

DEPARTMENT OF ZOOLOGY



RAFFLES
UNIVERSITY

Syllabus for M.Sc. ZOOLOGY

Choice Based Credit System
(With effect from the Session 2022 – 2024)

RAFFLES UNIVERSITY, NEEMRANA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF ZOOLOGY
Choice Based Credit System (CBCS)

Scheme of Examination (MSc Zoology) w.e.f. session 2022-2024

SEMESTER I						
Course Code	Paper Nomenclature	Credit	Hours	MM (Max. Marks)	MM (Internal Assessment)	Total
CORE COURSES						
Z00 – 401C	Invertebrate Zoology	4	4	60	40	100
Z00 – 403C	Biosystematics & Taxonomy	4	4	60	40	100
Z00 – 405C	Biochemistry and metabolism	4	4	60	40	100
Z00 – 407C	Animal Cell Biology	4	4	60	40	100
Z00 – 409C	Genetics	4	4	60	40	100
LAB COURSES						
Z00 – 111LC1	Lab Course – I (Z00 401,403, 405 C)	4	8	100	-	100
Z00 – 113LC2	Lab Course – II (Z00 407- 409 C)	4	8	100	-	100
	Total	28	36			
SEMESTER II						
Course Code	Paper Nomenclature	Credit	Hours	MM (Max. Marks)	Internal Assessment	Total
CORE COURSES						
Z00 – 402C	Animal Physiology	4	4	60	40	100
Z00 – 404C	Immunology	4	4	60	40	100
Z00 – 406C	Tools and Techniques	4	4	60	40	100
DISCIPLINE SPECIFIC ELECTIVE (ANY ONE)						
Z00 – 408DA1	Evolutionary Biology	4	4	60	40	100
Z00 – 410DA2	Applied Zoology	4	4	60	40	100
OPEN ELECTIVE						
Z00 – 412OE	Open Elective*	3	3			
FOUNDATION ELECTIVE						
Z00 – 207FE	Foundation Elective**	2	2			
LAB COURSES						
Z00 – 416LC3	Lab Course (Z00 402C,404C)	4	8	100		100
Z00 – 418LC4	Lab Course (406C , Z00 408DA1/ 410DA2)	4	8	100		100

	Total	29	37			
SEMESTER III						
Course Code	Paper Nomenclature	Credit	Hours	MM (Max. Marks)	Internal Assessment	Total
CORE COURSES						
Z00 – 501C	Vertebrate Zoology	4	4	60	40	100
Z00 – 503C	Developmental Biology	4	4	60	40	100
DISCIPLINE SPECIFIC ELECTIVE						
Group A (any one)						
Z00 – 505DA1	Endocrinology	4	4	60	40	100
Z00 – 507DA2	Cancer and Radiation Biology	4	4	60	40	100
Group B (any one)						
Z00 – 509DB1	Parasitology and Zoonosis	4	4	60	40	100
Z00 – 511DB2	Ecology and Wildlife Conservation	4	4	60	40	100
OPEN ELECTIVE						
Z00 – 513OE	Open Elective*	3	3			
LAB COURSES						
Z00 – 515LC5	Lab Course (Z00 301-302 C)	4	8	100		100
Z00 – 517LC6	Lab Course (Z00 303DA1/304 DA2 & 305 DB1/306DB2)	4	8	100		100
	Total	27	40			
SEMESTER IV						
Course Code	Paper Nomenclature	Credit	Hours	MM (Max. Marks)	Internal Assessment	Total
CORE COURSES						
Z00 – 502C	Biostatistics and Bioinformatics	4	4	60	40	100
Z00 – 504C	Advances in Apiculture	4	4	60	40	100
DISSERTATION AND SEMINAR						
Z00 – 506D	MS Dissertation and seminar	20	40	180	120	300
	Total	28	48			

* Exchange programme between schools

** To be selected from pool of foundation elective courses

M. Sc. I Year (I Semester)

ZOO – 401 C

INVERTEBRATE ZOOLOGY

Max. Marks: 60

Credit: 4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Evolutionary origin of Eukaryotic cells (including Protozoa)

Origin of Metazoa

Origin of complexity in metazoan

Evolution of sex

Reproduction and development in invertebrates; asexual (including parthenogenesis) and sexual; larval forms

Diversity and economic importance of invertebrates

UNIT – II

Locomotion: Amoeboid, Flagellar, Ciliary movements in Protozoa. Hydrostatic movement in Cnidaria, Annelida and Echinodermata. flight mechanism of insects; modifications of foot organelles in mollusca.

Nutrition: Amoeboid feeding, ciliary feeding in lower Metazoans, Filter feeding in Polychaetes, Molluscs and Echinoderms, Feeding mechanisms in Insects, Parasitic mode of feeding.

UNIT – III

Respiration: Respiration in lower invertebrates (up to helminthes), organs of respiration; gills, trachea and lungs in invertebrates, Respiratory pigments, Mechanism of Respiration.

Circulation: Patterns of Circulation and functions of body fluids.

Excretion: Excretory Organs, Coelomoducts, Nephridia, Coxal Glands and Malpighian tubules, excretory products.

UNIT – IV

Nervous System: Primitive Nervous system in Coelenterates and Echinodermata. Advanced Nervous System: Nematoda, Annelida, Arthropoda and Mollusca. Sense organs and their importance.

Endocrine system: role of neurosecretions and hormones in developmental events, survey of endocrinal structures and their hormones

Suggested readings

1. Barnes, RD. Invertebrate zoology. WG Saunders, Philadelphia.
2. Edward E Ruppert, Richard S Fox and Barnes. Invertebrates zoology: a functional evolutionary approach. CengageLearning India Private Ltd., New Delhi.
3. P S Verma, E L Jordan. Invertebrate Zoology 25th Edition, 2001. S. Chand Publications, New Delhi.
4. D. T. Anderson. Invertebrate Zoology. Second Edition, 1999 Oxford University Press
5. Janet Moore. An Introduction to the Invertebrates.2006. Cambridge University Press
6. Hunter, 1979. Life of Invertebrates, Collier Macmillan.
7. Biology of the Invertebrates: JA Pechenik
8. Invertebrate: Brusca and Brusca
9. Barrington, E.J.W. 1967. Invertebrate's structure and Function, Nelson, London.

ZOO – 403 C

BIOSYSTEMATICS & TAXONOMY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT - I

Biosystematics and taxonomy, importance and applications of Biosystematics.
Trends in Biosystematics: conventional and current approaches (chemotaxonomy, cytotaxonomy and molecular taxonomy). Biosystematics as a profession

UNIT - II

Species Concepts: Historical perspectives of species concepts (Typological, Nominalistic, Evolutionary, Biological, Phylogenetic). Concepts of Subspecies; Intraspecific groups (Deme, Form/Morphotype, cline, Variety)
Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals and microorganisms

UNIT – III

Reconstruction of phylogeny; cladistic method, apomorphies, synapomorphy, autapomorphy, symplesiomorphy, Maximum parsimony and Maximum likelihood
Reconstruction of invertebrate and vertebrate phylogeny, Phylogenetic interrelationship among various taxa

UNIT - I

Taxonomic procedures; taxonomic collections, preservation, curating, process of identification.
Typification; details of different zoological types
Taxonomic keys; different kinds of taxonomic keys, their merits and demerits, Important criteria used for classification in animals
ICZN; principles, interpretation and application of important rules, formation of scientific names of various taxa

Suggested readings

1. Principles of animal taxonomy, GG Simpson. Oxford IBH publishing company.
2. Ernest Mayr, 1997. Principles of Systematic Zoology, Tata-McGraw-Hill, New Delhi.
3. Minelli A, 1993. Biological Systematics. Chapman and Hall.
4. The diversity of life, EO Wilson, 2010. WW Northern and Co. Harvard University press.
5. Theory and practice of animal taxonomy. VC Kapoor. Oxford IBH publishing company private limited.
6. Kapoor, V.C. 1998. Theory of Animal Taxonomy, Oxford IBH Co. Pvt. Ltd., New Delhi.
7. Collection, preservation and identificataion of animals. JRB Alfred and Ramakrishna, 2004. ZSI publications.
8. Forey, P. L. *et al.* (1992) *Cladistics – A practical course in systematics*. Clarendron Press.
9. Sebuh, R.T. 2000. Biological systematics: Principles & Application, Cornell University Press.
10. Ruppert, Fox and Barnes, Invertebrate zoology: a functional evolutionary approach, Cengage India.

