Department of Zoology

Patna University

Courses of Studies

M.Sc. Zoology

Four Semester Course with CBCS

2016

Patna University

Scheme of M.Sc. (Zoology) Course in Semester system

(As per the regulation of semester system, vide Patna University letter No. Acad-1563 dated 27.10.2009)

1. The duration of M.Sc. (Zoology) course shall be of two academic session, each divided into two semesters.
2. The first academic session called M.Sc. (Part – I), shall consist of Semester I and II, while the second academic session, called M.Sc. (Part – II), shall consist of Semester III and IV.
3. There shall be a total of 16 papers in the entire course. It consists of 12 full and 01 half core papers and 03 full and 01 half elective (optional) papers.
4. The performance of a student in each paper shall be assessed on the basis of a Continuous Internal Assessment (CIA) of 30 marks and End of Semester Examination (ESE) consisting 70 marks.
5. The components of CIA shall be Marks
   a. Two Mid-Semester written/practical tests of one hour duration - 15
   b. Seminar/Quiz/Viva voce - 05
   c. Home assignment/field work/report writing - 05
   d. Regularity and behaviour - 05

   Total marks - 30
6. The evaluation of laboratory paper will also be based on CIA and end-semester Practical examination.

(R.K.Sinha)
Head of the Department

Department of Zoology, Patna University, Patna
M.Sc. Zoology (Four Semester Course)

Semester –I					
Code	**Subject**	**Credit**	**Internal Assessment**	**End semester Exam**	**Total**
Zoo-M-101	Molecular Cell Biology	5	30	70	100
Zoo-M-102	Genetics	5	30	70	100
Zoo-M-103	Instrumentation & Biostatistics	5	30	70	100
Zoo-M-104	Practical (Core)	5	30	70	100
		20	120	280	400

Semester –II					
Code	**Subject**	**Credit**	**Internal Assessment**	**End semester Exam**	**Total**
Zoo-M-201	Biochemistry & Physiology	4	30	70	100
Zoo-M-202	Vertebrate Endocrinology	5	30	70	100
Zoo-M-203	Gamete & Developmental Biology	5	30	70	100
Zoo-M-204	Practical (Core)	6	30	70	100
		20	120	280	400

Semester –III					
Code	**Subject**	**Credit**	**Internal Assessment**	**End semester Exam**	**Total**
Zoo-M-301	**Principles of Ecology**	5	30	70	100
Zoo-M-302	**Vertebrate Immunology**	5	30	70	100
Zoo-M-303	**Elective Theory I**	5	30	70	100
Zoo-M-304A	**Practical (Core)**	2	15	35	50
Zoo-M-304B	**Practical (elective)**	3	15	35	50
		20	120	280	400

Semester -IV					
Code	**Subject**	**Credit**	**Internal Assessment**	**End semester Exam**	**Total**
Zoo-M-401	**Animal Behavior**	5	30	70	100
Zoo-M-402	**Biosystematics & Evolutionary Biology**	5	30	70	100
Zoo-M-403	**Elective Theory II**	5	30	70	100
Zoo-M-404	**Practical (Elective)**	5	30	70	100
		20	120	280	400

Elective (Optional) Papers: Two to be selected, One each in semester III and IV					
Code	**Subject**	**Credit**	**Internal Assessment**	**End Semester Exam**	**Total**
Zoo-M-303	**Cytogenetics**	**5**	**30**	**70**	**100**
Zoo-M-303	**Basic Entomology**	**5**	**30**	**70**	**100**
Zoo-M-303	**Fish Biology**	**5**	**30**	**70**	**100**
Zoo-M-303	**Environmental Science**	**5**	**30**	**70**	**100**
Zoo-M-303	**Protozoan Parasitology**	**5**	**30**	**70**	**100**
Zoo-M-403	**Cell & Molecular Biology**	**5**	**30**	**70**	**100**
Zoo-M-403	**Applied Entomology**	**5**	**30**	**70**	**100**
Zoo-M-403	**Applied Fisheries**	**5**	**30**	**70**	**100**
Zoo-M-403	**Environmental Biology**	**5**	**30**	**70**	**100**
Zoo-M-403	**Helminth Parasitology**	**5**	**30**	**70**	**100**

PATNA UNIVERSITY
Course Structure: M.Sc. (Zoology)
First Semester: 4 Core Papers

Theory		Marks	Total
ZOO 101	Molecular Cell Biology	70	
ZOO 101	Internal Assessment	30	100
ZOO 102	Genetics	70	
ZOO 102	Internal Assessment	30	100
ZOO 103	Instrumentation & Biostatistics	70	
ZOO 103	Internal Assessment	30	100
Practical			
ZOO 104	Laboratory course	70	
ZOO 104	Internal Assessment	30	100

Second Semester: 4 Core Papers

Theory		Marks	Total
ZOO 201	Biochemistry & Physiology	70	
ZOO 201	Internal Assessment	30	100
ZOO 202	Vertebrate Endocrinology	70	
ZOO 202	Internal Assessment	30	100
ZOO 203	Gamete & Developmental Biology	70	
ZOO 203	Internal Assessment	30	100
Practical			
ZOO 204	Laboratory course	70	
ZOO 204	Internal Assessment	30	100

PATNA UNIVERSITY

Course Structure: M.Sc. (Zoology) Third Semester:

2½ Core Papers & 1½ Elective (Optional) Paper

Theory		Marks	Total
ZOO 301	Principles of Ecology	70	
ZOO 301	Internal Assessment	30	100
ZOO 302	Vertebrate Immunology		70
ZOO 302	Internal Assessment	30	100
ZOO 303	Elective paper I	70	
ZOO 303	Internal Assessment	30	100
Practical			
ZOO 304A	Laboratory course (core)	35	
ZOO 304A	Internal Assessment	15	50
ZOO 304B	Laboratory course (Elective)	35	
ZOO 304B	Internal Assessment	15	50

