Undergraduate Department of Zoology

Program for B.Sc. Zoology– 2015-2016 onwards (CBCS)

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
1	I	TAM/FRE/HIN/ 0000		**3**	**2**	**30**
1	II	ENG 1201	Conversational skills	**3**	**2**	**30**
1	III C	ZOO 1621	Invertebrata	**6**	**6**	**90**
1	III C	ZOO 1223	Invertebrata Laboratory	**2**	**2**	**30**
1	III C	ZOO 1531	Cell Biology (Theory cum Lab)	**(3+2) 5**	**(3+2) 5**	**75**
1	III S	BOT 1437	Plant biology – I (Theory cum Lab)	**(3+2) 5**	**(3+1) 4**	**60**
1	IV E	NME 0000	Non-Major Elective 1	**3**	**2**	**30**
1	IV LS	XXX 0000	Life Skill course – I	**3**	**2**	**30**
1	V	XXX 0000	NCA/NCN/NSS/PED/SLP			
			Total	**30**	**25**	**375**
2	I	TAM/FRE/HIN/0000		**3**	**2**	**30**
2	II	ENG 1202	Reading and writing skills	**3**	**2**	**30**
2	III C	ZOO 1622	Chordata	**6**	**6**	**90**
2	III C	ZOO 1224	Chordata Laboratory	**2**	**2**	**30**
2	III C	ZOO 1532	Economic Zoology (Theory cum Lab)	**(3+2) 5**	**(3+2)5**	**75**
2	III S	BOT 1438	Plant biology – II (Theory cum Lab)	**(3+2) 5**	**(3+1)4**	**60**
2	IV E	NME 0000	Non-Major Elective 2	**3**	**2**	**30**
2	IV LS	XXX 0000	Life Skill course – II	**3**	**2**	**30**
2	V	XXX 0000	NCA/NCN/NSS/PED/SLP			
			Total	**30**	**25+1**	**375/390**
3	I	TAM/FRE/ HIN/0000		**3**	**2**	**30**
3	II	ENG 2201	Study skills	**3**	**2**	**30**
3	III C	ZOO 2623	Microbiology (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
3	III C	ZOO 2625	Animal Physiology (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
3	III C	ZOO 2433	Genetics	**4**	**4**	**60**
3	III C	ZOO 2335	Evolution	**3**	**3**	**45**
3	III S	CHE 2413	Chemistry for zoologists – I (Theory cum lab)	**5**	**(3+1) 4**	**60**
3	V	XXX 0000	NCA/NCN/NSS/PED/SLP			
			Total	**30**	**27**	**405**

EM	Part	Course No.	Course Title	Hours	Credits	Marks
4	I	TAM/FRE/ HIN/0000		**3**	**2**	**30**
4	II	ENG 2202	Career skills	**3**	**2**	**30**
4	III C	ZOO 2624	Biological Chemistry (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
4	III C	ZOO 2626	Ecobiology (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
4	III C	ZOO 2428	Molecular Biology	**4**	**4**	**60**
4	III C	ZOO 2330	Molecular Biology Laboratory	**3**	**3**	**45**
4	III S	CHE 2414	Chemistry for zoologists-II (Theory cum Lab)	**5**	**4**	**60**
			Total	**30**	**27+1**	**405/420**
5	III C	ZOO 3637	Immunology (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
5	III C	ZOO 3639	Entomology (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
5	III C	ZOO 3641	rDNA technology (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
5	III C	ZOO 3543	Developmental Biology (Theory cum Lab)	**(3+2) 5**	**(3+2) 5**	**75**
5	IV LS	XXX 0000	Life Skill course-III	**3**	**2**	**30**
5	IV	ZOO 3245	Environmental Studies	**4**	**2**	**30**
			Total	**30**	**27**	**405**
6	III C	ZOO 3838	Biotechnology (Theory cum Lab)	**(5+3)8**	**(5+3) 8**	**120**
6	III C	ZOO 3440	Nanobiology	**4**	**4**	**60**
6	III C	ZOO 3642	Biodiversity (Theory cum Lab)	**(4+2) 6**	**(4+2) 6**	**90**
6	III C	ZOO 3544	Bioinformatics (Theory cum Lab)	**(3+2) 5**	**(3+2) 5**	**75**
6	IV LS	XXX 0000	Life Skill course – IV	**3**	**2**	**30**
6	IV VE	VAL 3230	Value Education	**4**	**2**	**30**
			Total	**30**	**27**	**405**
			Grand Total for Semester I – VI	**180**	**158+2**	**2370 / 2400**

C: CORE S: SUPPORTIVE E: NON MAJOR ELECTIVE LS: LIFESKILL VE: VALUE EDUCATION

Courses offered by the Department of Zoology to Non-Major Students

Part III Supportive

SEM	Course No.	Course Title	Hrs.	Cr	Marks
III	ZOO 2447	General Zoology – I Theory cum Lab	**(3+2) 5**	**(3+1) 4**	**60**
IV	ZOO 2448	General Zoology – II Theory cum Lab	**(3+2) 5**	**(3+1) 4**	**60**
		Total	**10**	**8**	**120**

Part IV Non-Major Electives

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	ZOO 1251	Human Biology	**3**	**2**	**30**
II	ZOO 1252 / ZOO 1254	Forensic Biology / Apiculture	**3**	**2**	**30**
		Total	**6**	**4**	**60**

Part IV: Life Skill Courses

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	ZOO 1249	Poultry Farming	**3**	**2**	**30**
II	ZOO 2252	Ornamental Fish Culture	**3**	**2**	**30**
V	ZOO 3255/ ZOO 3257	Medical Lab Technology / Ornithology	**3**	**2**	**30**
VI	ZOO 3258	Human Reproduction and Conception Control	**3**	**2**	**30**
		Total	**12**	**8**	**120**

ZOO2623 Microbiology (4+2=6 h/wk) (6cr)
(Theory cum Lab)

This theory cum laboratory course deals with structure and applications of microorganisms. The major areas include history, scope of microbiology and various classifications of microorganisms. The theory part deals with microbial taxonomy, microbial interactions, food borne microbes and medically important microbial diseases. The laboratory part includes the study of ubiquitous nature of microbes, growth curve, types of food borne microbes, medically and agriculturally important bacteria and coliform analysis.

1. **Fundamentals of microbiology:** Members of the microbial world - Characteristics of prokaryotic and eukaryotic cells - Microbial evolution - Phylogeny - Sterilization methods - Culture media - Microbiology and its origin - Microbiology today.
2. **Microbial taxonomy and microbial physiology:** Nomenclature and classification of bacteria - Structure and classification of viruses, algae, fungi and protozoa - Ultrastruture - cell wall, flagellum, fimbria, capsules, sheath, prostheca, stalk, spore and cyst - Bacterial growth curve - Factors affecting bacterial growth.
3. **Food and Industrial microbiology:** Food contamination - Spoilage and preservation of milk, meat, fish, chicken, vegetables and fermented foods - Microbes of perishable, semi perishable and non-perishable foods - Food borne diseases – Salmonellosis, Botulism and Parasitic disorders - Microbial enzymes - Selection and production of industrially important organisms and their products - Fermentors - Fermentations - Production of penicillin and single cell proteins.
4. **Agricultural and Environmental Microbiology:** FDA regulations - Agricultural products - Transgenic foods and their disorders - Fungal and bacterial diseases transmitted by crop plants - Microbial interactions and microbial associations - Purification of water and coliform analysis.
5. **Medical Microbiology and Virology:** Host-microbe relationships - Normal microbial biota of humans - Nosocomial diseases - Zoonotic diseases - Epidemic, endemic and pandemic diseases - Bacterial, fungal and protozoan diseases – Diagnosis and treatment of diseases with antimicrobial agents - Structure of HIV, adenovirus and pox viruses - Antiviral chemotherapy and vaccines.

The laboratory component includes the following exercises:

- Principle and working of laminar flow and autoclave.
- Sterilization methods – wet heat and dry heat sterilization.
- Preparation of media and culture methods.
- Preparation of bacterial smear and staining methods.
- Inoculation methods.
- Biochemical tests – IMVic, TSI, Starch hydrolysis, Caesin hydrolysis, urea hydrolysis and gelatin liquefaction.
- Bacterial growth curve.
- Quality analysis of food samples – Methylene blue reduction test of milk.
- Coliform analysis.
- Study of Rhizobium from the roots of leguminous plants.
- Isolation of medically important bacteria.
- Kirby-Bauer method – Studying antimicrobial agents.
- Industrial / Field visit.

Text book:

Willey UM, Sherwood LM and Woolverton CJ (2011) Precott's Microbiology. VIII Edition, Mc Graw-Hill international.

References:

Gunasekaran, P (1995) Laboratory Manual in Microbiology. New Age International Pvt. Ltd., New Delhi.

Pelczar MJ, Chan ECS and Kreigh NR (2000) Microbiology. VIII Edition, Tata McGraw Hill, New Delhi.

ZOO 2625 Animal Physiology (4+2= 6h/wk)(4cr)
(Theory cum Lab)

The theory part of this course covers the principles, mechanism and adaptations in digestion, excretion, respiration, circulation, thermo regulation, osmo-iono regulation, muscle contraction, neuronal conduction, sensory perception and hormonal control are discussed in detail. The laboratory component is complementary to the theory which includes experiments on enzyme activity, analysis of excretory products, types of respiration, temperature effects on metabolism, osmo-iono regulation, heart beat recording, blood glucose level testing and muscle twitch.

1. **Digestion and Excretion:** Intracellular and extracellular - Digestion and absorption of carbohydrate, protein, lipid and fat - Coprophagy – Cellulose digestion in animals. Protonephridia - Metanephridia - Nitrogenous wastes - Antennal gland - Malpighian tubules - Glomerular filtration - Mechanism and regulation of urine formation.
2. **Respiration and Circulation**: Mechanism of tracheal, gill, cutaneous and pulmonary respirations - Air breathing by fishes - Transport of respiratory gases – Types of heart - Mammalian heart - Regulation of heart beat - Capillary circulation – Composition and function of blood, Blood coagulation and pigments.
3. **Thermal and Osmo-iono regulation**: Heat balance - Temperature regulations of homeotherms - Torpor and hibernation - Hypo regulation - Osmo-iono regulation in Elasmobranchs and Teleosts.
4. **Neuro-muscular and Sensory Physiology**: Action potential - Nerve impulse - Synaptic transmission - Myosin and actin filament - Sliding filament theory - Neuro-muscular junction. Mammalian visual cycle, Physiology of vision, mechanism of hearing, taste in mammal, electricity in ray fish.
5. **Endocrine Physiology:** Mechanism of hormone action - Regulatory action of pituitary, thyroid, parathyroid, adrenal, pancreas and sex glands - Neuro-endocrine glands - Role of hormones in reproduction – Endocrine glands in crustacean and insects.

Laboratory component includes exercises as follows:

- Enzyme activity: Influence of temperature and pH.
- Respiration in fishes: Estimation of dissolved oxygen with reference to body sizes and activity.
- Respiration in terrestrial insects – Manometer technique.
- Opercular movement in fishes: Influence of temperature and calculation of Q10.
- Temperature preference by fishes.
- Study of human heart beat.

- Measurement of blood pressure of students and interpretation of variation.
- Water regulation and ionic regulation in animals such as crab and earthworm.
- Analysis of samples containing excreta of various animals.
- Blood sugar analysis in rabbit at normal condition and after injection of insulin.
- Simple muscle twitches and kymograph.
- Observation of circadian rhythm pattern in selected animals.

Text Book:

Schmidt-Nielson, K (2005) Animal Physiology: Adaptation and Environment. V Edition. Cambridge University Press, London.

References:

Hoar WS (1989) General and comparative physiology. Prentice Hall, New Delhi.
Kulshrestha, W (1977) Experimental physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
Siddique, AH (1974) Experimental physiology. Oxford and IBH Pub. Co, New Delhi.

ZOO 2445 Genetics (4h/wk) (4Cr)

This course aims to focus on the basic principles of genetics by presenting the important concepts of classical, microbial, population and human genetics. It deals with basic concepts of simple inheritance characters and gene mapping.

1. **Mendelism and chromosomal basis of Mendelism** Mendel's study of heredity - multiple alleles - gene interactions - quantitative traits - inbreeding - chromosome theory of heredity - non-disjunction - sex chromosomes and sex determination - dosage compensation - variation in chromosome number and structure.
2. **Linkage, crossing over and chromosome mapping**: Linkage as exception to Mendel's principle of independent assortment - cytological proof for crossing over - mechanism of recombination - chromosome mapping from recombination data - tetrad analysis.
3. **Behavioural genetics**: Nest cleaning behavior - defensive behavior - hoarding behaviour in honey bees - biological rhythms in Drosophila - *per* gene - single gene mutations and human behavior.
4. **Genetics of viruses and bacteria**: Genetic recombination in phage - transformation, conjugation and transduction - mechanisms - significance - experiments of Griffith, Zinder and Lederberg, Woolman and Jacob.
5. **Human and population genetics**: Mendelian traits in man - pedigree analysis - karyotype analysis - chromosomal abnormalities - twin studies - nature and nurture - genetic diseases - inborn errors of metabolism - genetic counseling - theory of allele frequencies - calculating gene and genotypic frequencies.

