

Barasat Government College
M.Sc. (CBCS) Zoology Syllabus (w.e.f 2019-20)

SEMESTER : I

Paper Code	Subject	Marks	Credit	Classes
	<i>Hard Core Theory</i>			
ZHT 101	Non-Chordates – Structure & Function	40	3	
	1. Origin of metazoans 2. Nutrition and Digestion: i) Food and feeding structure and mechanism of feeding and digestion in non-chordates ii) Filter feeding in Polychaeta, Crustaceans, Mollusca and Echinodermata iii) Feeding diversity in insects; symbiotic nutrition. 3. Respiration: i) Organs of respiration: Gills, lungs and trachea. ii) Respiratory pigments, Mechanism of respiration. 4. Excretion: i) Mechanism of Osmoregulation in Protozoa ii) Excretory structures and functions in Helminthes and Annelids, Evolution of nephridia iii) Malpighian tubule: structure and functions in Insects iv) Excretory products 5. Nervous System: i) Primitive Nervous systems : Cnidaria and Echinodermata. ii) Advanced nervous system - Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda). iii) Sense organs and their importance, Chemoreception, photoreception and mechanoreception, animal orientation, compound eye in insects 6. Locomotion: Locomotor organs/ organelles and modes of locomotion i) Amoeboid, Flagellar and Ciliary movement in Protozoa. ii) Principles of Hydrostatic movements in Annelida iii) Locomotion in Arthropods : Insect flight 7. Reproduction: i) Asexual, Sexual, Parthenogenesis, Hermaphroditism ii) Functional variations of reproductive structures in nonchordates iii) Hormones involved 8. Larval forms: Evolutionary significance. 9. Minor phyla: Overview; evolutionary significance			1 2 2 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 1 1 1
	<u>Books Recommended :</u>			
	1. The Invertebrate Vol. I, Protozoa through Ctenophora : Hyman L.H. 2. Invertebrate structure and function : Barrington E.J.W. 3. Evolution of Metazoan life cycle : Jagerstein G.			

	<p>4. The invertebrate Vol. 2 : Hyman L.H. 5. The invertebrate Vol. 8 : Hyman L.H. 6. Invertebrate Zoology : Barnes R.D. 7. Biology of higher invertebrate : Russel Hunter W.D.D. 8. The Invertebrates, smaller coelomate groups. Vol. 5 : Hyman L.H. 9. Animal Parasitism : Read C.P. 10. Kudo R.R. (1966) Protozoology : Charler, C. T. 11. Invertebrates : Barradailes L.A. & Potts F.A. 12. Biology of lower invertebrates : Russel W.D. Hunter 13. Zoology of Invertebrates : Marshall A.J. & Williams W.D. 14. A Functional anatomy of Invertebrates : Gtryyrt V. & Graham A. 15. Principles of comparative anatomy of Invertebrates : Backlemiccher W.N. 16. The Evolution of Metazoa : Hadisi J. 17. Annelids : Dales R.P. 18. Biology of Crustacea : Green J. 19. Mollusca : Morton J. E. 20. Echinodermata : Nichols D. 21. Invertebrate Zoology : Ruppert E. E. & Barnes R.D. 22. Invertebrates : Brusca R.C. & Brusca G.J. 23. Biology of the Invertebrates : Pechenik J.A.</p>			
ZHT 102	<p style="text-align: center;">Chordates – Structure & Function</p> <p>1. Origin of Chordates and their classification 1 2. Characteristic features and affinities of the following: 3 a. Hemichordata b. Cephalochordata c. Dipnoi 3. Vertebrate integument, development, structure of skin in vertebrates. Derivatives of Integument glands, scales, horns, claws, hoofs, feathers & hairs. 3 4. Comparative account of Jaw suspension. 2 5. Evolution of Heart, Aortic arches and Portal system. 2 6. Comparative account of respiratory system and gas bladder: General function and requirements, Aquatic gas exchangers, Ventilation of Internal gills, Aerial gas exchangers, Ventilation of lungs: Nature, Evolution and linkage 2 7. Nerves - Cranial, Peripheral and Autonomous nervous system 2 8. Sense organs: Component of sensory system/Simple receptors, General sensory organ, Special organs: Olfaction, Vomeronasal and Gustatory receptor, Lateral line system and Electroreception in fish 2 9. Flight adaptation in Bird 2 10. Aquatic adaptation in Birds and Mammals. 2</p> <p><u>Books Recommended :</u></p> <p>1. Chordate Structure and Function : Waterman A.J. 2. Chordate Morphology : Jolie M. 3. Vertebrate Body : Romer A.S. & Parson T.S.</p>	40	3	

	<p>4. Setae and Nerve Ring of an annelid</p> <p>C. Identification of non-chordate from museum specimens</p> <p>D. Study of the adaptive features of the nonchordates for their respective modes of life</p> <p style="text-align: center;">Chordates</p> <p>E. Major Dissections :</p> <ol style="list-style-type: none"> 1. Arterial system, venous system, cranial nerves (Vth, VIIth , IXth and X) of teleost 2. Urinogenital system of teleost 3. Arterial system of Rat 4. Accessory respiratory organ of fish <p>F. Minor Dissections & Mounting:</p> <ol style="list-style-type: none"> 1. Weberian ossicle and otolith of carp 2. Fish scales <p>G. Identification of chordates from museum specimens</p> <p>H. Study of the adaptive features of the chordates for their respective modes of life</p> <p>I. Sessional & Viva</p>			<p>1</p> <p>2</p> <p>2</p> <p>3</p> <p>1</p> <p>1</p> <p>2</p> <p>1</p> <p>1</p> <p>2</p> <p>2</p>
ZHL 102	Biochemistry	30	2	<ol style="list-style-type: none"> 1. Preparation of Buffer & pH adjustment 2. Colorimetric/Spectrophotometric Estimation of Glucose, RNA, DNA and protein (Lowry & Bradford method) 3. Determination of effect of substrate concentration and temperature on enzyme activity 4. Volumetric analysis of ammonia/urea 5. Estimation of Haemoglobin content 6. Determination of ESR 7. Sessional & Viva
ZHL 103	Histology & Histochemistry	30	2	<ol style="list-style-type: none"> 1. Microtomy, Tissue preparations from rat/mice and Fixation 2. Histological Staining: Eosin-Hematoxylin, PAS, Trypan Blue & NBT cell viability tests 3. Identification: Bursa of Fabricius, Spleen, Thymus,