Elective (Optional) Papers (any one of the following):

Semester III

1. **Cytogenetics**
2. **Basic Entomology**
3. **Fish Biology**
4. **Environmental Biology**
5. **Protozoan Parasitology**

PATNA UNIVERSITY
Course Structure: M.Sc. (Zoology) Fourth Semester:
2 Core Papers & 2 Elective (Optional) Papers

Theory		Marks	Total
ZOO 401	Animal Behavior	70	
ZOO 401	Internal Assessment	30	100
ZOO 402	Biosystematics & Evolutionary Biology	70	
ZOO 402	Internal Assessment	30	100
ZOO 403	Elective Paper II	70	
ZOO 403	Internal Assessment	30	100
Practical			
ZOO 404	Laboratory course (Elective)	70	
ZOO 404	Internal Assessment	30	100

Elective (Optional) Papers (any one of the following):

1. **Cell & Molecular Biology**
2. **Applied Entomology**
3. **Applied fisheries**
4. **Environmental Biology**
5. **Helminth Parasitology**

M.Sc. (Zoology): First Semester

Paper ZOO-M- 101: Molecular Cell Biology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: (A) Bio membrane

1. molecular composition and models of bio-membrane
2. Transport across bio-membrane – diffusion , facilitated diffusion, membrane pumps, symport and antiport

(B) Cytoskeleton

1. Microtubules and microfilaments: Structure and dynamics
2. Role of Kinesin and Dynein in cell movement, Axonal transport

Unit 2: DNA replication

1. Outline of prokaryotic replication
2. Replication features of single stranded phages
3. Mechanism and machinery of replication in eukaryotes
4. DNA damage and repair mechanisms

Unit 3: Transcription

1. Outline mechanism of prokaryotic transcription
2. Organization of eukaryoutic transcription machinery
3. General and specific transcription factors
4. Regulatory elements & DNA binding domains of transcription apparatus
5. Processing of primary transcript & RNA editing in eukaryotes

Unit 4: Translation

1. Genetic code: codon assignment and features
2. Outline of Prokaryotic translation
3. Eukaryotes translation: machinery (Ribosome & t RNA)
4. Eukaryotes translation: mechanism (Initiation, elongation and termination)

Unit 5: Intra cellular protein trafficking:

1. Targeting proteins to ER: Signal hypothesis
2. Co- and post – translational modifications of proteins
3. Trafficking mechanisms:
   (a) Vesicular transport
   (b) Protein sorting
   (c) Endocytosis and exocytosis

M.Sc. (Zoology): First Semester

Paper ZOO-M- 102: Genetics

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Organization of Chromosomes

1. Organization of eukaryotic chromosome: Nucleosome as functional particle,30- nm chromatin fibre, higher order structure of chromatin
2. Metaphase chromosomes: Organization of centromere and kinetochore, Organization of telomere and its maintenance
3. Heterochromatin : Types, organization, formation and significance
4. Structural organization and functional significance of Polytene and Lampbrush chromosomes.

Unit 2: Microbial genetics

1. Transformation, conjugation, transduction and sex-duction in bacteria
2. Construction of linkage map in bacteria
3. Molecular mechanism of recombination

Unit 3: Cell cycle

1. Stages and check points
2. Genetics of cell cycle regulation : Role of cyclins and CDKs
3. Molecular basis of cellular check points

Unit 4: Sex determination and dosage compensation

1. Genetic and Molecular basis of sex determination in *Caenorhabditis elegans*, Drosophila & human
2. Genetic basis of dosage compensation in *Caenorhabditis elegans*, Drosophila & mammals

Unit 5: Techniques & Methods in genetics

1. DNA sequencing : Base destruction method, chain termination method and automated sequencing, pyro- sequencing and next- generation sequencing.
2. DNA amplification: Polymerase chain reaction, its application and limitations.
3. DNA finger printing: VNTR profiling, STR profiling (Autosomal & Y Chromosome), mitochondrial DNA profiling,SNP profiling
4. Genome expression analysis : Southern, Northern & Western blotting, Reverse Transcription PCR, DNA micro array ,FISH

M.Sc. (Zoology): First Semester

Paper ZOO-M- 103: Instrumentation & Biostatistics

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)

Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)

Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: (A) Principles and uses of analytical instruments: pH meter, colorimeter, Spectrophotometer, Ultracentrifuge

(B) Microscopy

1. Principle of light transmission
2. Scanning and transmission electron microscopy
3. Fluorescence microscopy
4. Phase contrast microscopy
5. Confocal microscopy

Unit 2: (A) Separation techniques

1. Electrophoresis: SDS PAGE, Agarose gel electrophoresis
2. Chromatography: Column, GLC, HPLC
3. Organelle separation by centrifugation
4. Cell separation by flow cytometry and density gradient centrifugation

(B) Immunological techniques

1. Radio- immunoassay (RIA)
2. Enzyme-linked Immunosorbent assay (ELISA)

Unit 3: Basic Concept in Biostatistics

1. Sampling Design.
2. Methods of data collection.
3. Measurement and Scaling Techniques.
4. Statistical approach in Research.

Unit 4:

1. Standard deviation and standard error.
2. Concept of probability and its theorem
3. Errors in hypothesis testing
4. Test of significance (t-test, chi-square test).
5. Analysis of Variance (ANOVA) – One way & Two way.