Textbook:

Snustad, DP and Simmons, JM (2010) Principles of Genetics. V Edition, John Wiley & Sons, Inc.

References:

Hexter, W and Yost, HT (1980) The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
Levine, L (1969) Biology of the Gene. The CV Mosby Company, St. Louis, USA.

ZOO 2335 Evolution (3h/wk) (3Cr)

Evolution influences every aspect of the form and behavior of organisms. This course includes origin of life and evidences for evolution, theories of evolutionary thought, fossilization, isolation, speciation, natural selection and emphasis the biological and cultural evolution of man.

1. **Origin of life and evidences for evolution:** Origin of life - theories - creation - Cosmozoic - spontaneous generation - Chemical evolution - Bio-elements - selection - opinion of J.B.S. Haldane and A.L. Oparin - Urey Miller hypothesis - Origin of bio-molecules - Coacervation - Origin of pro- and eukaryotic cell – Evidences - Comparative, anatomical, vestigial organs, physiological, embryological, Biochemical evidences - Geographical distribution and realms.
2. **Theories of evolution:** Greek thinkers - ideas of evolution before Darwin - Lamarckism and Neo-Lamarckism - Darwinism and Neo-Darwinism - Germplasm theory - Mutation theory - Modern synthetic theory - Hardy Weinberg law and its importance.
3. **Trends in evolution:** Geological eras - Fossils and fossilization - dating of fossils - Extinctions - Living fossils – Adaptations – variations and origin - adaptive trends - Polymorphism - transient and stable – Mimicry and Coloration - Batesian and Mullerian – Sexual selection – Convergent, Divergent and Parallel evolution – Co-evolution.
4. **Isolation and its role in evolution:** Isolating mechanisms - different types - Species concepts - definition of species - origin of species - Allopatric and Sympatric speciation – Genetic drift - Founder's Principle.
5. **Evolutionary Processes:** Natural selection in action - Industrial Melanism - Evolution of horses - Time and place of origin, major evolutionary trends, phylogeny of probable sequence species of horse - Eocene, Oligocene, Miocene, Pliocene, and Pleistocene forms - Orthogenesis – Evolution of man - evolutionary trends in humans - Ancestors of primates - Apes-the closest relatives of man - fossil ancestors of man - Dryopithecus, Australopithecus (The Man-Ape of Africa), *Homo habilis* (The Handy Man), *H. erectus, H. Neanderthalensis* (Neanderthal man), The Cro-magnon, *Homo sapiens* (Modern man) - Socio-cultural evolution.

Text book:

Stebbins, GL (1966) Process of Organic Evolution. Prentice Hall, New Delhi.

References:

Dodson, EO (1960) Evolution: process and product. Affiliated East-West Press, New Delhi.
Simpson, GC (1967) The meaning of Evolution. New Haven, Yale University Press.
Colbert, EH (1969) Evolution of vertebrates, Wiley, New York.
Mayr, E (1973) Animal species and Evolution. The Belknap Press of Harvard University, Cambridge.
Dobzansky, T (1976) Genetics and the origin of species. Oxford and TBH Publishing Co., New Delhi.

ZOO 2624 **Biological Chemistry (4+2 = 6h/wk) (6cr)**
(Theory cum Lab)

Biological chemistry includes enzymes, and mechanism of enzyme action. It also includes chemistry and metabolism of carbohydrates, amino acids & proteins, lipids & nucleic acids. Citric acid cycle and oxidative phosphorylation are also included.

1. **Chemistry and metabolism of carbohydrates:** Monosaccharides – Structure - Classification - Disaccharides – Polysaccharides - Glycosaminoglycans- Glycoproteins and glycolipids – Basic concepts of metabolism – Glycolysis – Fermentation - Glycogen metabolism - Gluconeogenesis – significance of HMP shunt – Biological significance of carbohydrates.
2. **Chemistry and metabolism of amino acids and proteins:** Standard and non standard amino acids – Protein - Structure - Primary, secondary, tertiary and quaternary – Amino acid metabolism - deamination – transamination – transmethylation - Urea cycle - Amino acids as biosynthetic precursors – Biological significance of amino acids and proteins.
3. **Chemistry and metabolism of lipids:** Lipid classification - Lipoproteins – Fatty acid oxidation - Metabolism of cholesterol – Biological significance of lipids.
4. **Chemistry and metabolism of nucleic acid, Citric acid cycle and Oxidative phosphorylation:** Chemistry of nucleotides and nucleic acids - Synthesis of purine and pyrimidine - Nucleotide degradation – Convergence of metabolic pathways - Citric acid cycle- Amphibolic pathway - Electron transport - Oxidative phosphorylation.
5. **Enzymes:** Classification - Substrate specificity - Transition state – Michaelis-Menten equation - Factors affecting rate of enzyme activity – Mechanisms of enzyme action - Regulation of enzyme activity - Enzyme inhibition – Coenzymes and cofactors - Isozymes.

Laboratory component includes exercises as follows:

- Colorimetry
- Spectrophotometry
- pH metry
- Paper Chromatography
- Electrophoresis
- Centrifugation
- Qualitative analysis of carbohydrates
- Qualitative analysis of amino acids & proteins
- Qualitative analysis of lipids
- Enzyme kinetics I
- Enzyme kinetics II

Text book:

Voet D and Voet JG (2004) Biochemistry. III Edition. John Wiley & Sons Inc. USA.

References:

Murray RK, Granner DK, Mayes PA and Rodwell VA (2000) Harper's Biochemistry. XXV Edition. Appleton & Lange, USA.

Lehninger AC, Nelson DL and Cox MM (2001) Principles of Biochemistry. IV Edition, W.H. Freeman Company, USA.

Plummer DT (1996) An introduction to Practical Biochemistry. Tata McGraw Hill, New Delhi.

ZOO 2626 Ecobiology (4+2=6hr/wk) (6cr)
(Theory cum Lab)

This course deals with the study of living things in relation to their environment. Starting with the abiotic factors of the environment, the course runs through the population dynamics, biotic community structure, development and energy flow model. Unique environmental conditions and faunal adaptations of major habitats will be studied. Finally, major terrestrial biomes and zoogeography will be covered. Laboratory exercises supplement its theory counterpart to ensure better understanding. Physico-chemical analysis of water and soil, identification of planktonic forms and ecological adaptations in animals will be studied. Experiments on primary productivity and pollution analyses will be carried out. Established microcosm will be ecologically investigated. Field studies will be undertaken to observe and understand natural ecosystems in its reality and totality.

1. **Limiting and abiotic factors:** Soil profile and types – Limiting factors – Biological effects of temperature, light, water, precipitation, wind, fire and nutrients.
2. **Biotic community and ecosystem dynamics**: Interspecific interactions - Gause principle - Niche concept - Types of niches - Ecological equivalents- Models of Ecosystem development - Theories of climax state – Concept of productivity - Energy flow model – Phosphorus and Nitrogen cycles.
3. **Population dynamics**: Characteristics - Lincoln index - Life table - Survivorship curve - Net reproductive rate - Age pyramids - Growth rate - Point of inflection - Biotic potential - Exponential and logistic growth equations - Phases of logistic growth curve - Attributes of r- and K- selection.
4. **Habitat Ecology:** Environmental conditions and Faunal adaptations in: Halobiotic littoral zone (Rocky and sandy) - Pelagic zone (Neritic and oceanic) - Deep sea - Estuary - Mangroves - Lentic and Lotic systems.
5. **Zoogeography:** Precipitation and temperature regimes of world - Occurrence of biomes based on precipitation and temperature - Major terrestrial biomes of world –Latitudinal and altitudinal life zones – Means of animal distribution - Factors affecting animal distribution - Zoogeographical realms of world with emphasis on Oriental region - Wallace line.

Laboratory component includes the following exercises:

Estimation of:

- Dissolved oxygen
- Carbon di oxide in water
- Salinity in water
- Calcium and Magnesium in water
- Biological Oxygen Demand
- Chemical Oxygen Demand
- Primary Productivity of aquatic ecosystems.

Quantitative analysis of

- Organic carbon in soil
- Zooplankton
- Nutrients in water and soil
- Survey of pollutants
- Observation of Inter- and Intra-specific relationships
- Observation of ecological adaptations in animals.
- Maintenance of Microcosm and investigating the ecological changes.
- Field visits to many ecosystems.

Text book:

Odum, EP and Barrett, GW (2012) Fundamentals of Ecology. V Edition, Cengage Learning India Pvt. Ltd., Delhi, India.

References:

Eaton, AD and Franson MAH (2005) Standard methods for the examination of water and waste water. American Public Health Association, American Water Works Association, the Water Environment Federation, Washington DC.

Batish, SK (1992) Freshwater zooplankton of India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Subramanyam, NS and Sambamurty, AVSS (2000) Ecology. Narosa Publishing House, Chennai.

ZOO 2428 Molecular Biology (4h/wk) (4cr)

Molecular biology deals with the study of structure and function of genes and genomes. Students will learn the finest details of molecular configurations of genes, their physical properties and their nature of replication, transposition and recombination. This course also introduces how genes express and accurately transmit genetic information, and the mechanism of its regulation.

1. **The molecular nature of DNA and RNA:** Introduction to gene structure and function – DNA double helix – Structure of RNA – Alternate forms of DNA – Physical properties - G:C content, c-value and $c_o t$ curves – Extra nuclear genomes – Introduction to Genomics, Proteomics and Metabolomics – Human genome project.
2. **DNA replication, recombination and transposition:** Semiconservative replication - bidirectional - unidirectional - rolling circle and θ model replication - enzymology of DNA replication – DNA damages and various types of DNA repair mechanisms – Homologous and site specific recombination – Mobile genetic elements in prokaryotes and eukaryotes.
3. **Transcription:** Prokaryotic and eukaryotic RNA polymerases – Events in transcription of prokaryotes and eukaryotes – General transcriptional factors of eukaryotes – Post-transcriptional processing - capping, polyadenylation, splicing and alternate splicing – Catalytic RNA – RNA editing.
4. **Translation:** Genetic code - Deciphering of genetic code - Salient features of genetic code - 3D structure of tRNA – codon-anticodon interaction – Wobble hypothesis – Mechanism of protein synthesis in prokaryotes and eukaryotes – Inhibitors of protein synthesis – Post translational modification of proteins –Polyprotein.

5. **Regulation of gene expression:** i) Gene regulation in prokaryotes: Fine control of prokaryotic transcription - *lac* operon and *trp* operon - Regulatory RNA ii) Gene regulation in eukaryotes: GAL system in yeast - DNA binding proteins - Homeobox in gene regulation.

Text book:

Malacinski GM (2003) Freidfelder's Essentials of Molecular Biology. IV Edition, Narosa Publishing House, New Delhi, India.

References:

Brown TA (2007) Genomes 3. III Edition, Garland Science Publishing, New York.
Watson JD, Kopkins NK, Roberts JW, Stertz JA and Weiner AM (1994) Molecular Biology of the Gene. Benjamin and Cummings Pub Co., California, USA.

ZOO 2330 Molecular Biology Laboratory (3/wk) (3cr)

The laboratory course introduces the basic molecular biological methods of isolation and purification of nucleic acids (DNA and RNA) from prokaryotic and eukaryotic cells. The quantification of DNA, RNA and protein involving both traditional and modern methods are also dealt. Students gain hand-on experience from start to finish in isolation, purification and characterization of nucleic acids and protein.

1. Basic molecular biology lab – Micropipetting exercises, serial dilution, media and reagent preparation.
2. Isolation and purification of DNA from bacteria.
3. Isolation of DNA from blood.
4. Isolation of RNA from liver cells – Acid phenol extraction and Trizol method.
5. Agarose gel electrophoresis for DNA and RNA.
6. Quantification of DNA and RNA by spectrophotometry.
7. Estimation of DNA by diphenylamine method.
8. Estimation of RNA by Orcinol method.
9. Estimation of protein by Bradford microassay.
10. Study of mutagenesis in *E. coli*.
11. Study of *lac* operon – β-galactosidase activity.
12. Visit to university/institutional laboratories.

References:

Rajamanickam C (2001) Experimental Protocols in Basic Molecular Biology. Osho Scientific Publishers, Madurai.
Bansal MP (2013) Molecular Biology and Biotechnology Protocols. TERI, New Delhi.
Carson S, Miller HB and Witherow DS (2012) Molecular Biology Techniques: A classroom Laboratory Manual. Third Edition. Academic Press, San Diego, USA.

ZOO 3637 **Immunology** **(4+2=6h/wk) (6cr)**
(Theory cum lab)

This course attempts to provide a basic understanding in Immunology. The course covers cells and organs of the immune system, antigens, antibody structure, antibody diversity, antigen-antibody interactions, cell mediated and humoral immune response and complement. In the section on disorders of immune system, autoimmunity, hypersensitivity reactions, immunodeficiency disorders that includes AIDS are dealt. The laboratory component includes identification and enumeration of blood cells, location of lymphoid organs in selected vertebrates, preparation of antigens. Immunization techniques, methods of raising polyclonal antibodies, repetitive bleeding methods, antibody titration, complement mediated hemolysis, ELISA test for AIDS and skin test for allergy reactions.