	Stomach, Intestine, Tongue, Lungs, Uterus & all other normal tissues			1
	4. Estrous cycle of albino rats			
	5. Sessional & Viva			

SEMESTER : II

Paper Code	Subject	Marks	Credit	Classes
	<i>Hard Core Theory</i>			
ZHT 201	Developmental Biology & Gamete Biology	40	3	
	<p>1. Introduction: Basic concepts of development Potency, Commitment, Specification (autonomous and conditional), Induction, Competence, Determination and differentiation, Morphogenetic gradients, Cell fate and Cell lineages, Genomic equivalence and Cytoplasmic determinants.</p>			2
	<p>2. Techniques for the study of development: Microscopy, Microinjection, Cell sorting, Cell labeling methods.</p>			2
	<p>3. Sex, Gametes and Fertilization: Germ cell determinant and germ cell migration. Gametogenesis: spermatogenesis- phases, cellular changes, Oogenesis: types, stages. Fertilization in mammals: Recognition of gametes and acrosomal reaction , Prevention of polyspermy and gamete fusion, Activation of egg metabolism</p>			4
	<p>4. Cellular Interactions in Development: Nieuwkoop centre and mesodermal polarity. Molecular basis of mesoderm induction. Transcription factors induced in the organizer. Neural induction, Regional specificity of induction, Genetic specificity of induction (Paracrine factors - Hedgehog family, Wnt family, TGF, BMP). Surface receptors and signal transduction pathway - RTK pathway, Smad pathway, Wnt pathway, Hedgehog pathway and cell death pathway.</p>			4
	<p>5. Axis and Pattern Formation in Animals: The genetics of axis specification in <i>Drosophila</i>. (Maternal effect genes, zygotic genes, gap genes, pair rule genes, segment polarity genes; homeotic selector genes, realisator genes). Axis formation in amphibian: Anterior-Posterior patterning in Amphibia. Early Mammalian Development: Mammalian Anterior-Posterior Axis Formation, Dorsal-Ventral and left-Right Axes in Mammals. Organization of Hox gene in vertebrate, Hox code hypothesis.</p>			4

	<p>6. The vertebrate Organizer – The amphibian organizer, Early organizer inducing centers, Organizer’s role, Organizer maintenance.</p> <p>7. Reproductive Technologies - Assisted Reproductive Technologies : Amniocentesis, Sperm and ova bank; Artificial Insemination donor (AID); in <i>vitro</i> fertilization (IVF), procedures, variations of IVF, Success rates and complications; Gamete Intrafallopian transfer (GIFT), Intracytoplasmic sperm Injection (ICSI),- Advantages and disadvantages. Surrogate mothers.</p> <p>8. Teratogenesis - Developmental mechanism of teratogenesis. Contributions of teratology to developmental biology. Teratogens and induced birth defects.</p> <p>9. Stem cell: Embryonic stem cells, Induced pluripotent cells and Adult stem cell and regeneration therapy.</p> <p>10. Metamorphosis, Regeneration and Ageing Metamorphosis in Amphibians and Insects and their hormonal control Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration Ageing – The biology of senescence, Genes and ageing, DNA repair enzymes, Ageing and the insulin signaling cascade, Environmental and epigenetic causes of aging.</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. An introduction to Embryology : Balinsky, B. I. 2. Developmental Biology : Gilbert, S. F. 3. Developmental biology : Muller, W. A. 4. Principles of Development : Wolpert, Tickle, Martinez-Arias. 5. Essential Developmental Biology : Slack J. 6. Instant notes in Developmental Biology : Twyman, R.M. 7. Principles of Developmental Biology : Wilt, F. H. & Hake, S. C. 8. Principles of Developmental Genetics : Moody, S.A. 9. Molecular Principles of Animal Development : Arias, A. M. & Stewart, A. 10. Analysis of Biological Development : Kalthoff, K. 12. Developmental Biology : Berril 			2
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ZHL 202	Cell, Tissue & Molecular Biology	40	3	
	1. Structural organization and function of intracellular organelles: mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum			2
	2. Cytoskeleton structure and dynamics. Function of cytoskeleton and its role in motility.			2

	<p>3. Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle, check points and regulation</p> <p>4. Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation</p> <p>5. Membrane structure and function: Structure of model membrane, membrane fluidity, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes, liposomes</p> <p>6. Epithelial Tissue- Basic Organization, Types, Ultrastructure of Sebaceous Gland.</p> <p>7. Connective Tissue- Basic Organization, Types, Collagen.</p> <p>8. Muscular Tissue- Basic Organization, Types, Muscle Contraction (Molecular Basis)</p> <p>9. Skeletal Tissue- Basic Organization, Types</p> <p>10. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth</p> <p>11. Fundamental processes in cell biology</p> <p>a) DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).</p> <p>b) RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).</p> <p>c) Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).</p> <p>d) Control of gene expression at transcription and</p>			<p>2</p> <p>2</p> <p>3</p> <p>2</p> <p>2</p> <p>1</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
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	<p>translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).</p> <p>12. Apoptosis and Necrosis (definition, features of apoptotic cells, death receptor mediated, mitochondria mediated pathway, reverse apoptosis, engulfment of apoptotic body by macrophages, evasion of apoptosis by cancer, necroptosis, paraptosis, apoptosis and diseases)</p> <p>13. Cell signaling: Hormones and their receptors, cell surface receptor, mobile receptor, signaling through G-protein coupled receptors, signal transduction pathways (RTK and JAK-STAT, SMAD pathways), second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.</p> <p>14. Brief account of genome organization, Prokaryotes, Eukaryotes, Centromere, Telomere, Micro, Mini Satellite, Repetitive DNA, LINES, SINES</p> <p>15. Extracellular organelle-mitochondrial DNA</p> <p>16. Ribozymes</p> <p>17. Molecular Biology and Recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Molecular Cell Biology: J. Darnell <i>et al.</i> 2. Molecular Cell Biology: Lodish <i>et al.</i> 3. Molecular Biology of The Cell: Alberts <i>et al.</i> 4. Cell Biology: Cooper 5. Cell and Molecular Biology: De Roberties and De Roberties 6. Cell and Molecular Biology: G. Karp 7. Molecular Biology: Pollard 			<p>2</p> <p>2</p> <p>1</p> <p>1</p> <p>2</p> <p>2</p>
ZHT 203	<p align="center">Ecological Theories & Applications & Animal Behaviour</p> <p>Ecological Theories & Applications</p> <ol style="list-style-type: none"> 1. Population Ecology : Growth patterns, dynamics, life table, survivorship curve, Doubling time, natality, mortality, age distribution, intrinsic rate of natural increase, oscillation, regulation, dispersal 2. Metapopulation : concept, models, structure and dynamics 	40	3	<p>2</p> <p>2</p>