ZOO – 405 C

BIOCHEMISTRY AND METABOLISM

Max. Marks: 60

Credit:4

Examination Time: 3 hours

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT - I

Atoms, molecules and stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction), Water: biological importance, pH and acid - base balance. Buffers - biological importance. Redox potential and electron transport system, structure of soluble biomolecular pool of cells – aminoacids and peptides, monosaccharides, oligosaccharides and polysaccharides, nucleotides, vitamins and lipids.

UNIT - II

Covalent properties of proteins, proteins structure – primary, secondary, tertiary and quaternary, Enzymes, coenzymes, isoenzymes, allosteric enzymes, ribozyme and abzyme
Hormones – types, structure and properties
Nucleic acids – types, structure and conformation of nucleic acids

UNIT - III

Metabolic pathways of protein; transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids, Glycolysis and TCA cycle, glycogen breakdown and synthesis, interconversion of hexoses and pentoses, Cori cycle.
Metabolic pathways of lipids and nucleic acids; Biosynthesis of triglycerides, urea, aspartic acid, uridylic acid, adenylic acid.

UNIT - IV

Inborn errors of metabolism; glycogen storage disease, G-6-PD deficiency, lipid metabolism – metabolic disorders of cerebrosides, protein metabolism – PKU, Albinism, cystinuria, purine metabolism – primary gout, mineral metabolism and disease – hypocalcemia, hypercalcemia, osteoporosis

Suggested readings

1. David, L, Nelson and Michael M Cox. Lehninger's principles of Biochemistry.
2. Bell JN and Davidson GH, Textbook of physiology and Biochemistry, ELBS.
3. Sastry, KV. Animal physiology & biochemistry. Rastogi publications, Meerut.
4. Wilson and Walker. Principles and techniques of practical biochemistry. Cambridge University Press.
5. IH Segal. Biochemical calculations, Johan Wiley & sons.
6. D. Voet and JG Voet. Biochemistry, Johan Wiley & sons

ZOO – 407 C

ANIMAL CELL BIOLOGY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Introduction of cell biology and the scope of modern cell biology,
Universal features of cells on Earth,
Levels of cell organization (Structure of pro- and eukaryotic cells),
Cell membrane; Molecular organization and functions
Cytosol; Molecular organization and functions of cytoskeleton structures: Microfilaments, Microtubules and their role in cell architecture.
Signal transduction mechanisms; electrical and synaptic signaling in neurons, messengers and receptors.

UNIT - II

Molecular structure and function of Mitochondrion (oxidation events)
Nucleus: Molecular structure of chromosomes, Euchromatin and Heterochromatin, Role of Histone in packing DNA, Non-histone proteins, Organization and functions of Nucleolus.
Ribosomes; polypeptide synthesis
Molecular organization and functions of Cell Organelles: the endomembrane system (Endoplasmic reticulum, Golgi complex, Lysosomes, protein trafficking) and peroxisomes

UNIT - III

The Cell Cycle: Molecular events during cell cycle (DNA replication, Nuclear division and Cell division), Regulation of the cell cycle; cyclins and cyclin dependent protein kinases (CDK's), checkpoints, Cell Aging: characteristics and causes of aging; telomeres and aging; Apoptosis: Uncontrolled cell proliferation; the origin of cancer

UNIT – IV

Beyond the cell; cell adhesions; cell-cell adhesion proteins, cell junctions; adhesive junctions, tight junction, gap junctions, and extracellular structures; extracellular matrix (ECM), collagens and elastins. Agents that invade cells (viruses, viroids, and prions)

Suggested readings

1. E. D. De Robertis, 1987. Cell and Molecular Biology 8th Edition. Lippincott Williams & Wilkins
2. Jonathan, Slack. Genes. Oxford University Press, New Delhi.
3. Cell and molecular biology. Phillip Sheeler, Donal E Bianchi, 1987. Wiley.
4. Molecular biology of the cell, B Alberts, D Bray, J Lewis, M Raff, K Roberts and JD Watson. Garland publishing Inc. New York.
5. The Cell – A Molecular Approach. Cooper, Geoffrey M. Sunderland (MA): Sinauer Associates, Inc. 2007
6. Lodish, H., Berk, A Zipuosky, L.S. Matsudaira, P. Baltimore and Darnell, J. Molecular Cell Biology IV Ed. W.H. Freeman and Co., 2001.
7. Jeff Hardin, Gregory Bertoni, Lewis J Kleinsmith, 2016. Becker's world of the cell: technology update, 8th edition. Pearson publication, USA.

ZOO – 409 C

GENETICS

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Basic features of heredity; early conceptions of heredity, Mendelian genetics (discovery and rediscovery of Mendel's Laws, universality of Mendel's Laws, Allelic interactions, gene interactions), heredity and environment (Preformism and epigenesis, Heritability)

UNIT – II

Physical basis of heredity; chromosomes and genes (the behavior of chromosomes during cell division, linkage of traits – simple and sex linkage, chromosomal aberrations)

UNIT – III

Molecular genetics; heredity and nucleic acids, structure of nucleic acids, DNA replication, DNA as an information carrier: transcription and translation of the genetic code, mutations in the code, regulation of genes, cytoplasmic, or extracellular DNA, the biochemical products of gene expression, somatic cell genetics, recombinant DNA technology, DNA cloning, DNA sequencing

UNIT – IV

Human genetics

The human chromosomes, Fertilization, sex determination, and differentiation, Immunogenetics,

the genetics of human blood, Influence of the environment
Genetics and human diseases; Classes of genetic disease, Genetics of cancer, Cognitive and behavioral genetics, Genetic damage from environmental agents, Management of genetic disease

Suggested readings

1. Atherly et.al. The science of genetics, Saunders college pub, NY
2. Fairbanks and Anderson, Genetics-the continuity of life, Brooks/cole publishing company, NY
3. Gardner et.al. principles of genetics, John Wiley and sons, NY
4. Watson et.al. molecular biology of genes, the Benjamin Cummings publ, Tokyo.
5. Britannica 2010. The new encyclopaedia Britannica, Volume X, USA.
6. Strachan T and Read A, 2003. Human molecular genetics. Garland science.
7. Vogel F and Motulsky A. 1997. Human genetics: problems and approaches, springer Verlof.
8. Gardner EJ, Simmons MJ and Snustad DP. 2008. Principles of genetics, 8th edition, Wiley India.

ZOO – 411 LC - I

LABORATORY COURSE – I

(ZOO 401C, 403C, 405 C)

Paper Name: Laboratory course - I

Max. Marks: 150

Paper Code: ZOO – 108 LC

Examination Time: 6 hrs

INVERTEBRATE ZOOLOGY LAB COURSE LIST

1. Salient characteristics, identification and classification of representative types of invertebrate groups including Protozoa, Porifera, Cnidaria, Platyhelminthes, Nematodes, Annelida, Mollusca, Echinodermata, Hemichordata
2. Collection and identification of invertebrates in pond water
3. Demonstration of internal organs of earthworm/cockroach/Prawn/Pila
4. Collection and demonstration of spiders, ticks, mites
5. Study of Minor phyla with the help of specimens/CD/Video
6. Preparation of permanent slides (mouth parts of house fly, mosquitoes etc.)
7. Study Larval forms – any 10 larvae from different taxa

ANIMAL PHYSIOLOGY LAB COURSE LIST

1. Study of blood pressure
2. Detection of blood groups and Rh factor in man
3. Estimation of hemoglobin in human blood
4. Determination of blood clotting time
5. Quantitative estimation of blood glucose by Folin-Wu/Anthrone /DNS/O-Toluidine/Enzymatic method
6. Urine analysis in human urine sample: Test for urea, blood cells, bile salts, albumin, ketone bodies and sugar in human urine sample/visit to the pathology lab
7. Water and ionic Animal physiology regulation of freshwater animal in different osmotic media
8. Kymographic recordings of twitch, tetanus and fatigue
9. Blood parasite smear preparation.
10. Test of anemia in human beings