1. **Cells and organs of the immune system**: Introduction –historical perspectives – innate (non-specific) and acquired (specific) immunity – cells involved – primary & secondary lymphoid organs – tertiary lymphoid tissues.
2. **Antigens, antibody and their interactions**: Epitopes, haptens – immunogenicity-adjuvants - antibody structure - Deducing structure of IgG, IgM and IgA. Biological properties of various Ig classes - Primary interactions-affinity and avidity - secondary interaction-agglutination-precipitation
3. **Antibody diversity and humoral response**: Multigene organization of Ig genes – generation of antibody diversity - Role of T_H cells in humoral response-primary and secondary response-affinity maturation-class switching-generation of plasma cells and memory cells.
4. **Cell mediated immunity**: Structure and functions of MHC- Antigen processing and presentation- Activation of T_H cells and cytotoxic T cells - NK cells-antibody dependent cell mediated cytotoxicity (ADCC) – delayed type hypersensitivity (DTH).
5. **Regulation of immune response, complement and disorders of immune system**: Cytokines - Immune tolerance - regulation of immune response-complement. Classical and alternative pathways – biological properties of complement components. Auto-immunity-hypersensitivity reactions- Immunodeficiency disorders – AIDS.

<u>The Laboratory component includes exercises as follows:</u>

- Total and differential count of blood cells
- Lymphoid organs in vertebrates I – fish and amphibians
- Lymphoid organs in vertebrates II-reptiles, birds and mammals
- Raising polyclonal antibodies I-preparation of antigens
- Raising polyclonal antibodies II-routes of immunization
- Raising polyclonal antibodies III- bleedingtechniques and separation of serum
- Raising polyclonal antibodies IV-antibody titration
- Complement mediated hemolysis
- Ouchterlony double immunodiffusion (ODI)
- Mancini's single radial immunodiffusion (SRID)
- Immunology of ABO blood grouping
- ELISA test for AIDS
- Skin test for allergy reactions

Text:

Coico R and Sunshine G (2009) Immunology – a short course. 6th Edition, Wiley Blackwell, New York.

References:

Kindt TJ, Osborne BA and Goldsby RA (2006) Kuby Immunology. 6th Edition. W.H. Freeman and Co., New York.

Hudson, L and Hay, F (1989) Practical Immunology. 3rd Edition, Blackwell Science Publishers, Oxford.

Roitt IM, Brostoff J and Male D (2001) Immunology. 6th Edition, Mosby, London.

ZOO 3639 Entomology (4+2 = 6h/wk) (6cr)
(Theory Cum Lab)

This course is designed to make the students know about the basics of insect classification, morphology, anatomy, physiology and other facts of insect's life and about their economic importance. Classification up to order level with a special mention about significant families, their diversity, body plan, structure and function of various organs. Role of insect as pests, as vectors and beneficial insects will be taught. The laboratory course intended to systematically collect, preserve and identify insects. Students are taken to field to gain knowledge in the methods of collecting insects and preservation.

1. **Introduction and insect taxonomy:** Definition, scope of entomology - biological success of insects - insect diversity - insect evolution. Insect collection, preservation, dichotomous key – classifications up to orders.
2. **Insect anatomy:** Integument of insects - Head - Types of mouth parts, antennae, legs and wings.
3. **Insect physiology:** Feeding and digestion - Respiration - Circulation - Nervous system - Endocrine system - Reproductive system - Metamorphosis.
4. **Harmful insects:** Pests of paddy, coconut, sugar cane, cotton, brinjal - damage, symptoms and control.
5. **Beneficial insects**: Biology, rearing and economic importance of silk worm, honey bees and lac insects - Insects of medical and forensic importance.

Laboratory component includes exercises as follows:

- Collection and identification of insects.
- Study of beneficial insects.
- Investigation of a few agricultural pests.
- Investigation of insects of public health importance.
- Identification of storage pests.
- Survey on the insects available in the campus.
- Identification and comments on a few pterygotan insects.
- Evaluation of pesticide toxicity (LC_{50}).
- Identification of economic values of productive insects.
- Estimation of biodiversity of insects in an ecosystem.
- Field study.

Text book:

David BV and Ananthakrishnan TN (2004) General and Applied Entomology. Tata McGraw-Hill publishing Company Limited, New Delhi.

References

Ambrose DP (2004). The Insect Structure, Function and Biodiversity. Kalyani publishers, New Delhi.

Fennemore PG and Alka Prakhash (1992) Applied Entomology , Wiley Eastern Ltd., New Delhi.

Richards OW and Davies RG (1977) Imm's General Text book of Entomology Vol. 1 & 2. 10th Edition. B_1 Publication Pvt Ltd., New Delhi.

ZOO 3641 rDNA Technology (4+2=6h/wk) (6cr)
(Theory cum Lab)

This course is intended to introduce gene cloning and DNA analysis. It deals with extraction, purification and manipulation of DNA by restriction and other enzymes. An outline about the conventional and modern methods of rDNA transfer into living cells, the biology of cloning and expression vectors and the methods of gene analysis are also dealt. The course also provides a detailed account on the applications of gene cloning in the welfare of mankind. The laboratory course includes experiments on isolation and purification of genomic DNA and plasmids from bacteria, restriction digestion and ligation of DNA. It also includes exercises on the isolation of DNA from higher organisms and transformation of bacteria using rDNA by conventional competent cell transformation.

1. **Isolation, purification and manipulation of DNA:** Isolation of genomic DNA from bacteria, plant and animal cells – Purification of plasmid DNA and bacteriophage DNA – DNA manipulation - restriction endonucleases and other DNA manipulative enzymes – restriction digestion and ligation techniques – i*n vitro* mutagenesis.
2. **Introduction of rDNA into living cells:** Transformation of bacteria with rDNA – competent cell transformation – Methods of gene transfer in higher organisms - electroporation, biolistics, microinjection and liposome mediated gene transfer.
3. **Biology of cloning and expression vectors:** *E. coli* based vectors – λ and M13 based vectors – Cosmids – Phagemids – Yeast vectors – Ti and Ri plasmids – Plant and animal viral vectors – P element cloning vector – Cloning vectors for mammals - SV40 and adenoviruses – Expression vectors - types of promoters for expression vectors.
4. **Analysis of cloned gene:** Obtaining the clone of specific gene - direct selection and gene libraries – Studying gene location and structure - Southern transfer, *in situ* hybridization and FISH – Transcript and translation product analysis – DNA sequencing – PCR.
5. **Applications of gene cloning:** Transgenesis – production of recombinant proteins, vaccines, human insulin, diagnostic probes and other pharmaceutical compounds – Gene therapy and Stem cell therapy.

The laboratory component includes exercises as follows:

- Isolation and purification of Genomic DNA from *E.coli.*
- Isolation and purification of genomic DNA from plant and animal tissues.
- Purification of plasmids from *E. coli.*
- Restriction digestion of DNA.
- Ligation of DNA.
- Agarose gel electrophoresis of DNA samples.
- Competent cell preparation of bacteria.
- Transformation of competent cells using rDNA.

Text book:

Brown, TA (2010) Gene Cloning and DNA Analysis – an Introduction. VI Edition. Blackwell Science Publishers Ltd., Oxford, UK.

References:

Sambrook J and Russell DW (2001) Molecular cloning: A Laboratory Manual. III Edition. Cold Spring Harbor Press, Cold Spring Harbor, New York.

Becker JM, Caldwell GA and Zachgo EA (1996) Biotechnology – A Laboratory Course. II Edition. Academic Press, San Diego, USA.

Harisha, S (2007) Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, New Delhi, India.

ZOO 3543 Developmental Biology (3+2=5/h) (5 Cr)
(Theory cum Lab)

This course is designed to impart classical views and essential mechanisms regarding various aspects of development of animals with experimental approach. The course deals with gametogenesis, fertilization, cleavage patterns, embryonic stem cells, cleavage & gastrulation, and organogenesis in a mammal. Experimental embryological aspects such as embryonic induction, differentiation and nucleocytoplasmic interaction are discussed in detail.

1. **Gametogenesis and fertilization:** Anatomy of testis and ovary - spermatogenesis and oogenesis - Types of eggs - Polarity - Mechanism of fertilization - Post fertilization changes - Parthenogenesis.
2. **Cleavage, gastrulation and organogenesis:** Planes and patterns of cleavage - Types of blastula - Morphogenetic movements - Gastrulation process - Neurogenesis - Development of eye and kidney in chick.
3. **Embryonic and postembryonic adaptations:** Structure and types of plancentae - Placental physiology - Hormonal control - Patterns and mechanism of regeneration - Metamorphosis of frog.
4. **Experimental embryology-I:** Embryonic induction - Spemann's primary and secondary organizers - Types and process of differentiation - Nucleo-cytoplasmic interactions.
5. **Experimental embryology-II:** Nuclear transplantation experiments - Embryonic stem cells and pharmaceutical applications - Embryo transplantation techniques - *in vitro* fertilization - birth defects and teratology.

Laboratory component includes exercises as follows:

- Microscopic observation on invertebrate larval forms and their adaptations.
- Role of thyroxin in metamorphosis of frog.
- Chick embryo developmental stages – organogenesis.
- Role of retinoic acid signals that control posterior-anterior axis patterning in zebra fish.
- Role of retinoic acid during limb regeneration.
- *In vitro* culture and differentiation of frog tadpole cells.
- Induced breeding in mice by using HCG
- Blastoderm mounting in chick embryo.

Text book:

Balinsky, BI (2012) An introduction to Embryology. 5th Edition Thomson Asia Pvt. Ltd., Singapore

References:

Laura RK, Evans JH and Keller, TCS (1999) Experimental Developmental Laboratory: A Laboratory Manual. Academic Press, UK

Jain, PC (1994) Elements of Developmental Biology. Vishal Publications, Jalandhar, New Delhi.

Verma, PS and Agarwal, VK (2006) Chordate Embryology. S. Chand & Company Ltd., New Delhi.

ZOO 0000 Environmental Studies (4h/wk) (2c)

The course is designed to develop environmental awareness to under graduate students in an extensive manner. It deals with the natural resources, ecosystems and the impact of human activity on them. The course also imparts the biodiversity and pollution in the present status and the suggestion for sustenance.

1. **Renewable and non-renewable resources:** Definition, scope, awareness – Renewable and non renewable resources – Forest - use, overexploitation and deforestation – Water - use and over utilization of surface and ground water – Mineral - environmental effects of extracting and using mineral resources – Food - world food problems – Energy - growing energy needs – Land - land degradation – Conservation of natural resources.
2. **Ecosystems:** Concept, structure and function - Energy flow - Food chains and Food web - Ecological pyramids - Ecological succession – Ecosystems - aquatic, forest, grassland, desert and caves. Biogeochemical cycles.
3. **Environmental pollution:** Definition, causes, effects and control measures of air, water soil, noise and thermal pollution – Hazards of nuclear wastes and control.
4. **Sustainable environment issues**: Unsustainable and sustainable development - urban problems related to energy and water - Rain water harvesting - Watershed management - resettlements and rehabilitation problems - Environmental ethics.
5. **Environmental disasters:** Global warming - Green house gases - Ozone depletion – Case studies - Bhopal tragedy - Chernobyl disaster - Fukusima disaster - Prestige and deep horizon oil spill.

Text book:

Thatheyus, AJ (2011) Text book of Environmental Studies. Alpha Science International Ltd., Oxford, U.K.

References:

Bharucha E (2005) Text book of Environment studies. University Press Pvt. Ltd, Hyderabad.
Odum, EP (1971) Fundamental of ecology, WB Saunders, London
Sharma, PD (1999) Ecology and environment, Rastogi Publishers, Meerut.

ZOO 3838 Biotechnology (5+3=8h/wk) (8Cr)

Students will be trained in various aspects of biotechnology such as animal, plant, microbial and environmental biotechnology. The course also imparts biosafety, bioethics and intellectual property rights, issues related to biotechnology. The laboratory course integrates theory with extensive practical training on plant and animal cell culture, fermentation technology, vermicomposting, biodecolourization and environmental monitoring.

