

Syllabus
for
M.Sc. in Zoology (Semester with CBCS)

Approved by Board of studies

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M.Sc. Zoology Semester – I (ZOOL)
FC – 1 Foundation course (Compulsory)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10=10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Animal systematics & Evolutionary Mechanism

Group A :

Animal systematics

- Different types of Classification:
 - (Numerical / Phenetic, Cladistic, Evolutionary Systematics (Phylogenetic))
- Concept of Cytotaxonomy,
- Chemical and Molecular Taxonomy;
- Operative principles of nomenclature,
- application of important rules, IUZS
- Concepts of species

Group B:

Evolution mechanisms

Concept of Evolution, Evolutionary time scale; Synthetic theory of Evolution, Population, Gene frequency, Hardy Weinberg's law; concepts and rate of change in gene frequency through natural selection, migration and genetic drift. Adaptive radiation, Isolating mechanisms, speciation, Co Evolution. Molecular tools in taxonomy.

Recommended Books:

1. Pechenik J.A. – Biology of Invertebrates. 4th edn. Tata McGraw-Hill 2002
2. Riddle M. – Evolution. 2nd edn. Blackwell 1996
3. Piyanka E.R. - Evolutionary Ecology 5th edn Harper Collins 1994

M.Sc. Zoology Semester I (ZOOI)

CC – 1 (Core Course)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10=10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Invertebrate Diversity & Quantitative Biology

Group : A

Invertebrate Diversity

Protostomates and Deuterostomate groups

Origin of coelom – Acoela, Pseudocoela, Schizocoela and Enterocoela.

Locomotion: Protozoa, Echinodermata

Osmoregulation in Protozoa

Excretion: Annelida, Arthropoda

Respiration : Arthropods, Mollusca

Concept of Host specificity and Host parasite relationship

Group : B

Quantitative Biology

Measures of central tendency and dispersal;

probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation;

t-test; Analysis of variance; X^2 test, Basic introduction to Multivariate statistics.

Recommended Books:

1. Barrington E.J.W. – Invertebrate structure and function. 2nd edn. ELBS/Nelson 1973
2. Meglitsch P.A. & Schram F.R – Invertebrate Zoology. 3rd edn. Oxford univ press 1991
3. Ruppert E.E. & Barnes, R.D.- Invertebrate Zoology. 6th edn. Harcourt Asia 1994
4. Zar J.H. – Biostatistical Analysis. 4th edn. Pearson 2005
5. Khan I.A. & Khanum A. – Fundamentals of Biostatistics 2nd edn. Ukaaz Publ. 2007
6. Pagano M. & Gauvreau K. – Principles of Biostatistics. 2nd edn. Thomson 2007

M.Sc. Zoology Semester – I (ZOOL) CC – 2 (Core course)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10=10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Methods in Biology

Group A :

Spectroscopy & Spectrometry

Spectroscopy & spectrometry – ESR, Molecular structure determination using X-ray diffraction and NMR , Molecular analysis using light scattering, Microscopy - Resolving powers of different microscopes, scanning and transmission Electron Microscopes, different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM, image processing methods in microscopy.

Group : B

Histochemical, Immunotechniques and electrophysiological techniques

Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, In situ localization by techniques : FISH.

Electrophysiological methods:-Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

Recommended Books:

1. Skoog D.A., Holler F.J. & Crouch S.R. – Principle of Instrumental Analysis. 6th edn. Thomson 2007
2. Narayanan P.- Essentials of Biophysics. New Age 2000
3. Tembhare D.B. – Techniques in Life Science. Himalaya 2008
4. Willard H.H., Merritt Jr. L.L., Dean J.A. & Settle Jr. F.A. – Instrumental Methods of Analysis. 6th edn. CBS 1986
5. Pearse A.G.E.- Histochemistry - Theoretical and Applied. vols I-III Churchill
6. Wilson K.& Walker J. - Principles of Biochemistry and Molecular Biology. 6th edn. Cambridge Univ. Press 2007

M.Sc. Zoology Semester I (ZOOL)
CC (P) – 3 (Core course P – 3)

Practical based on theory papers CC1 and CC2

Scheme of Examinations: End terms (external) assessment

Full Marks: 100

Exam Duration: 4.00 hrs.

