DEPARTMENT OF

ZOOLOGY

SYLLABUS

PROPOSED SYLLABUS for BACHELOR OF SCIENCE

ELECTIVE & HONOURS ZOOLOGY

ZOO-101: Principles of Classification, Zoogeography & Palaeozoology	**75 marks** **100 lectures**

PRINCIPLES OF CLASSIFICATION

Unit 1. Classification. — 20 lectures — 15 marks

Classification of animals – historical account. Species concept. Taxonomy and Systematics, Taxonomic hierarchy.

Unit 2. Code and approaches in Taxonomy — 30 lectures — 20 marks

International Code of Zoological Nomenclature. Concepts of chemotaxonomy and numerical taxonomy. Approaches in taxonomy: morphometric and cytological techniques. Basic concept of molecular techniques in taxonomy.

ZOOGEOGRAPHY & PALAEOZOOLOGY

Unit 3. Zoogeography — 25 lectures — 20 marks

Zoogeographical regions of the world with characteristic fauna.

Marine realm and its division and characteristics.

Barriers – types and significance; Continental drift.

Discontinuous distribution.

Unit 4. Palaeozoology — 25 lectures — 20 marks

Fossils and fossilization, types of fossils; trace fossils and living fossils.

Dating of fossils, significance of fossils.

Geological time scale and associated fauna.

RECOMMENDED BOOKS

Darlington, P.J. *The Zoogeography: The geographical distribution of animals.* Wiley Publication, New York.

Hubbs, C.L. *Zoogeography*. Ayer Co Pub; Reprint Edition.

Illies, J. 1974. *Introduction to Zoogeography.* Macmillan.

International Commission for Zoological Nomenclature (ICZN). 1999 *International Code of Zoological Nomenclature.* Natural History Museum, Cromwell Road, London SW7 5BD-UK. (available online free: www.iczn.org).

Kapoor, V.C. *Theory and Practice of Animal Taxonomy.* Oxford-IBH Publishing Co., N. Delhi, Mumbai & Kolkota.

Mayer, E. *Principles of Systematics Zoology.* Mc-Graw Hill Publication, New Delhi.

Simpson, G.C. *Principles of Animal Taxonomy.* Oxford-IBH Publishing Co, New Delhi.

Tiwari, S. *Readings in Indian Zoogeography (Vol.1)* Today & Tomorrow Printers & Publishers.

ZOO-101P: Practical on Principles of Classification, Zoogeography & Palaeozoology **25 marks**

Taxonomic Procedures **10 marks**

Collection of specimens, recordings of: locally, co-ordinates, altitudes, river basin, lake, mountain range etc., methods of catch, local name, description of character, particularly colour in fresh.

Labelling/ Tagging of specimens and its correlation with field record book

Narcotization, Fixation and Preservation techniques-Wet, Dry, Slide Preparation

Camera-Lucida drawing of specimens.

Morphometric and meristic characters, data sheets and data entry.

Description of a species.

Identification using dichotomous keys.

Zoogeography & Palaeontology **5 marks**

Elementary knowledge about origin and evolution of groups of animals in Geological time scale.

Field Collection Trip & Report **5 marks**

Viva Voce **5 marks**

ZOO-202:	Functional Anatomy of Non-Chordata	75 marks 100 lectures

Unit 1. Protozoa, Metazoa and Porifera **25 lectures** **20 marks**

Protozoa: Distinguishing characters and classification upto orders.

Structure, locomotion, osmoregulation, nutrition, reproduction. Life history and pathogenicity of *Entamoeba histolytica, Trypanosoma gambiense, Plasmodium vivax, P.falciparum.* Reproduction in Paramecium and nutrition in *Euglena.*

Metazoa: Origin of Metazoa, metamerism and symmetry

Porifera: Distinguishing characters and classification upto orders. Canal system, skeleton. Economic importance of sponges.