1. **Animal Biotechnology**: Animal cell and Tissue culture - Media - Suspension culture - Fibroblast culture - Development and maintenance of cell line - Hybridoma technology - Monoclonal antibody production - Application of animal cell and tissue culture - Transgenic animals – Cloning - Cell banking - Downstream processing.
2. **Plant Biotechnology:** History and scope of plant biotechnology - *in vitro* culture techniques of explants - Organogenesis and micropropagation - single cell culture - protoplast culture - Plant genetic engineering using *Agrobacterium* - Transgenic plants and Bt based genetically modified crops.
3. **Microbial Biotechnology:** History and scope of microbial technology – microbial biomass – microbial metabolites – range of fermentation products – aerobic and anaerobic fermentation – culture media – immobilization – scale up of bioprocess – primary and secondary screening of production strains – fermentation economics.
4. **Environmental Biotechnology:** Environmental monitoring - Sampling analysis - Biosensor - Bioindicators - Biomarker - water quality criteria - Alternative energy sources - Renewable sources of energy - Oil recovery - Biofuels - Bioremediation - Biocontrol - Biofertilizer.
5. **Biosafety and Bioethics:** Definition - Requirement - Biosafety - Bioethics - social issues, Bioweapons and Patent laws - Patent rights – Case studies - Biopiracy – Ice minus bacteria - Monsanto

Laboratory component includes the following exercises

- Initiation of embryonic cell culture of frog.
- Mouse embryo Fibroblasts mono layer culture.
- Chick embryo Fibroblasts mono layer culture.
- Surface sterilization of explants.
- Initiation of callus on MS medium.
- Formation of shoot and roots of *Oryza sativum*.
- Formation of callus by phytohormones.
- Screening of microbes for metabolites.
- Aerobic and anaerobic fermentations of grape wine.
- Factors affecting fermentations.
- Biogas from animal wastes.
- Role of vermicompost on plant growth.
- Decolourisation of dyes employing microbes.
- Biodiversity indices in environmental monitoring.

Text book:

Satyanarayana, U (2005) Biotechnology. Books and Allied Pvt. Ltd., Kolkata.

References:

Ignacimuthu, SJ (2001) Methods in Biotechnology, Phoenix Publishing House Pvt., New Delhi.

Primrose, S.B (2001) Molecular Biotechnology. II Edition, Panima Publishing Corporation, New Delhi.

Gupta, PK (1996) Elements of Biotechnology. Rastogi and Co., Meerut.

ZOO 3440 Nanobiology (4hrs/wk) (4Cr)

It is an emerging area encompassing knowledge from all the fields of science. It includes introductory aspects, nanomolecular tools and techniques, nanostructures, applications of bionanotechnology in disease diagnosis and therapy and nanoproducts.

1. **Introduction:** Nanotechnology – Emergence – Scope – Nanoscale molecules – Advantages – Basic molecular plans
2. **Nanomolecular tools and techniques:** Quantum dots – Nanoparticles – Dendrimers – Nanotubes – Virus like particles – Atomic Force Microscopy – Confocal microscope.
3. **Nanostructures:** Biology as a model system for building nanostructures – Nanomotors – Micro Electro Mechanical Systems – Nano Electro Mechanical Systems.
4. **Applications of bionanotechnology in disease diagnosis and therapy:** Nanobiosensors – Tissue engineering – Cancer diagnostics – Drug delivery – Cancer therapy.
5. **Bionanoproducts:** Nanogel – Nanosponge – Bionanofabrics – Milk silk – Soya silk – Spider silk – Bioelectricity – Biobatteries – Biomimicry.

Text book:

Gonsalves, KE (2008) Biomedical Nanostructures. John Wiley & Sons Inc., Hoboken, New Jersey.

References:

Niemeyer, CM and Mirkin, CA (2004) Nanobiotechnology. I. Concepts, Applications and Perspectives. Wiley-VCH, Verlag GmbH & Co., Weinheim.

Stroscio, MA and Dutta, M (2004) Biological Nanostructures and Applications in Biology. Kluwer Academic Publishers, New York, Boston, USA.

ZOO 3642 Biodiversity (4+2=6/h) (6cr)
(Theory cum Lab)

The course aims to provide students a broad foundation in Biodiversity and Conservation. The course inculcate students in understanding of biodiversity in the context of ecosystem dynamics, ecosystem functioning and ecosystem services. The course also imparts the assessment of biodiversity and its threat using different methodologies, and analysis of measures to manage biodiversity threats by applying relevant scientific principles.

1. **Basics of Biodiversity:** Introduction - Concept and Definition - Scope of biodiveristy - Constraints of biodiversity - Genetic, Species, Ecosystem biodiversity - Measuring biodiversity – Alpha, Beta and Gamma Diversity - Species richness – Evenness-Dominance - Approaches to estimating diversity and dominance - Shannon and Simpson's index - India as a mega-diversity nation - Hotspots of Biodiversity.
2. **Value and significance of biodiversity:** Tangible benefits - food, fiber, fodder, medicines, and construction material - Intangibles - pollination, pest control, soil development and maintenance of soil fertility - soil and water conservation - nutrient cycling - Human-animal conflicts - existing conservation projects - Tiger, Rhino, Elephant, Turtles, Crocodiles, Birds, Coral reefs and Mangroves.
3. **Threats to biodiversity:** Loss of Biodiversity and its causes - Patterns of losses - Causes and factors of mass extinction - Listing of Threatened biodiversity including vulnerable, rare, threatened, Endangered and extinct plant and animal species - Wildlife Trade and Laws - Wildlife protection Act of India - CITES - TRAFFIC - RED Data Book - IUCN - Measures to control poaching and wildlife trade
4. **Conservation of biodiversity:** Aim for conservation - Current practices - Conservation of Genetic, Species and Ecosystem biodiversity - International conventions on conservation - Treaties on nature & conservation - *Ex situ* & *In situ* conservation - Vavilovin seed bank - Institutions and their role in conservation – Zoos - Natural history museums & collections - Zoological survey of India - Botanical survey of India - Forest research Institutes - Central Marine Fisheries research Institutes.
5. **Role of NGOs in conservation:** International NGOs - UNEP, GEF, WCS, Bird Life International - Important NGOs in India and their contributions - WWF, ATREE, BNHS, WTI and Kalpavriksha - Important NGO movements - Chipko movement - Silent valley - Narmada Bachao Aandholan - Pani Panchayats - Seed Movement.

Laboratory component includes the following exercises:

- Understanding the concept of sampling: Random sampling, sample size, quadrat, transect
  and point method for the study of community structure.
- Determination of frequency, density and abundance of different species present in the community.
- Determination of Species richness and evenness.
- Study the dispersion of the species by calculating mean and variance of species.
- Estimating Alpha (α), Beta (β) and Gamma (γ) diversity.
- Estimating species diversity by Shannon and Simpson's Index
- Preparation of field data sheet.
- Identification of butterflies, amphibians and reptiles (up to the species), bats and birds up to genus.
- Documentation of Avifauna within the college campus and adjoining areas.
- Visit to Zoos, Sanctuaries, National park.
- GPS field data collection and import to computer.

Text:

Krishnamurthy KV (2009) An Advanced Textbook on Biodiversity Principles and practice. Oxford & IBH publishing Co Pvt. Ltd., New Delhi.

References

Ghosh, A (2009) Biodiversity Conservation, APH Publications, New Delhi.
Sharma, PD (2005) Ecology and Environment. Rastogi Publication, New Delhi
Dutta, A (2001) Biodiversity and Ecosystem Conservation. Kalpaz Publications, New Delhi.
Negi ,SS (1993) Biodiversity and its Conservation in India. Indus Publications, New Delhi.
Ladle, RJ (2009) Biodiversity and Conservation: Response to biodiversity loss. Taylor and Francis, UK.

ZOO 3544 Bioinformatics (3+2=5h/wk) (5cr)
(Theory cum Lab)

This course is designed to introduce bioinformatics tools and analysis methods to students. Upon completion of the course, students should feel confidence in dealing with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades.

1. **Operating systems and Internet:** Operating System concept - Windows 98/XP, Windows server NT/2000, UNIX/LINUX - Internet evolution - Working of Internet - Use of Internet - Working with E-mail - An overview of Computer viruses - General Precautions.
2. **Search Engine:** Overview of World Wide Web (Web Server and Client) - Introduction to Search engine and Searching the Web - Searches on MEDLINE, PUBMED and bibliographic databases - Downloading files - Introduction to Web Browsers - Understanding HTML and URL, Domain name, IP Address – Blogging - Overview of available Bioinformatics resource in web.
3. **Bioinformatics and data generation:** Bioinformatics and its relation with molecular biology - Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer) - Data generation - Generation of large scale molecular biology data - Applications of Bioinformatics.
4. **Biological Database:** Introduction to data types and Source - Population and sample - Classification and Presentation of Data - Quality of data, private and public data sources - Biological Databases - Nucleic acid databases (NCBI, DDBJ, and EMBL) - Protein databases (Primary, Composite, and Secondary) - Specialized Genome databases (SGD, TIGR, and ACeDB) - Structure databases (CATH and SCOP).
5. **Sequence Alignments:** Introduction to Sequences, alignments and Dynamic Programming - Local alignment and Global alignment (algorithm and example) - Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm) - Methods for presenting large quantities of biological data.

Laboratory component includes exercises as follows:

- Types of biological databases and using it - Genbank, Protein Data Bank, Uniprot.
- Sequence Analysis Tools: BLAST, FASTA (Nucleic acids & Proteins), Clustal W and EMBOSS.
- Sequence Comparisons (Pairwise Sequence Alignments).
- To identify an unknown nucleotide sequence using the NCBI search tool BLAST
- Phylogenetic Analysis - Phylip.
- Molecular Modeling: Homology Modeling – Swiss modeller.

Text book:

Ignacimuthu, S (2005) Basic Bioinformatics. II Edition, Narosa Publishing House, New Delhi.

References:

Teresa K, David A and Parry-Smith (2001) Introduction to Bioinformatics. I Edition, Pearson Education, New Delhi.

Lesk, AM (2002) Introduction to Bioinformatics. I Edition, Oxford University Press, USA

Claverie JM and Notredame C (2006) Bioinformatics for Dummies. II Edition, John Wiley & Sons, Inc., USA.

Xiong, J (2006) Essential Bioinformatics. Cambridge University Press, New York.

ZOO 2447 General Zoology-I (3+2=5h/wk) (4cr)
(Theory cum Lab - Supportive course)

This course is an introduction to animal phyla. The theory part deals with the general characters and classification up to class level in animal kingdom. The groups Acoelomata, Pseudocoelomata, Coelomata, Prochordata, Pisces, Amphibia, Reptilia, Aves and Mammalia will be dealt with examples.

1. **Acoelomata:** Levels of organization – Outline classification up to phylum with examples - General characteristics – Protozoa - *Amoeba* sp. - life cycle of *Plasmodium* sp. - protozoan diseases – Porifera - canal system – Coelenterata – *Hydra* sp. - biology of corals and coral reefs.
2. **Pseudocoelomata:** Platyhelminthes - general characters - classification - *Taenia solium*– Life cycle of *Ascaris lumbricoides* - Helminth parasites in man.
3. **Coelomata:** General characteristics - Arthropoda, Mollusca and Echinodermata – *Periplaneta* sp. – Economic importance of insects – *Pila* sp. – torsion – *Asterias* sp. - water vascular system – larval forms.
4. **Prochordata, Pisces and Amphibia:** General characters of *Amphioxus*, *Balanoglossus* and *ascidia* – General characters of Pisces - *Scoliodon* sp. - accessory respiratory organs in fishes – economic importance of fishes – Amphibia - general Characters - *Rana* sp.
5. **Reptilia, Aves and Mammals**: General characters – Identification of poisonous and non-poisonous snakes – *Columba livia* - flight adaptations in birds - migration in birds - adaptive radiation of beak and feet – *Oryctolagus* sp. - dentition in mammals - aquatic mammals - economic importance of mammals.

The laboratory component includes the following exercises:

- Spotters- microscopic forms
- Spotters – lower invertebrates
- Spotters – higher invertebrates
- Spotters- Pisces
- Spotters – Tetrapods
- Mouthparts and digestive system of cockroach
- Salivary gland of cockroach
- Nervous system of cockroach

- Buccal cavity of frog - entire view
- Viscera of frog
- Digestive system of frog
- Urinogenital system of frog
- Nervous system of frog

Text book:

Chaki, KK, Kundu, G and Sarkar, S (2005) Introduction to General Zoology. Vol-1, New Central Book Agency Pvt. Ltd., Kolkata, India.

References:

Iyer, E (1993) Manual of Zoology Vol. II. Viswanathan (Printers & Publishers), Chennai.
Jordan, EL and Verma, PS (2013) Chordate Zoology. S. Chand & Co Ltd., New Delhi.

ZOO 2448 General Zoology – II (3+2=5h/wk) (4cr)
(Theory cum Lab - Supportive course)

This is a theory cum laboratory, which aims at imparting knowledge about the economical importance and applied aspects of zoology. The theory part deals with the principles and applications of genetics, health and hygiene with reference to man. It also emphasizes details on areas like entomology, immunology and applied zoology. The laboratory part includes the collection and preservation of insects, estimation of metabolic rate in fish, human traits, lymphoid organs of fish, hypersensitivity and experiments related to applied zoology.

1. **Human genetics**: Human chromosomes - gene maps - DNA fingerprinting - chromosomal abnormalities - human hereditary traits - Eugenics - Euphenics - Euthenics - Gene therapy - Human Genome Project.
2. **Human health and Hygiene**: Diseases - detection - types - infectious and non-infectious diseases - causes - prevention - treatment and control - drug resistance and abuse.
3. **Entomology**: Introduction - scope - common insects - general characters and structure - metamorphosis - beneficial and harmful insects - integrated pest management.
4. **Immunology**: Immune system - cells - organs - immune responses - antigen and antibodies - vaccines - hypersensitivity - autoimmune disorders.
5. **Applied Zoology**: Introduction to poultry farming and vermicomposting.

