

**B. Sc. (Pass Course and Honours)
SYLLABUS**

(Semester system, *w.e.f. Academic Year 2012*)

**DEPARTMENT OF ZOOLOGY
NAGALAND UNIVERSITY**

Semester		Course number	Name of paper	Credits	Total
I	Pass	ZOO-101	Introduction to Non-Chordates (Theory)	4	8
		ZOO-102	Introduction to Non-Chordates (Practicals)	1	
	Honours	ZOO-103	Evolutionary Biology and Animal Behaviour (Theory)	2	
		ZOO-104	Evolutionary Biology and Animal Behaviour (Practicals)	1	
II	Pass	ZOO-201	Chordates and Evolution (Theory)	4	8
		ZOO-202	Chordates and Evolution (Practicals)	1	
	Honours	ZOO-203	Immunology and Biostatistics (Theory)	2	
		ZOO-204	Immunology and Biostatistics (Practicals)	1	
III	Pass	ZOO-301	Cell and Molecular Biology I (Theory)	4	8
		ZOO-302	Cell and Molecular Biology I (Practicals)	1	
	Honours	ZOO-303	Cell and Molecular Biology II (Theory)	2	
		ZOO-304	Cell and Molecular Biology II (Practicals)	1	
IV	Pass	ZOO-401	Developmental Biology and Physiology (Theory)	4	8
		ZOO-402	Developmental Biology and Physiology (Practicals)	1	
	Honours	ZOO-403	Chordates and Physiology (Theory)	2	
		ZOO-404	Chordates and Physiology (Practicals)	1	
V	Pass	ZOO-501	Biochemistry and Genetics (Theory)	4	8
		ZOO-502	Biochemistry and Genetics (Practicals)	1	
	Honours	ZOO-503	Genetics/Applied Zoology/ Environmental Management (Theory)	2	
		ZOO-504	Genetics/Applied Zoology/ Environmental Management (Practicals)	1	
VI	Pass	ZOO-601	Ecology and Applied Zoology (Theory)	4	10
		ZOO-602	Ecology and Applied Zoology (Practicals)	1	
	Honours	ZOO-603	Choice Based Credit Paper. (NOTE: Colleges have the option of offering any paper relevant to zoology based on their manpower and infrastructure).	3	
		ZOO-604	Project work	2	

Guidelines

1. Fifteen (15) working weeks per semester (approx)
2. 1 credit (Theory) = 15 hours of teaching
3. 1 credit (Practicals) = 30 hours of teaching
4. Respective colleges to work out the required details/modalities based on number of classes per week and duration of classes.
5. All theory papers are of 100 marks (30% internal and 70% external assessment)
6. All practical papers are of 50 marks (100% internal assessment).

Semester I (Pass Course)

THEORY

ZOO-I01: Introduction to Non-Chordates

Unit I: Classification/Protoza

Principles of Taxonomy: Binomial nomenclature; classification of animal kingdom.

Protozoa: General characters and outline classification up to classes with examples.

Type-study: Nutrition, locomotion and reproduction in *Amoeba*, *Paramecium*.

Parasitic Protozoa: *Entamoeba* and *Leishmania*.

Unit II: Porifera/Cnidaria

Porifera: General characters and outline classification up to classes with examples.

Type-study: *Ascon* and *Sycon*- canal System. Structural organization of *Sycon*.

Coelenterate/Cnidaria: General characters and outline classification up to classes with examples.

Type-study: Corals and coral reefs. Polymorphism in Cnidarians.

Unit III: Platyhelminthes/Aschelminthes

Platyhelminthes: General characters and outline classification up to classes with examples.

Type-study: *Fasciola* and *Taenia* (Life history and parasitic adaptations).

Aschelminthes: General characters and outline classification up to classes with examples.

Type-study: *Ascaris* (Life history and parasitic adaptations).

Unit IV: Annelida/Arthropoda

Annelida: General characters and outline classification up to classes with examples.

Type-study: *Polychaeta* (adaptive radiation). Types and significance of coelom; metamerism and its significance.

Arthropoda: General characters and outline classification up to classes with examples.

Larval forms of crustaceans; moulting and metamorphosis in insects.

Unit V: Mollusca/Echinodermata

Mollusca General characters and outline classification up to classes with examples.

Torsion and detorsion; modifications of foot.

Echinodermata: General characters and outline classification up to classes with examples.

Echinoderm larvae and its significance; water-vascular system.

Semester I (Pass Course)

PRACTICAL

ZOO-I02: Introduction to Non-Chordates.