Unit 5:

1. Correlation: Karl Pearson & Rank's Correlation.
2. Regression.

Books Recommend:

1. A Biologists Guide to Principles and Techniques of Practical Biochemistry by K. Wilson & K.H. Goulding, ELBS Edn.
2. Introduction to Instrumental Analysis by Robert Brown. McGraw Hill Intyernational Editions.
3. Biostatistical Analysis - Jerrold H. Zar, Dorling Kindersley Pvt. Ltd. South Asia.
4. Biostatistics: A Foundation For Analysis In Health Science - Wayne W. Daniel, Jhon Wiley & Sons, Inc

M.Sc. (Zoology): First Semester
Paper ZOO-M- 104: Laboratory Course

PRACTICAL Time: 6 Hrs Full Marks: 70

1St Sitting

1. A brief account of the instruments, their principles of working and application (any one) 10

2. Squash preparation using any of the following: 10

   (a) *Chironomus* larva for polytene chromosomes
   (b) Onion root tip for mitosis and mitotic index
   (c) Grasshopper testes for meiosis and related features

3. Identification and comments upon spots (cytological slides: Nos. 05) 10

2nd Sitting

4. Genetics (any of the following) 10

   (a) Solving problems on Mendelian principles and sex-linked inheritance

   (b) Preparation of linkage map based on data from Drosophilla crosses and tetrad analysis in Neurospora

   (c) Pedigree analysis in human

5. Biostatics: Standard deviation, standard error, t-test, Chi-square test, correlation, regression 10

6. Class records, charts/ models & field collection 10

7. Viva-voce 10

M.Sc. (Zoology): Second Semester

Paper ZOO-M- 201: Biochemistry & Physiology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit1: Bioenergetics:

1. Laws of thermodynamics, internal energy, enthalpy, entropy
2. Concept of free energy, redox potential, energy rich compounds
3. Biological oxidation- outline of glycolysis and krebs's cycle.
4. Mitochondrial electron transport chain, oxidative phosphorylation

Unit 2: Protein & enzyme chemistry

1. Primary, secondary, tertiary, quarternary and domain structures
2. Stabilizing forces in protein structure
3. Peptide conformation (Ramachandran plot, helices, turns and sheets)
4. Mechanism of enzyme action
5. Kinetics of enzyme catalyzed reaction
6. Regulation of enzyme activity (non-genetic)

Unit 3 : Physiology of respiration

1. Respiratory pigment in different phylogenetic groups
2. Principle of gaseous exchange & Fick's modified equation
3. Transport of oxygen and carbon dioxide in blood and body fluids
4. Regulation of respiration (neural and chemical)

Unit 4 : Nerve & muscle physiology

1. Physiology of electrical and synaptic transmission in neurons
2. Neuro transmitters and their physiological function.
3. Mechanism and energetics of muscle contraction

Unit 5: Physiology of excretion and thermoregulation

1. Patterns of nitrogen excretion in different Phylogenetic groups
2. Osmoregulation in different vertebrates
3. Regulation of acid-base balance
4. Thermoregulation in homeotherms and poikilotherms, hibernation and aestivation

M.Sc. (Zoology): Second Semester

Paper ZOO-M- 202: VERTEBRATE ENDOCRINOLOGY

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit: 1. Aims and Scope of Endocrinology:

1. Glandular secretion, types and general properties of glands.
2. Classification of hormones, their chemical nature and gross features.
3. Hormones as messengers
4. Neuroendocrine system and neurosecretion
5. Hypothalemic control of endocrine system.

Unit: 2.: Biosynthesis of Hormones:

1. Biosynthesis of steroid hormones
2. Biosynthesis of amino acid derived hormones
3. Biosynthesis of polypeptide hormones

Unit: 3: Hormone Receptors:

1. β-adrenergic receptor
2. Insulin receptor
3. Steroid hormone receptor

Unit: 4 : General principles of hormone actions (signal transduction)

1. Second messenger concept [G proteins, Nucleotides (cAMP, cGMP), Calcium, Calmodulin, Phospholipids]
2. Lipid soluble hormones and intracellular receptor
3. Lipid insoluble hormone and intracellular signalling

Unit: 5 : Hormones and Reproduction:

1. Hormones involved in reproduction
2. Hormonal regulation of reproductive cycles (ovarian, estrous, menstrual, cycles).

Suggested Reading Material

1. E. J. W. Barrington. General and Comparative Endocrinology, Oxford, Clarendon Press.
2. P. J. Bentley. Comparative Vertebrate Endocrinology. Cambridge University Press.
3. R. H. Williams. Text Book of Endocrinology. W. B. Saunders
4. A. Gorbman et al. Comparative Endocrinology. John Wiley & Sons.
5. Hedley, Endocrinology.
6. Turner and Bagnara Endocrinology

M.Sc. (Zoology): Second Semester

Paper ZOO-M- 203: Gamete & Developmental Biology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit1: Gamete Biology

1. Cellular basis of spermatogenesis and Biochemistry of semen
2. Ovarian follicular growth and differentiation
3. Oogenesis and vitellogenesis
4. Ovulation and ovum transport
5. Molecular events during fertilization

Unit 2: (A) Multiple ovulation and Embryo transfer technology

1. *In vitro* oocyte maturation
2. Super ovulation
3. *In vitro*-fertilization

(B) Assisted Reproduction technologies

4. Collection and preservation of gametes
5. ICST, GIFT & Immuno - contraception

Unit 3: Basic concept of development

1. Potency, commitment, specification, induction, competence, determination and differentiation
2. Morphogenetic gradients, cell fate and cell lineages, genomic equivalence and cytoplasmic determinants.

Unit 4: Differentiation, morphogenesis and organogenesis

1. Cell differentiation: Role of cytoplasm and nucleus
2. Gene amplification and rearrangement during development
3. Axes and pattern formation in *Drosophila*.
4. Limb development and regeneration in vertebrates

Unit 5: Stem cell Biology

1. Definition and characteristics of stem cell
2. Type of stem cell (embryonic, adult and cancer stem cell)
3. Nuclear reprogramming of induced pluripotent stem cell, test for pluripotency
4. Potential application of stem cells, therapeutic cloning

Suggested Reading Material

1. Austen, C. R. and Short, R. V. Reproduction in animals.
2. Schatten and Schatten. Molecular Biology of fertilization.
3. F. T. Longo. Fertilization. Chapman & Hall.
4. R. G. Edwards. Human Reproduction.
5. Gilbert S F Developmental Biology, IX Edition
6. Balinsky B I and Fabian B C An Introduction of Embryology.