Laboratory component includes the following exercises:

- Insect collection, preservation and identification
- Study of beneficial and harmful insects
- Estimation of O_2 consumption in fish
- Lymphoid organs of fish – Demonstration
- Hypersensitivity – Demonstration
- Analysis of human traits – Mendelian's, fingerprinting/blood group
- Human karyotype and Ideogram
- Visits to poultry farming, vermicomposting, aquaculture and apiculture.

Text book:

Taylor DJ, Green, NPO and Stout SW (2005) Biological Science. R. Soper Editor, III Edition. Cambridge University Press, United Kingdom.

References:

Nigam, HC (1996) Modern Trends in Biology. Shohanlal Naginchand & Co, Jalandhar.
Sobti, RC (1991) Medical Zoology. Shohanlal Naginchand & Co, Jalandhar

ZOO 3255 Medical Laboratory Technology (3h/wk) (2Cr)
(Life skill course)

The objective of this course is to introduce various laboratory techniques involved in the analysis of the samples and the interpretation of the results. Further, students will be informed about the setting of a clinical laboratory. This course includes the collection and analysis of samples like urine, stool and sputum to test protein urea, glycemia and the presence of pus cells, parasite and various microorganisms. It also includes the examination of gastrointestinal contents, routine and special haematological tests, histopathology and serological tests.

1. **Biomedical laboratory**: Normal and abnormal conditions of body - Symptoms – Samples to be collected for analysis and diagnosis – Instruments – Rules and regulations to be followed for hazardous chemicals – sterilization methods.
2. **Biosamples:** Urine - Collection and preservation, physical and chemical analysis for kidney diseases, proteinuria, glycemia and hereditary disorders – Stool - Types and collection, microscopic and culture methods, interpreting microbial diseases – Gastro-intestinal contents – Sputum – Collection and staining for microscopic examination for respiratory disorders.
3. **Clinical haematology**: Phlebotomological methods - chemical analysis - cell counting (DC/TC) - estimation of ESR for pathological, physiological and hereditary disorders – Blood banking - Blood grouping and typing – Glucose tolerance test - Impaired glucose tolerance test - diabetic disorders - HbA1c test.
4. **Biomedical instrumentation**: ECG - EEG - X-ray - Stethoscope – Microscopic examination of cells from the body fluids for identifying disorders – Microtome and processing of tissues for tumors.
5. **Fertility test**: Semen analysis - hormonal changes - hormonal tests and pregnancy tests – factors affecting fertility.

Text:

Sood, R (1988) Medical Laboratory Technology. Jaypee Pub Ltd., New Delhi.

References:

Mukherjee, KL (1989) Medical Laboratory Technology. Vol, I, II & III, Tata McGraw Hill Pub, Co, New Delhi.
Syrey MF, William JM and Elvyn GS (1978) Diagnostic microbiology. The C.V. Mosby Co.

ZOO 3257 Ornithology (3h/wk) (2cr)
(Life skill course)

Learn about bird behavior, migration, ecology, conservation, and many other subjects. Each student will carry out documentation of local bird fauna which may results into a compilation of scientific publication. Students will develop expertise in bird studies which will be useful in taking up bigger challenges for studying birds with respect to their life history, behavior, ecology and also contribute to the ongoing Ornithological researches carried across the country.

1. **Bird Morphology, bird Communities, birds and Man:** Characteristics of birds - naming and classification - study of general bird morphology - morphological adaptations - Guilds - Stratification - Resource partitioning – Migration – Communication - Economic importance of birds - hazards of birds to aviation - effects of anthropogenic activity on birds.
2. **Field Ornithology:** Bird study techniques - Equipments - Areas of study - Field kit – Sampling - Bird photography - Bird ringing techniques - application - recording body measurements - usefulness of bird ringing data - ring recovery - Radio-telemetry - Use of gadgets like GPS, Camcorder, CCTV camera, night vision scope in bird study - Satellite pictures - Google Maps.
3. **Analysis of Field Data and Pterological Studies:** Analysis of field data - Applying statistics to evaluate data - Interpretation of data - Time budget analysis - Habitat utilization - Moulting pattern - Pellet and excreta analysis - Preparation of bird distribution maps - Role of birds in Ecosystem - Pollination, seed dispersal and insect control – Pterological studies - feather structure, types.
4. **Birds of India:** An overview of the history of Ornithology in India, SACON - Birds in folklore and Indian culture - Grassland - desert - wetland - forest - Himalayan birds - Bird biodiversity hotspots in India. Case study – Fall of House sparrow.
5. **Conservation of Birds:** Endangered bird species - Threatened birds - Red Data Book - IUCN criteria - Artificial breeding and release of endangered birds - Recent conservation issues - Decline of vultures - Role of NGO's in conservation of birds - Legal protective measures - Bird sanctuaries.

Text:

Ali, S (2002) The Book of Indian Birds. Bombay Natural History Society, Mumbai, India

References:

Ali S and Ripley, SD (2002) Handbook of the Birds of India and Pakistan. Vol 1-10, Oxford University Press, India.

Grimmett R, Inskipp C and Inskipp, C (2001) Pocket Guide to the Birds of the Indian Subcontinent: Helm Field Guides. Second Edition. Christopher Helm.

Kazmierczak K and van Perlo BA (2000) Field Guide to the Birds of the Indian Subcontinent. Yale University Press, New York.

ZOO 3258 Human Reproduction and Conception Control (3h/wk) (2cr)
(Life Skill Course)

The course on Human Reproduction and Conception Control includes female and male sexual anatomy and physiology, patterns of sexual behavior, conception, pregnancy, child birth, contraceptive methods, sexually transmitted diseases, reproductive disorders and therapy.

1. **Anatomy and physiology of female reproductive system:** External genitalia and internal structures - breasts – menstruation - ovulation - hormonal control.
2. **Anatomy and physiology of male reproductive system**: External genitalia and internal structures – male sexual function - erection - ejaculation - circumcision.
3. **Sexual behavior pattern, conception and pregnancy**: Love - types - celibacy - erotic dreams - fantasy - masturbation - homosexuality - atypical sexual behavior – Sexual arousal - role of hormones, brain, senses, food and chemicals – Sexual response - three stage and four phase model – Conceiving - pregnancy - fetal development - stages of child birth - breast feeding.
4. **Contraceptive methods and fertility control:** Contraceptive methods - hormone based oral and non-oral contraceptives - barrier methods - intrauterine devices - methods based on menstrual cycle - post-coital contraceptive methods - abortion - choice of contraception at different ages – Fertility control - male and female sterilization - vaccines for fertility control.
5. **Sexual diseases and disorders of reproductive system:** Common vaginal infections - Sexually transmitted diseases - gonorrhea - syphilis - AIDS - prevention – Disorders - hypoactive sexual desire, erectile, dyspareunia and orgasmic disorders - chronic illnesses and disabilities - menstrual cycle problems – Basics of sexual enhancement and sex therapy – Specific suggestions for men and women.

Text book:

Crooks, R and Baur, K (1996) Our sexuality. VI Edition, Brook /Cole publishing company, California, USA.

References:

Shapiro, HI (1988) The birth control book. Prentice Hall Press, New York.

Chaudhuri, SK (1999) Practice of fertility control - A comprehensive text book. IV Edition, B.I. Churchill Livingstone Pvt. Ltd., New Delhi.

Vander, AJ, Sherman, JH and Luciano DS (2001) Human Physiology: The Mechanism of Body Function. VIII Edition, McGraw Hill Inc. New Delhi.

UNDERGRADUATE DEPARTMENT OF ZOOLOGY
w.e.f. 2020-2021

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
1	I	TAM/FRE/HIN/ 0000		**3**	**2**	**30**
1	II	ENG 1201	Conversational skills	**3**	**2**	**30**
1	IIIC	ZOO 1621	Invertebrata	**6**	**6**	**90**
1	IIIC	ZOO 1223	Invertebrata Laboratory	**2**	**2**	**30**
1	IIIC	ZOO 1531	Cell Biology(Theory cum Lab)	**(3+2) 5**	**5**	**75**
1	IIIS	BOT 1437	Plant Biology - I	**(3+2) 5**	**4**	**60**
1	IVE	NME 0000	Non MajorElective 1	**3**	**2**	**30**
1	IVLS	XXX0000	Life Skill course - I	**3**	**2**	**30**

1	V	XXX 0000 or XXX 0000	NCA/NCN/NSS or Extension activity SLP			
			Total	**30**	**25**	**375**
2	I	TAM/FRE/HIN/0000		**3**	**2**	**30**
2	II	ENG 1202	Reading & Writing Skills	**3**	**2**	**30**
2	IIIC	ZOO 1622	Chordata	**6**	**6**	**90**
2	IIIC	ZOO 1224	Chordata Laboratory	**2**	**2**	**30**
2	IIIC	ZOO 1532	Economic Zoology(Theory cum Lab)	**(3+2) 5**	**5**	**75**
2	IIIS	BOT 1438	Plant Biology – II	**(3+2) 5**	**4**	**60**
2	IVE	NME 0000	Non MajorElective 2	**3**	**2**	**30**
2	IVLS	XXX 0000	Life Skill course - II	**3**	**2**	**30**
2	V	XXX 0000 or XXX 0000	NCA/NCN/NSS or Extension activity SLP			
			Total	**30**	**25+1**	**375/390**
3	I	TAM/FRE/ HIN/0000		**3**	**2**	**30**
3	II	ENG 2201	Study Skills	**3**	**2**	**30**
3	III C	ZOO 2623	Microbiology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
3	III C	ZOO 2625	Animal Physiology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
3	III C	ZOO 2433	Genetics	**4**	**4**	**60**
3	III C	ZOO 2335	Evolution	**3**	**3**	**45**
3	III S	CHE 2413	Chemistry for Zoologist - I	**5**	**4**	**60**
3	V	XXX 0000 or XXX 0000	NCA/NCN/NSS or Extension activity SLP			
			Total	**30**	**27**	**405**

ZOO 2

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
4	I	TAM/FRE/ HIN/0000		**3**	**2**	**30**
4	II	ENG 2202	Career Skills	**3**	**2**	**30**
4	III C	ZOO 2624	Biological Chemistry (Theory cum Lab)	**(4+2) 6**	**6**	**90**
4	III C	ZOO 2626	Ecobiology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
4	III C	ZOO 2428	Molecular Biology	**4**	**4**	**60**
4	III C	ZOO 2330	Molecular Biology Laboratory	**3**	**3**	**45**
4	III S	CHE 2414	Chemistry for Zoologist -II	**5**	**4**	**60**
			Total	**30**	**27+1**	**405/420**
5	III C	ZOO 3637	Immunology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
5	III C	ZOO 3639	Entomology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
5	III C	ZOO 3641	rDNA technology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
5	III C	ZOO 3543	Developmental Biology (Theory cum Lab)	**(3+2) 5**	**5**	**75**
5	IV LS	XXX 0000	Life Skill course-III	**3**	**2**	**30**
5	IV	ZOO 3200	Environmental Studies	**4**	**2**	**30**
			Total	**30**	**27**	**405**
6	III C	ZOO 3838	Biotechnology (Theory cum Lab)	**(5+3)8**	**8**	**120**
6	III C	ZOO 3446	Project	**4**	**4**	**60**
6	III C	ZOO 3642	Biodiversity (Theory cum Lab)	**(4+2) 6**	**6**	**90**
6	III C	ZOO 3544	Bioinformatics (Theory cum Lab)	**(3+2) 5**	**5**	**75**
6	IV LS	XXX 0000	Life Skill course – IV	**3**	**2**	**30**
6	IV VE	VAL 0000	Value Education	**4**	**2**	**30**
			Total	**30**	**27**	**405**
			Grand Total for Semester I – VI	**180**	**158+2**	**2370/2400**

C: CORE S: SUPPORTIVE E: NON MAJOR ELECTIVE LS: LIFESKILL VE: VALUE EDUCATION

Courses offered by the Department of Zoology to Non-Major Students

Part III Supportive

SEM	Course No.	Course Title	Hrs.	Cr	Marks
III	ZOO 2447	General Zoology – I Theory cum Lab	**(3+2) 5**	**4**	**60**
IV	ZOO 2448	General Zoology – II Theory cum Lab	**(3+2) 5**	**4**	**60**
		Total	**10**	**8**	**120**

Part IV Non-Major Electives

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	ZOO 1251	Human Biology	**3**	**2**	**30**
II	ZOO 1252 or ZOO 1254	Forensic Biology or Apiculture	**3**	**2**	**30**
		Total	**6**	**4**	**60**

Part IV: Life Skill Courses

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	ZOO 1249	Poultry Farming	**3**	**2**	**30**
II	ZOO 1256	Ornamental Fish Culture	**3**	**2**	**30**
V	ZOO 3255 or ZOO 3257	Medical Lab Technology or Ornithology	**3**	**2**	**30**
VI	ZOO 3258	Human Reproduction and Conception Control	**3**	**2**	**30**
		Total	**12**	**8**	**120**

Value Added Courses

SEM	Course No.	Course Title	Hrs.	Cr
I	ZOO 121V	Bee keeping	**2**	**2**
II	ZOO 122V	Aquarium fish keeping	**2**	**2**
III	ZOO 221V	Clinical Lab Techniques	**2**	**2**
IV	ZOO 222V	Shrimp culture	**2**	**2**
V	ZOO 321V	Fish farming	**2**	**2**
VI	ZOO 322V	Dairy farming	**2**	**2**

ZOO 4

PROGRAMME SPECIFIC OUTCOMES

Upon completion of this Programme, the graduates will be able to:

1. Apply the knowledge of Zoology in various aspects of society, industry and nature.
2. Identify and analyze problems using the principles of natural science.
3. Design solution for problems in areas in public health, environment and society.
4. Conduct investigations of higher order to solve problems in society and environment.
5. Perform procedures as per laboratory standards.
6. Apply concepts for the benefit of society from areas such as Economic Zoology, Entomology, Immunology and Evolution.
7. Contribute to the sustainability of the environment from the areas of Environment Studies, Ecobiology and Biodiversity.
8. Develop work and environment ethics based on the inputs from Biotechnology, Biodiversity and Genetics.
9. Develop communication skills through seminars & oral presentations, and become competent to take up careers in academics, research and to pursue higher studies.
10. Integrate individual and team work by laboratory and project work.