1. Mounting: (Temporary)
 - a) Spicules, gemmules and spongin fibres.
 - b) Pharyngeal and septal nephridia of earthworm.
 - c) Salivary glands and mouth parts of cockroach.

2. Study of Specimens.
 - a) Amoeba, Euglena, Vorticella
 - b) Sycon
 - c) Obelia ; Physalia, Aurelia, Metridium
 - d) Fasciola, Taenia (Life history)
 - e) Male and Female Ascaris.
 - f) Aphrodite, Heteronereis, Chaetopterus, Tubifex, Hirudinaria.
 - g) Limulus, Balanus, Scolopendra, Julus, Termite, Louse, Honeybee, Silkworm, Peripatus.
 - h) Chiton, Dentalin, Unio, Loligo, Sepia, Nautilus.
 - i) Pentaceros. Ophiura, Cucumaria, Antedon.

3. Slides
 - a) T.S. and L.S. of Sycon
 - b) Earthworm: T.S. of pharynx, gizzard and typhlosolar intestine.
 - c) Crustacean larvae.
 - d) Pentaceros (T.S. Arm), Echinoderm larvae.

4. Dissections
 - a) Digestive and nervous systems of earthworm.
 - b) Digestive and nervous systems of cockroach.
 - c) Digestive systems of Pila.

Suggested readings:

1. Barnes, R. (1981). Invertebrate zoology. *W. B. Saunders Co*
2. Barrington, E. W. J. (1969). Invertebrate structure and function. *ELBS*
3. Cox, F. E. G. (1994). Modern parasitology. *Blackwell scientific publications.*
4. Jordan, E. L. & Verma, P. S. Invertebrate Zoology. *S. Chand & Co.*
5. Boolotin & Stiles. College zoology. *MacMillan*
6. Parker & Haswell. Text book of Zoology Vol. II. *MacMillan*
7. Paven, P. H. & Johnson, G. B. Biology. *Mosby College Publ.*
8. Marshal & Williams. Text book of zoology.

Semester I (Honours)

THEORY

ZOO-I03: Evolutionary Biology and Animal Behaviour.

Unit I: Population Genetics and Evolution

Gene pool and gene frequency; chance mating or panmixis.

Hardy Weinberg law; factors influencing allele frequency or deviations from Hardy Weinberg equilibrium (selection, mutation, meiotic drive and migration pressure; random genetic drift, Founder principle).

Genetic polymorphism.

Unit II: Products of evolutionary change

Species concept: Isolation; types of isolation and types of isolating mechanism; speciation and modes of Speciation; barriers and different types

Unit III: Evolution of Man

Phylogenetic trees; multiple sequence alignment; construction of phylogenetic tree; interpretation of trees.

Unit IV: Animal Behaviour

Introduction to ethology; patterns of behaviour (innate and acquired).

Territoriality; aggression and conflict behaviour.

Communication: Crypsis, waggle dance; pheromones.

Biological clock: Biological rhythms, types of rhythms.

Unit V: Social behaviour

Insect societies (bees, ants, termites)

Altruism; alarm call of birds; individual selection hypothesis; kin selection hypothesis, reciprocal altruism hypothesis.

Semester I (Honours)

PRACTICAL

ZOO-I04: Evolutionary Biology and Animal Behaviour.

1. DNA databases and sequence retrieval from databases.
2. Multiple sequence alignments.
3. Construction of phylogenetic trees and interpretation of results.
4. Study of Hardy- Weinberg law using simulations.
5. Study of specimen: Honeybee, ants, termites.

Suggested readings:

1. Kimura, M. (1983). The natural history of molecular evolution. *Cambridge University Press*.
2. Mayr, E. (1980). Principles of systematic zoology. *Tata McGraw Hill*.
3. Edward O. Dodson (1971). Evolution process and products. *East West Press, Delhi*.
4. Florkin, E. & Margulis, S. (1981). Biochemical evolution. *Cambridge University Press*.
5. Otto, T. Sorbrig (1966). Evolution and systematic. *The McMillan Co*.

Semester II (Pass Course)

THEORY

ZOO-20I: Introduction to Chordates and Evolution.

Unit I: Classification: Protochordates, Agnatha

General characters and classification of Chordata up to orders.

Protochordates: General features and phylogeny of Hemichordates, Urochordates and Cephalochordates; retrogressive metamorphosis.

Agnatha: General features of living Agnatha and classification up to classes.

Unit II: Pisces, Amphibia

Pisces: General features and classification up to orders.

Osmoregulation, migration and parental care.

Amphibia: General features and classification up to orders.

Origin of terrestrial ectotherms; neoteny in *Urodela*.