M.Sc. (Zoology): Second Semester
Paper ZOO-M- 204: Laboratory Course

PRACTICAL Time: 6 Hrs Full Marks: 70

1St Sitting

1. Histological preparation (Paraffin Block preparation, section cutting and double staining of vertebrate tissues) 10

2. Experimental demonstration (any one of the following) 15
   a) Enumeration of RBC/WBC
   b) Preparation of blood film and identification of various blood cells and their differential counts.
   c) Determination of blood group
   d) Serum hormonal assay by ELISA (demonstration only)

3. Any one of the following experiments 15

   a. Determination of amylase activity
   b. Separation of amino acids by paper chromatography/ Separation of biochromes by column chromatography
   c. Colorimetric estimation of blood glucose, proteins, cholesterol and urea
   d. Preparation of different stages of chick embryo

2nd Sitting

3. Histochemical demonstration: 10
   PAS, Alcian blue, Mercury bromophenol blue, Sudan Balck B. Feulgen, Methyl green Pyronin Method

4. Class records, charts/models, Field collection 10

5. Viva-voce 10

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 301: Ecology and Environmental Science

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit1: Concept and Dynamics of ecosystem

1. Abiotic factors: Gases - Dissolved Oxygen (DO), nutrients (nitrate, sulphate, phosphate), turbidity / transparency, and biotic factors.
2. Energy flow: Lindemann's rule of trophic dynamics, energy flow models
3. Biogeochemical cycles: Nitrogen, Carbon, Sulphur and Phosphorous cycle

Unit 2: Principles pertaining to limiting factors

1. Liebig's Law of minimum, Shelford's Law of tolerance
2. Concept & Law of limiting factors
3. Factors compensation and ecotypes

Unit 3 : Population Growth, Predation and Regulation

1. Demography: . Life tables,. Generation time,. Net reproductive rate, Reproductive value
2. Population growth: Exponential growth, Verhulst-Pearl logistic growth model,
3. Population regulation extrinsic and intrinsic mechanisms
4. Concept of niche, niche width and overlap, fundamental and realized niche, resource partitioning character displacement

Unit 4: Global Environmental Issues

1. Climate Change
2. Carbon Footprint
3. Water Security – conservation of surface and ground water
4. Conservation of Biodiversity including wildlife.

Unit 5: Pollution Biology

1. Causes, effects and control of Water Pollution
2. Causes, effects and control of Air Pollution
3. Thermal and Radioactive pollution
4. Emerging pollutants: POPs, Pharmaceuticals.

Suggested Reading Materials

1. Krebs, C. J. Ecology. Harper and Row, New York.

2. Odum, E. P. Fundamentals of Ecology

3. Smith, R. L. and Smith, T.M. Ecology and Field Biology

4. Kormondy, E.J. Concepts of Ecology

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 302: Vertebrate Immunology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)

Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)

Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Innate and Acquired Immunology

1. Cell types of innate and adaptive immunity, Lymphocyte trafficking
2. Phagocytosis and inflammation
3. Humoral immunity: β cell activation and differentiation, primary and secondary humoral response
4. Cell mediated immunity: T - cell development and T-cell activation, CTL and NK cell mediated immunity

Unit 2: (A) Nature of Antigens

1. Antigenicity and immunogenicity, and the factors influencing it.
2. Characteristics of β and T cell epitopes and haptens
3. Super antigen and its role in T cell activation

(B) Structure and functions of Antibodies

1. Gross and fine structure
2. Classes and sub-classes
3. Antibody mediated effector functions and monoclonal antibodies

Unit 3: (A) Antigen- antibody interaction and Complement system

1. Antibody affinity and antibody avidity
2. Precipitation reactions
3. Agglutination reactions
4. Complement System - activation pathway, biological function and complement deficiencies
5. ELISA

(B) Cytokines : Classification and function, Cytokines receptors.

Unit 4: Organization and expression of Ig genes

1. Organization of Ig genes
2. Generation of antibody diversity
3. BCR and Generation of T-cell receptor diversity

Unit 5: Immunology and Diseases

1. Hypersensitivity (Type I, II, II, IV).
2. Auto-immunity
3. Immune responses to infectious agents - bacterial, viral and parasitic infection (Protozoa and Helminth parasites).
4. Immunodeficiencies

Suggested Reading Material

1. Kuby. Immunology. W. H. Freeman and Co. USA
2. W. Paul. Fundamentals of Immunology
3. I. M Roitt. Essential Immunology. ELBS Edition
4. F. H. Khan.Elements of Immunology
5. Abbas and Litchman. Cellular and Molecular Immunology
6. Tizzard. Immunology

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 303: Cytogenetics

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Regulation of gene expression in bacteria

1. Genetic, biochemical and molecular analysis of lac operon: Inducible system (negative control)
2. Positive control of lac operon: CAP/ cAMP regulation
3. The arabinose operon
4. Repressible system: Tryptophan operon
5. Mechanism of attenuation in *E.coli* & *B. subtilis*

Unit 2: Levels of gene regulation in eukaryotes - I

1. Transcriptional control
   (i) chromatin remodeling
   (ii) genome imprinting
2. Post - transcriptional control
6. alternate polyadenylation and
7. alternate splicing

Unit 3: Levels of gene regulation in eukaryotes-II

1. Translational control
(i) Ribosome selection
(ii) translation inhibition and
(iii) mRNA degradation

2. Gene silencing: RNA interference

3. Regulation of galactose utilization in yeast (eukaryotic model)

Unit 4: Cancer Biology

1. Cytology of cancer cells and types of cancer
2. Genetic basis: Oncogenes and tumour - suppressor genes
3. Chromosomal anomalies associated with cancer

Unit 5: Apoptosis

(i) Machinery of programmed cell death
(ii) Extrinsic and intrinsic pathways
(iii) Control of programmed cell death

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 303: Basic Entomology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Classification

1. Historical development of classification
2. Outline of classification
3. Classification up to sub orders and superfamilies in economically important groups (Coleoptera, Hemiptera and Lepidoptera)
4. Origin of insects.