BIOCHEMISTRY LAB COURSE LIST

1. Detection of carbohydrates, proteins and lipids in the given sample
2. Estimation of a sugar, an amino acid, a vitamin, a nucleotide/nucleic acid by appropriate chemical and biological methods
3. Separation of Serum and tissue protein with the help of electrophoresis
4. Test for presence of Salivary Amylase in human saliva
5. Estimation of protein by Biuret and Lowry methods
6. Estimation of amino acid by Ninhydrin method
7. The effect of concentration of enzyme (trypsin) activity
8. Identify unknown organic/inorganic compounds from a mixture with the help of chromatography
9. Quantitative estimation of blood urea/ creatine/ uric acid
10. Quantitative estimation of cholesterol in the blood
11. To adjust the pH of given buffer by pH meter
12. To prepare casein from milk
13. Estimation of creatinine in blood.
14. To test the urine for urea, proteins, ketones and sugar.
15. To investigate the effect of temperature on enzyme catalysed reaction
16. To investigate the effect of varying pH on enzyme catalysed reaction

ZOO – 413 LC - II

LABORATORY COURSE – II

(ZOO - 407C, ZOO - 409 C)

Max. Marks: 150

Credit:

Examination Time: 6 hrs

ANIMAL CELL BIOLOGY LAB COURSE LIST

1. To study the principle and working of various Microscope.
2. Study of meiosis from onion root tip
3. Extraction of DNA from tissues
4. Observation of a Eukaryotic cell under higher microscope
5. Extraction of membrane lipids and observation of lipid bilayer formation
6. To study different stages of mitosis in onion root tips
7. To prepare a temporary mount of Buccal epithelial cells.
8. To prepare polytene chromosomes from salivary glands of *Drosophila* larva.
9. Identification of mitotic and meiotic stages from permanent slides.

GENETICS LAB COURSE LIST

1. Study of mutant phenotypes of *Drosophila*
2. Study of law of independent assortment.
3. Chromosome banding (C, G, H banding)
4. Study of monohybrid and dihybrid crosses/sex linkage in *Drosophila*
5. Salivary gland squash preparation for the study of polytene chromosomes of *Chironomus* / *Drosophila*
6. To observe barr body in the Buccal Epithelial cells of human females.
7. Collection of *Drosophila* for the study of morphological characters of males and females
8. Preparation of human karyotype and study of chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided/ visit to Jaipur Science Park
9. Study of Hardy– Weinberg equilibrium in human population by taking the example of blood group system (ABO).
10. Pedigree Analysis

II Semester

ZOO – 402 C

ANIMAL PHYSIOLOGY

Max. Marks: 100 (60+40)

Credits: 04

Examination Time: 3 hrs

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UNIT – I

Digestion and absorption of food in gastrointestinal tract and regulation, BMR

Patterns of nitrogen excretion among different animal groups,

Physiology of excretion

Osmoregulation in aquatic and terrestrial environments

Ionic and osmotic balance

UNIT – II

Internal fluid environment

Composition of blood; plasma, formed elements, prevention of blood loss

Circulation; cardiovascular system and lymphatic system

Regulation of heart beat and blood pressure

Transport and exchange of gases

Acid –base balance, Regulation of body pH

UNIT – III

Thermoregulation - Heat balance in animals, Adaptations to temperature extremes, torpor,

Aestivation and hibernation, Counter current heat exchangers. Adaptations to Stress- basic

concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones

UNIT – IV

Muscles and receptor physiology: mechanoreception, photoreception, chemoreception,
Origin and propagation of nerve impulse through axon
Neurotransmitters and Neuromodulators
Animal movement, neuromuscular transmission

Suggested readings

1. Eckert, R. Animal physiology: mechanisms and adaptation, WH Freeman and Company, New York.
2. Hoar WS. General and comparative animal physiology, prentice hall.
3. Schiemdt Nielson. Animal physiology: adaptation and environment, Cambridge University Press.
4. Sastry KV and shukla V. Text book of physiology and biochemistry, Rastogi publications, Meerut.
5. General and Comparative Animal Physiology, Hoar W. S. (ed), Prentice Hall, India
6. Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed) Cambridge University Press, Cambridge, UK

ZOO – 404 C

IMMUNOLOGY

Max. Marks: 100

Credit Hrs: 4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT- I

Historical perspective and early theories of Immunology
cells and molecules involved in innate and adaptive immunity (Activation and differentiation of B and T cells, B and T cells receptors, Humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions

Major histocompatibility complexes, organs of the immune system (primary and secondary lymphoid organs), lymphatic system, Haematopoiesis

UNIT- II

Antigens, Antigenicity and immunogenicity. Properties of antigens, Haptens, Determinants, Adjuvants

Generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, Antigen – Antibody Interactions; precipitation, agglutination, immunoelectrophoresis, neutralizing reactions, complementation (classical, alternative and Lectin pathway)

UNIT – III

Mechanism of cell mediated and humoral immunity

MHC Structure and types

Endogenous pathway and exogenous pathway of antigen presentation

Vaccine: Immunization schedule types, attenuated and inactivated, DNA Vaccine, Recombinant Vaccine

UNIT – IV

Immunodeficiencies; Phagocytic deficiencies (neutrophil deficiencies, defective phagocytic functions), Humoral deficiencies (hyper IgM syndrome, X linked Agammaglobulinemia, Common variable hypogammaglobulinemia), Cell-mediated diseases (DiGeorge syndrome, Nude mice)

Hypersensitivity; Type I, II, III and IV

Tolerance; general features of immunologic tolerance, T and B Cell tolerance, induction of tolerance

Inflammation, hypersensitivity, autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital acquired immunodeficiencies, vaccines.

Suggested readings

1. Kuby et.al, 2006, Immunology, WH Freeman and company, USA
2. W Paul. Fundamentals of immunology.
3. Delves PJ, Martin SJ, Burton DR and Roitt IM. 2006. Roitt's Essential immunology, Blackwell publishing.
4. <http://rarediseases.org>
5. Murray et. al 2009. Harper's illustrated biochemistry. Lange medical book, McGraw Hill.
6. Nelson, DL, Cox, MM and Lehninger AL. 2009. Principles of biochemistry, WH Freeman and Co.

ZOO – 406 C

TOOLS AND TECHNIQUES

Max. Marks: 60

Credits: 4

Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Microscopy: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, The electron microscope; principles and applications of transmission electron microscope (TEM), scanning electron microscope (SEM)
Sample preparation techniques for light microscopy and electron microscopy
Other imaging methods; scanning probe microscopy and X-ray crystallography
Cryopreservations for microscopy
Detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH

UNIT – II

Biological and Histological Techniques; Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy
Centrifugation; basic principles of sedimentation, types of centrifuges, differential centrifugation, density gradient centrifugation, Ultracentrifugation
Chromatography; Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC)
Electrophoresis; Principles and applications of agarose and polyacrylamide gel electrophoresis
Colorimetry

UNIT – III

Spectrophotometry and Spectroscopy; Principle and applications of colorimetry and spectrophotometry, Flame emission spectroscopy, Atomic absorption spectroscopy, Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

Radiolabeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

UNIT – IV

Molecular biology techniques: Sequencing of proteins and nucleic acids; southern, northern and western blotting techniques, polymerase chain reaction (PCR), detection of molecules using ELISA, RIA, western blot

Methods for measuring nucleic acid and protein interactions, Real time PCR and Reverse transcriptase PCR, RFLP, RAPD and AFLP techniques.

Basics of Animal cell Culture: Setting of microbiological laboratory, Sterilization and Media preparation techniques, Inoculation and growth monitoring (Standard plate count technique), Isolation of a microbial colony and slant preparation, Culture media preparation, Cell proliferation measurements, Cell viability testing and Cell harvesting methods.