3. Community Ecology : structure, gradient analysis, niche model, species diversity, ecotone and edge effects, competition			2
4. Ecosystem concept : energy cycle in food web, productivity, impact of climate change; carbon taxing and trading			2
5. System structure and function : Mangrove ecosystem/ Herbivore dominated ecosystem/Freshwater ecosystem /wetland			4
6. Ecology of biological and industrial invasion : Eutrofication, Acidification			1
7. Biodegradation and bioremediation : concept, limitations, model analysis (air/water/soil)			2
8. Waste in ecosystem and management : Agricultural wastes/Biomedical wastes/Domestic wastes			2
Animal Behaviour			
1. Principles of animal behaviour : Conceptual approaches, theoretical approaches, empirical approaches; natural selection, proximate factors, observations by Nika Tinbergen			2
2. Learning : What animals learn? : Individual learning; social learning; Cultural transmission			1
3. Cooperation and conflict, aggression : Home territoriality, dispersal, Male-male competition and sexual selection- Fisher's Hypothesis and Handicap Hypothesis, parent-offspring conflict, range of cooperative behaviour and Prisoner's dilemma			2
4. Habitat selection, Food selection and Foraging theory			2
5. Aspects of socio-biology : social communication; songs and other forms of communication; social dominance, altruism and reciprocal altruism			2
6. Game theory			1
7. Group selection			1
8. Reproductive behaviour : Mating system and Courtship			1
9. Language : Humans as symbolic species; signal content and structure; orientation and cues; semiochemicals			2
<u>Books Recommended :</u>			
1. Ecology : M.L.Cain			
2. Concept of Ecology : E.J.Kormondy			
3. Ecology Principles and applications : J.L.Chapman &			

	Biostatistics			
	1. Biostatistics/Biometry : Definition and utilization in biological studies			1
	2. Basic concepts of : a) Terminologies used in biostatistics : Variable, Population, Data, Sample, Estimate b) Measures of Central Tendency c) Measures of Variation d) Graphical representation of data			4
	3. Hypothesis Testing and Student 't' distribution			2
	4. Probability Distribution – Concept of Probability, Binomial Distribution and Poisson Distribution			3
	5. Simple Linear Regression and Correlation			3
	6. Chi-square test, Student's t-test			3
	7. Analysis of Variance (ANOVA)			1
	8. Models : Definition, Classification, Usefulness			1
	<u>Books Recommended :</u>			
	1. Biophysical Techniques : Fryfelder			
	2. Animal Cell Culture – A Practical Approach : R.W. John (Ed.)			
	3. Introduction to Instrumental Analysis : R. Braun			
	4. A Biologists Guide to Principles and Techniques of Practical Biochemistry : K. Wilson & K. H. Goulding			
	5. Biotechnology : H. D. Kumar			
	6. Practical Biochemistry : Wilson & Wilmer			
	7. Biochemical Calculations : Segel			
	8. Biochemistry & Molecular Biology : W. H. Elliot & D. C. Elliot			
	9. Text Book of Biochemistry with clinical correlation : T. M. Devlin			
	10. Lehninger's Principles of Biochemistry : D. L. Nelson & M. M. Cox			
	11. Biochemistry : L. Stryer			
	12. Biochemistry : Voet & Voet			
	13. Introduction to Mathematics for Life sciences : Batschelet			
	14. Biometry : R. R. Sokal & F. J. Folhlf			
	15. Statistical Methods : G. W. Snedevor & W. G. Cochran			
	16. Biostatistics : D. Das			
	17. Biostatistics : G. Gupta			
	18. Introduction to Biostatistics : P. K. Banerjee			
	19. Biostatistics : P. N. Arora & P. K. Malhan			
	20. Elements of Biostatistics : S. Prasad			
	21. Sampling design and statistical methods for environmental biologist : R. H. Green			

	graphical presentation by EXCEL in Microsoft Office			
	13.Calculation of correlation among height, weight and age.			1
	14.ANOVA			1
	15.Sessional & Viva			
ZHL 203	Seminar	20	1	

SEMESTER : III

Paper Code	Subject	Marks	Credit	Classes
	<i>Hard Core Theory</i>			
ZHT 301	Insect Biology	40	3	
	1. Insect Classification : Major Orders with characters and examples			2
	2. Trophic adaptations in Insects (Terrestrial/Aquatic/High Altitude)			3
	3. Reproductive Strategies in Insects			2
	4. Insect Development and Metamorphosis			3
	5. Concept of Pest Status and Classification of Pesticides			2
	6. Introduction to Major Pests and Vectors of Medical, Veterinary and Agricultural Importance			4
	7. Remote Sensing Techniques in assessing crop damage and protection			1
	8. Methods of Insect Pest Control : Conventional and Non-Conventional; Pest Forecasting			2
	9. Concept of Integrated Pest Management			2
	<u>Books Recommended :</u>			
	1. The Principles of Insect Physiology : V. B.			