Unit III: Reptiles, Aves

Reptiles: General features and classification up to Orders.

Poisonous and Non-poisonous Snakes of India; poison apparatus and biting mechanisms in Snakes.

Aves: General features and classification up to orders; origin, flight adaptations; mechanism of flight and migration.

Unit IV: Mammals

General features and classification up to orders.

Egg-laying mammals; flying mammals; aquatic mammals; structure and derivatives of integument; osmoregulation in mammals.

Unit V: Evolution

Evidence of evolution; paleontological and geological time scales.

Theories of organic evolution: Lamarkism, Neo-Lamarkism, Darwinism, Neo-Darwinism, Modern Synthetic Theory, Germplasm Theory, Mutation Theory.

Natural Selection under Natural conditions: Melanism in moths or industrial melanism; resistance of insects to pesticides; antibiotic resistance in bacteria; infectious diseases in humans.

Semester II (Pass Course)

PRACTICAL

ZOO-202: Introduction to Chordates and Evolution.

A. Study of Specimen.

- a) Balanoglossus, Herdmania, Ciona, Salpa, Doliolum.
- b) Petromyzon, Scoliodon, Sphyrna, Torpedo, Chimaera, Notopterus, Labeo, Catla, Heteropneutes, Mystus.
- c) Necturus, Salamander, Bufo, Hyla.
- d) Chelona, Testuda, Hemidactylus, Varanus, Uromastix, Chameleon, Viper, Krait.
- e) Bat (Insectivorous and frugivorous).

B. Study of Slides.

- a) Balanoglossus, (proboscis, collar, hepatic region).
- b) Amphioxus (Oral hood, section through pharyngeal, intestinal and caudal regions).

C. Mounting.

- a) Placiod, cycloid and ctenoid Scales.

D. Osteology (Comparative study of amphibia to mammals).

- a) Atlas, Axis, Sacral vertebrae.
- b) Limb bones.
- c) Girdles.
- d) Ribs.

E. Histology: T.S. of Stomach, Intestine, Lungs, Kidney and Gonads in Frog / Mammal.

Dissection: Afferent branchial vessels of Scoliodon.
Efferent branchial vessels of Scoliodon.
Cranial nerves of Scoliodon.

Suggested readings:

1. Mayr, E. (1980). Principles of systematic zoology. *Tata McGraw Hill publishing company limited.*
2. Moody, P. A. (1970). Introduction to evolution. *Harper & Raw*
3. Savage, J. M. (1973). Evolution. *American Publishing Co.*
4. Volpe, E. P. (1089). Understanding evolution. *Universal Books, N. Delhi*
5. Chordate zoology and animal physiology. *S. Chand and Co*
6. Kent, G. C. (1965). Comparative anatomy of vertebrates. *C. V. Mosby & Co.*
7. Romer & Parsons. The vertebrate body. *Saunders.*
8. Hamilton, T. H. Process and pattern of evolution. *MacMillan*
9. Stebbins, T. H. Process of organic evolution. *PHI, N. Delhi.*

Semester II (Honours)

THEORY

ZOO-203: Immunology and Biostatistics.

Unit I: Components of Immune System

Innate: Adaptation (cell mediated and humoral)

Passive: Artificial and natural immunity.

Active: Artificial and natural immunity.

Haematopoiesis and role of haematopoietic factors; cells of the immune system; primary and secondary lymphoid organs, lymphatic system.

Unit II: Antigens/Immunoglobulins

Antigenicity and immunogenicity; immunogens, adjuvant and heptanes.

Immunoglobulins: Structure and functions; classes and function; antigenic determinants on immunoglobulin; antigen - antibody interactions.

Unit III: Immune Response

B lymphocytes and immune responsiveness.

T lymphocytes and immune responsiveness.

MHC: Structure, class, function and immune responsiveness.

Unit IV: Biostatistics I

Definition and scope - census and sampling methods.

Variables: Discrete and continuous.

Presentation of Data: Classification and tabulation.

Diagrams and graphs: Bar, pie, histogram, and line graph.

Concept of statistical population and sampling characteristics of frequency distribution.

Unit V: Biostatistics II

Measures of central tendency: Mean, median, mode and weighted arithmetic mean.

Measures of Dispersion: Range, quartile deviation, mean deviation and standard deviation.

Correlation and regression.

Semester II (Honours)

PRACTICAL

ZOO-204: Immunology and Biostatistics.

1. Dissection and display of lymphoid organ.
2. ABO blood group and Rh factor determination.
3. Preparation of single cell suspension of spleen.
4. Immunoelutrophoresis (working principle)
5. Preparation of charts – histogram, pie chart *etc* using statistical software.