Unit 2. Coelenterata, Ctenophora, Platyhelminthes and Nemathelminthes
25 lecture **20 maeks**

Coelenterata: Structural organization and affinities

Platyhelmintes: Structural organization in Trematoda and Cestoda. Life cycle and parasitic adaptation in *Fasciola hepatica* and *Taenia solium.*

Nemathelminthes: Distinguishing characters and classification upto orders. Life cycle pathogenicity and prophylaxis of *Ascaris lumbricoides*

Unit 3. Annelida, Arthropoda, Mullusca and Echinodermata
25 lecture **25 marks**

Annelida: Distinguishing characters and classification upto order. Excretory system, coelome, Trochophore larva – structure and affinities.

Arthropoda: Structural organization in different classes, mouth parts of insets, larval forms of Crustacea and Insecta. Metamorphosis and social life in insects.

Mollusca: Structural organization in Pelecypoda, Gastropoda and Cephalopoda, Torsion and detorsion in Gastropods, Structure and affinities of Neopilina.

Echinodermata: Structural organization in different classes; water vascular system, larval forms.

Unit 4. Minor Phyla **15 lectures** **10 marks**

Distinguishing characters and examples of Nemertinea, Rotifera, Acanthocephala, Sipunculida, Echiurida, Bryozoa (Ectoprocta), Brachyopoda and Phoronida.

RECOMMENDED BOOKS

Anderson, D.T. *Invertebrate Zoology.* Oxford University Press.

Brooks, W.K. *Handbook of Invertebrate Zoology.* Kessinger Publishers.

Ekambranath, M. & Ananthakrishnan, T.N. 2000. *Manual of Zoology, Part 1 & 2.* S. Vishwanathan Printers and Publishers, Chennai.

Parker, T.J. & Haswell, W.A. *A Text-book of Zoology, Volume 1,* McMillan Co.

ZOO-202P: Practical on Functional Anatomy of Non-Chordata **25 marks**

Dissections. **7 marks**

Nereis – digestive and nervous systems.

Cockroach – digestive, reproductive and excretory systems.

Pila – digestive and nervous systems.

Study permanent slides **2 marks**

Paramecium entire, conjugation, Monocystis, Euglena, Trypanosoma, LS of Sycon, Spongin fibres, Obelia colony, T.S. of Ascaris (male & female), T.S, of Fasciola and Taenia, Cercaria, sporocyst and redia of Fasciola, scolex, mature and gravid segments of Taenia. Mouth parts of Anopheles, Housefly and cockroach, bed bug (W/M), body louse (W/M), TS of gill of Pila, TS of arm of Star fish.

Study of specimens **5 marks**

Sycon, Spongilla, Physalia, Porpita, Favia, Tubipora, Madrepora, Aurelia, Sea – anemone, Alcyonium, Taenia, Hetronereis, Aphrodite, Chaetopterus, Sabella, Leech, Bonellia, Spider, Limulus, Millepede, Centipede, Crab, Peripatus, Scorpion, Termite, Daphnia, Cyclops, Balanus, Chiton, Dentallium, Pearl Oyster, Limax, Nautilus, Octopus, Sepia, Loligo, Solen, Aplysia, Starfish, Antedon, Holothuria, Sea urchin, Brittle star.

Temporary mounts **3 marks**

Spicules and gemmules of sponge, Obelia colony, ovary and spermatheca and septal nephridia of Earthworm, Parapodia of Nereis. Mouth parts of cockroach, house fly and mosquito. Radula of Pila, Daphnia, Cyclops, Mysis.

Records Books **3 marks**

Viva Voce **5 marks**

ZOO-303:	Functional Anatomy of Chordata	75 marks 100 lectures

Unit 1. General organization of Chordata **10 lectures** **08 marks**

General characters of chordata and classification upto classes.

Structural organization of Hemichordata, Urochordata and Cephalochordata.

Affinities of Amphioxus.

Unit 2. Agnatha and Pisces **15 lectures** **10 marks**

Petromyzon: external features, digestive system, respiratory system and reproduction.

Scoliodon: external features; respiratory, circulatory and reproductive system; brain and cranial nerves.

Air bladder, accessory respiratory organ of fishes. General characters and distribution of Lungfishes.

