
 - 3.3 Different forms of DNA (A, B, C & Z).
4. **Replication of DNA:**
 - 4.1 Models of DNA replication: Semiconservative mode (Experiments of Messelson and Stahl and that of Cairns), rolling circle mode and D-loop mode of replication. Role of antisense RNA in replication initiation in plasmids.
 - 4.2 Okazaki fragments and semi-discontinuous synthesis.
 - 4.3 Enzymes and accessory proteins involved in DNA replication.
 - 4.4 Primosome, replisome, Telomeric DNA and regulation of telomere length; reverse transcription.
5. **DNA Repair:**
 - 5.1 Excision repair, mismatch repair light dependant repair and SOS response

6. Transcription in prokaryotes and eukaryotes.

- 6.1 Initiation of transcription, elongation, termination and anti-termination
- 6.2 Promoter, enhancer and silencer sites
- 6.3 Transcription factors.
- 6.4 Post transcriptional modification of RNA
 - 6.4.1 Capping and Tailing of mRNA
 - 6.4.2 Removal of intron sequences by RNA splicing in mRNA, *t* RNA and r RNA, Splicing and Ribozyme.
 - 6.4.3 RNA editing- guide RNA.

7. The genetic code:

- 7.1 Characteristic features of the genetic code (triplet, comma less, non-overlapping a universal nature of the code).
- 7.2 Deciphering the code
- 7.3 Degeneracy of the code: Wobble hypothesis
- 7.4 Reading frame and frame shift.

8. Details of translation:

- 8.1 Initiation, elongation and termination of protein synthesis
- 8.2 Structure of *t* RNA
- 8.3 Various steps and factors involved in translation.

9. Regulation of gene expression in bacteria:

- 9.1 The operon model. : *Lac* operon, *lac* repressor, negative and positive control
- 9.2 Basic features of tryptophan operon
- 9.3 Operator-repressor regulation and attenuation regulation

10. Regulation of gene expression in phages:

- 10.1 Circuit of lytic cycle and lysogeny
- 10.2 Lytic cascade in λ phage
- 10.3 Transduction - generalized and specialized.

11. Regulation of gene expression in eukaryotes:

- 11.1 Regulation at transcriptional level
 - 11.1.1 Activation of transcription
 - 11.1.2 Repression of transcription
- 11.2 Regulation at translational level
 - 11.2.1 Regulation by alternate pathways of transcript splicing
 - 11.2.2 Anti - sense RNA strategies for regulating gene expression; molecular mechanisms of anti-sense molecules.

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ZOOL C 202 - BIOTECHNOLOGY AND BIOINFORMATICS

90 hrs

A. Biotechnology:

(60 hrs)

1. **Biotechnology: An Overview**

- 1.1 Scope and importance of biotechnology
- 1.2 Biotechnology in India.

- 2. Chimaeric DNA, Molecular Probes and Gene Libraries**
 - 2.1 Restriction enzymes for cloning
 - 2.1.1 Techniques of restriction mapping
 - 2.2 Construction of chimaeric DNA
 - 2.3 Molecular probes (production, labeling and uses)
 - 2.4 Southern, northern and western blotting
 - 2.5 Dot and slot blots
 - 2.6 Construction and screening of genomic and cDNA libraries

- 3. Cloning and Expression Vectors:**
 - 3.1 Cloning vectors for recombinant DNA (plasmids, phages, cosmids, viruses, transposons, YAC, MAC, etc.)

 - 3.2 Expression vectors for high level of expression of cloned genes (use of promoters and expression cassettes including baculovirus)

 - 3.3 Binary and shuttle vectors.

- 4. Polymerase Chain Reaction (PCR) and Gene Amplification:**
 - 4.1 Gene amplification
 - 4.1.1 Basic PCR and its modifications (inverse PCR, anchored PCR, PCR for mutagenesis, asymmetric PCR)
 - 4.1.2 Application of PCR in biotechnology and genetic engineering
 - 4.1.3 DNA polymorphism- RAPDs, VNTRs, SSRs
 - 4.1 Gene tagging
 - 4.2 DNA fingerprinting.
 - 4.3 DNA microarray.
 - 4.4 Molecular markers (RFLPs, RAPDs, mini satellites, microsatellites)

- 5. Sequencing and Synthesis of Genes:**
 - 5.1 DNA sequencing.
 - 5.2 Synthesis of genes
 - 5.2.1 Gene synthesis machines.

- 6. Animal Cell and Tissue Culture:**
 - 6.1 Laboratory facilities
 - 6.2 Scope of animal cell and tissue culture
 - 6.3 Advantages and disadvantages of tissue culture
 - 6.4 Culture media for cells and tissues
 - 6.5 Culture procedures
 - 6.5.1 Primary Culture,
 - 6.5.2 Cell Lines and Cloning:
 - 6.5.2.1 Disaggregation (enzymatic and mechanical) of tissue.
 - 6.5.2.2 Artificial skin and artificial cartilage

- 7. Hybridoma and Monoclonal Antibodies:**
 - 7.1 Hybridoma technology and the production of monoclonal antibodies
 - 7.2 Antibody engineering using genetic manipulations (Fv, Fab, Fc)

7.3 Uses of monoclonal antibodies (diagnosis, imaging, therapy, vaccines, enzymes, etc.).

8. Biotechnology in Medicine:

- 8.1 Animal and human health care (vaccines, diagnosis and cure of diseases including gene therapy and transplantation of bone marrow)
- 8.2 Genetic counseling (antenatal diagnosis, fetus sexing)
- 8.3 Forensic medicine (identification of murderers and rapists, etc.).

9. Use of Microbes in Industry and Agriculture:

- 9.1 Production of organic compounds by microbial fermentation (ethanol, acetone/butanol, gluconic acid.)
- 9.2 Production of enzymes by micro-organisms (amylases, proteases, lipases)
- 9.3 Production of antibiotics by micro-organisms
 - 9.3.1 Microbial transformations
 - 9.3.2 Single cell proteins (SCP) from micro organisms
- 9.4 Biohydrometallurgy and biomineralization
- 9.5 Biofertilizers
- 9.6 Bioinsecticides
- 9.7 Applications of genetically engineered bacteria.

10. Intellectual Property Rights (IPR) and Protection (IPP):

- 10.1 Intellectual property
 - 10.1.1 Intellectual property rights (patents, trade secrets, copyright, trademarks); choice of intellectual property protection.

11. Patenting of Biological Material:

- 11.1 International conventions
- 11.2 Obligations with patent applications
- 11.3 Patenting transgenic organisms and isolated genes
- 11.4 Plant breeder's rights (PBRs) and farmer's rights.

B. Bioinformatics:

(30 hrs)

1. Bioinformatics – I:

- 1.1 Biological data bases – generalized and specialized data bases- DNA, protein and carbohydrate data bases
- 1.2 EST, GSS, SNP and RNA databases
- 1.3 Nucleic acid sequence data bases
 - 1.3.1 Premier institutes for data bases
 - 1.3.2 Nucleic acids and amino acid codes used in database formats.