Suggested readings:

1. Elgert, K. D. (1996). Immunology-understanding the immune system. *John Wiley & sons*.
2. Paul, W. E. (ed) (1999). Fundamental immunology, 4th ed. *Lippincott- Raven Publications*.
3. Mishra, B. N. & Mishra, M. K. (1988). Introductory practical biostatistics.

Semester III (Pass Course)

THEORY

ZOO-301: Cell and Molecular Biology-I.

Unit I: An overview of the Cell

Prokaryotic and eukaryotic cell; cell size and shape; phages, virioids, mycoplasma and *Escherichia coli*.

Composition of Cells: Molecules of cell, cell membranes and cell proteins.

Cell Cycle: Mitosis, meiosis.

Cell components: Plasma membrane; transport of small molecules; endocytosis.

Unit II: Nucleus, Protein sorting and Transport

Nucleus: Nuclear envelope, nuclear pore complex, nuclear lamina; transport across nuclear envelope; nucleolus and rRNA processing.

Protein sorting and transport: The endoplasmic reticulum, Golgi apparatus; mechanism of vesicular transport, lysosomes.

Unit III: Mitochondria, Chloroplasts and Peroxisomes

Mitochondria: Structural organization, function; marker enzymes, mitochondrial biogenesis; protein import in mitochondria; semi-autonomous nature of mitochondria and chloroplasts; chloroplast DNA; peroxisome assembly.

Cytoskeleton and cell movement: Structure and organization of actin filaments; actin, myosin and cell movements; intermediate filaments, microtubules.

Unit IV: Chromosomes

Chromatin fibres: Euchromatin, heterchromatin (types).

Chemical composition: DNA, Histone and Non-Histone Proteins

Ultrastructure: Nucleosome concept, nucleosome and solenoid models; 10 nm, 30 nm fibres; radial loops and metaphase chromosome.

Special types of Chromosomes: Pene chromosomes, lampbrush chromosomes, supernumerary chromosomes.

Unit V: Nucleic Acids convey Genetic information

DNA as the carrier of Genetic information; the Central dogma (key experiments); DNA double helix (salient features); genetic code; direction of protein synthesis (key principle); types of DNA; types of genetic material; denaturation, renaturation; Cot curves; organization of DNA in prokaryotes, viruses and eukaryotes.

Semester III (Pass Course)

PRACTICAL

ZOO-302: Cell and Molecular Biology.

1. Study of Cell organelles (Slides)
2. Squash preparation for study of mitosis and meiosis.
3. Staining techniques for study of nucleus, mitochondria and Golgi complex.
4. Cytochemical staining of protein with bromophenol blue.
5. Cytochemical staining of histones with fast green.
6. Cytochemical staining of DNA with Feulgen.
7. Preparation of polytene chromosome from Chironomous larva.
8. Demonstration of mammalian sex chromatin.

Suggested readings:

1. Alberts *et al* (2001). Molecular biology of the cell. *Garland publications*.
2. De Robertis, E. D. P. & De Robertis, E. M. F. (1987). Cell and molecular biology. *Lea & Febiger Intl. ed.*
3. Gerald Karp (2007). Cell and molecular biology: Concepts and experiments. *John Wiley*
4. Powar, C. B. (1986). Cell biology. *Himalaya Publ.*
5. Burke, J. D. C. (1970). Cell biology. *William & Wilkins Co*

Semester III (Honours)

THEORY

ZOO-303: Cell and Molecular Biology II.

Unit I: Cell Wall, Intracellular Matrix and Cell interactions

Eukaryotic cell wall; extracellular matrix and cell matrix interactions; cell to cell interactions.
Cell signalling: Signalling molecules and their receptor; functions of cell surface receptors;
Intracellular signal transduction pathway; signalling networks.

Unit II: Cell Cycle / Death / renewal

Eukaryotic cell cycle; regulation of cell cycle progression.
Cell death and renewal: Programmed cell death, stem cells and maintenance of adult tissues, embryonic stem cells.

Unit III: Cancer

Development and causes of cancer; tumour viruses, oncogenes, tumour suppressor genes, cancer treatment, molecular approach.

Unit IV: Replication of DNA (Prokaryotes and Eukaryotes) / Repair

General principles; unidirectional and bidirectional replication; semi conservative, semi discontinuous; RNA Priming/ enzymes involved in DNA replication - DNA polymerase, DNA lipase, primase, telomerase and accessory proteins.
DNA damage and repair.