Unit 3. Amphibia and Reptilia **20 lectures** **12 marks**

Amphibia: origin and evolution, distinctive characters and classification upto living orders with examples, metamorphosis and neoteny.

Reptilia: distinctive characters and classification upto living orders with examples; affinities of Sphenodon; distinction between poisonous and non-poisonous snakes; biting mechanism in snakes; Mesozoic reptiles.

Unit 4. Aves and Mammalia **25 lectures** **20 marks**

Aves: origin of birds; distinctive characters and classification upto living orders with examples. Pigeon: feathers; digestive, respiratory, circulatory, urino-genital and skeletal system; brain; distinctive character of Ratitae & Carinatae with examples; general character of *Archaeopteryx.* Perching mechanism in birds.

Mammal: origin; general character and classification of Prototheria, Metatheria and Eutheria. Dentition and placentation in mammals.

Rabbit: skeletal, excretory and reproductive system.

Unit 5. Comparative anatomy **30 lectures** **25 marks**

Integumentary system: integument and its derivatives.

Digestive system: alimentary canals and associated glands.

Circulatory system: heart and aortic arches.

Skeletal system: jaw suspension; visceral arches, vertebral column; limbs and girdles.

Nervous system: brain; cranial nerves; spinal nerves.

Urino-genital system: succession of kidney and evolution of urino-genital ducts.

Endocrine glands: pituitary, thyroid, adrenal, pancreas and gonads.

RECOMMENDED BOOKS

Ekambranath, M. & Ananthakrishnan, T.N. 2000. *Manual of Zoology, (Chordata) Part 1 & 2.* S. Vishwanathan Printers and Publishers, Chennai.

Kent Jr. G.C. 1969. *Comparative Anatomy of the vertebrates.* The C.V. Mosby Corn. Toppan, Japan.

Kingsley,J.S. 1962. *Bulletins of Comparative Anatomy,* Central Book Depot, Allahabad.

Parker, T.J. & Haswell, W.A. A Textbook of Zoology, Volume 2, McMillan Co, Bombay, Calcutta, Madras

Sedgewicke, A. *A student textbook of Zoology.* Central Book Depot, Allahabad.

Wake, M.H. 1992. *Hyman's Comparative Vertebrate Anatomy, 3rd Edn.,* The University of Chicago Press

Weichert, C.K. *Anatomy of the Chordates.* McGraw Hill Book Inc., New York.

Weichert, W.C. & Presch, W. 1997. *Elements of Chordate Anatomy.* Tata-McGraw Hill Publishers Co, Ltd., New Delhi.

Young, J.Z. *The Life of Vertebrates.* Oxford University Press, New York.

ZOO-303P	Practical on Functional Anatomy of Chordata	25 marks

Dissections **6 marks**

Scoliodon – afferent and efferent branchial vessels; V, VII, IX and X cranial nerve; internal ear and brain (to be taken out)

Frog or toad – V, VII and X cranial nerves.

Calotes – arterial, venous and urino-genital system.

Study of specimens **6 marks**

Amphioxus, Balanoglossus, Ascidian, Petromyzon, Myxine, Electric ray, Sea horse, Saw fish, Sucker fish, Hammer headed shark, Salamander, Hyla, Hemidactylus, Mabuia, Varanus, Turtle, Tortoise, Chameleon, Draco, Cobra, Viper, Sea-snake, Krait, Parrot, Cuckoo, Kite, Myna, Flying fox, Duck-billed Platypus, Echidna.

Study of bones **5 marks**

Toad or frog – skull, lower jaw, pectoral & pelvic girdles, vertebrae

Calotes – skull, lower jaw, pectoral & pelvic girdles, atlas and axis.

Pigeon – lower jaw, cervical vertebrae, rib, pectoral and pelvic girdles and pygostyle.

Rabbit – skull, lower jaw, pectoral and pelvic girdles.