Unit 2: Morphology I

1. General organization of insect body
2. Comparative study of Antennae:
3. Comparative study of Mouth parts
4. Comparative study of Legs

Unit 3: Morphology II

1. Compound eye: structure including image formation
2. Wings : Veinations and modifications
3. Integument : Structure and moulting
4. Genitalia

Unit 4: Neuro-Endocrinology

1. Brain: Protocerebrum, Deutocerebrum & Tritocerebrum
2. Ventral nerve cord and ganglia
3. Neuro-endocrine glands: Types, structure & function
4. Neuro-haemal organs: corpora cardiaca and Aorta

Unit 5: Insect Physiology

1. Alimentary canal : Structure and Physiology of digestion.
2. Tracheal system: Structure and Physiology of Respiration
3. Excretory system : Structure & types of Malpighian tubules, Physiology of Excretion and osmoregulation
4. Haemolymph : Composition and function

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 303: Fish Biology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Taxonomy and evolution

1. Classification of fishes
2. Origin and evolution of elasmobranch
3. Origin and evolution of teleost
4. Crossopterygii: distribution, structure and affinities
5. Holocephali

Unit 2: Fish Anatomy

1. Integument: Structure and function
2. Alimentary canal & its modification in relation to feeding habit
3. Acoustico-lateralis system
4. Air bladder & its modification

Unit 3: Fish Physiology

1. Mechanism of gill respiration
2. Accessory respiratory organs
3. Sound production
4. Excretion and osmoregulation
5. Reproduction in fish

Unit 4: Fish endocrinology

1. Pituitary
2. Thyroid
3. Adrenal
4. Corpuscles of Stanius and Hepatopancreas

Unit 5: Fish behavior

1. Migration in fish
2. Parental care in fish
3. Sholing in fish
4. Mating behavior in fish

Suggested Readings:

1. A Text Book of Ichthyology by Lagler
2. Fish Endocrinology by B. N. Yadav
3. Fish Physiology by Smith
4. Fish Physiology by Hoar and Randall
5. Animal Behaviour and Evolutionary Approach by Alcock, J.

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 303: Protozoan Parasitology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit1: 1:

1. Parasitism, its ecological aspects, medical implications and control impediment.
2. Niches, habitats, environments and its significance in parasites life cycle.
3. Vertebrate alimentary canal, blood, tissue and other habitat.
4. General characteristic of Protozoa, Broad classification of protozoa Symbiotic associations- commensalism, parasitism, mutualism, phoresis

Unit 2: Symbiotic Amoebae and ciliates:

1. Genus *Entamoeba*
2. Other intestinal amoebae of human
3. Genus *Balantidium*

Unit 3: Trypanosomes and related organism:

1. Morphological forms
2. Genus *Leishmania*
3. Genus *Trypanosoma*
   Section A : Stercorari
   Section B : Salivaria
   Life Cycle, diagnosis and treatment

Unit 4 :Flageliates of alimentary & urinogenital tract:

1. Genus *Giardia*
2. Genus *Trichomonas*

Unit 5: Malarial Parasites and their relatives:

1. Family Plasmodidae, Life cycle and its variation.
   (*Plasmodium vivax, P. malariae, P. ovale & P. falciparum*)
2. Relapse and Recrudescence

Books Recommended:

1. Human Parasitology, 3rd Edition 2005, Burton J. Bogtish, Clint E. Carter, Thomas N. Oeltmann. Academic Press, U.K.
2. Parasitic Protozoa, J.P. Kreler & J.R. Baker- Allen & Unwin, Inc. USA.
3. Animal Parasitology, 3rd Edition 1994, J.D. Smyth, Cambridge University Press
4. Introduction to Parasitology- Chandeller

M.Sc. (Zoology): Third Semester
Paper ZOO-M- 303: Environmental Science

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1 : Concept and dynamics of ecosystem –

Biological productivity, primary production and method of its measurement, structure and function of major ecosystem's of the world (fresh water ecosystems, forest ecosystem, grassland, desert ecosystem)

Unit 2 : Population ecology-

Concept of meta-population, demes and dispersal, interdemic extinctions, age structured populations. Stochastic and time lag models of population growth. Lotka-Volterra equation for competition and predation, functional and numerical responses.

Unit 3 : Community ecology & succession-

Nature of communities, community structure and attributes, levels of species diversity and its measurements, influence of population interaction on communities, types, mechanisms, changes involved in succession, concept of climax

Unit 4 : Biodiversity

Importance, status, monitoring, documentation, threats and conservation of biological diversity. Shannon-Weiner index, dominance index, Similarity index, Association index

Unit 5 : Wildlife Management

Principles of conservation, major approaches to management, and Indian case studies on conservation/management strategy (project tiger, biosphere reserves)

M.Sc. (Zoology): Third Semester

Paper ZOO-M 304 A: Laboratory Course (Core)

PRACTICAL Time: 3 Hrs Full Marks: 35

1. Micrometry / Camera Lucida 10
2. Ecological experiments any one of the following 10
   a) Identification of Zooplankton
   b) Estimation of Dissolved Oxygen (DO)
   c) Estimation of Total Alkalinity
   d) Estimation of Total Hardness
3. Class records, charts, models, Field collection 05
4. Viva –voce 10

M.Sc. (Zoology): Third Semester

Paper ZOO-M 304 B: Fish Biology (Elective)