Unit V: Mechanism of Transcription

Transcription in prokaryotes: Mechanism; principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons.
Transcription in Eukaryotes: Mechanism; promoters, enhancer, gene silencers; mechanism of post transcriptional modification of mRNA.

Semester III (Honours)

PRACTICAL

ZOO-304: Cell and Molecular Biology II.

1. Study of bacterial and eukaryotic Cell (slides)
2. Study of semi conservative replication of DNA through micrographs/schematic representations.
3. Identification and study of cancer cells (slides).

Suggested readings:

1. Griffiths, A. J. F. *Et al* (1996). An introduction to genetic analysis. *W. H. Freeman and Co, N. York.*
2. Pollard, T. D. & Earnshaw, W. C. (2002). Cell biology. *Saunders.*
3. Gerald Karp (2007). Cell and molecular biology: Concepts and experiments. *Wiley and sons.*
4. Alberts, B. *et al* (1989). Molecular biology of cell II. Edn. *Garland Publishing Corp. Inc. London.*
5. Powar, C. B. (1986). Cell biology. *Himalaya Publ.*
6. De Robertis, E. D. P. & De Robertis, E. M. F. (1981). Cell and molecular biology. *Hold-Saimderu Int.*

Semester IV (Pass Course)

THEORY

ZOO-401: Developmental Biology and Physiology.

Unit I: Introduction

Structure of Gametes; types of eggs, egg membranes.

Gametogenesis: Spermatogenesis and oogenesis.

Early Embryonic development: Fertilization, sperm-egg interaction; biochemical events, mono- and polyspermy; types and patterns of cleavage; early development in chick (cleavage, blastulation, gastrulation); embryonic induction and organizers.

Unit II: Later embryonic development

Differentiation of Germ layers; formation of neural tube, skin, notochord, somites, coelom and digestive tubes (up to rudiments).

Extra embryonic membranes in human; implantation of embryo, placentation- structure, types and physiology of placenta.

Unit III: Nervous system and Muscles

Neuron: structure, types; resting membrane potential and its basis; action potential and its propagation in myelinated and unmyelinated nerve fibres; synaptic transmission and types of synapses, neuro-muscular junction, neurotransmitters.

Muscle: Types, ultrastructure; muscle proteins; molecular and chemical basis of muscle contractions; characteristics of muscle twitch; motor unit, summation; isotonic and isometric contractions, tetanus and rigor mortis, muscle dystrophies.

Unit IV: Respiration, Digestion, Excretion and Blood

Respiration: Histology of trachea and lungs; respiratory pigments; transport of oxygen in the blood (dissociation curve of oxyhaemoglobin); carbon monoxide poisoning; transport of CO₂ in the blood; respiratory volumes and capacities.

Digestion: Mechanical and chemical digestion of food; control and action of GIT secretion; role of GI hormones; absorption of carbohydrates, lipids, proteins, minerals and vitamins.

Excretion: Structure and function of kidney, ureter, bladder; renal blood supply; nitrogenous waste production (ureotelic, amonotelic, uricotelic)

Blood: ABO blood group; Rhesus System.

Unit V: Endocrine System

Nature of hormones; regulation of hormone secretion; structure of pituitary gland and control of anterior pituitary hormones by hypothalamic releasing hormones (neuroendocrine mechanism); control of posterior pituitary and its hormones; histology, functions and effects of abnormal secretion of endocrine glands; thyroid, parathyroid, thymus, pancreas, adrenal, ovary, testis.

Semester IV (Pass Course)

PRACTICAL

ZOO-402: Developmental biology and Physiology.

1. Study of permanent slides of developmental stages in frog (W.M and Sections): cleavage, blastula, gastrula, neurula, tail bud stage, tadpole.
2. Study of developmental stages showing primitive streak at 21h, 24h, 28h, 33h, 36h, 48h, 72h, 76h, 96h, by raising chick embryo in the laboratory.
3. Study of *in ovo* development of chick.
4. Study of gametes from slides (frog /rat).
5. Preparation of haemin crystals.
6. Estimation of haemoglobin content (by haemoglobinometer).
7. Estimation of O₂ consumption of fish with reference to body weight.
8. Blood grouping: A, B, O and Rh factor.
9. Permanent Slides: Examination of sections of mammalian, stomach, duodenum, ileum, liver, lung, kidney, ovary, testis.