2. Bioinformatics – II:

- 2.1 Sequence alignment and its evolutionary basis
- 2.2 Searching the database for sequence similarity
 - 2.2.1 Search programmes with special reference to FASTA, BLAST and CLUSTAL W.
- 2.3 Application of bioinformatics in phylogenetic analysis.

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ZOOL C 203 - COMPARATIVE ANIMAL PHYSIOLOGY

90 hrs

1. Nutrition, Digestion and Absorption:

- 1.1 Ruminant and non ruminant herbivory
- 1.2 Biochemistry of digestion and absorption of
 - 1.2.1 Carbohydrate
 - 1.2.2 Protein
 - 1.2.3 Fat
- 1.3 Liver and biliary system
- 1.4 Neuronal and hormonal regulation of nutritional intake
- 1.5 Secretion of digestive enzymes
- 1.6 Hunger drive and thirst.
- 1.7 Physiology of gastro-intestinal disorders
 - 1.7.1 Ulcer, Constipation
- 1.8 Nutritional disorders
 - 1.8.1 Obesity, starvation, anorexia, vitamin deficiency

2. Circulation

- 2.1 Circulation of body fluids Cytoplasm, hydrolymph, haemolymph, lymph and blood, respiratory pigments structure and function of pigments
 - 2.1.1 Circulatory mechanisms and fluid compartments, movement of body fluids open systems, closed system, lymph channel
- 2.2 Heart
 - 2.2.1 Types of hearts, chambered hearts, tubular heart, ampular heart, lymph heart, neurogenic and myogenic heart
 - 2.2.2 Pace makers and specialized conducting fibres
 - 2.2.3 Cardiac cycle and cardiac output

- 2.2.4 Blood pressure - Neural and Chemical regulation
- 2.2.5 Myocardial infarction, atherosclerosis
- 2.2.6 ECG
- 2.2.7 Cerebral circulation, blood brain barrier and cerebrospinal fluids
- 2.2.8 Placental circulation

3. Respiration

- 3.1 Comparison of respiration in different animal groups [brief account only]
- 3.2 Anatomical considerations
- 3.3 Neural and chemical regulation of respiration
 - 3.3.1 Respiratory centres
 - 3.3.2 Factors regulating respiration
- 3.4 Periodic breathing
- 3.5 Metabolic rate
 - 3.5.1 Basic metabolic rate and its measurement, R.Q and calculation based on it
- 3.6 Respiratory adjustments
- 3.7 Hypo ventilation, hypoxia, oxygen therapy, dyspnea, hyper ventilation, hypercapnia, respiratory buffering systems
- 3.8 Respiratory system in exercise
- 3.9 Oxygen toxicity, increased pressure of gas, decompression, inert gas narcosis
- 3.10 Respiration in unusual environment
 - 3.10.1 Foetal and neonatal respiration
 - 3.10.2 High altitude diving

4. Excretion

- 4.1 Comparison of excretion in different animal groups [brief account only].
 - 4.1.1 Osmoregulation, contractile vacuole, coelomoducts, flame cells, green glands, malpighian tubules, invertebrate nephridia
- 4.2 Vertebrate kidney
 - 4.2.1 Mechanism of tubular reabsorption and secretion
 - 4.2.2 Counter current mechanism
 - 4.2.3 Regulation of urine formation
 - 4.2.4 Concept of plasma clearance
- 4.3 Excretory products
- 4.4 Waste elimination, micturition
- 4.5 Regulation of water balance, electrolyte balance and acid base balance
- 4.6 Kidney disorders
 - 4.6.1 Acute renal failure, chronic renal failure-glomerulonephritis and pyelonephritis
- 4.7 Artificial kidney
- 4.8 Diuretic hormones.

5. Nerve physiology:

- 5.1 Neurons, action potential;
- 5.2 Gross neuroanatomy of brain and spinal chord
- 5.3 Peripheral nervous system
- 5.4 Neurotransmitters and Neurohormones
- 5.5 Synaptic transmissions
- 5.6 Electrical and chemical transmission
- 5.7 Drug modified transmission and synaptic junction
- 5.8 Neural disorders

5.8.1 Parkinson's disease, Epilepsy, Schizophrenia, Alzheimer's syndrome, Dyslexia

6. Sensory and Effector physiology:

6.1 Structural and functional classification, modality, intensity, exteroceptors interoceptors, secondary sense cells, transduction and sensory coding

6.2 Chemical senses

6.2.1 Taste and smell

6.2.2 Mechanism of reception

6.3 Mechanoreceptors

6.3.1 Hair cell, organ of equilibrium

6.4 Vertebrate ear

6.4.1 Structure; physiology of hearing

6.5 Vertebrate eye

6.5.1 Structure; physiology of image formation

6.6 Electro and thermoreceptors

6.7 Somatic sensations

6.7.1 Pain receptors; headache; pain suppression (analgesia) system in the brain and spinal cord

7. Muscle

7.1 Skeletal muscle

7.1.1 Ultrastructure and molecular organization

7.1.2 Protein components of muscle (mechanism and theory)

7.1.3 Contraction and relaxation of muscle

7.1.4 Energetics of muscle contraction

7.1.5 Muscle twitch, summation, tetanus, catch muscle, fibrillar muscle

8. Reproductive physiology:

8.1 General pattern of reproduction

8.2 Role of hormones in reproduction in human male

8.3 Role of hormones in implantation, pregnancy, parturition and lactation in human female

9. Endocrinology:

9.1 Endocrine glands

9.2 Basic mechanism of hormone action

9.3 Neuro-endocrine regulation

9.4 Pheromones

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ZOOL C 204 - IMMUNOLOGY AND PARASITOLOGY

90 hrs

A. Immunology

(60 hrs)

1. Historical background and scope of immunology

- 1.1 Overview of the immune system
- 1.2 Types of immunity
 - 1.2.1 Innate immunity
 - 1.2.1 Acquired immunity
- 1.3 Cells and organs of immune system

- 1.3.1 Primary and secondary lymphoid organs.
- 1.3.2 Haematopoiesis: Myeloid lineage; lymphoid lineage; cells of immune system.

2. Antigens (Immunogens):

- 2.1 Characteristic features of antigens
- 2.2 Factors affecting antigenicity (immunogenicity)
- 2.3 Epitopes; haptens
- 2.4 Adjuvants; role of adjuvants in enhancing immunogenicity
- 2.5 Superantigens

3. Antibodies (Immunoglobulins):

- 3.1 Structure of a typical antibody molecule
- 3.2 Different classes of immunoglobulins (IgA, IgD, IgG, IgM and IgE).
- 3.3 Hybridoma technology
 - 3.3.1 Monoclonal antibodies; applications of monoclonal antibodies.