ITEMS

MARKS DISTRIBUTION

- | | |
|---|----|
| • Anatomical observation (Dissection) | 25 |
| • Preparation of Buffer solution for electrophoresis /DNA quantification, Paper chromatography, | 10 |
| • Study of olfactory response in native <i>Drosophila</i> sp. | 10 |
| • Spotting 6 spots (Instruments/ slides/ specimens) [6x5=30] | 30 |
| • Records and Sessional work | 10 |
| • Viva- voce | 15 |

List of Practicals

Invertebrate Diversity

General anatomy of: (Dissection)Leech/ Prawn / Squilla/ Aquatic Beetle/Pila

Museum specimens: Important representatives of different invertebrate phyla showing peculiarities/ adaptive features/ association/stages

Specimen of connecting links and living fossils – limulus, peripatus

Specimens showing mimicry and melanism; Slides of larval stages

showing recapitulation of ontogeny (Helminthes, Crustacean) Preparation of taxonomic key upto order of the following

Coelenterata – Hydra, Obelia (medusa and polyp), Physalia, Gorgonia, Aurelia, Metridium

Rotifera – Brachionus

Annelida – Neries and Heteronereis, Arenicola, Chaetopetrus, Hirudo

Arthropods –Crab, Prawn, Lepus, Balanus, Butterfly, Study of *Drosophila* mutants, Water beetle, Cyclops

Mollusca - Chiton, Pila, Unio, loligo, Sepia, Octopus, Aplysia, Dentalium

Enchinodermata – Asteria, Echinus, Antedon, Cucumaria, Holothuria

Study of the following using permanent slides

Trematode, Cestode,

Biotechniques

Use of Ph meter, water bath, autoclave, balance, centrifuge, colorimeter, spectrophotometer Measurement, photography through microscope

Chromatographic separation of proteins (Paper) Separation of amino acids, Quantitative assessment of DNA and its separation by Agarose Gel electrophoresis.

Quantitative assessment of Glucose in a test solution by spectrophotometer/ Demonstration of P.C.R. Technique

Histology and Histochemistry

Preparation of fixatives for histological and different histochemical staining Paraffin sectioning Fixation of tissue Dehydration, clearing and embedding; Trimming and sectioning of paraffin blocks, Stretching and spreading of sections on slides

M.Sc. Zoology Semester II (ZOOL)

EC – 1 (Elective course – SE)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 = 10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

CELLULAR ORGANIZATION AND FUNDAMENTAL PROCESSES

Group A :

Membrane structure and function: (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).

Structural organization: structure & function of cytoskeleton and its role in motility **Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, and regulation of signaling pathways, Regulation of cell Cycle. **Cellular communication:** general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrin, neurotransmission and its regulation.

Group B:

FUNDAMENTAL PROCESSES:

DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, DNA damage and repair mechanisms, homologous and site-specific recombination).

RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport); non coding long RNA.

Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins).

Control of gene expression at transcription and translation level (prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Recommended Books:

1. Lodish H., Berk A., Matsudaira P. Kaiser C.A. , Krieger M., Scott M.P., Zipurky S.L., & Darnell J. – Molecular Cell Biology. 5th edn. W.H. Freeman 2004

2. Cooper G.M. – The Cell : A molecular approach. Asm Press 1997
3. Freifelder D. & Malacinski G.M. – Essentials of Molecular Biology 2nd edn. Panima 1993
4. Alberts B., Johnson A., Lewis J., Raff M., Roberts K. – Molecular Biology of the Cell. 4th edn. Garland Science 2002

M.Sc. Zoology Semester II (ZOOL)

CC – 4 (Core Course)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 = 10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Vertebrate Diversity & Ethology

Group A : Vertebrate Diversity

Fish – Air breathing organs, Lateral Line system

Amphibia – Origin of Amphibia , Metamorphosis and its neuroendocrine regulation.

Reptiles – Extinct Reptiles and cause of extinction. Sphenodon: Anatomical features , affinity, evolutionary significance

Birds- Common indian birds , Nest building, Migration

Mammals- Common Indian Mammals, Prototheria , Marsupials, Dentition.

Group B : Ethology

Approaches and methods in study of behavior; Proximate and ultimate causation;

Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Recommended Books:

1. Pough F.H., Janis C.M. & Heiser J.B. – Vertebrate Life. 6th edn. Pearson 2003
2. Young J.Z. – Life of Vertebrates. 3rd edn. Oxford 1982
3. Hildebrand M. – Analysis of Vertebrate Structure. John Wiley 1974.
4. Manning A. & Dawkins M.S. – An Introduction to Animal Behaviour. Cambridge 1995
5. Prasad S. – Animal Behaviour. CBS 2004
6. Mathur R. – Animal Behaviour. Rastogi 2002

M.Sc. Zoology Semester II (ZOOL)

CC – 5 (Core course)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 = 10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

SYSTEM PHYSIOLOGY

Group A

Blood and circulation - haemopoiesis and formed elements, blood volume, blood volume regulation, haemoglobin, haemostasis. Cardiovascular System: myogenic heart, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. **Respiratory system** - transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. **Nervous system** - action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. **Sense organs** - Vision, hearing and Taste.