Practical Record **3 marks**

Viva- voce **5 marks**

ZOO-404:	Biodiversity, Environmental Biology, Applied Zoology and Computer Application	75 marks 100 lectures

Unit 1. Biodiversity **30 lectures** **20 marks**

Biodiversity: concept; biodiversity hotspots; IUCN Red list category, Wildlife of India with particular reference to Manipur; methods adopted in wildlife census. Concept of wildlife conservation, implementation, in-situ & ex-situ conservation, captive breeding, biotechnological intervention. Sanctuaries and National parks of India, Ramsar sites.

Unit 2. Environmental Biology **30 lectures** **20 marks**

Concept of Ecosystem. Major ecosystem, man-made ecosystem and agro-ecosystem. Biotic and abiotic factors. Food chain and energy flow, ecological niche, habitat, biosphere and biome. Ecological succession. Biological cycle; water, oxygen, carbon and nitrogen.

Population. General features, natality, mortality, equilibrium density, immigration, emigration, ecological pyramids, sex ratio, dispersal and dispersion; Leidig's law of minimum and Shelford's law of tolerance; concept of limiting factors and life table construction method.

Environmental pollution. Types, sources, indicators, causes and control and prevention of pollution. Toxic effects of pesticides and industrial wastes. Biomagnification.

Unit 3. Applied Zoology **20 lectures** **20 marks**

Apiculture and Sericulture. Species diversity, life history, rearing methods, disease and economic utility of bees, tasar worms and mulberry silk worm.

Fisheries. Culture and capture fishery. Fishes of commercial value: food and ornamental. Introduction to different pisciculture technique: extensive and intensive pond fish culture.

Unit 4. Computer Applications **20 lectures** **15 marks**

Basic concepts of computer: hardware and software, operating systems. Computer application in Biological science. Elementary knowledge of Bioinformatics, E-learning, Networking. Programme used in biostatistics: SPSS, Minitab, phylogenetic study, modelling etc.

ZOO-404P	Practical on Biodiversity, Environmental Biology, Applied Zoology and Computer Application	25 marks

Environmental Biology **8 marks**

Study of ecosystem of pond. Identification of biotic and abiotic components.

Recording of turbidity, temperature and pH. Estimation of oxygen (Winkler's method) and Carbon dioxide (phenolphthalein method) of pond water.

Population study by tagging experiment (to track the movement of animals) – marking, releasing & recapturing method.

Applied Zoology **5 marks**

Study of life history stages of a Honey bee, a Silk moth and a fish. Morphological differences among the different castes of Honey bee.

Wildlife **5 marks**

Visit to Wildlife sanctuary of Zoo/ National Park/ any other worth visiting site and study of the available animals.

Viva-Voce **7 marks**

ZOO-505: Cell Biology and Genetics	**100 marks 120 lectures**

CELL BIOLOGY

Unit 1. Cellular organization **15 lectures** **15 marks**

Prokaryotic and eukaryotic cells. Intercellular adhesion and interaction. Extra-nuclear organization of cells: concept of unit membrane, active and passive transport.

Unit 2. Cytoplasmic organelles **20 lectures** **15 marks**

Plasma membrane. Structure and function of mitochondria, endoplasmic reticulum, ribosomes, lysosomes, cilia, flagella, cell vacuoles, Golgi body, microbodies.

Unit 3. Nuclear organization **10 lectures** **10 marks**

Nucleus: Nuclear envelope, nuclear matrix, nucleolus, chromosomes, chromatids, karyotyping, supernumerary chromosomes, chromatin-euchromatin and heterochromatin.

Unit 4. Cell regulatory mechanism **15 lectures** **15 marks**

Cell cycle, mitotic and meiotic cell division, regulation of cell division. DNA replication; Molecular expression of gene action: protein synthesis and its regulation, Lac Operon and Tryptophan Operon model.

GENETICS

Unit 5. Genetics **35 lectures** **35 marks**

History of Genetics, Mendelian inheritance patterns: quantitative inheritance, linkage maps.

Gene interactions: incomplete dominance, co-dominance, supplementary genes, complementary genes, epistasis, position effect, atavism, lethal gene, multiple alleles-hemolytic disease of new born (HDN). Sex determination in Drosophila and man.

Genetics of blood group. Modern concept of gene.