4. Organization and expression of immunoglobulin genes:

- 4.1 Primary immunoglobulin gene rearrangement
- 4.2 Immunoglobulin genes
- 4.3 Somatic recombination of gene segments
- 4.4 Rearrangement of V, D and J gene segments
- 4.5 V(D)J recombinase
- 4.6 Generation of immunoglobulin diversity;

5. Major histocompatibility complex:

- 5.1 Antigen processing and presentation
- 5.2 General organization MHC class I and MHC class II
- 5.3 MHC genes
- 5.4 Regulation of MHC expression
- 5.5 Functions of MHC complex

6. Complement system:

- 6.1 Classical pathway
- 6.2 Lectin pathway
- 6.3 Alternate pathways of complement activation
- 6.4 Formation of membrane attack complex (MAC)
- 6.5 Complement control proteins

7. Antigen-antibody interactions:

- 6.1 Serology: Use of serology in various diagnostic assays
- 6.2 ELISA, RIA, Immuno-electrophoresis.
- 6.3 Agglutination reactions
 - 6.3.1 Haemagglutininations, WIDAL test.
- 6.4 Precipitation reactions

8. Failure of host defense mechanism

- 8.1 Immunodeficiency diseases
- 8.3 Acquired immune deficiency syndrome

9. Hypersensitivity reactions:

- 9.1 Type I hypersensitivity/Immediate (IgE mediated) hypersensitivity (allergy)
- 9.2 Type II hypersensitivity
- 9.3 Type III hypersensitivity
- 9.4 Delayed type hypersensitivity (DTH)

10. Auto-immunity

- 10.1 Making and breaking of self tolerance
- 10.2 Autoimmune diseases
 - 10.2.1 Organ specific auto-immune disease
 - 10.2.2 Systemic auto-immune diseases
- 10.3 Genetic and environmental basis of autoimmunity

11. Transplantation immunology

- 11.1 Graft rejection
 - 11.1.1 Role of T cells in graft rejection
- 11.2 General immunosuppressive therapy
- 11.3 Specific immunosuppressive therapy
- 11.4 Clinical transplantation.

12. Tumor Immunology

- 12.1 Tumor antigens
- 12.2 Immune responses to tumor antigens

13. Vaccination

- 13.1 Requirements for an effective vaccine.
- 13.2 Different types of vaccines
 - 13.2.1 Live attenuated vaccine
 - 13.2.2. Inactivated polypeptides as vaccines
 - 13.2.3 Recombinant vaccines
 - 13.2.4 DNA vaccines.
- 13.3 Route of vaccination

1. Parasitology

(30 hrs)

1. General Parasitology:

- 1.1 Introduction to Parasitology:
 - 1.1.1 Parasitism and types of parasitic infection
 - 1.1.2 Kinds of hosts
 - 1.1.3 Transmission of parasites
 - 1.1.4 Parasitic zoonosis

2. Parasite host specificity

- 2.1 Isolation of parasite populations
- 2.2 Kinds of parasite host specificity
- 2.3 Specificity factors related to infection and growth
- 2.4 Comparative host specificity
 - 2.4.1 Protozoans
 - 2.4.2 Cestodes
 - 2.4.3 Trematodes
 - 2.4.4 Nematodes
- 2.5 General rules and principle

3. Protozoan parasites of higher vertebrates (brief account on life cycle of any one species):

- 3.1 *Babesia*
- 3.2 *Theilaria*
- 3.3 *Trypanosoma*
- 3.4 *Plasmodium*

3. Trematode parasites of higher vertebrates (brief account on life cycle of any one species):

- 4.1 *Schistosoma*,
- 4.2 *Fasciola*
- 4.3 *Echinostoma*
- 4.4 *Paramphistomum*

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**ZOOL P 205 - PRACTICAL III
(CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY)**

Cytogenetics:

1. Chiasma frequency studies using grasshopper testes squashes.

2. Preparation of chromosomes from rat or mouse bone marrow or human or any other lymphocyte cultures.
3. Analysis of metaphase chromosomes from rat or mouse bone marrow or any other suitable material by means of G and C banding.
4. Preparation of human karyotype from photographs (Xerox copies would be sufficient) of chromosome spreads – Normal and abnormal
5. Identification of human blood cell types and demonstration of drumstick on neutrophils, employing any suitable stain. Staining of human buccal epithelial smear to demonstrate Barr body.
6. Preparation and analysis of salivary gland polytene chromosomes of *Drosophila* larvae.
7. Cell fractionation and isolation of nuclei from a suitable tissue e.g., rat liver.
8. Histochemical staining of carbohydrates (PAS), Protein (Bromphenol blue), lipids (Sudan Black), DNA (Feulgen stain), DNA and RNA (Methyl Green –Pyronin)

Molecular Biology

1. Induction of chromosome aberrations in roots of *Allium cepa* or any other suitable material such as *Tredescontia* by a suitable clastogenic agent and its demonstration by means of root tip squashes.
2. Maintenance of *Drosophila melanogaster* culture. Demonstration of sex-linked inheritance by means of suitable crosses e.g., wild type with white eye color mutant.
3. Gene mapping of *Drosophila melanogaster*, using textbook problems.
4. Extraction of DNA, RNA and Proteins followed by their estimation. Estimation of DNA by diphenylamine test and RNA by orcinol and protein by Lowry *et al* methods.
5. Maintenance of *E.coli* culture (Shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.
6. Isolation of genomic DNA (Isolation of DNA from cultured cells and tissues)
7. Isolation of RNA from Yeast.
8. *Drosophila* banding techniques and karyotyping.
9. Preparation of restriction fragments and their separation by electrophoresis

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ZOOL P 206 - PRACTICAL IV (ANIMAL PHYSIOLOGY AND PARASITOLOGY)

Animal Physiology

1. Detection of digestive enzymes in the hepatopancreas of crab.
2. Determination of Effect of temperature, on salivary amylase activity.
3. Determination of Effect of pH on salivary amylase activity.

4. Determination of Effect of substrate concentration on salivary amylase activity.
 5. Diffusion of substances through intestine of frog.
 6. Determination of osmotic concentration of human RBC.
 7. Enumeration of human RBC.
 8. Differential count of human WBC.
 9. Determination of vertebrate haemoglobin using colorimetry.
 10. Total and differential count of WBC
 11. Effect of osmotic stress on rate of respiration.
 12. Determination of salinity variations on volume/weight ratio.
- Nervous conduction in Arthropods.