PRACTICAL Time: 3 Hrs Full Marks: 35

1. Taxonomic identification of a locally available fish upto species level based upon morphometric-meristic analysis and identification keys. 5 marks
2. Spotting 10 marks
   (i) Museum specimens – 2
   (ii) Bone- 1
   (iii) Slides - 2
3. Micrometry/ paraffin sectioning and permanent slide preparation. 5 marks
4. Practical records/ Charts/ Models/ Collection 5 marks
5. Viva-voce 10 marks

M.Sc. (Zoology): Third Semester

Paper ZOO-M 304 B: Laboratory Course (Elective)

Environmental Science

PRACTICAL Time: 3 Hrs Full Marks: 35

1.	Separation, Characterization and quantification of urban solid wastes	10
2.	Study of vegetation / soil fauna by quadrate Method	10
3.	Class records, charts, models, Field collection	05
4.	Viva –voce	10

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 304 B: Cytogenitics

PRACTICAL Time: 3 Hrs Full Marks: 35

1St Sitting

1. Chromosome preparation (one of the following) 10

(a) Squash preparation of polytene chromosomes and study of their banding pattern
(b) Squash preparation of meiotic chromosomes from grasshopper testes and Estimation of chiasma frequency and terminalization
(c) Flame-drying preparation of mitotic metaphase chromosome of mice/rat/ fish
(d) Flame-drying preparation of meiotic metaphase chromosome of mice/rat.

2. Drosophila genetics (any one of the following) : 10
   (a) Identification and comments upon wild and mutant phenotypes of Drosophila.
   (b) Setting of Drosophila crosses and analysis of results.
3. Practical records (including slides, charts, model, field work) 05
4. Viva-voce 10

M.Sc. (Zoology): Third Semester

Paper ZOO-M- 304 B: Basic Entomology

PRACTICAL Time: 3 Hrs Full Marks: 35

6. Preparation of permanent slides (any one of the following): 10

   (a) Whole specimen
   (b) Mouth parts
   (c) Antennae
   (d) Legs

7. Identification and comments upon spot A to E : 10
   (a) Insects - 2
   (b) Slides – 2
   (c) Damaged material by pest -1

8. Practical records (including slides, charts, model, field work) 05
9. Viva-voce 10

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 401: Animal Behaviour

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: **Basics of Animal Behavior**

1. Ethology- Definition, Branches , Significance
2. Approaches and methods in the study of Behavior
3. Patterns of Behavior- (a) Innate behavior- Kinases/ Taxes, Simple reflex, Comparison of reflex and complex behaviors, Instinct and, Motivation

(b) Learned behavior- Habituation, Imprinting, Conditioned reflex , Trial & error learning, Reasoning and Cognition

Unit 2: **Social Behavior**

1. Social behavior of insects (Honey bees, Ants and termites)
2. Social organization of Primates
3. Altruism: Reciprocal altruism, Inclusive fitness, group selection , and Kin - selection

Unit. 3: **Reproductive Behavior**

1. Evolution of sex and reproductive strategies
2. Mating system
3. Courtship & Parental Behaviors: Parental care and parental Investment

Unit 4. **Biological Rhythms**

1. Circadian, Circannual, Lunar, Tidal and Epicycles
2. Navigation including orientation
3. Migration of Birds

Unit 5. **Control of Behavior**

1. Neural control of behavior
2. Hormones and Behavior
3. Ecological aspects of behavior: Habitat selection, Optimal foraging theory, and Aggressive behavior

Books Recommended:

1. Principles of Animal Behavior – Lee Alan Dugatkin , W. W. Norton & Company, Inc. 500 Fifth Avenue, New York .
2. Animal Behavior – John Alcock, Sinauer Associates, Inc, Sunderland, Massachusetts, U. S. A.
3. Comparative Animal Behavior:– Richard Maier. Allyn and Bacon, Boston
4. Animal Behaviour – **David McFarland** . Pitman Publishing Private Limited, Melbourne

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 402: Biosystematics & Evolutionary Biology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Biosystematic

1. Definition & basic concept of Biosystematics and taxonomy , its importance and application in biology.
2. Hierarchy of categories, outline of classification of animals, important criteria used for classification up to Classes in each phylum
3. Species concept : Biological and phylogenetic, sub - species and other infra- specific categories, evolutionary relationship among taxa
4, International code of Zoological nomenclature (ICZN): operative principles, and important rules, Zoological nomenclature and scientific names of various taxa
5. Trends in taxonomy : Chemo - taxonomy, cyto - taxonomy and molecular taxonomy

Unit 2: Pattern of genetic variation and natural selection

1. Genetic polymorphisms, variation in chromosome structure, protein structure and nucleotide sequences
2. Concept of Natural Selection (Darwinian and neo- Darwinian),mode of its operation: stabilizing, directional and disruptive modes of Natural Selection

Unit 3: Molecular evolution

1. Variation in the evolution of protein and DNA sequences
2. Molecular phylogenies
3. Rates of molecular evolution and molecular clock
4. Neutral theory of molecular evolution
5. Origin of new genes and evolution of multi gene family

Unit 4: Mechanism of speciation

1. Patterns and mechanisms of reproductive isolation and its role in evolution
2. Models of speciation : sympatric and allopatric

Unit 5: Population genetics

1. Gene pool, allele frequency and genotype frequency
2. Hardy-Weinberg principle of genetic equilibrium and its mathematical derivation
3. Detailed account of destabilizing forces of genetic equilibrium:
   Natural selection, Mutation ,Migration, Meiotic drive, and Genetic Drift

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 403: Cell & Molecular Biology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Nucleus

1. Ultrastructure, molecular organization and functions of nuclear envelopes
2. Functional architecture of interphase nucleus
3. Ultra structure of nucleolus: organization of rDNA
4. Nucleolar function: synthesis of rRNA, its processing and biogenesis of ribosomes
5. Mechanism of nuclear cytoplasmic exchange

Unit 2: Transposable genetic elements

1. Discovery and definition: Ac/Ds elements in maize
2. Prokaryotic elements: Insertion sequences and transposons
3. Retrotransposons and DNA transposons in eukaryotes
4. Mechanism of transposition (conservative and replicative)

Unit 3: Genomics

1. Whole genome shotgun sequencing
2. Functional genomics: Predicting gene and protein function by sequence analysis
3. Genome organization in humans: The Human Genome Project, main features of human genome
4. Comparative genomics : Features of model prokaryotic , eukaryotic and organelle genomes.