Mapping of Courses with Programme Specific Outcomes (PSOs)

Course Code	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
ZOO 1621	✓		✓	✓	✓					
ZOO 1223	✓					✓		✓	✓	✓
ZOO 1531	✓	✓								
ZOO 1251	✓	✓								
ZOO 1249	✓		✓			✓				
ZOO 1622	✓	✓								
ZOO 1224	✓	✓							✓	✓
ZOO 1532	✓					✓	✓			
ZOO 1254	✓					✓	✓		✓	
ZOO 1252		✓	✓	✓	✓	✓			✓	
ZOO 1256	✓	✓				✓	✓		✓	
ZOO 2623	✓	✓		✓	✓	✓	✓		✓	
ZOO 2625	✓	✓								
ZOO 2433	✓			✓	✓	✓		✓	✓	
ZOO 2335	✓	✓		✓		✓				
ZOO 2447	✓	✓		✓					✓	
ZOO 2624	✓				✓					
ZOO 2626		✓	✓	✓	✓		✓	✓	✓	✓
ZOO 2428	✓	✓		✓						
ZOO 2330					✓				✓	✓
ZOO 2448	✓		✓			✓			✓	
ZOO 3637	✓				✓	✓				
ZOO 3639	✓		✓			✓			✓	
ZOO 3641			✓		✓				✓	
ZOO 3543	✓	✓			✓				✓	
ZOO 3255		✓		✓	✓			✓		✓
ZOO 3257	✓	✓	✓				✓		✓	
ZOO 3200	✓	✓					✓	✓	✓	
ZOO 3838				✓	✓	✓		✓	✓	
ZOO 3446		✓	✓	✓					✓	✓
ZOO 3642			✓		✓		✓	✓	✓	
ZOO 3544					✓				✓	
ZOO 3258	✓	✓				✓				

ZOO 6

Mapping of Programme Specific Outcomes (PSOs) with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	✓	✓		✓	✓		✓	✓	✓	
PSO2	✓	✓		✓		✓	✓	✓		
PSO3	✓	✓	✓	✓		✓	✓		✓	✓
PSO4	✓	✓	✓	✓		✓	✓	✓	✓	✓
PSO5	✓	✓	✓			✓	✓	✓		
PSO6	✓	✓		✓	✓	✓	✓	✓	✓	✓
PSO7	✓	✓	✓	✓	✓	✓	✓		✓	✓
PSO8	✓	✓	✓	✓		✓	✓			✓
PSO9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PSO10	✓	✓	✓	✓		✓	✓			

ZOO 1622 *Chordata* *6hrs / 6cr*

This course provides a general and basic understanding of chordates. It discusses the diversity, adaptations, affinities, organization, comparative study and taxonomic status of chordates. Type study for each class is also included.

Upon completion of this course, students will be able to:

i. Outline and classify prochordates and chordates.
ii. Explain the characteristics of Agnatha and Pisces.
iii. Assess the adaptations and evolutionary importance of Amphibia and Reptilia.
iv. Outline and classify Aves and Mammalia with examples.
v. Compare the various systems of Chordates.

Unit 1: Chordata and Prochordata *18 hrs*

Salient features - outline classification of phylum chordata up to class level with examples - Prochordates- classification -*Amphioxus* sp., *Balanoglossus*sp. and *Ascidian*sp. - life history - affinities - retrogressive metamorphosis.

Unit 2: Agnathaand Pisces *18 hrs*

Classification up to orders with examples - *Petromyzon*sp.- life history, comparison between lampreys and hag fishes - scales - fins - S*coliodon* sp.Electric organs - parentalcare - migration – economic importance of fishes - accessory respiratory organs.

Unit 3: Amphibia and Reptilia *18 hrs*

Classification up to orders with examples- adaptive features of Anura, Urodela, Apoda - *Rana*sp.- parentalcare - *Calotes* sp. - statusof *Sphenodon*sp.- identificationof poisonous and non-poisonous snakes – biting mechanisms – poison apparatus - venom - Jacobson'sorgan - South Indian amphibians and snakes.

Unit 4: Aves and Mammalia *18 hrs*

Classification up to orders with examples - flight adaptations - migration, adaptive radiation of beaks and feet – characters of *Archaeopteryx* - features of Ratitae- *Columba*sp.,*Rattus* sp.- adaptation of aquatic mammals, flying mammals - dentition and adaptive radiation in mammals - economic importance - South Indian birds and mammals.

Unit 5: Comparative anatomy *18 hrs*

Integument and its derivatives - endoskeleton - skull,girdles (Birds & Reptiles)- digestive system (Shark & Birds) - nervous system (Shark & Birds)- sense organs (Shark & Frog).

Textbook

Jordan EL and Verma PS (2013) Chordate Zoology, S.Chand& Co Ltd., New Delhi.

References

Romer, AS (1992)The vertebrate body, 3rdEdition,Vakils, Fefer and Simons Pvt. Ltd, Mumbai.
Ayyar, E (1982) Manual of Zoology Vol.II-.S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai.
Kotpal, RL (2014)Modern textbook of Zoology Vertebrates. 3rd Edition Rastogi Pubications, Meerut.
Saxena, RK and Saxena, S (2008) Comparative anatomy of vertebrates.Viva books Pvt. Ltd., New Delhi.

Mapping of Course Outcomes with Bloom's Taxonomy

ZOO 8

	K1	K2	K3	K4	K5	K6
CO1		2				
CO2		2				
CO3					5	
CO4		2				
CO5				4		

Mean = 3

ZOO 2335 *Evolution* *3h / 3cr*

Evolution influences every aspect of the form and behavior of organisms. This course includes origin of life and evidences for evolution, theories of evolutionary thought, fossilization, isolation, speciation, natural selection and emphasis the biological and cultural evolution of man.

Upon completion of this course, students will be able to:

i. Explain the origin of life and evidences for evolution
ii. Analyze the various theories of evolution
iii. Discuss the concepts of evolutionary trends
iv. Analyze the isolating mechanisms and adaptations
v. Evaluate the evolution of horse and human

Unit 1: Origin of life and evidences for evolution **9hrs** Origin of life - theories -special creation - Cosmozoic - spontaneous generation - Chemical evolution - Bio-elements - selection - opinion of J.B.S. Haldane and A.L. Oparin - Urey Miller hypothesis - Origin of biomolecules - Coacervation - Origin of pro- and eukaryotic cell - Evidences - anatomical, physiological, embryological, biochemical and molecular phylogenetic evidences.

Unit 2: Theories of evolution *9hrs*
Lamarckism and Neo-Lamarckism - Darwinism and Neo-Darwinism - Germplasm theory - Mutation theory - Modern synthetic theory - Hardy Weinberg law and its importance.

Unit 3: Trends in evolution *9hrs*
Geological eras - Fossils and fossilization - dating of fossils - Extinctions - Living fossils - adaptations - variations and origin - adaptive trends - Polymorphism - transient and stable - Mimicry and Coloration - Batesian and Mullerian mimicry.

Unit 4: Isolation and its role in evolution **9hrs**
Isolating mechanisms - different types - Species concepts - definition of species - origin of species - Allopatric and Sympatric speciation - Genetic drift - Founder's Principle.

Unit 5: Evolutionary Processes *9hrs*
Natural selection in action - Industrial Melanism - Evolution of horses - Time and place of origin, major evolutionary trends, phylogeny of probable sequence species of horse - Eocene, Oligocene, Miocene, Pliocene, and Pleistocene forms - Orthogenesis - Evolution of man & cultural evolution.

Textbook
Stebbins GL (1966) Process of Organic Evolution. Prentice Hall, New Delhi.

References
Darwin, RC (1859) On the Origin of Species by the means of Natural Selection, John Murrey, Abemarel Street London.
Dobzansky, T(1976) Genetics and the origin of species. Oxford and TBH Publishing Co., New Delhi.
Dodson, EO (1960) Evolution: process and product. Affiliated East- West Press, New Delhi.

ZOO 10

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1		2				
CO2		2				
CO3			3	4		
CO4		2		4		
CO5					5	

Mean = 3.3

ZOO 2428 *Molecular Biology* *4hrs / 4cr*

Molecular biology deals with the study of structure and function of genes and genomes. Students will learn the finest details of molecular configurations of genes, their physical properties and their nature of replication, recombination, mutation and transposition. This course also introduces how genes express and accurately transmit genetic information, and the mechanism of its regulation.

Upon completion of this course, students will be able to:

i. Explain the molecular nature of nucleic acids.
ii. Analyze the mechanisms involved in DNA replication,recombination, mutation and DNA repair.
iii. Compare the transcription process in prokaryotes and eukaryotes.
iv. Discuss the mechanisms involved in transcription.
v. Evaluate the different transposable elements and assess regulation of gene expression.

Unit 1: The molecular nature of DNA and RNA *12hrs*

Introduction to gene structure and function – DNA double helix –Alternate forms of DNA – Physical properties - G:C content, c-value and c_ot curves – Extra nuclear genomes - Structure and types of RNA – human genome project.

Unit 2: DNA replication, recombination, Mutation and repair systems 12 hrs

Semicon servative replication - bidirectional - unidirectional - rolling circle and θ model replication - enzymology of DNA replication- Homologous and site specific recombination, Mutation - types - DNA repair mechanisms.

Unit 3: Transcription *12hrs*

RNA polymerases -Mechanisms of transcription in prokaryotes and eukaryotes- General transcriptional factors of eukaryotes - Post-transcriptional processing - capping, polyadenylation, splicing and alternate splicing.

Unit 4: Translation *12hrs*

Genetic code - Deciphering of genetic code - Salient features of genetic code - 3D structure of tRNA -codon-anticodon interaction - Wobble hypothesis - Mechanism of protein synthesis in prokaryotes and eukaryotes - Inhibitors of protein synthesis - Post translational modification.

Unit 5: Transposition, Regulation of gene expression 12hrs

Transposable elements - IS,Tn3,Tn10 and Mu, Fine control of prokaryotic transcription - *Lac*operon - Gene regulation in eukaryotes: GAL system in yeast, Role of chromatin structure in gene regulation- DNA binding proteins.

Textbook:

Malacinski GM (2003) Freidfelder's Essentials of Molecular Biology. IV Edition, Narosa Publishing House, New Delhi, India.

References:

Brown TA (2007) Genomes 3. III Edition, Garland Science Publishing, New York.
Watson JD, Kopkins NK, Roberts JW, Stertz JA and Weiner AM (1994) Molecular Biology of the Gene. Benjamin and Cummings Pub Co., California, USA

ZOO 12

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1		2				
CO2		2				
CO3			3			
CO4				4		
CO5					5	

Mean = 3.2

ZOO 2433 Genetics 4hrs / 4cr

This course aims to focus on the basic principles of genetics by presenting the important concepts of classical, microbial, population and human genetics. It deals with basic concepts of simple inheritance characters and gene mapping.

Upon completion of this course, students will be able to:

i. Analyze the patterns of Mendelian and non-Mendelian inheritance.
ii. Explain sex determination, linkage and crossing over.
iii. Predict the genetic basis of behavior.
iv. Explain the mechanisms of genetic recombination in bacteria and viruses.
v. Assess the concepts of human genetics, compute gene and genotypic frequencies.

Unit 1: Mendelism *13 hrs*

Mendel's study of heredity –symbols- terminology- laws –related problems - multiple alleles - gene interactions –epistasis, incomplete dominance, complementary and supplementary genes, - quantitative traits - inbreeding.