Parasitology:

1. Preparation and uses of blood and tissue impression smears.
 2. Collection and preservation of Protozoan parasites.
 3. Collection and preservation of trematode parasites.
 4. Collection and preservation of vector arthropods.
 5. Collection and study of intra-molluscan study of trematodes from freshwater gastropods.
 6. Collection and study of metacercariae from freshwater fishes and other hosts.
 7. Study of medically important larval forms of insect pests.
 8. Study of prepared permanent slides of parasites.
 9. Collection, Preservation and identification of snail hosts of Trematode parasites.
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III SEMESTER

ZOOL C 301 – DEVELOPMENTAL BIOLOGY 90 hrs

1. Developmental dynamics of cell specification:

- 1.1 Autonomus specification
- 1.2 syncitial specification
- 1.3 Conditional specification; morphogenetic gradient.

2. Cell fate, potency, determination and differentiation.

3. Genomic equivalence and cytoplasmic determinants.

4. Genomic imprinting.

5. Cell communication in development:

- 5.1 Induction and Competence:
 - 5.1.1 Cascade of induction – reciprocal and sequential inductive events; instructive and permissive interactions; epithelial- mesenchymal interactions.
- 5.2 Paracrine factors.

5.3 Signal transduction cascades – fibroblast growth factors and RTK pathway; JAK-STAT pathway, hedgehog family; wnt family.

5.4 Juxtacrine signaling and cell patterning *eg. C. elegans*; the notch pathway.

6. Gametogenesis, fertilization and early development:

6.1 Production of gametes

6.2 Cell surface molecules in sperm egg recognition

6.3 Slow block polyspermy (mammals)

6.4 Fast block polyspermy (sea urchin)

6.5 Zygote formation, cleavage, blastula, gastrulation, formation of germ layers.

7. Genetics of axis specification in Drosophila:

7.1 Early Drosophila development

7.2 Genes that pattern the Drosophila body plan

7.3 Primary axis formation during oogenesis

7.4 Generating dorsal-ventral pattern in the embryo

7.5 Segmentation and anterior-posterior body plan

7.6 Segmentation genes; homeotic selector genes.

8. Early development and axis formation in amphibians:

8.1 Primary embryonic induction

8.2 Mechanism of axis determination in amphibians

8.3 Functions of the organizer

8.4 The regional specificity induction

8.5 Specifying the left right axis

9. Later embryonic development:

9.1 Eye Induction

9.2 Limb Development in Vertebrates

9.3 Differentiation of neurons

10. Sex Determination

10.1 Chromosomal sex determination in Drosophila & mammals

10.2 Environmental sex determination

11. Post embryonic development:

11.1 Metamorphosis; Insects and amphibians

11.2 Regeneration

11.3 Aging: senescence genes; role of free radicals; hormones and aging

12. Teratogenesis

13. Endocrine disruptors

14. Stem cells: Embryonic stem cell; adult stem cell; medical application

15. Impacts of pesticide on development

REFERENCES

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ZOO C 302 – ECOLOGY

90 hrs

1 Ecosystem

- 1.1 Concept of the ecosystem
- 1.2 Properties of Ecosystem
 - 1.2.1 Biomagnifications
 - 1.2.2 Ecological efficiency
 - 1.2.3 Ecological niche
 - 1.2.4 Edge Effects & Ecotones
 - 1.2.5 Ecocline & Ecotype
 - 1.2.6 Ecological Equivalents.

2 Energy Concepts

- 2.1 Energy flow within the Ecosystem
- 2.2 Laws of thermodynamics
- 2.3 Concept of productivity
 - Primary productivity; Measurement of primary production; Secondary productivity; Energy partitioning in food chains and food webs; Metabolism and size of Individuals
- 2.4 Decomposition
- 2.5 Ecological footprint
- 2.6 Carbon footprint

3 Population Ecology

- 3.1 Life table
- 3.2 Survivorship curves
- 3.3 Dispersion
- 3.4 Concept of carrying capacity
- 3.5 Population fluctuation and cyclic oscillations
- 3.6 Population Growth curves: Sigmoid growth curve; J-shape growth curve.
- 3.7 Regulation of population: Density independent and density dependent mechanisms of Population regulation
- 3.8 r- and k- selection

3.9 Population interactions: Mutualistic interactions; Symbiotic relationship; Parasitism; Predation; Competition

4 Community Ecology

4.1 Keystone Species,

4.2 Umbrella Species

4.3 Flagship species

4.4 Ecosystem Engineers

4.4 Biodiversity –Hot spots

4.5 Diversity indices: Dominance indices; Shannon index; Simpson's index; Brillouin index; Rank Abundance; Diagrams; Jaccard Coefficient; Sorensen Coefficient; Cluster Analysis

5 Biomes

5.1 Terrestrial Biomes

5.1.1 Tropical rain forest

5.1.2 Tropical deciduous forest,

5.1.3 Temperate rain forest,

5.1.4 Temperate deciduous forest,

5.1.5 Taiga,

5.1.6 Savanna,

5.1.7 Prairie,

5.1.8 Hot desert,

5.1.9 Cold desert &Tundra,

5.2 Marine Biomes

5.2.1 Open Oceans,

5.2.2 Hydrothermal vents,

5.2.3 Coral reefs,

5.2.4 Kelp Forest, Sea grasses,

5.2.5 Rocky Intertidal, Sandy shores

5.2.6 Mangrove Forest and salt marshes

5.3 Freshwater Biomes

5.3.1 Lakes,

5.3.2 Wet lands

5.3.3 Rivers,

5.3.4 Estuaries.

REFERENCES

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ZOO C 303 - CONSERVATION BIOLOGY – I

90 hrs

1 Conservation and its Importance

- 1.1 Meaning of conservation
- 1.2 Approaches to conservation
- 1.3 Conservation biology-principles
- 1.4 Categories for conservation status
- 1.5 Economic Evaluation of conservation: Cost benefit analysis; Safe minimum standard criteria

2 Threats to Biodiversity

- 2.1 Extinction: Current human caused mass extinction; Secondary Extinction; Extinction vulnerability
- 2.2 Anthropogenic impacts
 - 2.2.1 Habitat destruction, degradation, fragmentation and loss
 - 2.2.2 Overexploitation: Types of exploitation; Consequences of exploitation. Commercial harvesting, International Wildlife Trade
 - 2.2.3 Global Climate Change
 - 2.2.4 Pollution: Air pollution; Water pollution; Noise pollution; Land Pollution
 - 2.2.5 Pesticides & Salinisation
- 2.3 Exotic/ Invasive species: Impacts; Success rates
- 2.4 Genetically Modified Organisms

3 Conservation of Biodiversity

- 3.1 Conservation strategies
 - 3.1.1 In-situ conservation: Protected Areas; National parks
 - 3.1.2 Ex-situ conservation: Seed banks; Botanical gardens; Zoos
- 3.2 Conservation in Captivity: Problems of captive breeding; Adaptations to captivity; Reintroduction & release.