Group B:

Excretory system -urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, electrolyte balance, acid-base balance.

Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

Reproductive system- Sperm maturation in male reproductive tract and the role of testicular hormones in eutherian mammals
Ovarian and uterine cycles and their hormonal control

Recommended Books:

1. Guyton A.C. & Hall J.E. – Text Book of Medical Physiology. 9th edn. Saunders 1996
2. Talwar G.P. & Srivastava L.M. (edt.) – Text Book of Biochemistry and Human Biology. 3rd edn. Prentice Hall India 2003.
3. Sherwood L., Kalandorf H. & Yancey P.H. - Animal Physiology : From Genes to Organisms. Thomson 2005
4. Schmidt- Nelson K. - Animal Physiology : Adaptation and Environment. 5th edn. Cambridge Univ. Press 1998
5. Hoar W.S. - General Comparative Physiology. 3rd edn. Prentice Hall India 1983

M.Sc. Zoology Semester II (ZOOL)
CC (P) - 6 (core course P – 6)

Practical based on theory papers **CC4 & CC5**

Scheme of examinations End Term (external) Assessment

Full Marks : 100

Exam Duration : 4:00 hrs.

ITEMS

MARKS DISTRIBUTION

Anatomical observation (Dissection)	25
Physiology experiments – 1	20
Colorimetric estimation [Protein/ Glucose/] measurement of blood pressure.	
Spotting (Bone/ Instrument and Models) (6x5=30)	30
Records and Sessional work	10
Viva - voce	15

List of Practicals

Vertebrate diversity

Anatomical observation of: (Dissection)

General Anatomy of any bony fish

Accessory respiratory organs in fish – Channa/Heteropneustes/Clarias,
Anabus Cranial nerves and blood vessels in Labeo / Wallago

Museum studies

Models/Photographs – Latimeria, Sphenodon, different types of beaks
and feet in birds, nest of birds,; Specimens – Petromyzon, Myxine,
Electric ray, Acipenser, Caecilian, Hyla/ Rhacophorus, Axolot larva /
Salamander, Draco, Turtle, Snakes : Cobra, Krait, Rattle snake, Sea
snake, Water snake, Bat,; Bones - Skeleton of a bony fish, Chelonia,
Snake, Dentition

Mammals Physiology

Measurement of metabolic rate in small animals – effect of stress on gill
ventilation in fish. Determination of blood pressure in man in different
physiological conditions with help of Sphygmomanometer by
auscultation Method to show effects of exercise plotting time of
acclimation. Determination of Haemoglobin content by haemocytometer.
Permeability of erythrocyte membrane as a function of osmolarity of salt
solution. Demonstration ECG

Ethology- Study of Activity patterns and reproductive behavior of native
Drosophila sp.

M.Sc. Zoology Semester III (ZOOL)

CC – 7 (Core course – 7)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 = 10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Comparative and molecular endocrinology & Developmental Biology

Group A: Comparative and molecular endocrinology

Chemical Nature of Hormones, half-life and mechanism of their action.
Receptor types, second messenger system,
Mammalian endocrine glands and their hormones: Pineal, Pituitary, Thyroid and Adrenal
Function of the hormones secreted from – Hypothalamus (mammals only)
Urophysis, Parathyroid, Ultimobranchial glands, Corpuscles of stannius
Internal and chromaffin cells, Gut endocrine cells, kidney, Heart, thymus, Pancreatic hormones.

Unit B: Developmental Biology

Basic concepts of development and embryogenesis : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development, cell surface molecules in sperm-egg recognition; embryo sac development; embryonic fields, gastrulation and formation of germ layers; Morphogenesis and organogenesis : Pattern formation in *Drosophila*. vulva formation in *Caenorhabditis elegans*, eye lens induction, differentiation of neurons,

Recommended Books:

1. Gilbert – Developmental Biology
2. Berril N.J. – Developmental Biology. Tata McGraw – Hill 1982
3. Norris D.O. – Vertebrate Endocrinology 3th edn. Elsevier / A.P. 2006
4. Bolander F.F. – Molecular Endocrinology 3rd edn Elsevier / A.P. 2006
5. Hadley M.E. – Endocrinology 5th edn. Prentice Hall int. 2000

M.Sc. Zoology Semester III (ZOOL)

CC – 8 (Core course – 8)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 = 10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Biochemistry and Immunology

Group A :

Biochemistry:

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Bioenergetics, oxidative phosphorylation, coupled reaction, biological energy transducers. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Conformation of nucleic acids (A, B, Z), t-RNA. Stability of proteins and nucleic acids. Metabolism of nucleotides.