	<p>Wigglesworth</p> <ol style="list-style-type: none"> 2. Elements of Entomology : R. Singh 3. Modern Entomology : D. B. Tembhare 4. The Science of Entomology : W. S. Romoser 5. Entomology : C. Gillott 6. General and Applied Entomology : B.V. David & T. N. Ananthkrishnan 7. The Insects : Structure, Function and Biodiversity : D. P. Ambrose 8. A Textbook of Entomology : H. H. Ross, C. A. Ross & J. R. Ross 9. Insect Biodiversity : Functional Dynamics and Ecological Perspectives : T. N. Ananthkrishnan 10. Biology of Insects : S. C. Saxena 11. Text Book of Applied Entomology : K. P. Srivastava 12. Plant Protection Technique : P. B. Chatterjee 13. Entomology And Pest Management : L. P. Pedigo 14. Insect Pest Control : Using Plant Resources : S. Ignacimuthu, s.j. 15. Agricultural Pests of South Asia And Their Management : A. S. Atwal & G. S. Dhaliwal 16. Integrated Pest Management : Concepts and Approaches : G. S. Dhaliwal & R. Arora 17. Elements of Insect Ecology : S. S. Yazdani & M. L. Agarwal 			
ZHT 302	<p align="center">Parasitology, Immunology & Microbiology</p> <p><u>Parasitology</u></p> <ol style="list-style-type: none"> 1. Classification and evolution of parasites (Protozoa—Kinetoplastidan flagellates and Sporozoans, Helminths) and pathogens of humans. 3 2. Host parasite interaction: Molecular, cellular and physiological aspects of host-parasitic interaction. Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behaviour by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells. 3 3. Zoonosis and its significance 1 4. Vector Biology 2 5. Myiasis and its implication 1 6. Parasitic diseases of veterinary, poultry and public health 2 	40	3	

	<p><u>Immunology</u></p> <ol style="list-style-type: none"> 1. Cell and Molecules involved in innate and adaptive immunity. 2. Antigen processing, presentation and MHC 3. Structure and function of antibody molecules, Generation of antibody diversity, Monoclonal antibodies 4. B & T cell Cooperation 5. Inflammation (outline idea) & Hypersensitivity (outline idea). 6. The Complement System 7. Vaccines. <p><u>Microbiology</u></p> <ol style="list-style-type: none"> 1. Classification and biology of Microbes (Bacteria, Virus & Protozoa). 2. Microbial fermentation and production of small and macro molecules. 3. Bioluminescence. 4. Control of Microbes; Antibiotics. 5. Microbial Diseases. 6. Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response) <p><u>Books recommended :</u></p> <ol style="list-style-type: none"> 1. Foundation of Parasitology: Janovy & Roberts 2. Clinical Parasitology: Beaver 3. Parasitology: Cheng 4. Animal Parasitology: Smyth 5. Outlines & Highlights For Human Parasitology : Roberts & Janovy 6. Parasitology : Bogitsh, Carter & Alteman 7. Outlines & Highlights For Human Parasitology : Bogitsh 8. Essentials of Immunology: I. Roitt 9. Immunology: Abbas 10. Immunology: Rao 			<p>1</p> <p>2</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>3</p> <p>4</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
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	<p>11. Schaum Series Immunology</p> <p>12. NMS-Immunology : R. Hyde, Williams & Wilkins</p> <p>13. Basic Immunology : Functions and disorders by Abbas & Litchman</p> <p>14. Kuby's Immunology : Goldsby, Kindt & Osborn, W.H. Freeman</p> <p>15. Instant Notes of Immunology : P.M. Lydyard <i>et al.</i></p> <p>16. Microbiology : Prescott, Harley & Klein</p> <p>17. Microbiology : Pelczar <i>et al.</i></p> <p>18. General Microbiology : H.G.Schlegel</p> <p>19. Introduction to Microbiology : A.S.Rao</p> <p>20. General Microbiology : S.B.Sullia & S. Shantharam</p> <p>21. A Textbook of Microbiology : R.C. Dubey & D.K. Maheshwari</p> <p>22. Instant Notes of Microbiology : J. Nicklin <i>et al.</i></p>			
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ZHT 303	Fish Biology	40	3	
	1. Classification of fishes: Principles of classification, Detailed study of major fish orders: Cypriniformes, Clupeiformes, Ophiocephaliformes, Perciformes, Mastacembeliformes.			2
	2. Evolution of fishes: Origin and evolution of major groups of fishes, Evolutionary strategies and morphological innovation. Extinct fish groups. Living fossils of fishes.			2
	3. Form and locomotion: Body form, Type and origin of fins, Swimming mechanism and buoyancy regulation			2
	4. Anatomy and Physiology of Fishes: i) Digestive and Respiratory System: Structure and physiology of digestive and respiratory system of fin fishes. Associated digestive gland and their functions. Aquatic and aerial respiratory mechanisms. Evolutionary significance of accessory Respiratory Organ.			3
	ii) Circulatory and Excretory System: Hematology of fin fishes. Cardiovascular physiology of fishes. Gas transport, Acid balance, Nitrogen excretion and metabolism. Osmoregulation of fin fishes.			3
	iii) Reproductive and Endocrine System: Reproductive strategies, Types of reproduction, parental care, breeding cycle. Endocrine glands (Pituitary and Thyroid) and their hormonal regulation.			3
	5. Fish migration: Types, regulation and Significance.			2
	6. Poisonous and venomous fish, Electric organs and Bioluminescent organs			2
	Books Recommended :			
	1. Physiology of fishes, Vols. 1 and 2 : Brown M.E.			
	2. Fish Physiology, Vols I : Hoar W.S. & Randall O.J.			
	3. Ichthyology : Lagler K. F., Bardach J.E. Miller R.R. & May Passino, D.R.			
	4. A History of Fishes : Norman & Greenwood			
	5. A textbook of Fish Biology and Fisheries : Khanna S.S. & Singh H.R.			
	6. A Textbook of Fishery Science and Indian Fisheries: Srivastava C.B.L.			
	7. The Physiology of Fishes : Evans D. H.& Claiborne J. D.			