4 Conservation Techniques

- 4.1 PCR for genotyping endangered species
- 4.2 RAPD as a tool of taxonomic assessment
- 4.3 DNA Fingerprinting – the use of satellite markers
- 4.4 RELP for assessment of genetic variation among individuals

5. Conservation Genetics

- 5.1 Effective population size
- 5.2 Small populations
 - 5.2.1 Genetic threats to small populations: Genetic drift; Inbreeding depression; Mutational meltdown.

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- 33 I R New (2006) Conservation Biology in Australia.Oxford Uty. Press.

ZOOL C 304 –CONSERVATION BIOLOGY – II

90 hrs

1. The Legal Foundations of Conservation Biology

- 1.1 National laws relating to Biological Diversity
 - 1.1.1 Convention on Biological Diversity (1992)
 - 1.1.2 TRIPS agreement
 - 1.1.3 The Biological Diversity Act 2002
 - 1.1.4 Regulation of access to biological diversity
 - 1.1.5 Biological Diversity Rules, 2004
- 1.2 The National Biodiversity Authority
- 1.3 The State biodiversity boards
- 1.4 Major international conservation laws and treaties
 - 1.4.1 International protection of migratory species
 - 1.4.2 International protection of endangered species
 - 1.4.3 International protection of habitats and ecosystems
 - 1.4.4 Protection of commercially valuable species
- 1.5 Rio summit
- 1.6 Copenhagen summit

2. Conservation in Practice

- 2.1 People as agents of conservation
- 2.2 Conservation biology as vocation

- 2.3 Articulating personal mission and purpose in conservation
 - 2.4 Building a professional network of contacts and references in conservation
 - 2.5 Conservation as a social process
 - 2.6 Emerging trends in conservation biology
- 3. Conservation of Population**
- 3.1 Managing populations
 - 3.2 Managing invasive populations.
 - 3.3 Managing meta-populations of spatially disjunct subunits.
- 4. Conservation and Human Societies**
- 4.1 Conservation and sustainable development at the local and national level
 - 4.2 International Agencies: Governmental and Nongovernmental organizations
 - 4.3 Traditional societies, conservation and sustainable use.
- 5. Conservation of Ecosystems**
- 5.1 Conservation of Habitats and Landscapes: Preservation and conservation of habitats; Landscape management
 - 5.2 Conservation of Terrestrial Ecosystems: Forests; Grass lands; Deserts
 - 5.3 Conservation of Aquatic Ecosystems: Management of freshwater habitats for conservation; Conservation of marine habitats and biodiversity; Conservation of Wetlands
- 6. Restoration Ecology**
- 6.1 Definition and development
 - 6.2 Restoration protocols and procedures for ecological restoration
 - 6.3 Restoring terrestrial and aquatic ecosystem
 - 6.4 Restoration in urban areas
 - 6.5 Biocultural restoration
- 7. Conservation and Management of Specific Taxon**
- 7.1 Specific conservation requirements and management guidelines (two representative cases): Invertebrates (with specific reference to Arthropods); Fishes; Amphibians; Reptiles; Birds; Mammals

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ZOO P 305 – PRACTICAL V (DEVELOPMENTAL BIOLOGY)

1. Induced ovulation in fish/frog
2. Effect of bilateral eyestalk ablation on moulting in the crab *Barytelphusa cunicularis*.
3. Ovarian index under de-eye stalking of a crustacean.
4. Collection, preservation and permanent preparation of invertebrate larval forms (any five)
5. Rearing of amphibian embryo & larvae and identification of different developmental stages.
6. Vital staining of chick embryo.
7. Histological preparation of chick embryo (any two stages).
8. Preparation of permanent/temporary stained whole mounts of chick embryo.
9. Sperm count of frog
10. Regeneration study on amphibian tadpole

ZOO P 306 – PRACTICAL VI (ECOLOGY & CONSERVATION BIOLOGY)

1. Identification of marine plankton.
2. Separation and Identification of soil micro arthropods applying Berlese funnel
3. Sampling methods: Pitfall traps, Line transect, Quadrate sampling, Point quarter sampling
4. Intertidal studies: rocky shores, sandy (marine) shore, muddy shore and estuaries.
5. Estimation of salinity, pH, phosphates, chlorides and silicates in water samples.
6. Estimation of dissolved oxygen
7. Determination of dissolved Carbon dioxide

IV SEMESTER

ZOOL E 401– RESEARCH METHODOLOGY- CONCEPTS & METHODS

90 hrs

1. Sampling methods: direct, indirect.
2. Methods of recording physical parameters in field studies.
3. Remote sensing: Applications
4. GIS
5. Digital photography and Videography; photomicrography.

6. Scientific Writing: Literature collection, methodology of writing scientific reports, research papers, popular science articles; dissertation/thesis; research project proposals.
7. Open access publishing and open source software.
8. Scientific drawing.
9. Preparation and display of museum specimens: dry preservation (slides; insect boxes); wet preservation.
10. Taxidermy and Museology.
11. Micrometry, Cytophotometry.

References:

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8. Biological Techniques:
9. Richard Dawkins (2008). Modern Science Writing. Oxford University Press
10. Paul Oliver (2008). Writing your thesis. Sage Publications.
11. Ranjith Kumar (2008). Research Methodology (4th edn). Pearson Education
12. Michael R Peres (2007). Focal Encyclopedia of Photography. Elsevier
13. Liz Hamp-Lyons & Ben Heasley (2008) Study writing. Cambridge University Press.

ZOOL E 402 BIOSYSTEMATICS & TAXONOMY

1. Definition and basic concepts of biosystematics, taxonomy and classification.

- 1.1 History of Classification
- 1.2 Trends in biosystematics:
 - 1.2.1 Chemotaxonomy
 - 1.2.2 Cytotaxonomy
 - 1.2.3 Molecular taxonomy, DNA Barcoding
- 1.3 Dimensions of speciation and taxonomic characters.
- 1.4 Species concepts: species category, different species concepts, Subspecies and other infra-specific categories.
- 1.4 Theories of Biological Classification: Hierarchy of Categories.

2. Taxonomic Characters.

- 2.1 Different kinds.
- 2.2 Origin of reproductive isolation, biological mechanism of genetic incompatibility.
- 2.3 Taxonomic procedures: Taxonomic collections, preservation curation, process of identification.
- 2.4 Taxonomic keys, different types of keys, their merits and demerits.

2.5 International code of Zoological Nomenclature (ICZN): Operative principles, interpretation and application of important rules: Formation of Scientific names of various Taxa.

3. Biodiversity Indices

- 3.1 Evaluation of biodiversity indices.
- 3.2 Evaluation of Shannon - Weiner Index.
- 3.3 Evaluation of Dominance Index.
- 3.4 Similarity and Dissimilarity Index.