Suggested readings

1. Animal Cell Culture - A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Brawn. McGraw Hill International Editions.
3. Randhir Singh. Practicals in Biochemistry
4. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edn.
5. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
6. K. Wilson and K.H. Goulding. A Biologist's guide to principles and techniques of practical biochemistry.
7. T.G. Cooper. Tools of Biochemistry.

ZOO – 408 EA

EVOLUTIONARY BIOLOGY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Emergence of evolutionary thoughts: Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis.

Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

Paleontology and evolutionary history: The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; Major groups of animals

UNIT – II

Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.

The Mechanisms: Population genetics – populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

UNIT – III

Macroevolution: major evolutionary events; Modes of speciation; allopatric, sympatric, parapatric and peripatric

Concepts of species; phylogenetic concept, biological concept and other concepts of species

Adaptation with special reference to deep sea, desert and aerial

Phenotypic plasticity, Polymorphism

UNIT – IV

Horse evolution

Stages in primate evolution including Homo (Human evolution)

Altruism, selfish gene, coevolution and kin selection

Extinctions and mass extinctions

Suggested readings

1. Mark Ridley, 2003. *Evolution*, John Wiley & Sons, UK.
2. Futuyama, D.J. *Evolutionary Biology- III Ed.* Sinauer Associates Inc. Massachusetts, 1998.
3. Gerhart, J and Kirchner, M. *Cell, Embryos & Evolution.* Blackwell Science Publishers, 1997.
4. Price, P.W. *Biological Evolution.* Saunders College Publishing, 1995.
5. Smith, J.M. *Evolutionary Genetics.* Oxford University Press
6. Camilo J.Cela - Conde and Francisco J. Ayala. 2007. *Human Evolution-Trails from the Past.* Oxford University Press.Oxford ,UK
7. Campbell.B.G.2009. *Human Evolution.* Transaction Publishers, NJ, USA
8. Darwin, C.D. 1859. *On the Origin of Species by Means of Natural Selection.* John Murray, London.
9. Dan, G. and Li,W.H. 2000. *Fundamentals of Molecualr Evolution.* (2nd edn.). Sinauer Associates Inc. MA, USA
10. Elliott,Sober, 2008. *Evidences and Evolution: The Logic Behind the Science.* Cambridge University Press,UK.
11. Simpson, GG, 1953. Horotely, bradytely, and tachytely, Ch. 10 in the ‘major features of evolution’, Columbia University Press, pp 313-337, New York. (download from www.stephenjaygould.org)
12. Hickman et al. 2006. *Integrated principles of zoology*, McGraw Hill International edition, NY

ZOO – 410 EA

APPLIED ZOOLOGY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – 1

Breeding in animals, including marker – assisted selection
Transgenic animals
Application of immunological principles (vaccines, diagnostics)
Microbial fermentation and production of small and macro molecules
Bioresource and uses of biodiversity
Genomics and its application to health, including gene therapy

UNIT – II

Animals of economic Importance:

Animals of Medical importance and control of *Pediculus humanus corporis*, *Anopheles*, *Culex*, *Aedes*, Apiculture and Pearl Culture including industries and institutes in India

UNIT – III

Fish Technology: Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed

Camels: Economic and medical significance of Camels

UNIT- IV

Animal Husbandry and Poultry Farming: Preservation and artificial insemination in cattle;
Induction of early puberty and synchronization of estrus in cattle
Principles of poultry breeding, Management of breeding stock and broilers, Processing and
Preservation of eggs

References

1. Economic zoology 1991-92, GS Shukla and VB Upadhyay, Rastogi publication, Meerut.
2. Fish and fisheries, Kamleshwar Pandey and JP Shukla, 2007, Rastogi publication, Meerut.
3. Fish and fisheries of India, VG Jhingran. 1982. Hindustan Publication, Corp.
4. A hand book on economic zoology, Jawed Ahsan and Subhas Prasad Sinha, S Chand and Company Ltd, Ramnagar
5. Al-Juboori, Mohammed, M., Rashid, J., Kurian, j., and El Refaey, S. (2003). Nutritional and medicinal value of camels *Camelus dromedaries* milk. WTT Transactions on Ecology and the Environment, volume 170, WIT Press, www.witpress.com
6. Refer National Research Centre on Camel, Bikaner

ZOO – 412 OE

OPEN ELECTIVE

Max. Marks: 60

Credit: 3

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

Course offered by other Schools of the University

1. School of Humanities – English communication skills
2. School of Law – IPR
3. School of Agriculture -Vermicomposting
4. School of Pharmacy –
5. School of Management -

UNIT – 1

UNIT – II

References:

ZOO – 414 FE

FOUNDATION ELECTIVE

Credit: 2

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – 1

Research Process: scientific method, criteria for good research

Research design: meaning and need for research design, features of good design

Paragraph writing: proper use of verb, noun, pronoun, tense, use of MS office, excel, power point for preparing a scientific report

Presentation of numerical data and scientific figures, usage of line, bar graph, charts to describe the results,

UNIT – II

Scientific presentation: preparation and order of material, use of web information

Different ways to make impressive presentation: general gesture for presentation, speed, loudness, clarity during presentation, use of appropriate vocabulary during presentation, general discussion

Scientific paper and review writing: correspondence with editors and reviewers, appropriate citations, copyright and ethical issues in drafting, acknowledgement, keywords, usage of different softwares for MS preparation, checking plagiarism

References:

Richard, Ellis. Communication skills: step ladders to success for professional, Gutenberg Press, Malta
John, W. Davis. Communication skills: a guide for engineering and applied science students, Prantics Hall, 2001.

Gupta, S. Commiunicaiton skills and functional Grammar, University Science Press, N Delhi

Llyod, M., Bor, R. Communication skills for medicine, Elsevier press, Churchill Liverstone Elsevier.

ZOO – 416 LC - 3

LABORATORY COURSE – III

(ZOO 402C, 406C)

Paper Name: Laboratory course - I

Max. Marks: 150

Paper Code: ZOO – 108 LC

Examination Time: 6 hrs

List of practical for ‘Biosystematics and Taxonomy’

1. LII

2.

List of practical for ‘Immunology’

1. LII

2.

List of practical for ‘Tools and Techniques’

1. LII

2.

ZOO – 418 LC 4

LABORATORY COURSE – IV

(ZOO 408EA/410 EA)

Max. Marks: 150

Examination Time: 6 hrs

List of practical for ‘Evolutionary Biology’

1. LII

2.

List of practical for ‘Applied Zoology’

1. LII

2.

Developmental biology, evolutionary biology, molecular biology

1. Estimation of ovarian egg counts.
2. Culture of live food organisms and estimation of population density of live food organisms.
3. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
4. Collection and identification of aquatic weeds.
5. Collection and identification of aquatic insects.
6. Study of feeding habits of fishes by gut content analysis.
7. Aquarium design and maintenance.
8. Formulation and preparation of artificial fish food
9. Analysis of proximate composition (protein and fat) of fish
10. Analysis of proximate composition (protein and fat) of artificial fish food
11. To study the stages of Evolution of the prokaryotes.
12. To study the stages of Evolution of the eukaryotes.
13. To study evolutionary history of Primates.
14. Human evolutionary tree.
15. Study of evolutionary time scale.
16. Serial homology supporting evolution.
17. Phenotypic Plasticity supporting evolution.
18. Paleontological evidences supporting evolution.
19. Study of natural Selection in action.
20. To study different examples of co-evolution between different organisms.
21. Exercise for Hardy-Weinberg law.

PRACTICALS:

1. Study of frog and mouse sperm and sperm smear preparation.
2. Study of developmental stages of frog and chick embryos from permanent slides.
3. Observation of chick embryo.

Course no.: 16ZOO21CL2 M.M.: 100

Course Title: Laboratory Course Time: 6 Hr

Laboratory Course outcomes

CO1: Students would gain expertise in understanding the complex molecular mechanisms occurring in cell and the applications of molecular technologies.

CO2: The study of molecular biology provides the necessary information about the chemistry of life to allow the students to understand the basis of life. .

CO3: Students would gain expertise in physiology of animals

CO4: A suitable understanding of execution of each system of different groups of animals with their up to date comparison.