Suggested readings:

1. Gilbert, S. T. (2000). Developmental biology, 6th ed. *Sinauer, Sunderland.*
2. Hoar, W. S. (1983). General and comparative physiology. *Prentice Hall.*
3. Balinsky, B. I. (1976). An introduction to embryology, 6th ed. *W. B. Saunders & Co*
4. Prosser, C. L. Comparative animal physiology.
5. Chordate zoology and animal physiology. *S. Chand and Co*
6. Saunders, J. W. Developmental biology: Patterns/Principles/Problems. *MacMillan Publ.*
7. Wilson, J. A. Principles of animal physiology. *Collins MacMillan Publ.*

Semester IV (Honours)

THEORY

ZOO-403: Chordates and Physiology.

Unit I: Comparative Anatomy of Chordates

Respiratory system: Skin, gills, lungs, air sacs and voice apparatus, air bladder and accessory breathing organs in fishes.

Circulatory System: Evolution of heart and aortic arches, venous system and lymphatic system (frog, birds, reptiles, mammals).

Skeletal system: Axial and appendicular system (frog, birds, reptiles, mammals).

Nervous system: Central and autonomic nervous systems (frog, birds, reptiles, mammals).

Sense organs: Chemoreceptors; mammalian eye and ear.

Unit II: Blood / Heart

Blood: Composition; structure and function of haemoglobin; haemopoiesis; haemostasis; coagulation of blood; disorders of blood.

Heart: Outline structure of heart; coronary circulation; origin and conduction of cardiac muscle; cardiac cycle; cardiac output and its regulation; autonomic control and chemical regulation;

Blood pressure and its regulation; electrocardiogram.

Unit III: Excretory System

Urineriferous tubules (structure); mechanism of urine formation; counter current system of urine concentration; hormonal control of renal function; water balance; renal failure and dialysis.

Unit IV: Endocrine System

Nature of hormones; regulation of hormone secretion; mode of action of hormones; signal transduction pathways utilised by steroidal and non steroidal hormones; role of cyclic AMP as a second messenger in hormone action.

Unit V: Reproductive physiology

Male reproductive system: Structure of testis; hormonal control of testicular function; endocrine function of the testes.

Female reproductive system: Structure of ovary; young oocyte; mature Graffian follicle;

Hormonal control of ovary function; estrous, anestrous, proestrus, metestrus;

Menstrual cycle: Proliferative phase, luteal phase, menstruation phase.

Semester IV (Honours)

PRACTICAL

ZOO-404: Chordates and Physiology.

1. Study of air bladder and accessory breathing organs in fishes.
2. Enumeration of total count of white blood cells.
3. Enumeration of total count of red blood cells.
4. Recording of frog's heart beat *in situ* and with perfused heart.
5. Recording of blood pressure using a sphygmomanometer.
6. Study of endocrine glands in rat/chick.
7. Histology of mammalian endocrine organs: Ovary, testis, adrenal, uterus, seminal vesicles, thyroid and pancreas.
8. Pituitary extract preparation - fish / frog / rat.

Suggested readings:

1. Samson Wright's applied physiology. *Oxford University Press*
2. Jordan, E. L. & Verma, P. S. Chordate Zoology. *S. Chand & Co.*
3. Eckert, R. & Randall, D. Physiology. *W. H. Freeman & Co*
4. Hainsworth, F. R. Animal physiology: Adaptations in functions. *Addison-Wesley Publ.*
5. Gordon, M. S. *et al.* Animal physiology. *MacMillan Publ.*

Semester V (Pass Course)

THEORY

ZOO-501: Biochemistry and Genetics.

Unit I: Carbohydrates and their metabolism

Structure and properties of important mono-, di- and polysaccharides; glycolysis; fermentation; citric acid cycle; pentose phosphate pathway; gluconeogenesis.

Shuttle systems: malate - aspartate shuttle; glycerol phosphate shuttle, and cori cycle; glycogen metabolism (glycogenesis and glycogenolysis).

Unit II: Lipids and their metabolism

Structure, properties and functional significance of fatty acids, triglycerides and steroids. Biosynthesis and β -oxidation of saturated fatty acids, ketogenesis, types and properties of lipoproteins.

Unit III: Proteins and their metabolism

Structure and general properties of amino acids; four levels of structures in proteins;

Catabolism of amino acids: Transamination, deamination and urea cycle; fate of glucogenic and ketogenic amino acids with examples of serine and leucine respectively.

Enzymes: Introduction, kinetics, mechanism of action, inhibition.

Unit IV: Genetics

Mendelian genetics and its extension; principles of inheritance; Mendel's laws and experiments; concept of genotype, phenotype, dominance, recessiveness.

DNA as genetic material; chromosome theory of inheritance; laws of probability; pedigree analysis; incomplete dominance and co-dominance; multiple alleles, lethal alleles; epistasis and pleiotropy.