Point mutation, chromosomal aberration, chromosomes number, form and rearrangement with reference to speciation in Drosophila, polyploidy (molecular basis of mutations). Non-chromosomal inheritance, human genetics, disease of single gene inheritance, normal and abnormal karyotypes, genetics counselling.

Unit 6. Molecular Genetics and Tools **10 lectures** **10 marks**

RFLP (Restriction Fragment Length Polymorphism) RAPD (Randomly Amplified Polymorphic DNA), AFLP (Amplified Fragment Length Polymorphism), Application of RFLP in DNA fingerprinting, Polymerase Chain Reaction (PCR). Human genome project.

RECOMMENDED BOOKS

Barke, J.D.C. *Cell Biology.* Willian & Wilkins Co.

deRobertis, E.D.P. & deRobertis, E.M.F. *Cell and Molecular Biology.* Holt-Saunders International Edn.

Gardener, E.J. *Principles of Genetics.* John Wiley & Sons Inc., New York.

Lehninger, A.L., Nelson, D.L. & Cox, M.M. *Principles of Biochemistry.* CBSD Publisher & Distributors, Delhi.

Prescott, D.M. *Methods in Cell Biology,* bookman Associates, Jaipur.

Strickberger, M.W. 2005. *Genetics.* Prentice-Hall of India, New Delhi.

Swanson, C.P., Mezz, T & Young, W.J. Cytogenetics: *Chromosomes in diversions, Inheritance and Evolution.* Prentice-Hall of India, New Delhi.

ZOO-506:	Evolution, Adaptation, Ethology, Biotechnology & Bioinstrumentation	100 marks 120 lectures

Unit 1. Evolution **30 lectures** **30 marks**

History of evolutionary thought. Origin of life. Evidence of evolution, modern concepts of organic evolution, Hardy-Weinberg law, Sewall-Wright effect.

Role of mutation in evolution. Variation, Natural selection- directional, stabilizing and disruptive types.

Isolating mechanism and their role in evolution. Speciation. Evolution of man.

Unit 2. Adaptation **20 lectures** **15 marks**

Structural adaptation of animals with Cursorial, Aquatic and Volant modes of life.

Basic concepts of adaptation of animals to deep sea, desert and cave.

Colouration and mimicry in animals.

Adaptive radiation and convergence.

Unit 3. Ethology **25 lectures** **20 marks**

Description and types of animal behaviour. Learning in animals.

Types of communication in insects. Pheromones and their role. Parental care in fishes.

Courtship behaviour in fishes and birds.

Biological Rhythm: Circadian rhythm.

Migration in insects, fishes and birds.

Unit 4. Biotechnology **30 lectures** **25 marks**

Introduction, history, scope, importance and types of biotechnology.

Importance of viruses, bacteria, algae and fungi in biotechnology.

Biotechnology of alcohol fermentation and bio-insecticide.

Principles and techniques of animal cell cultures.

Brief idea of health care biotechnology, production of human insulin.

Elementary knowledge of genetic engineering.

In-vitro fertilization in human and other assisted reproductive technology (ART).

Transgenic animals.

Unit 5. Bioinstrumentation **15 lectures** **10 marks**

General principles and brief ideas on the types of Microscopy, Spectrophotometry, Electrophoresis, Chromatography and Centrifugation.

RECOMMENDED BOOKS

Alcock, J. *Animal behaviour an evolutionary approach.* Sinauer Associates Inc., Massacheusets.

Chadrasekharan, M.K. *Biological Rhythm.* Vishwanathan Printers, Chennai.

Lull, R.S. 1976. *Organic Evolution.* Light & Life Publisher.

Plummer, D.T. *An Introduction to Practical Biochemistry.* Tata- McGraw Hill Publ., New Delhi

Trehan, K. *Biotechnology.* John Willey & Sons.

Wilson, K. and Walker, J. 2000. *Practical Biochemistry, Principles and Techniques, 5th Edn.,* Cambridge University Press.

ZOO-507P	Practical on Cell Biology and Genetics Evolution, Adaptation, Ethology, Biotechnology and Bioinstrumentation	100 marks

Cell Biology and Genetics

Squash preparation of onion root tip for the study of mitosis.