Group B:

Immunology

Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

Recommended Books:

1. Delves P.J., Martin S.J., Burton D.R. & Roitt I.M. – Roitt's Essential Immunology. 11th edn. Oxford 2006
2. Kuby, J. – Immunology
3. Murray R.K., Granner D.K., Mayes P.A. & Rodwell V.N. - Harper's Biochemistry. 21st edn. Lange 1988
4. Nelson D.L. & Cox M.M. - Lehninger Principles of Biochemistry. 3rd edn. 2000
5. Voet D., voet J. & Pratt C.W. - Fundamentals of Biochemistry. Life at the Molecular Level. 2nd edn. Wiley Asia 2006

M.Sc. Zoology Semester III (ZOOL)
EC – 2 (Elective course- GE/DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 = 10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Fish and Fisheries

Group: A

Classification of living fishes up to orders

Aquaculture – Definition and classification

Nutritional value and economic importance of fishes: brief account of byproducts

Outlines of fish culture in ponds, Ornamental fishes, larvivorous fishes

Freshwater and important marine fishes of India

Group: B

Adaptations in teleosts – hill stream, cave dwelling, antifreeze, colouration, bioluminescence

Migratory behaviour in fishes, Aquatic respiration in teleosts

Structure of gills, gills areas and its significance, gas exchange and ventilation of gills

Alimentary canal and its modification in relation to food and feeding habits in teleosts

Recommended Books:

1. Wootton R.J. – Fish Ecology Blackie 1992
2. Nikolsky G.V. – The Ecology of Fishes Academic Press 1963
3. Greenwood P.H. – Norman's History of Fishes 3rd edn Ernest 1975
4. Lagler, Bardach, Miller & May Passino – Ichthyology Wiley 2003
5. Pillay – Aquaculture : Principle and Practice of Fishing 1st Indian edn New Books 2006

M.Sc. Zoology Semester III (ZOOL)
EC – 2 (Elective course- GE/DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 =10 MARKS). From the rest seven questions any three (3X20 = 60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Entomology

Group: A

Classification and phylogeny of Insects

Classification of the Apterygote Orders : Thysanura, Diplura, Protura and Collembola,; Classification of Exopterygote Orders : Orthoptera, Dictyoptera, Hemiptera

Classification of Engopterygote Orders : Lepidoptera, Diptera, Hymenoptera and Coleoptera,; Structures and life processes :

Integument : Structure and chemistry, cuticular modifications, Apolysis, Ecdysis and sclerotization,; Head and Thorax : Its appendages and their modifications,; Digestive system : Alimentary canal, salivary glands, mechanism of digestion, micro-organisms of the intestine.

Group: B

Sense organs and perception : Mechanoreceptors, Auditory organs, Chemoreceptors, Thermoreceptors. Humidity receptors and visual organs

Effector organs : The sound and light producing organs

Insect Physiology :

Respiration – Respiration in aquatic, terrestrial and endoparasitic insects

Excretion – Malpighian tubules and other organs of excretion, Metabolic pathways of nitrogenous excretion i.e. urea uric acid, ammonia and aminoacids.

Reproductive Physiology : Oogenesis, yolk formation, ovulation and oviposition, spermatogenesis, transfer of sperms and spermatophores, Mating and fertilization, Endocrine system and hormones & pheromones

Recommended Books:

1. Chapman – The Insects : Structure and Function 4th edn
ELBS 1998
2. Imms A.D. – A General Text Book of Entomology 2 vols.
Asia Pubi 1997
3. Wigglesworth – Principles of Insect Physiology ELBS 1972

M.Sc. Zoology Semester III (ZOOL) EC – 2 (Elective course- GE/DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1X10 =10 MARKS). From the rest seven questions any three (3X20 =60 MARKS) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Ecology

Ecology

Group: A

The Environment: Light, temperature, Soil, Water, Concept of limiting factors: Schelferd's Law of Tolerance, Leibig's Law of minimum, Biotic Environment.

Concept of Niche: Habitat & Niche, Niche width & Niche overlap, Fundamental and realized Niche, Multidimensional hyper volume Niche.

Population Ecology: Characters of population, Population growth curves, population regulation, Life history strategies (r and k selection), Lotka- voltera model of population interaction, Predator Prey interaction, Host – Parasite interaction.

Group: B

Community Ecology: Community structure and attributes analytical and synthetic characters, Levels of species diversity and its measurement, edges & ecotones.

Ecosystem Ecology: Ecosystem structure and function, Energy flow in Ecosystem, Mineral cycling of C,N,P. Food chain, Food web, Food Pyramid, Lindman's Trophic dynamic concept, Major biomes of world- Forest, Tundra, Taiga, Grassland , Desert. Concept of Productivity: Primary , Secondary & tertiary : Factors and methods of Measurement .