REFERENCE

- 1. M. Koto-The. Biology of biodiversity-Springer
- 2. E.O. Wilson-Biodiversity-Academic Press Washington.
- 3. G.G.-Simpson-Principle of animal taxonomy Oxford IBH Publication company.
- 4. E-Mayer-Elements of Taxonomy
- 5. Bastchelet-F-Introduction to mathematics for life scientists Springer Verlag, Berling.
- 6. Peter, S. (2002) Ecology: Theories and Applications. Prentice Hall of India
- 7. Skoal R.R. and F.J.Rohiff Biometry-Freeman, San-Francisco.
- 8. Snecdor, G.W. and W.G. Cochran Stastical Methods of affiliated-East-West Press, New Delhi.
- 9. Murry J.D. Mathematical Biology-Springer, Verlag, Berlin.

ZOOL E 403 FISHERIES BIOLOGY

90 Hours

1. Fish Taxonomy

- 1.1. Classification and distribution of economically important fin fishes

2. Integument

- 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

- 3.1. Body shape and musculature
- 3.2. Mechanism of propulsion

4. Life history of fishes

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

5. Digestive physiology

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

6. Circulatory physiology

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

7. Respiratory physiology

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

8. Excretory and Osmoregulatory physiology

- 8.1. Excretory organs
- 8.2. Osmoregulation in marine, brackish water and fresh water fishes

9. Endocrine physiology

- 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

- 10.1. Deep sea fishes
- 10.2. Cave dwelling fishes
- 10.3. Hill stream fishes

11. Oceanography

- 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

- 12.1. Characteristics of brackish and estuarine waters
- 12.2. Estuarine productivity

13. Limnology

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

References:

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2. Jayaram. K.C. 2013. Fundamentals of Fish Taxonomy. Delhi.
3. Joseph S. Nelson. 2006. Fishes of the World, 4th Edition ISBN: 978-0-471-25031-9

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8. Wetzel, R.G. Limnology. W.B. Saunders Co., 1975.
9. Sedgewick. A Student's textbook of Zoology, Vol. I & II.
10. Usinger. General Zoology, Vols. I & II.
11. Marshall & Williams. Textbook of Zoology. Vol.I.
12. Parker and Hasswell. Textbook of zoology, Vertebrates. Vol.II.
13. Barnes. General Zoology
14. Day, F. The fishes of India.
15. S.S. Khanna. An introduction to fishes
16. K.G. Lagler. Ichthyology
17. Prosser & Brown. Comparative Physiology
18. Hoar. Comparative Physiology
19. Hoar & Randall. Fish Physiology

ZOOL C 404 PROJECT WORK

The main objective of introducing a project work in the curriculum is that the student who completes this course should get hands on experience in independent research work in the field of biodiversity conservation and management. He/she should equip himself/herself to face challenges in Conservation Biology and should be able to provide trained manpower in the field. A topic in the optional subject – Biodiversity: Conservation and Management shall be assigned to each student. The research work related to this topic will be carried out by each student under the supervision of a teacher. The report of the findings shall be submitted by each student in the form of a dissertation which shall be submitted for evaluation a day prior to the date of viva voce examination of the fourth semester. A declaration by the student to the effect that the dissertation submitted by him/her has not previously 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 supervision are to be furnished in the dissertation.

Dr. Johny Joseph,
Course Director, Dept. of Zoology,
Mananthavady Campus

KANNUR UNIVERSITY
I SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 101 - PHILOSOPHY OF SCIENCE, HISTORY OF BIOLOGY,
EVOLUTION AND PHYLOGENY

Time: 3 Hours

Total Marks: 60

I. Short answer questions (Answer any four)

5×4= 20

1. Explain Hume's problem of induction.
2. Differentiate inductive and deductive reasoning with suitable examples.
3. Major contributions made by Charles Darwin.
4. Write notes on major events of mass extinction.
5. Comment on logical positivism.
6. Write any one method for estimating the proportions of polymorphic loci.

II. Short Essay (Answer any two)

8×2=16

7. What do you mean by phenotypic plasticity? Illustrate with examples.
8. Write notes on the following:
(a) Genetic Drift (b) Neutral Evolution
9. Explain inbreeding depression and heterosis.
10. Briefly describe the history of science during 20th century.

III. Essay (Answer any two)

12×2=24

11. Write an essay on origination and diversification of biological diversity.
12. Explain Hardy Weinberg principle and notes on its significance in evolution.
13. a. Genetic basis of reproductive isolation
b. Polyploidy and recombinational speciation
14. Write an essay on major events in evolutionary time scale.

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KANNUR UNIVERSITY
I SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 102 - CHEMISTRY FOR BIOLOGISTS

Time: 3 Hours

Total Marks: 60

I. Short answer questions (Answer any four)

5×4= 20

1. Write an account on the forces stabilizing the structure of nucleic acids.
2. What is meant by Allosteric inhibition?
3. Write short notes on Zymogens & Isozymes.
4. Explain the steps involved in the conversion of pyruvate to acetyl Co A.
5. Explain the role of prostaglandins.
6. What are shuttle mechanisms? Illustrate with examples.

II. Short essay (Answer any two)

8×2=16

7. Write a short essay on β - oxidation of fatty acids.
8. Enzyme inhibition in the treatment of AIDS.
9. Write a short note on high energy compounds with an emphasis on ATP in the biological system.
10. Write notes on the following reactions with examples:
 - (a) Transamination
 - (b) Decarboxylation
 - (c) Deamination

III. Essay (Answer any two)

12×2=24

11. Write an essay on the biosynthesis of cholesterol.
 12. Write an essay on glycolysis and how is it regulated?
 13. Describe the role of B-complex vitamins as coenzymes.
 14. Write an essay on electron transport system and its inhibitors.
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KANNUR UNIVERSITY
I SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 103 - PHYSICS FOR BIOLOGISTS & STATISTICS FOR
BIOLOGISTS

Time: 3 hours

Total Marks: 60

Part A – Physics for Biologists

Section A

I. Short Answer Questions (Answer any two) (5x2=10)

1. Give an account on flow cytometry and its applications.
2. Explain the technique of ultrasonography.
3. Write an account on MRI.

Section B

II. Short Essay Questions (Answer any one) (8x1=8)

4. Write a short account on ESR and NMR spectrophotometry.
5. Explain Laser technique & its application.

Section C

III. Essay Questions (Answer any one) (12x1=12)

6. What is tracer technique? Describe its application in biology. Mention biological effects of radiation.
7. Write essay on electron microscopy. Mention differences between SEM & TEM.

Part B – Statistics for Biologists

Section A

IV. Short Answers question (Answer any two) (5x2=10)

1. What do you mean by chi square test?
2. Write notes on techniques of drafting of a good questionnaire.
3. Calculate mean for the following data by using shortcut method.