	8. Biology of Fishes : Bone, Q. Moore R. 9. Biology of Fishes Bond, C.E. 10. The Senses of Fish Adaptations for the Reception of Natural Stimuli : von der Emde R., Mogdans J. & Kapoor B. G. 11. The Freshwater Fishes of the Indian Region : Jayaram K. C. 12. Fish and Fisheries of India : Jhingran V. G.			
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	<i>SOFT CORE THEORY (Any Two)</i>			
ZST 301	Environmental Physiology	25	1	
	1. Historical review of human impact on environment.			1
	2. Stress and strain, principles of animal responses to environment.			1
	3. Animal response to stress environments- Osmoregulation in fish, water conservation in desert animals; diapause, hibernation and aestivation, animal responses to high altitude and deep sea environment.			3
	4. Reproductive and life style adaptations a) Breeding patterns: continuous and discontinuous. b) Factors controlling reproductive pattern: a) proximate and b) ultimate factors.			2
	5. Nutritive adaptations: a) Nutrition in benthic environment. b) Coral-microalgal symbiosis.			2
	6. Endocrine disruptors: a) Endocrine disruption hypothesis, environmental disruptors. b) Mechanism of endocrine disruption, environmental consequences.			2
	<u>Books Recommended :</u>			
	1. Animal Physiology : Mechanisms and Adaptation : R. Eckert			
	2. Animal Physiology: From genes to organisms : Sherwood, Klandorf & Yancey			
	3. Biochemical Adaptation : P. W. Hochachka & G. N. Somero			
	4. General and Comparative Animal Physiology : W. S. Hoar			
	5. Animal Physiology : Adaptation and Environment : Schmidt-Nielsen			
	6. Physiology : A Regulatory System Approach : F. L.			

	<p>Protection & Formation: Erosion Control, Nutrient Cycling, Water Regulation & Supply, Disturbance Regulation</p> <p>5.2.2. Provisioning Services : Oxygen, Food, Fuel, Wood & Non Wood Products, Biodiversity & Bioresources,</p> <p>5.2.3. Supporting Services : Nutrient Cycling, Biologically Mediated Habitats, Maintenance of Wildlife Habitats</p> <p>5.2.4. Cultural Services : Inspirational, Recreation & Tourism, Science & Education [Traditional Resource Uses] & Spirituality</p> <p>6. Land Use Change Decisions</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Ecosystem Services : Global Issues, Local Practices S. Jacobs, N. Dendoncker & H. Keune (Eds.) 2. Valuing Ecosystem Services : Toward Better Environmental Decision-Making. 3. Ecosystem Services – Concept, Methods and Case Studies : K. Grunewald & O. Bastian (Eds) 4. Ecosystem Services: From Concept to Practice. Jetske A. Bouma & Pieter J. H. van Beukering (Eds.) 5. Bosland: Application of the Ecosystem Services Concept in a New Style of Forest Management. P. Vangansbeke, L. Gorissen & K. Verheyen. Ecosystem Services. http://dx.doi.org/10.1016/B978-0-12-419964-4.00041-X 2014. Elsevier Inc. 6. Ecosystem services: Key concepts and applications. 2010. Department of the Environment, Water, Heritage and the Arts, Canberra. Commonwealth of Australia. Occasional Paper Series No. 1 : 26. 			<p>1</p> <p>1</p> <p>1</p> <p>1</p>
ZST 303	<p align="center">Toxicology</p> <ol style="list-style-type: none"> 1. Toxicity <ol style="list-style-type: none"> 1.1 Acute and chronic effects; factors influencing toxicity 1.2 Route of exposure; dose response relationship 1.3 Food additives and contaminants 1.4 Hepatotoxicity, neurotoxicity, genotoxicity, reproductive toxicity and immunotoxicity 1.5 Teratogenesis and carcinogenesis 2. Toxins <ol style="list-style-type: none"> 2.1 Microbial toxins 2.2 Mycotoxins; algal toxins; fungal toxins 2.3 Plant and animal toxins 2.4 Bioaccumulation and biomagnifications 	25	1	<p>2</p> <p>2</p>

	<p>3. Xenometabolism</p> <p>3.1 Cytochrome P450</p> <p>3.2 Phase I reaction and Phase II reaction</p> <p>3.3 Metabolism of drug, pesticide, toxin; compartment model</p> <p>4. Dimensions of toxicological study</p> <p>4.1 Ecotoxicology with relation to heavy metal and pesticide toxicity</p> <p>4.2 Industrial toxicology, sewage management</p> <p>4.3 Forensic and Clinical Toxicology</p> <p>4.4 Biomonitoring and biomarker study</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. A Text book of Modern Toxicology : E. Hodgson 2. Developmental Immunotoxicology : S.H.Holladay 3. The Handbook of Biomarkers : K.K.Jain 4. Biomarkars for Antioxidant Defense and Oxidative Damage : Aldini et al. 5. Ecotoxicological Testing of Marine and Freshwater Ecosystems : Emerging Techniques, Trends and Strategies : Besten <i>et al.</i> 6. Wildlife Toxicology : Emerging Contaminant and Biodiversity Issue : Kendall <i>et al.</i> 7. Physiological approach to the lower animals : J.A. Ramsay 8. A Text Book of Environmental Studies : Chatwal & Sharma 9. Physiological Animal Ecology : G.N.Louw 10. Animal and Temperature : Phenotypic and Evolutionary Adaptation : I.A.Johnston 11. Physiological Ecology : An Evolutionary Approach to Resource Use : C.R. Townsend 12. Environmental Physiology : P.G. Willmer & I. Johnston 13. Principles of Environmental Toxicology: I. C. Shaw & J. Chadwick 14. Basic Environmental Health : A. Yassi, T Kjellstom, T. de Kok, T. Guidotti 15. Environmental Health : M. T. Morgan 16. Handbook of Environmental Health and Safety – Principle and practices : H. Koren 17. Living with the Earth: Concepts in Environmental Health Science (2 nd Ed.): G. S. Moore 18. Principles of Ecotoxicology. 2 nd Ed. : C.H. Walker, S.P. Hopkin, R.M. Sibly & D.B. Peakall 19. Environmental Biology and Toxicology : P.D. Sharma 20. Environmental Pollution and Toxicology : M. Asthana and D.K. Astana 21. Text book of Preventive and Social Medicine : J.E. 			<p>2</p> <p>6</p>
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	Park & K. Park 22. Environmental Epidemiology: A. Basheer			
ZST 304	<p style="text-align: center;">Wildlife & Management</p> <ol style="list-style-type: none"> 1. Indian Wildlife – Their importance and Conservation Status : Basic concepts , importance, wildlife wealth of India, threats to Indian wildlife, threatened wildlife, Red Data Book & IUCN Red List of threatened animals, aims & objectives of wildlife conservation, modes of conservation(<i>In-Situ</i> & <i>Ex-Situ</i>), necessity for wildlife Conservation 2. Wildlife Habitat Ecology : Concept of Biome, Biomes of the World – An Overview, Biomes Types of India, Biogeographic zones of India 3. Protected Area Concept : Types of Protected Areas in India, Concepts of Biosphere Reserve, Concept of Corridor, UNESCO World Heritage Site, Concept of Joint Forest Management (JFM) 4. Management of Wildlife : Distribution, status, habitat utilization pattern, threats to survival of : Himalayan Salamander, Olive Ridley Turtle, Great Indian Bustard, White-Rumped Vulture, Himalayan Musk-Deer, Nilgiri Tahr 5. Special Management Programme of Wild Animals in India : Project Tiger, Project Elephant, Operation Rhino, Lion Conservation Project, Crocodile Conservation Project 6. Man and Wildlife : Human-Wildlife conflict in India : Human –Elephant Conflict, Human-Tiger Conflict 7. Wildlife Trade : Assessment, Documentation & Preventive Measures 8. Wildlife Legislation : Administrative Measures and Laws : National Acts related to wildlife conservation, important convention for wildlife conservation, Leading organizations, institutes and NGO’s of India in conservation initiatives <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Wildlife Biology – An Indian Perspective : G. K. Saha & S. Mazumdar 2. A Primer of Conservation Biology : R. B. Primack 3. Conservation Biology : A Primer for South Asia : K.S. Bawa, R. B. Primack & M. A. Oommen 	25	1	4 2 2 4 4 2 2 3