Ecological Succession: Types, mechanisms, changes involved in succession, concept of climax, Hydrosere & Xerosere.

Recommended Books:

1. Piyanka E.R.- Evolutionary Ecology 5th edn Harper Collins 1994
2. Simmons I.G. – The Ecology of Natural Resources 2nd edn ElBS / Edward Arnolds 1983
3. Dash M.C. & Mishra P.C. – Man and Environment McMillan 2001
4. Stiling P. – Ecology : Theories and Applications 4th edn Prentice Hall India 2002

M.Sc. Zoology Semester III (ZOOL) EC – 2 (Elective course- GE/DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1x10=10marks). From the rest seven questions any three (3x20=60marks) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Cell and Molecular Genetics

Group A: Structure and function of cell

Cellular transport, Active and Passive,; Transport through nuclear pore complexes , Cell cycle regulation, Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. Epigenetic Control. Apoptosis and its molecular mechanism

Group B: Genetics

Extensions of Mendelian principles : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. **Gene mapping methods:** Linkage maps, mapping with molecular markers, mapping by using somatic cell hybrids, **Extra chromosomal inheritance:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. **Microbial genetics:** mapping genes by interrupted mating, fine structure analysis of genes. **Human genetics:** Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders (Turner's ,Klinefelter's & Down's). Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Recombination: Homologous and non-homologous recombination including transposable elements (P element , Jumping genes); Junk DNA; c value paradox.

Recommended Books:

1. Brown T.A. – Gene Cloning. 4th edn. Blackwell 2005
2. Nicholl O.S.T. – An Introduction to Genetic Engineering, Cambridge Univ. Press 1994
3. Mitra S : - Genetic Engineering; Principle and Practice. Mac Millan 2002
4. Smith J.E. – Biotechnology. 3rd edn. Cambridge Univ. Press 1986
5. Jayaraman. – Concepts in Biotechnology, Universities Press 2002

M.Sc. Zoology Semester III (ZOOL)
CC (P) – 9 (Core Course – 9)

Practical based on Theory Papers CC 7 & CC 8

Scheme of Examinations,; End term (external) assessment

Full Marks : 100

Exam Duration : 4:00 hrs

ITEMS

MARKS DISTRIBUTION

Endocrinology (Dissection)	25
Biochemistry (protein estimation)	10
Immunology (Blood Group analysis)	10
Spotting (Slides/Models) (6x5=30)	30
Records	10
Viva - voce	15

List of Practical

Endocrinology

Dissection –

- Endocrine glands of fish

Study of permanent Slides

Different stages of development in frog (cleavage, blastula, gastrula, organogenesis)

Different stages of development in chick (slides)

Study of vaginal smear in rat by temporary mounting (methylene blue)

Biochemistry; Biochemical estimation of protein: Bradford's method

Estimation of glucose, Estimation of serum total cholesterol

Determination of glycogen content of rat liver colorimetrically

Quantitative analysis of lipid : Saponification value of fat Immunology

Study of permanent slides: Thymus, Spleen, lymph node, Pituitary, thyroid, Adrenal

Antigen antibody interaction (Blood group analysis) ; Collection of serum & plasma,; Blood film preparation and identification of cell types

Demonstration of Ouchterlony double diffusion (ODD)

M.Sc. Zoology Semester IV (ZOOL)

Core course – 10 (CC10)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1x10=10marks). From the rest seven questions any three are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

APPLIED BIOLOGY

Group: A

Microbial fermentation and production of small and macro molecules.
Application of immunological principles, vaccines, diagnostics. Organ transplantation & its response
Transgenic animals; Infertility and IVF. Genomics and its application to health and agriculture, including gene therapy. Bio resource and uses of biodiversity, Bioremediation, Biosensors

Group: B

Molecular Biology and Recombinant DNA methods:

Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors.

Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms, detection of post translation modification of proteins. DNA sequencing methods & next generation sequencing, strategies for genome sequencing.

Methods for analysis of gene expression at RNA and protein level, large scale expression, micro array based techniques. RFLP, RAPD and AFLP techniques

Recommended Books:

1. Primrose S.B. – Molecular Biotechnology. 2nd edn. Panima 2001
2. Glick B.r. & Pasternak J.J. – Molecular Biotechnology. 3rd edn. ASM Press 2003
3. Golemis E. (edt) – Protein-Protein Interactions. Cold Spring Harbor Laboratory Press 2002
4. Brown T.A. – Gene Cloning. 4th edn. Blackwell 2005
5. Nicholl O.S.T. – An Introduction to Genetic Engineering. Cambridge Univ. Press 1994

M.Sc. Zoology Semester IV (ZOOL)
EC – 3 (Elective course GE / DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1x10=10 marks). From the rest seven questions any three (3x20=60 marks) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Fish and Fisheries

Group: A

Cultivable water: quality and quantity

Physical and chemical properties of water influencing fish culture.