Unit 4: Cell- cell signaling

1. Signaling from plasma membrane to nucleus: Type of signal (G protein and protein kinases), target cells and effector organs
2. Cell surface receptors of signaling molecules
3. Signal transduction pathways and their regulation
4. Second messenger system

Unit 5: Recombinant DNA Technology

1. Tools and techniques (enzymes, vectors, cloning strategies)
2. Construction and screening of DNA libraries
3. Application of recombinant DNA technology

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 403: Applied Entomology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Insect Control and Management

1. Chemical Control : Types, merits and demerits
2. Biological control : Types, merits and demerits
3. Integrated Pest Management (IPM)

Unit 2: Insect Pests

1. Pests of Paddy : Life history and control measures
2. Pests of Wheat: Life history and control measures
3. Pests of Sugarcane and stored grains: Life history and control measures

Unit 3: Chemical nature and function

1. Pheromones
2. Diapauses
3. Attractants, repellants and anti-feedants

Unit 4: Reproductions and Development

1. Male reproductive organs: Testes, Vas deferens, ejaculatory duct, accessory glands & seminal vesicles
2. Female reproductive organs: Ovaries, types of ovarioles, oviduct & common oviduct and accessory glands
3. Types of Larvae and their metamorphoses

Unit 5: Forensic Entomology

1. Forensically important insects
2. Collection of data from cadaver site
3. Interpretation of data for predicting time and cause of death

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 403: APPLIED FISHERIES

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1: Fresh water Aquaculture

1. Construction and lay out plan of different types of ponds and their management
2. Role of physico-chemical and biological factors in aquaculture
3. Aquatic weeds & their control
4. Pen & cage culture
5. Pollutants and their effect on fisheries

Unit 2: Fish biotechnology

1. Cryopreservation of fish gamete
2. Induced breeding in fish
3. Androgenesis and Gynogenesis
4. Cytogenetical techniques in aquaculture
5. Integrated fish farming

Unit 3: Fish immunology & fish Pathology

1. Organs related to immunity in fish and mechanism of immunity
2. Bacterial diseases in fish and their control
3. Fungal and viral diseases in fish and their control
4. Parasitic diseases in fish and their control

Unit 4: Fisheries resources

1. Reverine fisheries resources of India
2. Reservoir fisheries in India
3. Lacustrine fisheries in India
4. Estuarine fisheries in India
5. Marine fisheries in India

Unit5: Post harvest Technology

1. Principles and methods of fishing crafts and gears
2. fish preservation
3. Fish byproducts
4. Fish marketing

Suggested Readings:

Fish and Fisheries of India by V. G. Jhingaran
Fish Biotechnology by W.S. Lakra and S. Ayyappan
Fish Immunology by Anderson
A Text Book of Fish Diseases by Canoy
Post Harvest Technology by K. K. Balachandran

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 403: Helminth Parasitology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1:

1. Classification of the phylum Platyhelminthes.
2. General characteristics of Trematoda (Fluke) and life cycle pattern.
3. General characteristics of Cestoda (tape worms) and life cycle pattern

Unit 2 :

1. Visceral fluke : Type, example of liver fluke;
   Fasciola hepatica, Clonorchis sinesis, Opesthorchis felineus
2. Intestinal fluke: *Fasciolopsis buski*
3. Lung fluke : *Paragonimus wetermani*

Unit 3:

1. Blood flukes : Etiology, diagnosis, chemotheraphy
   I. *Schistosoma mansoni*,
   II. Schistosoma haematobium
   III. Schistosoma japonicum

Unit 4:

1. Intestinal tape worms : *Diphyllobothrium latum*
2. *Taenia solium*, *Taenia saginata* and Human cysticercosis, *Hymenolepis nana*
3. Extra intestinal tape worms Human Spargonosis *Echinococcus granulosus* and Human Hydatiosis

Unit 5:

1.Host Specificity
2.Effect of parasitism on host
3.Effect of parasitism on parasites
4.Evolution of parasitism
5.Anthelminthics

Books Recommended:

1. Human Parasitology, 3rd Edition 2005, Burton J. Bogitsh, Clint E. Carter, Thomas N. Oeltmann. Academic Press, UK
2. Animal Parasitologyu, 3rd Edition 1994, J.D.Smyth. Cambridge University Press.
3. Introduction to Parasitology – Chandeller
4. A text book of Cilinical Parasitology, Belding

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 403: Environmental Biology

Time: 3 Hrs Full Marks: 70

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 Marks)
Part B: 5 Questions (short answer type), 1 from each group, 4 to be answered (5 x 4 = 20 marks)
Part C: 5 Questions(long answer type) , 1 from each group, 3 to be answered (10 x 3 = 30 marks)

Unit 1 : Limnology-

Origin and types of lakes, ecological zonation in lakes

Unit 2 : Environmental monitoring:-

Chemical and biological monitoring. Concept of indicator organisms and bio-monitoring of water quality. Concept of biotic and diversity indices.

Unit 3 : Pollution and environmental health:

Global environmental problems, global warming, ozone depletion, acid rain, photochemical smog, sources hazards and control of air, water and solid waste pollution

Unit 4 : Bioremediation and Phytoremediation

Need and scope of bioremediation; environmental applications of bioremediation; future outlook; phytoremediation- biotechnology of cleaning up the environment by plants

Unit 5 : Ecotoxicology

Definition of toxicology, toxic substance in the environment, concept of dose response relationship, acute toxicity, chronic toxicity, lethal concentration, effective concentration, bioaccumulation, biomagnification, median tolerance limits.