Interaction of genes: Complementary, supplementary, inhibitory and duplicate types.

Sex linked inheritance and sex linked traits.

Unit V: Linkage, crossing over and sex determination, gene Mapping

Linkage and crossing over; cytological basis of crossing over; molecular mechanism of crossing over; two factor and three factor crosses; interference and co-incidence; sex linkage and non-disjunction of sex chromosome in *Drosophila*.

Sex determination: Chromosomal mechanism; environmental factors affecting sex determination; Barr bodies; dosage compensation; gene mapping in *Drosophila*.

Semester V (Pass Course)

PRACTICAL

ZOO-502: Biochemistry and Genetics.

1. Biochemical detection of carbohydrates, proteins and lipids in a given sample.
2. Study of action of salivary amylase at optimum condition.
3. Effect of pH and temperature on the action of salivary amylase.
4. Detection of abnormal constituents in urine.
5. Calorimetric estimation of glucose/Protein in a given solution.
6. Mendelian laws and gene interaction using *Drosophila* crosses.
7. Study of human karyotype (normal and abnormal).
8. Study of linkage, recombination, gene mapping using marker based data from *Drosophila*.

Suggested readings:

1. Stryer, I. (1988). Biochemistry II. *Freeman and Co.*
2. Plummer, L. (1989). Practical biochemistry. *Tata McGraw.*
3. Murray, R. K. *et al* (1995). Harper's biochemistry, 24th ed. *Prentice Hall.*
4. Lewin, B. (2000). Gene. *John Wiley & sons.*
5. Strikburger, M. W. (1994). Genetics. *Macmillan Publ. Co.*
6. Russel, P. J. (1998). Genetics. *The Benjamin Cummins Publishing Co.*
7. Lehninger (2004). Principles of biochemistry 4th ed.
8. Gilbert, F. (2000). Basic concepts in biochemistry: A student's survival guide. 2nd ed. *McGraw Hill*
9. Price, N. E. & Stevens, L. (1982). Fundamentals of enzymology. *OUP*

Semester V (Honours)

THEORY

ZOO-503: Genetics / Applied Zoology / Environmental Management.

Unit I: Extra nuclear Inheritance

Inheritance in eukaryotes; maternal inheritance.

Inheritance by cellular organelles; chloroplast inheritance; mitotic segregation.

Inheritance by Mitochondria (Neurospora and yeast)

Inheritance by Endosymbionts; sigma virus in Drosophila, kappa particles.

Unit II: Chromosomal and gene Mutation

Cytogenetics: Structural changes in chromosome; deletion, duplication, inversion, translocation.

Changes in number of chromosomes - aneuploidy, euploidy, haploid, polyploidy.

Gene Mutation: Somatic and genetic mutation; spontaneous and induced mutation; forward and reverse mutation.

Mutagens: Radiations, temperature, chemical.

Unit III: Human Genetics

Pedigree analysis; amniocentesis; twins (basic types).

Disorders due to mutant genes; brachydactyly.

Inborn errors of metabolism: Phenylketonuria, alkaptonuria, albinism, sickle-cell anaemia.

Human sex anomalies: Turners syndrome, poly X females, Klinefelter's syndrome, XYY males, hermaphrodites.

Unit IV: Reproductive health and human welfare

Pregnancy; parturition; lactation; health and diseases during pregnancy.

Infertility in male and female: causes, diagnosis and management.

Foetal alcohol syndrome: Signs and symptoms; FAS related disabilities.

Assisted reproductive technology; sex selection, sperm banks, frozen embryos, *in vitro* fertilization (IVF).

Unit V: Effects of Human activities, Sustainable development, Resource conservation, Global environment change

Generation of waste; types (agricultural, municipal, industrial).

Management of waste and disposal (concept of reduce, reuse and recycle).

Eutrophication; bioremediation; depletion of forests.

Sustainable development; threats, ecological footprint.

Water: Rainwater harvesting, aquifers, groundwater recharge, watershed management;

Greenhouse effect and global warming; climate change; shrinkage of glaciers and polar ice caps and consequent effects on river and sea levels; ozone layer depletion; vegetation and biota.

Semester V (Honours)

PRACTICAL

ZOO-504: Genetics / Applied Zoology / Environmental Management.