Marks	10-20	20-30	30-40	40-50	50-60	60-70	70-80
No. of students	11	18	20	26	29	27	17

P. T. O

Section B

V. Short Essay Questions (Answer any one)

(8x1=8)

4. Calculate the mode by grouping and analysis method for the following data.

Marks	1	2	3	4	5	6	7	8	9	10	11	12
No of students	4	6	8	12	16	13	9	7	15	5	3	2

5. Briefly describe different kinds of diagrams. Write notes on its advantages.

Section C

VI. Essay Questions (Answer any one)

(12x1=12)

6. Define sampling. Write an essay on types of sampling and its importance in research.

7. Define ANOVA. Certain manure was used on four plots of land A B C D. Four beds were prepared in each plot and the manure used. The output of the crop in the beds of plots A B C D is given below. Using ANOVA find out whether the difference in the means of the products of crops of the plots is significant or not.

A	B	C	D
6	15	9	8
8	10	3	12
10	4	7	1
8	7	1	3

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KANNUR UNIVERSITY
I SEMESTER M.Sc. Applied Zoology Examination
ZOOL E 104 - BEHAVIOURAL SCIENCES

Time: 3 Hours

Total Marks: 60

I. Short answer questions (Answer any four) 5 x 4 = 20

1. What is migration? Describe the types of fish migration.
2. What is ritualization? Describe the sources of raw material for ritualization.
3. Explain the hormonal impact on various behavioural patterns.
4. Write on the monogamous mating system with examples.
5. What is the difference between instinctive and learned behaviour?
6. Write a short account on single gene mutation which influences behavior.

II. Short essay (Answer any two) 8 x 2 = 16

7. What are the types of aggression? Write on the game theory models of aggression.
8. Write a short essay on orientation and navigation in bird migration.
9. Give an account on the role of signals in various communication systems in animals.
10. What is social learning? Give different means by which social learning operates.

I. Essay (Answer any two) 12 x 2 = 24

11. Write an essay on different feeding strategies.
12. Explain chemical or olfactory communication with reference to pheromones.
13. What is Biological clock? Describe the types of biological clocks and write on the mechanisms of biological clock.
14. Define parental behaviour, parental care and parental investment. Write factors affecting parental care ?

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KANNUR UNIVERSITY
II SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 201 - CYTOGENETICS AND MOLECULAR BIOLOGY

Times: 3 Hours

Total Marks: 60

Part A Cytogenetics

I. Short answer Questions (Answer any two) 5 x 2= 10

1. Explain the mode of inheritance of haemophilia.
2. What is the role of COP – II coated vesicles in protein trafficking.
3. Mitochondria are considered as prokaryotic symbionts in Eukaryotes. Explain.

II. Short essay Questions (Answer any one) 8 x 1= 8

4. P elements are examples for eukaryotic transposons. Explain.
5. Explain numerical abnormalities of human chromosomes.

III. Essay Questions (Answer any one) 12x1=12

6. Cell division in eukaryotes is genetically regulated. Explain with examples.
7. Explain intercellular communication with examples.

Part B Molecular Biology

I. Short answer Questions (Answer any two) 5 x 2= 10

8. Differentiate prokaryotic genomes from eukaryotic genomes.
9. Explain C-value paradox with examples.
10. Explain the formation and significance of Okazaki fragments.

II. Short essay Questions (Answer any one) 8 x 1= 8

11. Explain degeneracy of genetic code with the support of illustrations and Wobble hypothesis.
12. How does RNA editing contribute to protein diversity in eukaryotes? What roles do guide RNAs in RNA editing?

III. Essay Questions (Answer any one) 12x1=12

13. Gene expression is regulated at transcriptional and translational levels. Explain.
14. Experiments of Messelson and Stahl and that of Cairns explain semi-conservative model of DNA replication. Discuss in detail.

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KANNUR UNIVERSITY
II SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 202 - BIOTECHNOLOGY & BIOINFORMATICS

Time: 3 Hours

Total Marks: 60

I. SHORT ANSWER QUESTIONS (Answer any four)

(4 x 5 = 20)

1. Comment on CLUSTAL.
2. What is BLAST? Enumerate different types.
3. Write a short account on RNA data bases.
4. Importance of Biotechnology
5. Applications of bioinformatics in phylogenetic analysis.
6. Write a brief account on biological data bases.

II. SHORT ESSAY (Answer any two)

(2 x 8 = 16)

7. Write a short essay on IPR & IPP.
8. Define SCP? Write the steps involved in its production.
9. Write an account on the following
 - (a) DNA fingerprinting
 - (b) Southern blotting.
10. Write a short essay on restriction enzymes in genetic engineering.

III. ESSAY (Answer any two)

(2 x 12 = 24)

11. Write an essay on following.
 - (a) Modifications of PCR.
 - (b) Molecular markers.
12. Write an essay on expression vectors for high level expression of cloned genes.
13. Genetically engineered bacteria are widely used in agriculture and industry. Illustrate with suitable examples.
14. (a) Screening of genomic libraries.
 - (b) Somatic cell fusion.

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KANNUR UNIVERSITY
II SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 203 COMPARATIVE ANIMAL PHYSIOLOGY

Times: 3 Hours

Total Marks: 60

I Short answer questions (Answer any four) 5 x 4 = 20

1. Explain counter current mechanism in vertebrate excretion.
2. Explain the role of Sodium and Potassium ions in the generation of action potential.
3. What is organ of Corti? What is its function?
4. Explain the role of Iodine in endocrine system.
- 5 Briefly describe olfactory reception mechanism.
- 6 What is cerebral circulation?

II Short Essay Question (Answer any two) 8 x 2 = 16

7. Explain how buffer system help to maintain the p^H of body fluids.
8. Explain drug modified synaptic transmission.
9. Write a short essay on renin angiotensin aldosterone pathway.
10. Briefly describe the energetics of muscle contraction.

III Essay (Answer any two) 12 x 2 = 24

11. Abnormal eating habits lead to nutritional disorders. Explain in detail with examples.
12. Discuss the structure and function of respiratory pigments in animals.
13. Explain the mechanism and regulation of ventilation in mammals with the help of suitable diagrams.
14. Explain the role of hormones in reproduction of human females.

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KANNUR UNIVERSITY
I SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 204 IMMUNOLOGY AND PARASITOLOGY

Time: 3 Hours

Total Marks: 60

Section A

I Short answer Questions (Answer any four) 5 x 4 = 20

1. Write a short account on types of parasitic infection and hosts.
2. What you mean by parasitism? Give a short account on different types of parasitic infection.
3. Give an account on comparative host specificity of different groups of invertebrates.
4. With the help of diagrams describe the life cycle of 1) Babesia 2) Theilaria
5. With the help of suitable diagram describe the life cycle of 1) Schistosoma 2) Fasciola
6. Write a short account on parasitic zoonosis with suitable examples.

Section B

II Short essay Questions (Answer any two) 8 x 2 = 16

7. Write a short note on cells and organs of immune system. Explain primary and secondary lymphoid organs.
8. Write a short essay on the production of monoclonal antibodies and Hybridoma technology. What are the applications of monoclonal antibodies?
9. Write a short note on MHC genes. How the MHC gene expression is regulated? What are the functions of MHC complex?
10. Describe type II and type III hypersensitivity reactions.