Natural food for fish in pond

Role of plankton, blooms and benthos in fish culture Fertilizers and their role

Supplementary feeding and artificial feeds

Sewage fed fisheries, Integrated fish culture, paddy field fish culture and cage culture.

Important eservoirs and rivers of Jharkhand – their problems and commercial

Common aquatic weed and their control

Group: B

Cultivable species

Introduction of exotic species – Composite culture, extensive and intensive culture

Fish seed production.

Induced breeding _ importance, technique, physiology and new generation of commercial agents

Collection of seeds from natural resources – transport of carp seeds and breeders

Management of r ursorery, rearing and stocking ponds

Fishing technology – nets, crafts, gears, acoustic and other recent techniques.

Fish Endocrinology- Pituitary, interrenal, ultimobranchial gland, corpuscles of stannius

Recommended Books:

1. Wootton R.J. – Fish Ecology Blackie 1992
2. Nikolsky G.V. – The Ecology of Fishes Academic Press 1963
3. Greenwood P.H. – Norman’s History of Fishes 3rd edn Ernest 1975
4. Lagler, Bardach, Miller & May Passino – Lchthyology Wiley 2003
5. Pillay – Aquaculture : Principle and Practice of Fishing 1st Indian edn New Books 2006

M.Sc. Zoology Semester IV (ZOOL)

EC – 3 (Elective course GE / DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1x10=10 marks). From the rest seven questions any three (3x20=60 marks) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Entomology

Group:A

Ecological management of the crop environment:

Sanitation, destruction or modification of alternate hosts and habitats

Tillage, irrigation and water management

Trap cropping and strip harvesting

Chemical control :

Insecticides – nomenclature, formulae and different types of formulations.

common insecticides used in pest control

Mode of action of insecticides and toxicity to humans.

Group: B

Definition of Biological control, agents of Biological Control Parasites, Parasitoids, Predators and pathogenic microorganisms. Mass production and distribution.

Advantages and disadvantages of Biological control.

Integrated Pest Management (IPM)

Other methods of insect Pest Management

Management of insect Pests by Sterile- Insect Technique (Chemosterilants)

Attractants, Repellents, Antifeedants and Pheromones.

Recommended Books:

1. Chapman – The Insects : Structure and Function 4th edn ELBS 1998
2. Imms A.D. – A General Text Book of Entomology 2 vols. Asia Pubi 1997
3. Wigglesworth – Principles of Insect Physiology ELBS 1972

M.Sc. Zoology Semester IV (ZOOL)

EC – 3 (Elective course GE / DC)

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FM- 70

Duration: 3 Hrs

Ecology

Group: A

Pollution Ecology: Water Pollution:- Types, Source & effects of pollutants, Biodegradable & Non-degradable pollutants, Eutrophication, Bioindicators, Biomagnification, Bioremediation. Air pollution:- Source & effects of Air pollution, Concept of green house effect, Ozone depletion, Acid rain. Soil pollution:- Source & effects.

Ecotoxicology:- Toxic Substances & Xenobiotics, Routes and Rates of administration, Environmental and Behavioural factor affecting toxicity, Effectiveness and Response. Synergism and Antagonism. Basic principles of dose response, Mechanism of action & Biotransformation of toxicants, Antidotes, Toxicity Test.

Group: B

Conservation Biology: Principles of conservation, Concept of resource, types, Conservation and management of water, soil, forests. Concept of Biodiversity, types, concerned, endangered, threatened, vulnerable and rare species, In-situ, ex-situ, and megadiversity zones, Hot spots, The Indian efforts. Wild-Life Management.

Environmental Biotechnology: Biotechnological Methods, Biofiltration, waste water treatment, waste management, Bioremediation of wetlands and waste lands. Biofuel production.

Recommended Books:

1. Piyanka E.R.- Evolutionary Ecology 5th edn Harper Collins 1994
2. Simmons I.G. – The Ecology of Natural Resources 2nd edn EIBS / Edward Arnolds 1983
3. Dash M.C. & Mishra P.C. – Man and Environment McMillan 2001
4. Stiling P. – Ecology : Theories and Applications 4th edn Prentice Hall India 2002

M.Sc. Zoology Semester IV (ZOOL) EC – 3 (Elective course GE / DC)

A total of eight questions will be asked (Four questions from each group). Question 1 will be of multiple choice type and compulsory (1x10=10 marks). From the rest seven questions any three (3x20=60 marks) are to be answered selecting not more than two from any group.