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 404: Environmental Biology

PRACTICAL Time: 6 Hrs Full Marks: 70

Ist sitting

1. Qualitative and quantitative estimation of Zooplankton and Benthos. 10

2. Physico-chemical analysis of any one 10

   (a) Water : DO, BOD, COD, Chloride, Carbonate and Bicarbonate alkalinity, Calcium and Magnesium hardness / Ca^{++} and Mg^{++}

   (b) Soil: pH, Chloride, Total alkalinity, Hardness, Water retention capacity of different types of soil.

3. Estimation of Nitrite, Sulphate, and Phosphate by Spectrophotometry. 10

IInd sitting

4. Determination of LC_{50} using fish / insect larvae for known pollutants like Heavy Metal/any agro-chemical/industrial effluents. 05

5. Spotting - Zooplankton, Zoo-macro-benthos, Nekton (2x5) 10

7. Class Records 05

8. Dissertation including Power Point Presentation and Viva 20

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 404: Cell & Molecular Biology

PRACTICAL Time: 6 Hrs Full Marks: 70

1St Sitting

1.	Cytochemical demonstration of protein/lipid/carbohydrate/nucleic acids	15
2.	Vital staining of secretory granules and mitochondria	1 0
3.	Identify and comments up on spots (1-5): Cytological slides	10

2nd Sitting

4.	Any one of the following:	10
(a)	Identification of sex-chromatin from buccal epithelial cells /leucocytes	
(b)	Estimation of sperm count from epididymal wash of laboratory mammals	
(c)	Study of abnormalities in the head morphology of vertebrate sperms	
(d)	Isolation of DNA and its separation by agarose gel electrophoresis (demonstration only)	
(e)	PCR amplification of known DNA/ RAPD(demonstration only)	
5.	Practical records (including slides, charts, model, field work)	05
6.	Dissertation and Viva-voce	20

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 404: fish and Fisheries

PRACTICAL Time: 6 Hrs Full Marks: 70

1St Sitting

1. Any one of the following experiments: 10
   i) O_2 Consumption in relation to body size
   ii) Hematological analysis (Hb estimation, RBC counting)
   iii) Estimation of pH using pH meter, Dissolved Oxygen, Total alkalinity, Total Hardness
2. Spotting: 5 x 2 = 10
   i) Museum specimen - 01
   ii) Bones - 01
   iii) Slides - 02
   iv) Fishing gear/aquatic weeds - 01
3. Microtomy/paraffin sectioning and permanent slide preparation 10

2nd Sitting

4. Taxonomic identification of a local available fish up to species level 5
   (based upon morphometric- meristic analysis and identification key)
5. Any one of the following 10
   i) Biological analysis of water including Phytoplankton, Zooplankton, Macrophytes and Zoomacrobenthos.
   ii) Identification of representative fish parasites and their life histories
   iii) Identification of fry and fingerlings of major cultivated species of fresh water fish
6. Practical records (including slides/chart/model/field work) 5
7. Dissertation and Viva 20

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 404: Fisheries

PRACTICAL Time: 6 Hrs Full Marks: 70

1. Any One of the following experiments: 5 marks
   - (i) Physicochemical analysis of given water sample- Transparency, pH, DO, total alkalinity, Hardness, Chloride.
   - (ii) Biological analysis of water- phytoplankton, zooplankton, neuston, nekton, macrophytes and benthos.
   - (iii) Identification of fish fry and fingerlings of major cultivated fishes.
   - (iv) Haematological analysis- Hb, RBC/WBC count, Serum estimation, preparation of blood film.

2. Spotting 10 marks
   - (i) Aquatic weed -1
   - (ii) Slide (parasite) – 1
   - (iii) Fishing gear -1
   - (iv) Non piscine specimen related to aquaculture – 1
   - (v) Plankton -1
3. Practical records/ Charts/ Models/ Collection 05 marks
4. Viva-voce & evaluation of dissertation work 15 marks

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 404: Applied Entomology

PRACTICAL Time: 6 Hrs Full Marks: 70

1. Any one of the following experiments: 10

   (i) Dissection of grasshopper or honey bee or wasm to expose general anatomy and nervous system.
   (II) Identification of Insects

2. Permanent slide preparation of any one 10

   (i) Whole specimen
   (ii) Mouth parts

   (iv) Antennae
   (v) Legs
   (vi) Wings
   (vii) Poison apparatus

3. Identification and comments upon spots 1-5 5x2= 10

   (i) Morphological slides -2
   (ii) Histological slides -2
   (III) Damaged material by a pest- 1

2^{nd} sitting

4. Identification of insects up to family (two insect) 2x2½ = 5

5. Identification and life history of any one pest 10

6. Field works and records 05

7. Dissertation & Viva voce 20

M.Sc. (Zoology): Fourth Semester

Paper ZOO-M- 404: Parasitology

PRACTICAL Time: 6 Hrs Full Marks: 70

1. Studies of the permanent slides of protozoan and Helminth parasites 15

2. Preparation of permanent slides of larvae / adult parasites provided 10

3. Study of common parasites from: 15

   (i) Rectum of frog
   (ii) Alimentary canal of fowl
   (III) Rumen of Goat

2^{nd} sitting

4. Preparation and staining of blood films 10

   (a) Thin blood film
   (b) Thick blood film

   (i) Preparation of blood film from rodents(wild rat, rabbit, fish for Trypanosomes).
   (ii) Preparation of blood film from malarial patient
   (a) Microscopic faecal examination.

5. Practical records (including slides, chart, models, field work). 10

6. Viva voce 20