Temporary and permanent squash preparation of the grasshopper testis for the study of meiosis.

Temporary squash preparation of the salivary gland chromosomes of Drosophila and Chironomus.

Study of permanent slides showing autosomes and sex chromosomes of a grasshopper and a mammal.

Karyotyping of chromosomes

Demonstration of Sex Chromatin (Barr body)

Demonstration of mitochondria by supra vital staining (Janus green)

Adaptation **10 marks**

Study of mimicry in insects: stick insect, leaf insect, moth, cicada, sea horse, flat fish, remora, flying lizard, bat etc.

Ethology **10 marks**

Tagging (paper/aluminium) of animals and recapture to study pattern of migration.

Study of different types of nest of animals. Study of Parental Care.

Biotechnology **10 marks**

Demonstration of alcohol fermentation using yeast.

Demonstration of soyabean fermentation using starter culture.

Demonstration of curd making using starter culture.

Bioinstrumentation **10 marks**

Preparation of standard curve of amino acid and protein (bovine serum albumin)

Measurement of cell/ spores size using micrometer.

Demonstration of oil emulsion technique in microscopy.

Separation of tissue extract using centrifuge.

Demonstration of electrophoresis-paper/gel.

Practical Record **5 marks**

Slide Submission Mitosis, meiosis and Salivary gland Chromosomes **10 marks**

Viva Voce **15 marks**

SCHEME OF PRACTICAL EXAMINATION FOR ZOO-507P

All questions are compulsory. There will be no options. The question setter will select anyone from the options available below for a particular examination.

	Marks
1. Any one of the following:	**10**
a. Temporary slides preparation of Mitosis from onion root tip	
b. Temporary slides preparation of Meiosis from Grasshopper testis/mammals.	
c. Salivary gland chromosomes of Drosophila/ Chironomus larva.	
d. Vital staining of Mitochondria.	
2. Demonstration of Barr body, stained and temporary mount.	**10**
3. Karyotyping of images of chromosomes provided.	**10**
4. Demonstration of Alcohol/ Soyabean/ Curd fermentation.	**10**
5. Any one of the following:	**10**
a. Preparation of Calibration curve of Amino acid/ Protein.	
b. Measurement of Cell/Spores size using micrometer.	
c. Preparation of tissue extract by centrifugation	
d. Setting up and demonstration of Electrophoresis.	
6. Comment on adaptation: mimicry/ camouflage of animals	**7**
7. Any one of the following:	**10**
a. Demonstration of tagging experiment for migration of animals.	
b. Demonstration of nesting behaviour/parental care of animals.	
8. Permanent slides submission: (Mitosis-2, Meiosis-2, Salivary gland chromosomes-1)	**10**
9. Practical Record	**8**
10. Viva Voce	**15**

ZOO-608: Animal Physiology, Endocrinology and Immunology	100 marks 120 lectures

ANIMAL PHYSIOLOGY

Physiology with special reference to mammals.

Unit 1. Nutrition **15 lectures** **12 marks**

Nutrition requirements-macro and micro nutrients, digestion and absorption.

Unit 2. Heart, Blood and Circulation **15 lectures** **12 marks**

Origin, conduction and regulation of heart beat; cardiac cycle, electrocardiogram, composition and function of blood, blood group and Rh factor, haemoglobin and haemopoiesis, peripheral circulation, blood pressure and blood coagulation.

Unit 3. Respiration **15 lectures** **12 marks**

Mechanism and control of breathing. Transport of oxygen and carbon dioxide, oxygen dissociation curves of haemoglobin, Bohr effect, Haldane effect, chloride shift.

Unit 4. Excretion **15 lectures** **12 marks**

Physiology of urine formation, mechanism of micturition, role of kidney in water regulation, salt and acid base balance.

Unit 5. Muscle, Nerves and Sense Organ **25 lectures** **20 marks**

Ultrastructural, chemical and physiological basis of skeletal muscle, muscle contraction; molecular mechanism of muscle contraction, Cori's Cycle.