1. Pedigree analysis (Human inherited traits).
2. Human karyotypes (Normal, abnormal)
3. Project work

Suggested readings:

1. Odum, E. P. (1996). Ecology: A bridge between science and society. *Senauer*
2. Lewin, B. (1997). Gene VI. *Oxford University Press*.
3. Russel, P. J. (1998). Genetics. *The Benjamin Cummins Publishing Co. Inc.*
4. Strickburger, M. W. (1977). Genetics. *MacMillan Collier Co.*

Semester VI (Pass Course)

THEORY

ZOO-601: Ecology and Applied Zoology.

Unit I: Introduction to Ecology

History; autecology, synecology; species (sympatric and allopatric);

Abiotic factors: laws of limiting factors; Liebig's law of minimum and Shelford's law of tolerance; brief account of light and temperature as limiting factors; sil types and soil erosion.

Unit II: Population

Unitary and modular populations; population density, natality, fecundity, mortality, life tables or survivorship curves, age ratio, sex ratio, age structure; population growth patterns: exponential/Malthusian and sigmoid growth patterns; population dispersal.

Unit III: Community

Characteristics of community diversity and community stratification.

Habitat and niche, ecotone/edge effect, ecotypes, ecological indicators, succession, stages of primary succession, climax community.

Structure of an ecosystem; food chain, food web, trophic levels, grazing and detritus type of food chain; ecological pyramids, energy flow in ecosystem.

Biogeochemical cycle: water, oxygen, carbon, nitrogen, sulphur, phosphorus

Unit IV: Human diseases

Epidemiology of infectious diseases; transmission, prevention and control of diseases; tuberculosis, amoebiasis, malaria and swine flu.

Applied entomology: Outlines of apiculture, sericulture with emphasis on *Bombyx mori*, lac culture.

Unit V: Insect control / Aquaculture

Insect control: Mechanical, physical, cultural; classification of insect control with reference to chlorinated hydrocarbons, organophosphates, carbonates and synthetic pyrethroids. general aspects of Integrated Pest Management (IPM).

Aquaculture: Introduction to aquaculture, binomics of Indian Major Carps (IMC), live fishes and exotic carps; induced breeding, integrated fish farming and transportation of fish seeds.

Semester VI (Pass Course)

PRACTICAL

ZOO-602: Ecology and Applied Zoology.

1. Determination of population density in a terrestrial community or hypothetical community by quadrat method.
2. Study of life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
3. Study of types of soil, their texture by sieve method and rapid tests for pH, chlorides, nitrates, carbonates and organic carbon.
4. Estimation of primary productivity of grassland ecosystem.
5. Study of permanent slides and specimen of protozoan, helminthes (parasites) associated with human disease.
6. Study of permanent slides of commonly found parasites.
7. Economic importance of commonly occurring insect pests and preparation of life cycle of these pests.
8. Study of beneficial insects and their life stages.
9. Maintenance of freshwater aquarium.

Suggested readings:

1. Odum, E. P. (1996). Ecology: A bridge between science and society. *Sinauer Associates Inc.*
2. Chapman, J. L. And Reiss, M. J. (1992). Ecology, principles and applications. *Cambridge University Press.*
3. Verma, P. S. & Agarwal, V. K. (1983). Environmental biology (principles of ecology). *S. Chand & Co.*
4. Singh, J. H. *et al* (2006). Ecology, environment and resource conservation. *Anamaya Publ. N. Delhi*
5. Kendeigh, S. C. Animal ecology. *Prentice Hall*
6. Kormondy, E. T. Concept of ecology. *Prentice Hall*
7. Shukla & Upadhya. Economic zoology. *Rastogi Publ.*
8. Jingram, V. G. (1991). Fish and fisheries of India. *Hindustan Publishing Corp. N. Delhi*
9. NIIR Board of consultants and engineers (2003). Hand book of fisheries and aquaculture technology. *Asia Pacific Business Press Inc.*

Semester VI (Honours)

THEORY

ZOO-603: (Choice Based Credit System)

Colleges have the option of offering any paper relevant to zoology based on their manpower and infrastructure. Some broad topics are mentioned below as probable themes/topics.

Biotechnology

Genetic Engineering

Microscopy and Chromatography

Pisciculture

Aquaculture

Sericulture

Biodiversity

Semester VI (Honours)

PROJECT WORK

ZOO-604: Project work.

Colleges may offer any relevant project work.

Suggested readings:

1. Harris, R. (1991). Biological microscopy for biology: A practical approach. *Oxford University Press*.
2. Plummer, D. T. (1987). An introduction to practical biochemistry. *Tata McGraw Hill*.
3. Harris, R. Biological microscope for biology: A practical approach. *OUP*
4. Maniats, J. Molecular cloning: A laboratory manual. *Cold Spring*
5. Any other as may be deemed fit.