FM- 70

Duration: 3 Hrs

Cell and molecular Genetics

Group A: Techniques in Genetic Engineering

Electrophoresis (DNA & PROTEINS). Molecular cloning of DNA in bacteria and in eukaryotic systems. Different Cloning vectors. Nucleic acid detection by blotting and hybridization. Preparation of Genomic & cDNA libraries. Oligonucleotide synthesis (primer concept), Polymerase Chain Reaction (PCR). DNA sequencing methods including next generation sequencing, Human Genome Project. DNA fingerprinting Expression of recombinant proteins (expression vector)

DNA-protein and protein-protein interactions- gel mobility shift assay, Chromatin immunoprecipitation (ChIP), foot printing, western blotting,

Group B: Gene function analysis

In - Vitro mutagenesis, site-specific mutagenesis and mutation detection techniques, Gene Knock out in bacteria and eukaryotic Organisms.

RNAi and specific gene silencing.

Gene chip and Microarray technology.

Production of antibodies, monoclonal Antibody, Recombinant Vaccine, Recombinant insulin, GM Crops, bt Cotton, bt Brinjal.

Recommended Books:

1. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
2. Lewin B. (2008). Gene XI, Jones and Bartlett
3. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
4. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics 7. Edition. Benjamin Cummings
6. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings
- 7.
- 8.
- 9.

M.Sc. Zoology Semester IV (ZOOL)
EC – 4 (Elective course GE / DC)

Practical based on theory papers EC 2 & EC 3

Scheme of examination

End term (external) assessment

Full Marks: 100

Exam Duration: 3:00 hrs

Ecology Special

ITEMS

MARKS DISTRIBUTION

• Water analysis	15
• Soil analysis	10
• Biotic analysis	10
• Bio-statistical analysis	10
• Adaptation Study Spotting (6X5=30)	30
• Records and Sessional work	10
• Viva voce	15

List of Practical

Water Analysis- Estimation of BOD of sample

Estimation of Carbonate, Bicarbonate and Hydroxide & Chloride in sample water. Estimation of hardness & Oxygen and Carbon of sample water. Estimation of Magnesium and Calcium in sample water

Soil Analysis- Estimation of OMC / Total Carbon of a soil sample

Estimation of CaCO₃ in a soil sample. Estimation of soil respiration rate in a sample

Biotic Analysis

Sampling and Identification of freshwater palanktons.

Qualitative, Quantitative assessment and working of Indices of diversity and dominance of Palankton, Benthos, Soil fauna, Soil Microbes

Biostatistical Analysis

Analysis of correlation coefficient and simple linear regression in a set of data

Estimation of density and relation frequency by quadrate analysis

Analysis of similarity index in the species composition by 2x2 contingency table

Adaptation study. Aquatic insects, Terrestrial Insects, Freshwater fish (Hill Stream fish). Marine fish & Higher Vertebrates

Ecological Equipments

Ecological significance of plants and earthworm Identification of Aquatic plants and Bioindicator Species

**M.Sc. Zoology Semester IV (ZOOL)
EC(P) – 4 (Elective course GE / DC)**

Practical based on theory papers EC 2 & EC 3

Scheme of Examinations,; End term (external) assessment

Full Marks : 100

Exam Duration : 3:00 hrs,

Fish and Fisheries

ITEMS	MARKS DISTRUBUTION
• Anatomical observation (Dissection)	20
• (Digestive system of herbivore and carnivore fishes; • /brain of bony fish/ARO of air breathing fish)	
• Gut analysis and determination of feeding habit	10
• Measurement of water pH/TC/DC/ Hb Contents	15
• Spotting – 6 [Representative of major classes-1, • histological slides – 1, Endocrine section-1, • fish showing adaptation -1, exotic/ ornamental/ • larvivorous fish – 1]	30
• Records and Sessional work	10
• Viva voce	15

List of Practical

Anatomical observation of a bony fish

General anatomy, Digestive system of herbivore and carnivore fishes, Reproductive system, Pituitary gland, Weberian Ossicle. Representatives of major groups (except teleosts). Taxonomic identification of important fresh water and marine fishes up to genus Study of histological slides of various organs. Study of slides, related to annual breeding cycles – ovary, testis, pituitary etc. Study of skeletal system of bony fish

Study of exotic, ornamental, larvicidal fishes. Study of adaptive features hill stream fishes, fishes showing parental care, bioluminescence. adaptations – feeding, respiratory, flying, poisonous, electric organs etc.

Haematology – blood corpuscles, T.C., D.C., and Hb content /Haematocrit Study of fishing gears and ecological equipments. Collection, identification of plankton, weeds and aquatic plant

Determination of feeding habit on the basis of gut / gut content

Visit to fish market, landing site, fish pond, fish farm, breeding centers, fish reservoir and National Institutes of Fisheries Research.