Nerves impulse. Nature, origin and propagation of nerves impulse along a neuron; synapse and myo-neural junction. Integrative functions of central nervous system.

Sense organ: functions of organ related with vision, sound perception, taste, smell and touch. Electroencephalogram (EEC).

ENDOCRINOLOGY

Unit 6. Endocrinology **25 lectures** **25 marks**

Definitions of endocrine glands, neurosecretory cells.

Functions and hormones secreted by the following glands: pineal, hypothalamus, pituitary, thyroid, thymus, parathyroid, islets of Langerhans, adrenal, testis and ovary.

Miscellaneous hormones secreted by gastrointestinal system, kidney, placenta and heart and their functions.

Unit 7. Immunology **10 lectures** **7 marks**

Introduction to immunology, innate immunity and acquired immunity, structures and types of Ig, antigens – antibodies reaction, mechanism of immune responses, brief idea of HIV and AIDS.

RECOMMENDED BOOKS

Bell, G., Davidson, J.N. & Smith, D.E. *Textbook of Physiology and Biochemistry.* ELBS and Churchill Livingstone.

Ganong, W.F. *Medical Physiology.* McGraw Hill Publ., N.Delhi.

Guyton, A.C. & Hall J.E. *Textbook of Medical Physiology. 9th Edn.,* Elsevier, a division of Reed Elsevier India Pvt., Ltd.

Keele, C., Neil, E & Joels, N. *Samson Wright's Applied Physiology.* Oxford University Press, Bombay, Calcutta, Madras

Prosser, C.L. & Brown, F.A. *Comparative Animal Physiology.* W.B. Saunders Cor Philadelphia, Toppan Co. Tokyo, Japan

Rastogi, S.C. *Essential of Animal Physiology.* Wiley Eastern Ltd.

Schil-Nelson, K. *Animal Physiology, Adaptation and Environment.* Cambridge University Press

Turner C.L. *General Endocrinology.* W.B. Saunders, Toppan Co. Ltd., Tokyo, Japan

ZOO-609: Developmental Biology, Histology and Biological Chemistry 100 marks 120 lectures

DEVELOPMENTAL BIOLOGY

Unit 1. Gametogenesis, Fertilization & Parthenogenesis 20 lectures 20 marks

Spermatogenesis, oogenesis and vitellogenesis. Egg maturation, egg membranes, polarity of egg. Fertilization and Parthenogenesis.

Unit 2. Animal egg, early stages of development, foetal membranes 20 lecture 20 marks

Types of animal eggs, pattern of cleavage. Blastulation and gastrulation in frog and chick. Germ layers and their derivatives and homologies. Fat maps. Structure and development of extra-embryonic membranes. Placenta and its types.

Unit 3. Organogenesis, Tissue interactions & Metamorphosis. 20 lectures 20 marks

Organogenesis of central nervous system, sense organ, heart and kidney. Tissue interaction (induction) in development. Metamorphosis-retrogressive and progressive. Regulation of metamorphosis in Anura and Insecta. Organizer concept.

HISTOLOGY & BIOLOGICAL CHEMISTRY

Unit 4. Histology 20 lectures 15 marks

Basic principles of histological techniques. Microscopic anatomy of the following organs of a mammal: skin, stomach, intestine, pancreas, liver, lung, kidney, spinal cord, nerves, heart, arteries, veins, capillaries, lymph nodule, spleen, testis and ovary.

Unit 5. Biological Chemistry 40 lectures 25 marks

Biological chemistry, its scope and importance. Chemistry of carbohydrates, protein, lipids, and nucleic acids, enzyme, nature, classification and function of enzymes.

Co-enzymes and prosthetic groups. Enzyme actions.

Intermediary metabolism. Carbohydrate. Embden-Meyerhoff pathway, TCA cycle, Glycogenolysis and glycogenesis, gluconeogenesis. Biological oxidations with special reference to the role of the electron transport system. Basic concept of Bioenergetics.

Lipid. Oxidation of fatty acids, fate of glycerol, ketone body formation and utilization. Interaction of carbohydrate and lipids.