Unit 2: Sex determination, Linkage and crossing over *14 hrs*

Sex determination – XX/XY, XX/XO, ZZ/ZO and ZZ/ZW – environmental and hormonal determination -sex linked inheritance – X and Y linked - dosage compensation, Lyon's hypothesis - Barr bodies. Linkage –discovery–Concept - types - Morgan experiment in Drosophila - cytological proof for crossing over – Creighton and McClintock experiment - mechanism of recombination – recombination frequency.

Unit 3: Behavioural genetics *10 hrs*

Nest cleaning behavior in honey bees – Nurturing behaviourin mice - Biological rhythms in Drosophila - *per* gene - single gene mutations and human behavior – LeschNyhan Syndrome, Huntington's disease – complex human behaviour – twin studies – intelligence – personality.

Unit 4: Genetics of bacteria and viruses **10 hrs**

Mutant phenotypes in bacteria - transformation and conjugation - discovery, mechanism. T_4 and lambda phage - plaques - transduction - discovery - generalized and specialized mechanism.

Unit 5: Human genetics *13 hrs*

Mendelian traits in man - pedigree analysis - karyotype analysis– Q, G, R, C banding– chromosome variation - euploidy, aneuploidy, polyploidy - chromosomal abnormalities – Down's, Klinefelter's, Turner's and cri du chat syndrome -inborn errors of metabolism – phenylketonuria, alkaptonuria and albinism- genetic counseling – eugenics, euthenics and euphenics.

Textbook

Snustad, DP and Simmons, JM (2010). Principles of Genetics 5th Edition. John Wiley & Sons Inc.

ZOO 14

References

Hexter, W and Yost, HT (1980) The Science of Genetics. Prentice Hall of India Pvt Ltd., New Delhi.

Levine, L (1969) Biology of the Gene. The CV Mosby Company, St. Louis, USA.

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1		2				
CO2		2				
CO3				4		
CO4			3			
CO5					5	

Mean = 3.2

ZOO 2624 *Biological Chemistry (Theory cum Lab)* *4+2 = 6hrs / 6cr*

Biological chemistry includes enzymes, and mechanism of enzyme action. It also includes chemistry and metabolism of carbohydrates, amino acids & proteins, lipids & nucleic acids. Citric acid cycle and oxidative phosphorylation are also included.

Upon completion of this course, students will be able to:

i. Assess the structure and metabolism of carbohydrates.
ii. Understand the structure of amino acids & proteins.
iii. Discuss the mechanism of enzyme action and the regulation of enzyme activity.
iv. Assess the chemistry and metabolism of lipids and nucleic acid and convergence of metabolic pathways.
v. Analyze the various metabolic pathways and their significance

Unit 1: Carbohydrates *12hrs*

Structure, Classification, Properties and Biological significance -Monosaccharides - ribose, glucose, fructose - Disaccharides - Sucrose and lactose. Polysaccharides - Starch and Glycogen.

Unit 2: Amino acids and proteins *12hrs*

Standard and non-standard amino acids, Classification based on structure, side chains, charges, polar and non polar - Structural organization of proteins - primary, secondary, tertiary and quaternary - Properties and Biological significance of amino acids and proteins.

Unit 3: Enzymes *12hrs*

Classification - Substrate specificity - Factors affecting rate of enzyme activity - Mechanisms of enzyme action - Regulation of enzyme activity - Enzyme inhibition - Coenzymes and cofactors - Isozymes.

Unit 4: Lipids and Nucleic acids *12hrs*

Lipids: Classification, structure of Simple lipids - fats, Compound lipids - phospholipids - lecithin, glycolipids - gangliosides and lipoproteins and Derived lipids - Steroids - Cholesterol. Nucleic acids - components - nitrogenous bases - nucleosides - nucleotides - Biological significance of lipids & nucleic acids.

Unit 5: Metabolism of carbohydrate, lipids and proteins *12hrs*

Glycolysis - significance of Glycogenesis, Gluconeogenesis and Pentose phosphate pathway - Deamination and transamination reactions -Urea cycle - β-oxidation of fatty acids - TCA cycle - Electron transport chain - Oxidative phosphorylation.

Laboratory component includes exercises as follows:

- Colorimetry
- Spectrophotometry
- pH metry
- Paper Chromatography
- Electrophoresis
- Centrifugation
- Qualitative analysis of carbohydrates

- Qualitative analysis of amino acids & proteins
- Qualitative analysis of lipids
- Enzyme kinetics I
- Enzyme kinetics II

Textbook

Voet D and Voet JG (2004) Biochemistry. 3rd Edition. John Wiley & Sons Inc. USA.

References

Satyanarayana,U and Chakrapani, U(2008) Essentials of Biochemistry, 2nd Edition, Books and Allied (P) Limited, Kolkata.

Murray RK, Granner DK, Mayes PA and Rodwell VA (2000) Harper's Biochemistry. 25th Edition. Appleton & Lange, USA.

Lehninger AC, Nelson DL and Cox MM (2001) Principles of Biochemistry. 4th Edition, W.H. Freeman Company, USA.

Plummer DT (1996) An introduction to Practical Biochemistry. Tata McGraw Hill, New Delhi.

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1				4		
CO2		2				
CO3			3			
CO4				4		
CO5				4		

Mean =3.2

ZOO 3544 *Bioinformatics* *3+2=5hrs / 5cr*
(Theory cum Lab)

This course is designed to introduce bioinformatics tools and analysis methods to students. Upon completion of the course, students should feel confidence in dealing with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades.

Upon completion of this course, students will be able to:

i. Discuss the differences between internet and WWW and their characteristics.
ii. Outline HTML, URL, browsers, search engines and applications of bioinformatics.
iii. Use various bioinformatics tools to analyze sequence data and visualize structure data.
iv. Explain various biological databases.
v. Outline pair-wise and multiple sequences alignments and scoring.

Unit 1: Internet and World Wide Web **5 hrs**
Introduction to internet - Working of Internet - Use of Internet - Working with E-mail - An overview of Computer viruses - General Precautions - Overview of World Wide Web (Web Server and Client)

Unit 2: Information gateway *8 hrs*
Introduction to Search engine and Searching the Web - Downloading files - Introduction to Web Browsers - Understanding HTML and URL, Domain name, IP Address - Blogging - Overview of available Bioinformatics resource in web.

Unit 3: Biological Data and Bioinformatics **8 hrs**
Bioinformatics and its relation with molecular biology -Sequence data and analyzing tools (FASTA, BLAST, BLAT)-Structure data-visualization and analysis tools (RASMOL, SPDBV)- Applications of Bioinformatics.

Unit 4: Biological Database *12 hrs*
Biological Databases - Nucleic acid databases (NCBI, DDBJ, and EMBL) - Protein sequence databases (Primary, Composite, and Secondary) - Specialized Genome databases(SGD, TIGR, and ACeDB) - Structure databases (CATH and SCOP).

Unit 5: Sequence Alignments *12 hrs*
Sequence alignments – Alignment scoring – Local alignment and Global alignment - Pairwise alignment (BLAST and FASTA) and multiple sequence alignment (ClustalW) - Phylogenetic analysis (MEGA)

Textbook:

Ignacimuthu, S(2005) Basic Bioinformatics. II Edition, Narosa Publishing House**,** NewDelhi.

ZOO 18

References:

Teresa K, David A and Parry-Smith (2001) Introduction to Bioinformatics. I Edition, Pearson Education, New Delhi.

Lesk, AM (2002) Introduction to Bioinformatics. I Edition, Oxford University Press, USA

ClaverieJM andNotredameC (2006) Bioinformatics for Dummies. II Edition, John Wiley & Sons, Inc., USA.

Xiong**,** J (2006) Essential Bioinformatics. Cambridge University Press,New York.

Laboratory component includes exercises as follows:

- Bibliographic databases and full text research articles retrieval (PUBMED).
- Sequence retrieval from GenBank
- Flat file comparison – GenBank, EMBL and DDBJ
- Sequence alignment –BLAST, FastA
- Multiple sequence alignment – Clustal W
- Phylogenetic tree construction
- Protein sequence and structure databases- Uni ProtKB,PDB
- Visualization of protein structure- RasMol, SPDBV
- Identification of restriction map sites using software.

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1		2				
CO2			3			
CO3			3			
CO4			3	4		
CO5				4		

Mean =3.2

ZOO 3637 *Immunology* *4+2=6hrs / 6cr*
(Theory cum lab)

This course attempts to provide a basic understanding in Immunology. The course covers cells and organs of the immune system, antigens, antibody structure, antibody diversity, antigen-antibody interactions, cell mediated and humoral immune response and complement. In the section on disorders of immune system, autoimmunity, hypersensitivity reactions, immunodeficiency disorder and graft rejection are dealt. The laboratory component includes identification and enumeration of blood cells, location of lymphoid organs in selected vertebrates, preparation of antigens, immunization techniques, repetitive bleeding methods, antibody titration and skin test for allergy reactions.

Upon completion of this course, students will be able to:

i. Explorethe importance of Immune cells and lymphoid organs.
ii. Understand the nature of antigens, antibody and their interactions.
iii. Demonstrate the immune response mediated by MHC and lymphocytes
iv. Evaluate immune regulation and immune tolerance.
v. Analyze the hyper and poor activity of immune system.

Unit 1: Overview of the immune system *10 hrs*
Introduction -historical perspectives - innate (non-specific) and acquired (specific) immunity - cells involved - vaccines - primary & secondary lymphoid organs.

Unit 2: Antigens, antibody and their interactions *10 hrs*
Antigen - Types- factors influencing immunogeneticty - adjuvants - Structure and Biological properties of Immunoglobulin classes – IgG, IgM, IgA, IgD and IgE. Primaryinteractions- affinity and avidity-secondary interaction-agglutination-precipitation.

Unit 3: Immune Response: *14 hrs*
Humoral and cell mediated immunity – Primary and Secondary response - MHC – Structure- Antigen Processing and Presentation – Biology and Activation of B and T Lymphocytes.

Unit 4: Regulation of Immune Response and Tolerance *14 hrs*
Cytokines - Complement components- Biological properties - Classical and alternate pathways - Immune tolerance – Auto immunity – SLE and Rheumatoid arthritis.

Unit 5: Hypersensitivity, Immunodefficiency disorders and Transplantation 12 hrs
Overview of Type I, II, III, IV Hypersensitivity reactions - Immunodeficiency disorders - AIDS - Graft rejection - types of Grafts and mechanism of graft rejection.

The Laboratory component includes exercises as follows:

- Total and differential count of blood cells
- Lymphoid organs in vertebrates I – fish
- Lymphoid organs in vertebrates II- Chick
- Preparation of Soluble and Insoluble Antigens
- Routes of immunization
- Bleeding techniques and separation of serum and plasma
- Antibody titration – Ammonium Sulphate precipitation method
- Isolation of Lymphocyte using Ficoll Solution
- Ouchterlony double immunodiffusion (ODI)

- Mancini's single radial immunodiffusion (SRID)
- Immunology of ABO blood grouping
- Skin test for allergy reactions

Textbook

Coico R and Sunshine G (2009) Immunology – a short course. 6th Edition, Wiley Blackwell, New York.

References

Garvey JS, Cremer NE and Sussadorf DH (1977) Methods in Immunology. 3rd Edition, The Benjamin Cummings Pub co., Massachusetts.

Kindt TJ, Osborne BA and Goldsby RA (2006)Kuby Immunology. 6th Edition. W.H. Freeman and Co., New York.

Hudson, L and Hay, F (1989) Practical Immunology. 3rd Edition, Blackwell Science Publishers, Oxford.

Roitt IM, Brostoff J and Male D (2001) Immunology. 6thEdition, Mosby, London.

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1				4		
CO2		2				
CO3				4		
CO4					5	
CO5				4		

Mean =3.8

Value Added Courses

ZOO 121V **Bee Keeping** **2hrs / 2cr**

This course is designed to make the students know about scope and the importance of apiculture, bee morphology, anatomy, life cycle, honey processing, bee products, honey bee enemies and diseases. Honey properties and application in various fields are also covered.

Upon completion of this course, students will be able to:

i. Discuss the introduction and scope of apiculture
ii. Explain the honey bee morphology, anatomy and life cycle
iii. Analyze methods of honey process and bee products
iv. Evaluate different bee enemies and diseases
v. List out the honey properties and its products

Unit 1: Introduction to apiculture *6 hrs*

History of bee keeping - Definition -Bee keeping in worldwide - Traditional bee keeping in India - Modern beekeeping - Urban or backyard beekeeping - Apiculture development in India - institutions involved - Role of Central Honey Bee Research & Training Institute.

Unit 2: Honey Bee morphology, anatomy and life cycle **6 hrs**

Morphology of honey bees - Honey bee species - indigenous and exotic - identification - origin, systematics and distribution of honey bees - colony life and social organization - queen, drone, worker -communication of honey bees.

Unit 3: Honey processing and bee hive products *5hrs*

Honey extraction and handling - Quality control standards - Honey testing kit - Processing of honey - Other valuable by products of honey bees - Bee venom and Royal jelly extraction - Propolis.