List of practicals

1. To perform extraction of nucleic acids
2. To perform SDS PAGE
3. To perform isolation of genomic genetic material
4. To estimate RNA in the given material/sample
5. To perform blotting to analyse the given sample
6. DNA gel extraction
7. Competent cell preparation
8. Microscopy applications

9. Solutions and Buffers preparation

10. To estimate DNA in the given material/sample
11. Assessment of proliferation in cultured cells by MTT assay
12. To find the blood group and Rh factor of own blood
13. To estimate the amount of Hb present in human blood
14. To estimate the RBC count present in 1mm³ volume of blood.
15. To estimate the WBC count present in 1mm³ volume of blood.
16. Determination of MCV, MCH, and MCHC.
17. Determination of colour Index of blood.
18. Demonstration of the blood clotting time.
19. Demonstration of the erythrocyte sedimentation rate.
20. Demonstration of the haemolysis.
21. To study the effect of osmolarity of solution on RBC
22. Qualitative estimation of salivary amylase
23. To study the effect of varying pH on salivary amylase
24. To determine the effects of varying temperatures on the activity of salivary amylase
25. To study the rate of respiration by aquatic animals
26. Spiro metric analysis of pollution impact on human beings and its implications.

M. Sc. II Year (III Semester)

ZOO – 501 C

VERTEBRATE ZOOLOGY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Introduction of Chordates and Vertebrates

Introduction: Origin of Chordates and recent theories, General organization and features of chordates. Protochordata: Life cycle of Salpa, Doliolum and Amphioxus, Significance of Retrogressive metamorphosis

UNIT- II

Fish and Amphibians

Origin, Evolution of Agnatha, Placoderms and Chondrichthyes, Osteichthyes

Adaptive radiation in bony fishes

Origin, Evolution and adaptive radiation in Amphibians

Pisces and Amphibia; salient features, description of their habit and habitats, movement, nutrition, gas exchange and transport, excretion, sensory system, reproductive patterns, development and larval characters

UNIT- III

Reptiles and birds

Origin and Evolution of Reptiles, Adaptive radiation in living Reptiles, Poisonous and Non-poisonous Snakes in India and Extinct Reptiles

Origin and evolution of Birds

Aerial adaptations, Mechanism of flight and migration

Reptilia, and Aves; description of their habit and habitats, movement, nutrition, gas exchange and transport, excretion, sensory system, reproductive patterns

UNIT- IV

Mammals

Origin and Evolution of Mammals. Adaptive radiations in Monotremes, Marsupials. Aquatic Mammals and Eutherians

Mammals; description of their habit and habitats, movement, nutrition, gas exchange and transport, excretion, sensory system, reproductive patterns, Dentition in Mammals

Suggested readings

1. Colbert
2. Kardong
3. Marshall, A.J. and Williams W.D. (Ed). Text Book of Zoology: Vertebrates-VII (Ed.) Vol. II AITBS, Publishers and Distributors, 1995.
4. Young, J.Z. The Life of Vertebrates. III Ed Clarendon Press, Oxford, 1981.
5. William, N. Mcfarland, F. and Harvey Pough Tom J.C. and Heiser J.B. Vertebrate Life. Collier-Macmillan Publihers, London, 1979.
6. Romer, W.B. The Vertebrates Body. Saunders, Philadelphia, 1956.

ZOO – 503C

DEVELOPMENTAL BIOLOGY

Max. Marks: 60

Credits:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Basic concepts of developmental biology: 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.

UNIT – II

Gametogenesis, fertilization and early development:

Production of gametes, cell surface molecules in sperm-egg recognition in animals; fertilization and zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals; embryogenesis,

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila (role of maternal genes, patterning of early embryo by zygotic genes- gap genes, pair- rule genes, segment polarity genes, homeotic selector genes- bithorax and antennapedia complex), amphibia and chick;

UNIT – III

Organogenesis – vulva formation in *Caenorhabditis elegans*; eye lens induction, limb development and regeneration in vertebrates (epimorphic regeneration of reptile (salamander) limb); differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Aging and senescence – Programmed cell death (apoptosis, autophagy and necrosis), aging and senescence, genes involved in alteration in timing of senescence

UNIT – IV

Applications and Medical implications of developmental biology –

Reproductive technologies; in-vitro fertilization, Intracytoplasmic sperm injection, GIFT, ZIFT, Cloning; SCNT, ECNT and Gene therapy; defective genes, somatic gene therapy, types of vectors used in gene therapy (retrovirus, adenovirus, plasmid), germ line gene therapy, Therapeutic use of stem cells
Teratogenesis; environmental assaults on human development, teratogenic agents like alcohol, retinoic acid etc

Suggested readings

1. SF Gilbert, 2006. Developmental biology, sinauer associates Inc. Massachusetts.
2. Wolpert et. al. 2007. Principles of development. Oxford university press.
3. Jonathan MW. Slack. Essential developmental biology, willey Blackwell publ.
4. LW Browder et.al. Developmental biology, saunders college publishing, Philadelphia.
5. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGraw-Hill Science, New Delhi.
6. Balinsky, B. I (1981) Introduction to Embryology. Hall Saunders, Philadelphia (5th ed.)
7. Rao, K.V. 1993. Developmental Biology: A Modern Synthesis. Oxford and IBH Publishing Co. Pvt. Ltd.
8. Subramanian, T. Developmental Biology, Narosa Publishing House, 2002.

ZOO – 505 DA 1

ENDOCRINOLOGY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Definition and scope of endocrinology; Structure of various endocrine glands; Phylogeny of endocrine glands

Hormones as second messengers: endocrine, paracrine and autocrine hormones. Structure and function of the hypothalamus: hypothalamo – hypophyseal system; feedback mechanism.

Biosynthesis and physiological roles of hormones

UNIT – II

Types of hormone receptors. Signal transduction mechanisms. Protein hormones: Membrane receptors G-proteins – cAMP signaling pathway. Thyroid hormones: Mechanism of action of thyroxine, tri-iodothyronine and tetra-iodothyronine. Mechanism of action of steroid hormones (genomic and non-genomic pathway).

Inhibitors of hormone biosynthesis and their use

UNIT – III

Renin – Angiotensin System (RAS). Erythropoietin and Atrial Natriuretic Factor (ANF). Thymosins and Growth factors. Role of parathormone, calcitonin and cholecalciferol (Vit D) in calcium homeostasis. Role of insulin and glucagon in glucose homeostasis.

UNIT – IV

Ovaries and testis, hormonal control of reproduction
Regulation of gonadal activity: Hypothalamus – hypophyseal – gonadal axis.
Oestrous and menstrual cycles and their regulation by hormones
Pineal and photoperiodic regulation of breeding cycle of vertebrates
Current developments in design and production of hormonal contraceptives,
Recombinant protein hormones production and application in regulation of fertility in farm animals and humans

List of Recommended Books

1. Mac E. Hadley, Jon E. Levine. Endocrinology, Pearson Prentice Hall, 2007
2. H. Maurice Goodman. Basic Medical Endocrinology, Fourth Edition, 2008, Academic Press, Elsevier
3. F Bolander. Molecular Endocrinology, 3rd Edition, 2004, Academic Press, Elsevier
4. E.J.W. Barrington. General and Comparative Endocrinology, Oxford, Clarendon Press.
5. P.J. Bentley. Comparative Vertebrate Endocrinology. Cambridge University Press.
6. R.H. Williams. Text Book of Endocrinology, W.B. Saunders
7. C.R. Martin. Endocrine Physiology. Oxford Univ. Press.
8. Bentley: Comparative Vertebrate Endocrinology (1998, Cambridge University Press)
9. Chester-Jones et al: Fundamentals of Comparative Endocrinology (1987, Plenum Press)
10. Gorbman et al: Comparative Endocrinology (1983, John Wiley)
11. Norris: Vertebrate Endocrinology (4th ed 2007, Elsevier)
12. Hadley: Endocrinology, Prentice Hall (2000, International Edition)

PRACTICALS:

1. Study of endocrine glands in rat.
2. Estimation of hormones by ELISA (LH, FSH, Progesterone).
3. Demonstration of Hypothalamohypophysio gonadal (HPG) axis.
4. Histological preparation and immunocytochemical demonstration of endocrine tissues.