	<i>Hard Core Lab</i>			
ZHL 301	<p style="text-align: center;">Entomology & Fisheries</p> <ol style="list-style-type: none"> 1. Key preparation of common insects 2. Identification of economically important insects 3. Estimation of diversity of soil micro-arthropods by Tullgren funnel 4. Techniques of insect control measure : Knapsack sprayer 5. Key preparation of common fishes 6. Identification of important fishes 7. Morphometric measurement of fish 8. Sessional & Viva 	40	2	<ol style="list-style-type: none"> 1 2 1 1 1 2 1
ZHL 302	<p style="text-align: center;">Parasitology, Immunology & Microbiology</p> <ol style="list-style-type: none"> 1. Identification of parasites and microbes 2. Fixation, Staining and Identification of Fish Parasites 3. Culture of a bacteria and counting of Colonies 4. Antigen-Antibody Interaction (Haemoagglutination assay) 5. Identification of Immunological tissues 6. Slide Agglutination Test 7. Demonstration of Immunization processes – Ip 8. Immunization Protocol Demonstration of Thioglycolate induced peritonitis (cell infiltration and inflammatory exudates) 9. Isolation and preparation of rat/mice peritoneal macrophages 10. Sessional & Viva 	40	2	<ol style="list-style-type: none"> 2 2 2 2 2 2 2 2 2
	<i>Elective Theory</i>			
ZET 301	<p style="text-align: center;">Ecology & Environmental Biology</p> <ol style="list-style-type: none"> 1. Ecology and the Ecosystems <ol style="list-style-type: none"> 1.1 Biotic and abiotic components 1.2 Concept of Energy flow 1.3 Food chains, Food webs and Ecological pyramids 1.4 Importance of Trophic level and Trophic level score 1.5 Concepts of production/productivity, biomass and standing crop 2. Population Ecology <ol style="list-style-type: none"> 2.1 Basic concepts & characteristics of Population 2.2 Niche and guild concept, Gause's principle, Co-existence 2.2 Population Fluctuations/Dynamics 2.3 Reproductive Strategies of Population : r & K Selections 	50	4	<ol style="list-style-type: none"> 3 4

2.4	Population Control : Extrinsic and Intrinsic Factors			
3.	Community Ecology			6
3.1	Characteristics, Composition, Structure of Community			
3.2	Community Dynamics (Ecological Succession), Ecotone (edge effect)			
3.3	Ecosystem development, Climax concept in succession			
3.4	Concept of Metapopulation : Demes and dispersal, interdemic extinctions, age structural population			
3.5	Competition theory, Predation, herbivore and parasitism, coevolution and mutualism			
3.6	Life tables and fecundity tables, Sociality, mating system and mate choice, sex ratio and fitness			
4.	Biodiversity Degradation and Conservation			3
4.1.	Species loss and ecosystem loss			
4.2	Recovery and remediation of biodiversity			
4.3	Convention on Biodiversity			
5.	Natural Resources and Management			4
5.1	Global environment picture			
5.2	Human population expansion and its causes			
5.3	Effect of human population expansion on natural resources			
	a) Water resource management			
	b) Soil degradation and its conservation			
	c) Food – i) Hunger, malnutrition and famine			
	ii) Genetically modified food – promise and problems			
6.	Energy Resources			3
6.1	Conventional and non-conventional sources			
6.2	Renewable Energy : Promise of solar energy			
6.3	Indirect solar energy			
6.4	Biomass based energy (Biofuel) for transportation			
6.5	Additional renewable energy options			
	<u>Books Recommended :</u>			
1.	Ecology : M.L.Cain			
2.	Concept of Ecology : E.J.Kormondy			
3.	Ecology Principles and applications : J.L.Chapman & M.J.Reiss			
4.	Ecology : M.Begon, C.R.Townsend, J.L.Harper			
5.	Ecology : Recliffs and Miller			
6.	Ecology : J.Krebs			
7.	Ecology : N.S. Subrahmanyam 7 A.V.S.S. Sambamurty			