M.Sc. Zoology Semester IV (ZOOI) EC(P) – 4 (Elective course GE / DC)

Practical based on theory papers EC 2 & EC 3

Scheme of Examinations,; End term (external) assessment

Full Marks: 100,

Exam Duration: 4:00 hrs

Entomology

ITEMS

MARKS DISTRIBUTION

- | | | |
|--|------------|----|
| • Adapting feature of aquatic/ Semiaquatic/terrestrial insects | 10 | |
| • Temporary mounting of any body parts of insects | 05 | |
| • Calculation of species diversity of insects by Shnnon-Weiner | | |
| • Index from generated data | 15 | |
| • Taxonomic description of a member of any order studied | 15 | |
| • Spotting | (6x5=30) = | 30 |
| • Practical Records | | 10 |
| • Viva voce | | 15 |

List of Practical

Taxonomy description & indentification of following order :

Orthoptera, Dictyoptera, Hemiptera, Hymenoptera, Diptera, Coleoptera & Lepidoptera. Study of permanent slides of body parts. Study of Histological slides. Pest study on affected objects.

Life history of beneficial insects like – lac & tasar. Study of parasites, predators, parasitoids & pattrogens. Embryological study through Drosphila culture. Study of adaptive features in some order of insects.

Minor dissection:

Temporary mounting of special type of mouth parts, wings, legs, ovpositer, sting apparatus antennae – adaptation – arista.

Calculation of species diversity by Shannon-weiner index from generated data
Study of the external morphology of an insect, wings, haltere, clytra

Study of the adpative feature of terrestrial and aquatic insects Study of parasitic insects (Fleas and Lice). Study of the mouthparts of the representative of the order: orthoptera, Dictyoptera, Hemiptera, Lepidoptera and Hymenoptera. Study of respiratory structure of terrestrial, semi-aquatic and aquatic insects. Study of the life cycles of Termites, Honeybee, Mosquitoes

M.Sc. Zoology Semester IV (ZOOL) EC(P) – 4 (Elective course GE / DC)

Practical based on theory papers EC 2 & EC 3

Scheme of Examinations, End term (external) assessment

Full Marks: 100,

Exam Duration: 4:00 hrs

Cell and molecular Genetics

ITEMS	MARKS	DISTRUBUTION
• One Major Experiments		25
• Two Minor Experiments	(2X10= 20)	20
• Spotting (6X5=30)		30
• Records and Sessional work		10
• Viva voce		15

List of Practical:

1. Genomic and plasmid DNA isolation, Restriction digestion (Major Experiments)
2. Preparation of bacterial growth medium, Amp LB plate and culture of bacteria. (Minor Experiments)
3. Preparation of transformation buffer and bacterial transformation experiment. (Minor and Major Experiments)
4. Agarose gel electrophoresis of DNA and SDS-PAGE for protein. (Major Experiments)
5. Histochemical demonstration of Golgi body, Mitochondria, Barr body. (Minor Experiment)
6. Chemical Calculations and preparations of Buffers and solutions. pH and its determination (minor experiments)
7. Bacterial Gram's staining (minor experiments)
8. Extraction and Estimation of proteins by chemical and spectrophotometric methods.(major experiments)
9. Study of cell division (Onion Root Tip and Grass Hopper Testis) and polytene chromosome. (Major experiments)
10. Trapping and culturing native *Drosophila* sp.
 - a. Study of Life cycle and Preparation of Polytene chromosome from *Drosophila* larvae. (Major experiments)

M.Sc. Zoology Semester IV (ZOOL)
PW – (Core Course – 11)

PROJECT WORK/DISSERTATION

FM-100

Time- Two semester (III & IV)

The two typed copies of project work signed by the supervisor and certified by the Head of the department as a bonafide work of the examinee shall be submitted at least one month prior to the commencement of **Semester IV** examination. The project shall comprise of Introduction, Review of Literatures, Materials and Methods, Results, Discussion, Summary and References, along with the declaration by the candidate that the work is original and not submitted to any other university for the award of any degree, duly certified by the supervisor.

The scheme of evaluation for dissertation shall be as follows:

- Every student will be guided by one faculty member as the supervisor of the project.
- Project work would be assigned at the end of semester II to enable students to initiate work on the same.
- The project would formally begin from Semester III and has to be completed by end of Semester IV, one month prior to the end semester examination.
- **The project will be evaluated on the basis of project report writing (60 marks) and viva – voce (40 marks).**
- There shall be an oral presentation (conducted by the board of faculty members including one external member) at the end of semester IV on dissertation.