Section-C

III Essay Questions (Answer any two) 12 x 2 = 24

11. Write an essay on immunoglobulins. Describe about the different classes of immunoglobulins
12. Write an essay on the different pathways for the activation of compliment system and formation of Membrane Attack Complex (MAC).
13. Write an essay on vaccination.
14. Write down the basic principles and applications of antigen-antibody interactions.

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KANNUR UNIVERSITY
III SEMESTER M.Sc. Applied Zoology Examination

ZOOL C 301 - DEVELOPMENTAL BIOLOGY

Time: 3 hours

Total marks: 60

I. Short answer questions(Answer any four) 5×4=20

1. Write a short note on spermiogenesis
2. 'Although necessary for the survival of most cells, the reduction of molecular oxygen to water is also hazardous process that inflits much damage'. Justify the statement.
3. Explain the terms cell potency, fate, determination and differentiation.
4. Write a short note on genomic imprinting.
5. Explain juxtacrine signaling pathway.
6. What do you mean by morphogenetic gradients? Explain the role of morphogen in the development of drosophila.

II. Short Essay (Answer any two) 8×2=16

7. Write a short note on impact of pesticide on development.
8. Explain the anterior - posterior patterning in drosophila embryo.
9. Write a short essay on metamorphosis in amphibians.
10. Write a short essay on the formation and differentiation of neural tubes.

III. Essay (Answer any two) 12×2=24

11. Write an essay on fertilization and early development.
12. Write an essay on mechanism of chromosomal sex determination in drosophila and mammals.
13. Explain the mechanism of dorsoventral axis formation in *Xenopus* and comment on the molecular mechanism of mesoderm induction.
14. Write an essay on the signal transduction cascades in biological development.

KANNUR UNIVERSITY
III SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 302 - ECOLOGY

Time: 3 hours

Total marks: 60

I. Short Answer Questions (Answer any four) 5×4=20

1. Write short notes on natality and mortality
2. Explain mutualistic interactions.
3. Explain ecofeminism with example.
4. Explain energy partitioning in food chains.
5. Distinguish autecology from synecology.
6. Explain Jaccard co-efficient.

II. Short essay Questions (Answer any two) 8×2=16

7. Write short essay on deep and spiritual ecology
8. Write a short essay on tropical rain forest and temperate evergreen forest
9. Write notes on adaptation for desert life in animals.
10. What is ecosystem diversity? Explain with examples.

III. Essay Questions (Answer any two) 12×2=24

11. Write an essay on population growth curves.
12. Explain internationalisation of ecological issues.
13. What is productivity? Write in detail primary and secondary productivity and energy flow in the ecosystem.
14. Write an essay on forest ecosystems

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KANNUR UNIVERSITY
III SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 303 - CONSERVATION BIOLOGY I

Time: 3 Hours

Total marks: 60

I. Short Answer Questions(Answer any four) 5×4=20

1. What is inbreeding depression?
2. Explain extinction vulnerability.
3. Write an account on Mutational meltdown.
4. Explain eutrophication.
5. Distinguish In-situ and Ex-situ conservation.
6. Write short notes on exotic species

II. Short Essay Questions (Answer any two) 8×2=16

7. Explain genetic threats to small populations
8. Write a short essay on the problems of captive breeding and adaptations to captivity.
9. Principles of conservation biology.
10. Briefly explain various methods of Ex-situ conservation methods.

III. Essay Questions (Answer Any Two) 12×2=24

11. Elaborate various conservation strategies
12. Write an essay on Anthropogenic threats to bio diversity
13. Write an essay on the impact of environmental pollution on biological diversity.
14. Explain the major causes of extinction of biodiversity.

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KANNUR UNIVERSITY
III SEMESTER M.Sc. Applied Zoology Examination
ZOOL C 304 - CONSERVATION BIOLOGY II

Time: 3 hours

Total marks: 60

I. Short Answer Questions (Answer any four) 5×4=20

1. Emerging trends in conservation biology.
2. Comment on biological diversity act, 2002.
3. What is meant by “Edge effect”? Mention the importance of edge effect in conservation of population.
4. Management of invasive populations.
5. Write an account on Rio summit.
6. Bio-cultural restoration.

II. Short Essay Questions (Answer any two) 8×2=16

7. Conservation as a social process.
8. Comment on governmental and nongovernmental organizations involved in conservation.
9. Comment on major international conservation laws for migratory species and endangered species.
10. Give an account on the conservation and management of wetland ecosystems.

III. Essay Questions (Answer Any Two) 12×2=24

11. Restoration protocols and procedures for ecological restoration.
12. Write an essay on conservation and management of forest ecosystems.
13. Write an essay on conservation of habitats and landscapes.
14. Specific conservation requirements and management guidelines to birds.

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KANNUR UNIVERSITY
IV SEMESTER M.Sc. Applied Zoology Examination
ZOOL E 401: RESEARCH METHODOLOGY – CONCEPTS AND
METHODS

Time: 3 hours

Total marks: 60

I. Short Answer Questions (Answer any four) 4x5=20

1. Micrometry.
2. Wet preservation.
3. Science of remote sensing. Elaborate.
4. Scientific drawing.
5. Photomicrography and its biological applications.
6. Museology.

II. Short essay (Answer any two) 2x8=16

7. Define *taxidermy* and write the steps involved. Add notes on Rogue Taxidermy.
8. Write benefits of open source software.
9. Write a detailed note on sampling methods.
10. Applications of remote sensing.

III. Essay (Answer any two) 2x12=24

11. Methodology of writing a scientific thesis.
12. Write about the methods of recording physical parameters in field studies.
13. Give a critical account of molecular taxonomy.
14. Essay on preparation and display of museum specimens.

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KANNUR UNIVERSITY
IV SEMESTER M.Sc. Applied Zoology Examination
ZOOL E 402 BIOSYSTEMATICS & TAXONOMY

Time: 3 hours

Total marks: 60

I. Short Answer Questions (Answer any four)

1. Chemotaxonomy **4×5=20**
2. DNA barcoding
3. Biological species concept
4. Taxonomic collection methods
5. Homonymy
6. Methods of Curation

II. Short Essay Questions (Answer any two)

2×8=16

7. Different types of taxonomic keys. Explain merits & demerits of each.
8. Write an essay on diversity indices.
9. Explain different tools used in molecular taxonomy.
10. Explain different kinds of taxonomic characters.

III. Essay Questions (Answer any two)

2×12=24

11. Explain the various dimensions of speciation.
12. Define species. Write notes on different species concepts and its merits & demerits.
13. Write an essay on different patterns and genetic basis of reproductive isolation.
14. Define systematics. Explain the rules and recommendations of ICZN.

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