ZOO – 507DA2C

CANCER AND RADIATION BIOLOGY

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

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

UNIT-II

Hallmarks of Cancer I: Mechanism of tissue invasion and metastasis, Micrometastasis, dormancy, and colonization. Tumour angiogenesis. Tumour: Benign tumour, Malignant tumour, carcinoma and sarcoma, leukemia and lymphoma, epithelial and non epithelial tumours, specialized tumours

UNIT III

Genetic basis of cancer: Proto-oncogene and oncogene (ras, myc, abl). Tumour suppressor gene (p53, RB, BRCA1 and BRCA 2). Tumour viruses and retrotransposons. Growth factors and signal transduction. Euchromatin and heterochromatin, Preparation of metaphase plate (Chromosome banding pattern).

UNIT IV

Treatment of cancer: surgery, radiation therapy, chemotherapy, hormone therapy, immune therapy, hyperthermia, gene therapy, other treatment methods (cryosurgery, laser therapy, photodynamic therapy)

References

1. Lauren Pecorino (2012) *Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics* (2nd Edition) by Oxford University Press
2. Weinberg, Robert A. (2007) *The Biology of Cancer*. New York: Garland Science.
3. Raymond W. Ruddon (2007) *Cancer Biology*. Oxford University Press.
4. L. M. Franks, N. M. Teich (1997) *Introduction to the Cellular and Molecular Biology of Cancer*. Oxford University Press
5. John Mendelsohn (2008) *The molecular basis of cancer*. Saunders/Elsevier
6. Eric J. Hall and Amato Giaccia (2011) *Radiobiology for the Radiologist*. 7th edition. Lippincott Williams and Wilkins.
7. A.P. Casarett (1968) *Radiation Biology*. Prentice Hall
8. Forshier Steven (2002) *Essentials of Radiation Biology and Protection*. Delmar

PRACTICALS

1. Study of Apoptotic and Necrotic morphology.
2. Trypan Blue dye exclusion Test.
3. Preparation of Metaphase plate.
4. Study of Chromosome aberration.

Z00 – 509DB1

PARASITOLOGY AND ZOOONOSIS

Max. Marks: 60

Credit:4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Introduction: Origin and Evolution of Parasitism, Kinds of Hosts and Parasites,
Host parasite interaction: recognition and entry processes of different pathogens like bacteria, viruses into animals host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, cell-cell fusion in both normal and abnormal cells

UNIT – II

Pathogens and disease

Pathogenic Microorganisms

Pathogenic Protozoan's

Pathogenic Nemetodes

Pathogenic Trematodes

Pathogenic Cestodes

UNIT – III

Zoonoses: Definitions, Concept and classification of Zoonoses,
Ecological aspects of Zoonoses, Role of Wild animals (birds, bats etc.), domestic animals , and laboratory animals in transmission of zoonoses
Vectors-, Milk-, meat-, egg-, fish- and water- spread Zoonoses, Occupational zoonoses, Nosocomial zoonoses, xenozoonoses
Maintaining and improving animal and human health in the future with the better understanding of Zoonotic diseases

UNIT – IV

Nationally and internationally emerging and re-emerging Zoonoses
Principles of Zoonoses management: methods of prevention, control and eradication of

Zoonoses

Study of zoonotic pathogens as agents of bio-terrorism

References:

1. Hoare, C. A. Hand Book of Medicinal Protozoology. London, Baltimore, Tindall and Cox, 1950.
2. Levine, N. D. Protozoan parasites of Domestic Animals and Man. II Ed. Minncapolis: Burgess, 1978.
3. Noble, E.R. and Noble, G.A. Parasitology: The Biology of Animal Parasites. London Kimpton, 1961
4. Smith, K.G.V. Insects and other Arthropods of Medical Importance, London: British Museum of National
1. History. 1973.
5. Soulsby, E.J.L Biology of Parasites. New York: Academic Press, 1966.
6. Smyth, J.D. Introduction to Animal Parasitology. London: Hodder and Stoughton. 1976.
7. Zoonoses and communicable diseases common to man and animals. Vol.1-3. PAHO.
8. Krauss et al. Zoonoses Infectious diseases transmissible from animals to humans. 3rd Ed. ASM Press.
9. Hugh-Jones et al. Zoonoses Recognition, Control and Prevention. Iowa State University Press.
10. Marquardt et al. Biology of disease vectors. 2nd Ed. Elsevier.

Z00 – 511DB2

ANIMAL ECOLOGY, ETHOLOGY AND WILDLIFE CONSERVATION

You have to work out more ----- , include syllabus of ethology?

Max. Marks: 60

Credit: 4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT - I

The Environment: physical, biotic environment

Habitat and niche, resource partitioning, character displacement

Levels of ecological study

Characteristics of population, population growth curves, population regulation; life history strategies (r and k selection)

Concept of metapopulation (demes and dispersal, interdemic extinctions, age structured populations)

Biogeographic zones of India,

UNIT – II

Community ecology ; community structure and attributes, levels of species diversity and its measurement, edges and ecotones, species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis

Concept of climax

Energy flow and mineral cycling

theory of island biogeography

UNIT – III

Wildlife and its importance

Wildlife of India, status, monitoring and documentation, major drivers of biodiversity change,

Endangered species of India and their present status
Protected Areas in India; national parks, wildlife sanctuaries, hot spots, hope spots, etc.
IUCN classification of species, Red Data Book

UNIT- IV

Wildlife and illegal trade and its control
Problems in plantations and exploited forests
Management of wildlife habitats, biodiversity management approaches
Species conservation projects (for Tiger, Lion, Rhino and Crocodile) and Management plan for Protected Areas (Biosphere reserve programme)
Management of excess population and translocation
Captive breeding (*in-situ and ex-situ*) gene pool conservation
Wildlife protection Act, 1972, amendments and its applications
Indian biodiversity Act
Techniques to study wildlife; tools and techniques, use of biotechnology

Suggested readings

1. Rogers WA. Techniques for wildlife census in India (a field manual), wildlife institute of India, Dehradun.
2. Ali and Ripley. Handbook of birds of India (1-10 volumes), Oxford University Press, Bombay.
3. Prater, SH. The book of Indian animals, BNHS publication, Bombay.
4. EP Gee. The wildlife of India. Govt of India.
5. Saharia, VB. Wildlife in India, Natraj publications, Dehradun.
6. Majupuria, TC. Wildlife wealth of india, Tecpress services, LP., 487/42-SOL Wattenslip, Pratunam Bangkok, 10400, Thailand.
7. ENVIS Centre, wildlife Institute of India, Dehradun.
8. Chatrath, K.J.S. 1992. Wetlands of India, Ashish Publishing House, New Delhi.
9. Heywood, V.H. (Eds) 1995. Global Biodiversity, Published for UN Environmental Programme, Cambridge University Press.
10. Hosetti, B.B. 2006. Concepts in Wildlife Management, Daya Publishing House, Delhi. III edition
11. Stiling, P, 2002. Concepts in Ecology: Theories and Applications IV Ed. Prentice Hall of India Pvt. Ltd., New Delhi-110 001.
12. G. Sinclair and R.E. Anthony, 1994. Wildlife Ecology and Management, Blackwell Scientific Publ. Boston.
13. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.

Z00 – 513OE

OPEN ELECTIVE

**Exchange programme between schools
School of Law – IPR/ biodiversity Act**

Z00 – 515 LC5
LAB COURSE
(Z00 501C, 503C)

List of practical for Vertebrate zoology

1. Ppp
2. Ppp
3. pp

List of practical for Developmental
Biology

1. ll
2. kkk
- 3.

Z00 – 517 LC6

LAB COURSE

**(Z00 505DA1/507 DA2 &
509 DB1/511DB2)**

List of practical for ‘Endocrinology’

1. III
2. kkk

List of practical in ‘Cancer and Radiation Biology’

1. III
2. kkk

List of practical in ‘Parasitology and Zoonosis’

1. III
2. kkk

List of practical ‘Animal Ecology and wildlife
conservation’

1. III
2. kkk

M. Sc. II Year (IV Semester)

ZOO – 502 C

BIOSTATISTICS AND BIOINFORMATICS

Max. Marks: 60

Credit: 4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Introduction and scope of Biostatistics

Basic concepts of Biostatistics: Variables, constants, observation, data, population.