Proteins. Metabolism of amino acids. Oxidative deamination, trans-aminations, decarboxylation, enzymology of urea cycle. Fate of glucogenic and ketogenic amino acids. Interrelationship of metabolic pathways.

RECOMMENDED BOOKS

Balinsky, B.I. *Introduction to Embryology.* Saunder College Publishers, Philadelphia.

Browder, L.W. *Development Biology.* Saunder College Publishers, Philadelphia.

Fawcett, D.W. *Bloom & Fawcett – A textbook of histology.* Hodder-Arnold Publication.

Jayaraman, J. 1981. *Laboratory Manual in Biochemistry.* New Age International Publishers, New Delhi – 110002

Murry, R.K., Granner, D.K., Mayer, P.A. & Rodwell, V.W. *Harper Biochemistry.* McGraw Hill Publ.

Lehninger, A.L., Nelson, D.L. & Cox, M.M. *Principles of Biochemistry.* CBSD Publishers & Distributors, Delhi.

ZOO-610P: Practical on Animal Physiology, Endocrinology, Immunology, Developmental Biology, Histology & Biological Chemistry 100 marks

Animal physiology 30 marks

Effects of isotonic, hypotonic and hypertonic solutions on erythrocytes

Counting of RBC and WBC using Haemocytometer

Estimation of Haemoglobin percentage of a blood sample: amphibia or mammal.

Preparation of haemin crystal.

Coagulation of blood

Recording of frog's heartbeat. Demonstration of the effect of acetylcholine, atropine and epinephrine on the heartbeat.

Endocrinology 10 marks

Dissection of endocrine gland in rat.

Study of permanent slides: sections of pituitary, thyroid, adrenal, pancreas, testis and ovary.

Immunology 10 marks

Determination of ABO and Rh factor of Blood

Developmental Biology 6 marks

Study of developmental stages of frogs (permanent slides, WM): cleavage, gastrula and neurula.

Study of developmental stages of chick (permanent slides, WM): 18, 24, 36, 48 and 72 hours of incubation.

Study of permanent slides of section of Blastula and gastrula of chick and neurula and external gills of frog.

Histology 16 marks

Microtomy – fixation, embedding, block making, sectioning, staining and mounting of tissues.

Study of permanent slides – section of esophagus, stomach, duodenum, ileum, pancreas, lung, kidney and skin of mammal and amphibian.

Biological Chemistry 10 marks

General test for identification of carbohydrate, lipid and protein

Separation of amino acid using paper chromatography.

Colorimetric estimation of protein from a calibration curve (provided)

Practical Record	**8 marks**
Slide Submission	**5 marks**
Viva – Voce	**10 marks**

SCHEME OF PRACTICAL EXAMINATION FOR ZOO-610P

All questions are compulsory. There will be no options. The question setter will select anyone from the options available below for a particular examination.

		Marks
1.	**Any one of the following:** a. Counting of RBC b. Counting of WBC c. Estimation of Haemoglobin percentage	**12**
2.	**Any one of the following:** a. Effects of isotonic, hypotonic and hypertonic solution on erythrocytes b. Preparation of Haemin Crystals c. Coagulation of Blood	**8**
3.	**Any one of the following:** a. Recording of heartbeat of Frog b. Demonstration of effects of acetylcholine, atropine and epinephrine on heartbeat of frog	**10**
4.	**Determination of ABO and Rh blood group**	**10**
5.	**Any one of the following:** a. Detection of carbohydrate/ lipid/ protein in tissue sample b. Separation of amino acid by paper chromatography c. Colorimetric estimation of Protein/ Amino acis	**10**
6.	**Section cutting and stretching of ribbon from the paraffin block supplied for histology**	**5**
7.	**Dissection of an endocrine gland**	**4**
8.	**Identification and comment on slides, 3 each of Endocrinology Histology and Embryology (2x9)**	**18**
9.	**Record Book**	**8**
10.	**Submission of histology (microtomy) slides (10 slides)**	**5**
11.	**Viva Voce**	**10**