	8. Fundamentals of Ecology : M.C.Dash 9. Ecology and Environment : P.D. Sharma 10. Environment – Problems & Solutions : D.K.Asthana & M. Asthana 11. An Introduction to Environmental Studies : K.P. Srivastava 12. Fundamentals of Environmental Science : Dhaliwal <i>et al.</i> 13. Environmental Science : T.K.Khan			
	<p style="text-align: center;">Parasitology & Immunology</p> 1. Human diseases caused by Virus (polio, avine influenza) Bacteria (cholera, tuberculosis), Fungi (ringworm) 2. Metabolism (Carbohydrate, Protein) of Protozoa and Helminthes 3. Ultrastructure & Life cycle pattern of important Protozoa and Helminthes (Viz., <i>Entamoeba</i> , <i>Giardia</i> , <i>Leishmania</i> , <i>Trypanosoma</i> , <i>Fasciola</i> , <i>Taenia</i> , <i>Ascaris</i>) 4. Epidemiology – epidemiology of malaria, Leishmaniasis, filariasis. 5. Toll-like receptors, cell-mediated effector functions 6. Vectors and its importance in transmission of parasites. 7. Nosology with respect to Protozoa & Helminthes. 8. Antigen-Antibody reaction and its role in clinical parasitology; common methods like GDP, CIEP, ELISA, immunoblot, IFA, Flow-cytometry, MCAB etc. 9. Hypersensitivity (Type I, II, III, IV) <u>Books Recommended :</u> 1. Outlines & Highlights For Human Parasitology : Roberts and Janovy 2. Parasitology : Bogitsh, Carter and Alteman 3. Outlines & Highlights For Human Parasitology : Bogitsh 4. NMS-Immunology : R. Hyde, Williams and Wilkins 5. Basic Immunology : Functions and disorders : Abbas and Litchman 6. Kuby’s Immunology by Golds : Kindt and Osborn	50	4	6 4 7 3 1 1 2 4 4
	<p style="text-align: center;">Entomology</p> <p><u>Insect Organization & Physiology</u></p> 1. Classification & Identification of economically important insect orders / Taxonomic characterization of insects (upto family) 2. External Morphology	50	4	2

2.1	Integument-structure, types, cuticle formation and functions			2
2.2	General structure and appendages : Head, Thorax and Abdomen			2
3.	Insect Flight and Migration			3
4.	Anatomy and Physiology			
4.1	Feeding and Digestion : Modes of feeding and digestion, Strategies of food finding and recognition, Social feeding, Food storage, Role of microorganisms in digestion			4
4.2	Excretion in insects : Ultra structure of Malpighian tubule, Crypyonephridial condition, Physiology of excretion, water and salt balance in insects			2
4.3	Accessory Respiratory Organs			1
4.4	Circulatory System : Structure and Physiology of circulation, Haemolymph- Composition, Types and Functions of Haemocytes, Insect Immunity			2
4.5	Reproduction & Development : Structure of Male and female reproductive organs in insects, Types of ovariole, Mechanism of sperm transfer, Embryogenesis, Special forms of embryonic development (oviparity, ovoviviparity, parthenogenesis, paedogenesis); metamorphosis and eclosion			4
4.6	Endocrine Organs and Hormones/ Chemical coordination : Endocrine System : Endocrine organs and their functions, Hormone sources, Neuro-endocrine integration; Insect Allelochemicals and semiochemicals			3
4.7	Nervous and Sensory System : Components of nervous system; Mechanoreception; Chemoreception; Sound production- Structures, mechanisms and significance; Photoreception-Types, structure of compound eyes and image formation; Light production-Structure, mechanism and significance			6
5.	Insect-plant interaction			2
<u>Books Recommended :</u>				
1. Principal of Insect Morphology : R.E.Snodgrass				
2. Imms General Text Book of Entomology : O. W. Richards & R. G. Davies				
3. The Insects : Structure & Function : R.F.Chapman				
4. The Principles of Insect Physiology : V. B. Wigglesworth				
5. Borror and DeLong's Introduction to the Study of Insects : C. A. Triplehorn & N. F. Johnson				
6. An Outline of Entomology : P. J. Gullan & P. S. Cranston				

	<p>7. Elements of Entomology : R. Singh 8. Modern Entomology : D. B. Tembhare 9. The Science of Entomology : Romser & Stoffolans 10. Entomology : C. Gillott 11. Entomology : Romoser 12. The Insects : Structure, Function and Biodiversity : D. P. Ambrose 13. A Textbook of Entomology : H. H. Ross, C. A. Ross & J. R. Ross 14. Insect Biodiversity : Functional Dynamics and Ecological Perspectives : T. N. Ananthkrishnan 15. Text Book of Applied Entomology : K. P. Srivastava 16. Entomology And Pest Management : L. P. Pedigo 17. Introduction to General and Applied Entomology : V. B. Awasthi 18. General and Applied Entomology : B.V. David & T. N. Ananthkrishnan 19. Encyclopedia of Entomology : J. L. Capinera</p>			
	<p style="text-align: center;">Cytogenetics & Molecular Biology</p> <p>1. Inheritance Biology A) Mendelian principles: Dominance, segregation, independent assortment. 1 B) Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests 1 C) Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. 2 D) Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. 2 E) Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. 2 F) Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. 2</p> <p>2. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth, chemical carcinogenesis, angiogenesis 2</p> <p>3. Fundamental processes in cell biology a) DNA replication, repair and recombination (Unit of 2</p>	50	4	

	<p>replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).</p> <p>b) RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).</p> <p>c) Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).</p> <p><u>Books Recommended:</u></p> <ol style="list-style-type: none"> 1. Molecular Cell Biology: J. Darnell <i>et al.</i> 2. Molecular Cell Biology: Lodish <i>et al.</i> 3. Molecular Biology of The Cell: Alberts <i>et al.</i> 4. Cell Biology: Cooper 5. Cell and Molecular Biology: De Roberties and De Roberties 6. Cell and Molecular Biology: G. Karp 7. Molecular Biology: Pollard 8. Gene VIII: Lewin 9. Molecular Biology Of The Gene: Watson 			<p>2</p> <p>2</p>
	<p style="text-align: center;">Aquaculture & Fisheries</p> <ol style="list-style-type: none"> 1. Aquaculture : definition, scope and importance 2. Food fishes and their economic importance Indian Major carps: <i>Catla catla</i>, <i>Labeo rohita</i>, <i>Cirrhinus mrigala</i> Exotic carps: <i>Hypophthalmichthys molitrix</i>, <i>Ctenopharyngodon idella</i>, <i>Cyprinus carpio</i> Cat fishes: <i>Clarias batrachus</i>, <i>Heteropneustes fossilis</i> Other groups: <i>Anabas testudineus</i>, <i>Channa striatus</i>, <i>Etroplus suratensis</i> 3. Concepts of different systems of freshwater aquaculture: Monoculture; Polyculture/ composite fish farming; Integrated fish farming; Cage culture; Pen culture; extensive, intensive, semi-intensive and Traditional systems of fish farming. 4. Hybridization and genetic manipulation in fishes; Basic concepts of Selective breeding (Intergeneric, 	50	4	<p>1</p> <p>2</p> <p>3</p> <p>3</p>