Types and collection of data: Sampling, primary data, Secondary data. Presentation of data: Line diagram, bar diagram, pie diagram, graphic presentation of data.

Measurement of central tendency and dispersal: Mean, Median, Mode. Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation, Standard error, Coefficient of variation

UNIT – II

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, etc.

Hypothesis testing – Null and Alternate hypothesis

Experimental design – components, CRD, RBD, RMD, LSD, strip and split plot.

UNIT – III

Application of Software -MS Word, MS Excel, MS PowerPoint, Acrobat Reader,
Statistical Software (MS Excel, SPSS, SPAR and MINITAB)
Databases -MS Access (Brief account only)
Global Information System -BIOSIS, Medline and Medlars, AGRIS; E Journals and E Books
Publishing

UNIT – IV

Introduction and scope of Bioinformatics
Nucleic acid and protein sequence databases
Sequence alignment- pairwise, multiple, local and global alignment
Database searching - PAM, BLOSUM and BLAST.
Web-based tools for sequence searches, motif analysis and presentation
Gene structure prediction and detection of functional sites in DNA sequences
Protein secondary structure prediction, fold recognition, transmembrane topology prediction

Suggested readings

1. Bailey, N.T.J. 1994. Statistical Methods in Biology (3rd edn). Cambridge University Press.
2. Bright Wilson. 1990. An Introduction to Scientific Research. Dover Publications. NY.
3. Chap T.Le.2003.Introductory Biostatistics. John Wiley & Sons, NJ, USA.
4. Clough, P. and C.Nutbrown.2002. A Student's Guide to Methodology: Justifying Enquiry. Sage, London.
5. Daniel, W.W. 2006. Biostatistics: A Foundation for Analysis in the Health Sciences (7th edn). John Wiley & Sons, New York.
6. Dharmapalan, Biju. 2012. Scientific Research Methodology. Narosa Publishing House, New Delhi
7. Finney, D.J. 1980. Statistics for Biologists. Chapman and Hall, London
8. Frank, Harry and Steven C. Althoen, 1995. Statistics: Concepts and Applications. Cambridge University Press
9. Jeremy R. Garret.2012. The Ethics of Animal Research. The MIT Press, MA. USA
10. Kothari C.R., 2009. Research Methodology: Methods and Techniques (2nd edn.). New Age International Publishers, New Delhi.
11. Pagano, M and K.Gauvreau. 2000. Principles of Biostatistics. Brooks/Cole, CA, USA
12. Paul Oliver.2005. Writing Your Thesis. Vistaar Publications. New Delhi.
13. Peter Medawar.1979. Advice to Young Scientist. Harper and Row, London.
14. Phillippe Cullet.2005. Intellectual Property Protection and Sustainable Development. Lexis Nexis Butterworths Wadhwa, Nagpur
15. Prabhakara ,G.N. 2006. Biostatistics. Jaypee Bro. New Delhi

16. Pradeep Sinha and Priti Sinha.2010.Computer Fundamentals. BPB Publications, New Delhi Rajathi A. and P. Chandran, 2010. SPSS for You. MJP Publishers, Chennai.
17. Shane Torbert.2011. Applied Computer Science. Springer-verlag, New York.
18. Zar, Jerrold H. 2008. Biostatistical Analysis (3rd edn.). Pearson Education Inc., New Delhi.
19. A.Malcolm Campbell, Laurie, J. Heyer., (2004): Discovery Genomics, Proteomics, and Bioinformatics: Pearson Education (Singapore) Pte. Ltd.,
20. Arthur, M. Lesk: (2003) Introduction to Bioinformatics: Oxford University Press
21. S.C.Rastogi, N.Mendiratta, P.Rastogi: (2005)- Bioinformatics –Methods and Application: Prentices Hall of India Pvt. Ltd –New Delhi.
22. T.K.Attwood., D.J.Parry-Smith., Samiron Phukan; (2007) – Introduction to Bioinformatics- Pearson Education.
23. 6. Prasad, S. 2004. Elements of Biostatistics. Rastogi publications. Meerut, India.
24. Robert R. Sokal & James F. Rohlf. 1994. Biometry- The Principles and Practice of Statistics in Biological Research. 3rd ed. W. H. Freeman & Company publishers.

ZOO – 504 C

ADVANCES IN APICULTURE

Max. Marks: 60

Credit: 4

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – I

Role of honey bee in agro-ecosystem and utilitarian value to man kind
History of Apiculture: Definition, Bee keeping in world-wide, In India
Traditional bee keeping, Modern beekeeping, Urban or backyard beekeeping
Honey bee species and identification: Introduction to honey bee; Origin, systematics and distribution; Types of honey bees, Species of honey bees and their identification
Colony organization, Polymorphism, Caste system, Division of labour

UNIT – II

Communication in honey bees: Bee learning and communication – Learning - Color learning in honeybees, Color discrimination, Color learning rates and preferences, Color memory, Timing in color learning, Neurobiology of color vision; Communication - Odor plume, Trophallaxis,
Adaption of honey bees: Structural, Behavioral, Ecological and Physiological Adaptations of Bees. Necessities of honey bee adaptations

UNIT – III

Bee keeping as an occupation: Extent of Beekeeping in Rajasthan and India,
Limitations on the development of beekeeping, Advantages of extensive beekeeping, Beekeeping equipments and initiation into keeping a colony, the future of beekeeping
Beekeeping techniques and Apiary management; Establishment of a colony,
Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products, Bee flora and planned pollination services

UNIT – IV

Diseases and economics; diseases, preventive and curative measure

Use of honey, bee wax, propolis, royal Jelly, bee Venom

Composition of honey and its nutritive value

Important Institutions pertinent to Apiculture in Rajasthan and India: National Bee Board, Bee Research and Training Institute, Apiaries

Suggested readings

1. Dewey M. Caron, 2013. Honey Bee Biology and Beekeeping, Revised Edition. Wicwas Press, Kalamazoo.
2. Pradip V Jabde, 1993. Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture, Agricultural Pests and their Controls. Discovery Publishing House, New Delhi.
3. Eva Crane, 1999. The World History of Beekeeping and Honey Hunting. Routledge, India.
4. Ted Hooper, 2010. Guide to Bees & Honey: The World's Best Selling Guide to Beekeeping. Northern Bee Books, Oxford.
5. D. P. Abrol. Scientific Publisher, New Delhi.
6. S. B. Withhead. Axis books Publisher, Jodhpur. Honey bees and their management
7. Honey bees: Diseases, Parasites, Pests, Predator and their management. N. Nagaraja and D. Rajagopal , M.J.P Publisher, Chennai.
8. A Handbook of Beekeeping Dharamsing and D. P. Singh (, Agrobios India (Publisher), Jodhpur.
9. <http://ecoursesonline.iasri.res.in>

Practical

1. Study of Honey bee species, Castes and Bee morphology.
2. Study of Beekeeping equipments: Bee box and tools.
3. Study of Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom
4. A compulsory visit to an Apiary or Central Bee Research & Training Institute or a Beekeeper to gain a first hand experience in handling bees.
5. Study of bee flora in the locality and observations on bee foraging Behaviour.

ZOO – 506 D

MS DISSERTATION AND SEMINAR

Max. Marks: 300

Credit: 20

Examination Time: 48 hrs

This is kind of internship programme and the University will provide reference letter to the student to carry out his/her research in any of organization or research institutes in the locality

Taxonomy

1. To prepare the dichotomous key of the Porifera, Coelenterata, Arthropoda, annelida, Mollusca and Echinodermata
2. Composition assessment of taxonomic diversity in a given habitat eg. Grassland, aridland, wetland etc.
3. Preparation of dichotomous key of 4 specimens up to family (insects/spiders/ fishes/ snakes of any three taxa).
4. Preparation of Cladogram based on the specimens provided (at least five museum specimen).