Unit 4: Honeybee enemies and diseases *7hrs*

Bee enemies -wax moth, ants, wasps andpests -diagnosis and identification. Bacterial disease - American Foulbrood and European Foulbrood. Viral diseases - Deformed Wing Virus, Sac brood Virus, Black Queen Cell Virus, Kashmir Bee Virus, Acute Bee Paralysis and Virus. Fungal disease - Chalk brood and Stonebrood. Protozoan disease –Nosemosis andNosemacerana.

Unit 5: Honey - its properties and application in various fields **6hrs**

Honey - its medicinal properties - application in various fields - other valuable byproducts of honey bees - value added honey products - properties of honey products - Nutrients and composition of honey -acid content and flavor effects.

Textbook

Ambrose DP (2004) The insect structure, function and biodiversity. Kalyani Publishers, New Delhi

References

Ted Hooper (2010) Guide to Bees & Honey: The World's Best Selling Guide toBeekeeping. Northern Bee Books, Oxford.

Morse, RA and Flottum, K (1998) Honey Bee Pests, Predators and Diseases. Third Edition, WicwasPublishers,.3rd edition.

Cramp, D(2012) The Complete Step-by-step Book of Beekeeping: A Practical Guide to Beekeeping, from Setting up a Colony to Hive Management and Harvesting the Honey. Lorenz Books, London.

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1			3			
CO2		2				
CO3				4		
CO4					5	
CO5	1					

Mean = 3.0

ZOO 122V *Aquarium Fish Keeping* *2hrs / 2cr*

The main objective of the course is to impart knowledge on fish culture and breeding of commercially important ornamental fishes. It gives an overview on the biology of aquarium fishes, fish feed, transportation techniques, entrepreneurship, budget and maintenance of aquarium.

Upon completion of the course the students will be to:

i. Appreciate the basic concepts of aquarium fish keeping.
ii. Understand the biology of aquarium fishes.
iii. Acquire knowledge on the preparation of fish feeds.
iv. Outline the fish transportation techniques.
v. Examine the factors involved in maintenance and management of aquariums.

Unit 1: Introduction to Aquarium Fish Keeping **6 hrs**

Introduction to aquarium keeping and its types- aquarium accessories- basic knowledge on profile of ornamental fishes in world and India- scope of aquarium fish industry as a cottage industry- exotic and endemic species of aquarium fishes.

Unit 2: Biology of Aquarium Fishes *6 hrs*

Common characters and sexual dimorphism of fresh water and marine aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angelfish, Blue morph, Anemone fish and Butterfly fish - breeding and rearing of live bearers.

Unit 3: Food and feeding of Aquarium fishes **5 hrs**

Use of live fish feed organisms- preparation and composition of formulated fish feeds - aquarium fish as larval predator.

Unit 4: Fish Transportation *6 hrs*

Live fish transport- fish handling - packing - forwarding techniques.

Unit 5: Maintenance of Aquarium *7 hrs*

General aquarium maintenance -health management in ornamental fish farming- aquarium plant propagation- management of ornamental aquatic plants and its trading- budget for setting up an aquarium fish farm as a cottage industry.

Textbook

Yadav BN (2006) Fish and fisheries. 4th Edition. Daya Publishing house, New Delhi.

References

Dick Mills, 1987. Illustrated Guide to Aquarium Fishes. Published by Galley and Price, an imprint of W.H. Smith and Sons Limited, England.

Cato JC and Brown CL eds. (2003) Marine ornamental species: collection, culture and conservation. Blackwell Publishing, Ames, Iowa.

ZOO 24

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1			3			
CO2		2				
CO3				4		
CO4		2				
CO5				4		

Mean = 3.0

ZOO 221V *Clinical Lab Techniques* *2hrs / 2cr*

This course provides a comprehensive coverage of the procedures and routine diagnostic tests in a clinical lab. It deals withcollection of biological samples, reagent preparation, storage of chemicals and maintenance of lab records. This course will help the students to acquire knowledge about the biochemical, microbiological and immunological tests in clinical labs and also about the basic biomedical instruments.

Upon completion of this course, the students will be able to:

i. Appreciate the biological sample collection procedures
ii. Explain the composition of blood and routine blood tests in labs.
iii. Outline the reactions involved in identification of infectious microbes in blood & fertility tests
iv. Demonstrate the routine urine tests performed in labs.
v. Outline the basic biomedical instruments available in clinical labs.

Unit 1: Biological sample collection, chemical preparation & storage methods 4 hrs
Collection of urine - sputum - pus- cerebrospinal fluid - swab - eye and ear exudates - blood and stool samples –Phlebotomologicalmethods – BMI - Reagent & buffer preparation, calculations- Storage of chemicals and maintenance of lab records.

Unit 2: Blood tests&Blood group determination 7 hrs
composition of blood - glucose and HbA1c test - Plasma lipids, proteins and lipoproteins, cholesterol, uric acid in blood - Enzymes of clinical importance - cardiac markers - Blood grouping and typing principles.

Unit 3: Urine tests and analysis of miscellaneous fluids 7 hrs
Composition of urine -microscopic examination of urine sediments -rapid chemical tests of urine-Protein & glucose- Cerebrospinal fluid - physical and microscopic examinations - clotting.

Unit 4: Identification of infectious agentsand fertility tests 6 hrs
Identification of bacteria in blood - swab and exudates - culturing pathogenic microbes - antigen antibody reactions - hormonal and Immunologic test for pregnancy - Semen analysis.

Unit 5: Biomedical instruments *6 hrs*
Use of microscopes in cell counting -WBC, RBC, Platelets - Centrifugation- Separation of plasma - Stethoscope, Sphygmomanometer - ECG - EEG - X-ray -Microtome and processing of tissues - PCR and auto analyzer.

Textbook

Mukherjee KL(1990). Medical Laboratory Technology, A procedure Manual for routine diagnostic tests,TATAMcGraw-hill publishing company limited, New Delhi.

References

Sood, R (1988) Medical Laboratory Technology. Jaypee Pub Ltd., New Delhi.
Syrey MF, William JM andElvyn GS (1978) Diagnostic microbiology. The C.V.Mosby Co.

ZOO 26

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1			3			
CO2		2				
CO3				4		
CO4				4		
CO5		2				

Mean =3.0

ZOO 222V *Shrimp culture* *2hrs / 2cr*

Shrimp culture is a vibrant economic activity contributing to agriculture, national economy, nutritional security, employment generation and foreign exchange. This course is vested with responsibilities in guiding and coordinating shrimp culture practices.

Upon completion of this course the students will be able to

i. Gain in depth knowledge and field exposure on sustainable shrimp culture practices.
ii. Learn effective soil and water quality management practices.
iii. Create basic understanding on nutritional requirements of shrimp and feeding practices.
iv. Provide holistic knowledge on shrimp pathogens and their control measures.
v. Familiarize the students with concepts and principles of shrimp farm management and prepare them to exploit business opportunities.

Unit 1: Sustainable Shrimp farming *5 hrs*

Present global and national scenario - Extensive, semi- intensive, intensive and super intensive culture practices - Freshwater, brackish water and marine shrimps - *Penaeus monodon, P. indicus, Macrobrachiumrosenbergii and M.malcolmsonii.*

Unit 2: Anatomy and physiology of shrimp *5 hrs*

Body organization and structure of shrimp - Digestive - respiratory - urinogenital systems - egg and larval stages of development.

Unit 3: Pond construction and water quality management *5 hrs*

Site selection - designing - components and construction of tanks - pump and pipeline systems - water intake and outlet design - aerator and fabrication - water quality analyses.

Unit 4: Feeding and disease management *5 hrs*

Types of feed dry and non-dry - Feeding practices and schedule - feed economics and evaluation (FCR, PER and NPU) - feed additives - Viral, bacterial and fungal pathogens - clinical symptoms, diagnosis and control measures

Unit 5: Harvest, post-harvest technology and marketing management 5 hrs

Harvesting techniques - shrimp grading and quality evaluation - chilling and freezing techniques - packaging and marketing - marketing channels and problems - role of co-operative societies, government and non-government organizations.

Textbook

Rao, PS(1983) Fisheries economics and management in India, Pioneer publishers anddistributors.

References

Bliss, DE (1983) The biology of Crustacea, Vol.1-10, Academic press, New York.

MPEDA (Marine Products Export and development Authority), 1996. A manual of shrimp farming, MPEDA, Kochi, India

CMFRI (1982) Manual of research methods for fish and shell fish nutrition. CMFRI, special publication No.8, CMFRI, Cochin, India.

ZOO 28

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1			3			
CO2						6
CO3			3			
CO4					5	
CO5		2				

Mean = 3.8

ZOO 321V *Fish farming* *2hrs / 2cr*

This course is designed to make the students know about the scope of aquaculture, principle of site selection for fish, preparation of fish pond, Types of fish culture, Integrated fish farming and also cultural organisms, diseases & control measures and marketing.

Upon completion of this course, students will be able to

i. Explain the scope of Aquaculture-Principle of site selection
ii. Analyze the preparation of fish pond
iii. Discuss about the types of fish culture
iv. Evaluate the Integrated fish farming
v. Identify the culturable organisms

Unit 1: Site Selection *6 hrs*

Definition of aquaculture - scope of aquaculture - principle of site selection for fish farms - water - soil types and other parameters

Unit 2:Preparation of fish pond *6 hrs*

Construction of fish farm- liming irrigation fertilization- water quality management

Unit 3: Types of fish culture *6 hrs*

Types of culture-monoculture- composite fish culture- monosex culture- pen culture - cage culture- culture in Pokkalifields - culture in Bheries

Unit 4: Integrated fish farming *6 hrs*

Integrated fish farming - paddy cum fish culture- fish cum poultry farming- fish cum dairy farming - fish cum pig farming

Unit 5: Culturable organisms, diseases and marketing **6 hrs**

Culture of Indian major carps - Tilapia- fresh water prawn culture - marketing of fishes - types of fish marketing - Protozoan and bacterial diseases of fishes - control measures.

Textbook

Gupta.SK and Gupta PC (2006) General and Applied Ichthyology. S. Chand & Co., New Delhi

References

Santhanam, R, Sukumaran, N and Natarajan, P (1990) A Manual of Fresh water Aquaculture. Oxford &IBH Publishing Co. Pvt. Ltd.
Shanmugam, K(1990) Fishery biology and aquaculture. LeoPathippagam, Madras, India.

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1	1	2				
CO2	1	2	3			
CO3	1	2	3			
CO4				4	5	6
CO5			3	4	5	6

Mean 3.2

ZOO 30

ZOO 322V *Dairy Farming* *2hrs / 2cr*

This is a comprehensive course deals mainly with the methods involved in dairy farming. The course covers about the principles of dairy farming in India and importance of milk and products. It also deals with the description of characters of breeds of cattle and buffaloes. Aspects of breeding methods and management of dairy farm also covered.

Upon completion of this course, students will be able to:

i) Summarize the principles and importance of dairy farming in India.
ii) Differentiate the various breeds of cattle, their advantages and disadvantages.
iii) Identify the breeds of buffaloes and their management.
iv) Discuss the various methods involved in breeding of dairy animals.
v) Utilize the methods adopted in the management of dairy farm.

Unit 1: Dairy farming in India *6 hrs*

Dairy development in India - present and future - Nutritive value of milk - Milk and milk products and their role in human nutrition - Dairy Cooperatives - NDRI, NDDB, TCMPF etc.

Unit 2: Breeds of cattle *6 hrs*

Indigenous breeds - Milch /milk breeds-Dual purpose-draught breeds-cross breeds - exotic dairy breeds - advantages and disadvantages

Unit 3: Breeds of buffaloes **6 hrs**

Indian buffalo breeds - Murrah - Jaffrabadi - Nili-Ravi - Mehsana - Surti – Nagpuri. Life span -economic uses of water buffaloes - Breeding and management problems - Nutrition, health and other relevant information about buffalo

Unit 4: Breeding of dairy animals **7 hrs**

Selection methods - Individual, family and sibling selection - economic characters in dairy cattle - System of breeding - classification-advantages and disadvantages - Reproductive system of cow and bull - Artificial insemination - Embryo transfer technology - semen collection and insemination - pregnancy diagnosis - state and national breeding policies

Unit 5: Housing and dairy farm management **5 hrs**

Selection of site - systems of housing - sanitation and cleaning - care and management of calves, heifer, milch, pregnant, bulls and bullocks - Feed formulations- common diseases of dairy animals and their management.

Textbook

Banerjee GC (2019) A text book of animal husbandry. EighthEdition, Oxford and IBH Publishing Pvt. Ltd., New Delhi.

References

Tomar, SS (2010) Text book of animal breeding. Kalyani Publishers, New Delhi.

Kumar, AT (2008) Handbook of animal husbandry. Indian Council of Agricultural Research (ICAR), New Delhi.

Sastry, NSR and Thomas, CK (2005) Livestock production management. Kalyani Publishers, New Delhi

Dairy India (2007) Edited by Sharad Gupta, Dairy India Yearbook Publications, 2007, pp xxiv+840

Mapping of Course Outcomes with Bloom's Taxonomy

	K1	K2	K3	K4	K5	K6
CO1		2				
CO2					5	
CO3				4		
CO4		2				
CO5			3			

Mean = 3.2