Tools and techniques

5. To study the principle of cell fractionation for isolation of sub-cellular organelles.
6. To separate and identify sugar by Thin Layer Chromatography
7. Qualitative estimation of given enzyme by colorimetric method.
8. To study the Beer Lambert's law for spectrophotometry.
9. To isolate chloroplast pigments from leaf by paper chromatography.
10. To isolate amino acids by paper chromatography/TLC.
11. To perform agarose gel electrophoresis.
12. To perform affinity column chromatography
13. To perform ion exchange column chromatography
14. To perform PCR for a given sample
15. To perform SDS-PAGE.
16. To dry SDS-PAGE.
17. To perform ELISA

METHODS IN BIOLOGY

Methods in field biology: Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods.

Ecology: Radio telemetry, Camera trapping, binoculars, telescope.

Paper Name: Animal Behaviour

Max. Marks: 60

Paper Code: ZOO – 403

Examination Time: 3 hrs

Note: Examiner will set nine questions and the students will be required to attempt five questions in all. Question No. 1 is compulsory containing 'short answer types' questions covering the entire syllabus. Further, examiner will set two questions from each unit and the students will be required to attempt one question from each unit.

UNIT – 1

Principles and mechanisms of animal behavior

Four propositions of Tinbergen, Stimuli, Fixed action pattern, imprinting, approaches and methods in study of behaviour

UNIT- 2

Cooperation and conflict

Male-male competition and sexual selection, Fisher's and handicap hypothesis, parent-offspring conflict, range of cooperative behaviours and prisoner's dilemma

UNIT - 3

Foraging

Optimal foraging theory, foraging and predation risk; defense strategies against predators, territoriality and group foraging

UNIT- 4

Sensory system and communication

Signal content and structure, orientation and cues, aggressive behavior, social dominance, migration

Suggested reading

1. Peter Marler and Hamilton, mechanism of animal behavior, John Wiley and sons, USA
2. John Alcock, animal behavior, sinauer associate, USA
3. Dawkins and Manning, An introduction to animal behavior, Cambridge university press, UK

Instruction for the students

Hard core – there are core courses in every semester. These courses are to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a ssia discipline of study.

Soft core elective – soft core is a course which can be chosen from a pool of papers. It will be supportive to the discipline of study and mandatory as per course curriculum.

Foundation course – the foundation course is based upon the content tht leads to knowledge enhancement. It is mandatory as per course curriculum.

Interdisciplinary course/open elective – open elective course may be from an unrelated discipline. It is interdisciplinary/open elective and mandatory as per course curriculum.

Practical Schedule

Veterinary Epidemiology & Zoonoses

Sr.No.	Topic
4	Demonstration of selected software programmes / models e.g. EPIZ00, Handi STATUS and India – Admas- EPITRAK. – bio-informatics, net surfing, hypothesis testing.
5	Study of Evaluation of vaccines and diagnostic tests. – quality assurance and quality testing of vaccines.
6	Determination of Association and risks : relative risks, odd's ratio and attributable risk.
7	Survey of an animal disease on farm. – data collection, clinical sampling, selection of sample size, estimation of disease rate, calculation of confidence interval, hypothetical testing, statistical analysis etc.
8	Study of field survey of zoonotic diseases.
9	Isolation and identification of important bacterias of zoonotic importance from animal and human sources including foods of animals origin.
10	Isolation and identification of important viruses of zoonotic importance from animal and human sources including foods of animal origin.
11	Isolation and identification of important parasites of zoonotic importance from animal and human sources including foods of animal origin.
12	Isolation and identification of important rickettsia and chlymydes of zoonotic importance from animal and human sources including foods of animal origin.
13	Isolation and identification of important fungi of zoonotic importance from animal and human sources including foods of animal origin.
14	Study of rural environment and health status of rural community.
15	Visit to primary health centre / human hospital.
16	Study of common diseases affecting rural / urban population and probable relationships of these human disease conditions with animal diseases present in the area.
	Structural organization in the field of zoonoses; National and international organizations, referral laboratories, datasheets; databank, websites, and other valuable repositories.
10.	Study of Geographic information system (GIS) and forecasting systems pertaining to zoonoses;
11.	Approaches and techniques for the diagnosis of zoonoses

12.	Definition, description, etiology, host range, epidemiology, diagnosis and management of important bacterial zoonoses – Anthrax, brucellosis, borreliosis,
13.	Campylobacteriosis, tuberculosis, paratuberculosis, etc
14.	Salmonellosis, shigellosis, yersiniosis, leptospirosis
15.	Listeriosis, plague, tularaemia, glanders, Maloidosis, staphylococcosis, streptococcosis, tetanus, botulism
16.	Clostridial infections, <i>E. coli</i> , <i>Aeromonas hydrophilla</i> , etc
17.	<i>Bacillus cereus</i> , <i>Plesiomonas</i> , <i>Vibrio parahaemolyticus</i> , erysipelotheix rhusiopathie, cat scratch disease, etc
18.	Lyme disease, tularemia, necrobacillosis, rat bite fever, opportunistic pathogens, etc
19.	Rabies, vesicular stomatitis, influenza, contagious ecthyma, pox group and some rare and potential zoonoses e.g. Newcastle, etc
20.	Hantaviruses, herpes, ebola and Marburg viruses, Chandipura virus, etc
21.	Food-borne viruses viz. rota, tickborne encephalitis, FMD, hepatitis A & E, Norwalk, entero, parvo, adeno, cytomegalo, astro, calci and corona viruses
22.	Prion zoonoses (BSE, CJD, etc)
23.	Japanese encephalitis, Kyasanur forest disease, chickungunya, etc. Vector-borne viruses viz. Crimean-Congo haemorrhagic fever,
24.	dengue fever, West-Nile viruses, yellow fever, rift-valley fever, equine encephalitis, louping ill,
25.	Q fever and other rickettsiosis, <i>Coxiella burnetii</i> , Asian Ixido Rickettsiosis, Boutonneuse fever, Flea- borne typhus, Infection caused by <i>Bartonella henselae</i> , Queensland tick typhus, Rickettsial pox, rocky mountain spotted fever, scrub typhus, Zoonotic typhus caused by <i>R. prowazekii</i>
26.	Chlamydial zoonoses, Psittacosis
27.	Fungal zoonoses – Dermatophytosis, blastomycosis, coccidioidomycosis, cryptococcosis, histoplasmosis, aspergillosis
28.	Candidiasis, rhinosporidiosis, sporotrichosis, zygomycosis
29.	Parasitic zoonoses – Echinococcosis, taeniasis, cysticercosis,
30.	Toxoplasmosis, trichinellosis, cryptosporidiosis, filariasis
31.	fasciolopsiosis, sarcocystosis, zoonotic trematode infections, cutaneous and visceral larva migrans, schistosomiasis, leishmaniasis, trypanosomosis etc
32.	Socioeconomic impact of zoonosis

Practical Schedule

Course Title: ZOONOSES AND PUBLIC HEALTH

Course No.: VPH 604
Course Credits: (2+1)

Sr. No.	Topic
1.	Samples and sampling; use of random tables
2.	Estimation of sensitivity, specificity, analytical precision, etc of different tests employed for the diagnosis of zoonoses
3.	Isolation and identification of important bacterial zoonotic pathogens
4.	Isolation and identification of important viral zoonotic pathogens
5.	Isolation and identification of important parasitic zoonotic pathogens
6.	Isolation and identification of important rickettsial zoonotic pathogens
7.	Isolation and identification of important chlamydial zoonotic pathogens
8.	Isolation and identification of important fungal zoonotic pathogens
9.	Characterization of the metabolites, toxins, etc: bioassays, chromatography, etc Identification of virulence, pathogenicity, etc
10.	Diagnosis of zoonoses using immunological (allergic) tests
11.	Diagnosis of zoonoses using serological tests
12.	Diagnosis of zoonoses using molecular and other advanced techniques
13.	Calculation of incidence, prevalence, morbidity rate. Mortality rate, case fatality rate, odds ratio, etc
15.	Representation of zoonotic data: charts, pie, bar, etc
16.	Retrieval of data : national and global repositories