	<p>interspecific); Ploidy manipulation, Androgenesis, Gynogenesis, Transgenesis: Transgene delivery, integration, expression</p> <p>5. Induced breeding in carps and catfishes: Hypophysation technique, Ecological requirements for induced breeding ;Concept of Bundh breeding and synthetic hormones</p> <p>6. Coldwater fishery: Definition, characteristics of coldwater bodies, major genera of coldwater fishes, adaptation of coldwater fishes</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Aquaculture Bardach J. E. & Ryther J. H. 2. Biotechnology & Genetics in Fisheries and Aquaculture : Beaumont A. R. & Hoare K. 3. Biology of Fishes: Bond C. E. & Chakrabarti N. M. 4. The Physiology of Fishes : Evans D. H. 5. Fish and Fisheries of India : Jhingran V. G. 6. Aquaculture : Pillay T. V. R. 7. Textbook of Fish : Reddy P. V. G. K., Ayyappan S., Thampy D. M. & Krishna, G. 8. Fish Biology : Srivastava, C. B. L. 			3
				2
	<i>Elective Lab</i>			
ZEL 301	Ecology & Environmental Biology	40	3	
	<ol style="list-style-type: none"> 1. Assessment of habitat quality – terrestrial and aquatic system <ol style="list-style-type: none"> a) Free CO₂, Dissolved O₂, Hardness, alkalinity and salinity b) Biological Oxygen Demand of Water 2. Preparation of vermibeds and vermicast collection 3. Evaluation of LC₅₀/LD₅₀ of a toxicant by Probit analysis 4. Evaluation of effect of toxicant on tissues – Histochemical and biochemical changes 5. Ecological comment on blood and gut parasites 6. Visit to Waste water treatment plant/Thermal Power plant 7. Sessional & Viva 			5
				2
				2
				4
				2
	Parasitology & Immunology	40	3	
	<ol style="list-style-type: none"> 1. Post Mortem Investigation of invertebrates & vertebrates for protozoan, helminthes, arthropods and ectoparasites; their fixation, preservation, staining & mounting 2. Cell counting and cell viability-Cytotoxicity Analysis: Microscopy/Hemacytometer 			4
				4

	3. Animal Handling and - Mouse Handling / Injection of Antigen			2
	4. Preparation of serum and Isolation of Spleen, Thymus and Bone marrow cells.			2
	5. Sessional & Viva			
	Entomology	40	3	
	1. Insect diversity, Collection, Preservation and Identification			2
	2. Identification of body parts (Mounting) : antenna, mouth parts, legs, wings, sting, aedagus, etc.			2
	3. Dissection of digestive system of some selected insects			2
	4. Dissection of nervous system of some selected insects			2
	5. Dissection of reproductive system of some selected insect			2
	6. Identification of insect tissues			1
	7. Slide preparation of insect haemolymph to identify different types of haemocytes			1
	8. Isolation of soil insects using Tullgren Funnel/Berlese Funnel and Identification			2
	9. Submission of insects from representative orders (at least from 10 different orders)			
	10. Sessional & Viva			
	Cytogenetics & Molecular Biology	40	3	
	1. DNA isolation (from blood or tissue)			2
	2. Gel Electrophoresis, Staining and analysis of DNA concentration,			2
	3. Elusion of DNA from gels			2
	4. Purification of DNA			2
	5. PCR			2
	6. Plasmid DNA isolation			2

	Aquaculture & Fisheries	40	3	
	1. Collection and Identification of commercially important fishes- Inland and marine waters			2
	2. Studies of life histories of cultivated freshwater fishes, preparation and mounting of the various stages and their identification.			2
	3. Pituitary gland extraction and its preservation.			2
	4. Survey of aquatic plants, their collection and identification.			
	5. Field Visit to a local fish farm / Institute for study of aquaculture and training.			
	6. Sessional and Viva			

SEMESTER : IV

Paper Code	Subject	Marks	Credit	Classes
	<i>Hard Core Theory</i>			
ZHT 401	<p style="text-align: center;">Taxonomy, Biodiversity & Conservation Biology</p> <p><u>Taxonomy :</u></p> <ol style="list-style-type: none"> 1. Taxonomic Categories : Species and Supra- and Infra Specific Categories 2. Taxonomic Characters : Kinds, Measurements, Weighting and Analysis 3. Phenetic and Cladistic Schools : Numerical Taxonomy : Analysis, Methodology; Construction of Phenogram and Cladogram; Polarity decision; Parsimony; Out group comparison; Phylogenetic groups : Monophyly, Paraphyly, Polyphyly; Determination of Genetic Distance 4. Phylogenetic Trees : Understanding Phylogenetic Trees; Kinds of Phylogenetic Trees 5. Trends in Taxonomy : Cytotaxonomy, Chemotaxonomy, Molecular Taxonomy; Basics of Barcoding, Applications of DNA Barcode, Constraints of DNA Taxonomy; Parataxonomy 6. ICZN – its operative principles, interpretation and application of important rules, Zoological Nomenclature 7. Procedures and Keys in taxonomy : Taxonomic Collections, Preservation, Curating, Process of identification; Taxonomic Keys : Types and their merits and demerits; Taxonomic publications; Types and Process of Typification 8. Limitations of Biological Species Concept : Agamospecies. Dimensions of Species 9. Significance of Taxonomy <p><u>Biodiversity & Conservation Biology</u></p> <ol style="list-style-type: none"> 10. Definition and indices of biodiversity 	40	3	<p>1</p> <p>1</p> <p>2</p> <p>1</p> <p>2</p> <p>1</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p>

11. Levels of biodiversity : genetic, species and ecosystem			1
12. Values and uses of biodiversity			1
13. Megadiversity and hotspots of biodiversity			1
14. Threats to biodiversity			1
15. Problem of genetic diversity loss over time			1
16. Genetic drifts including dispersion, effective and minimum viable population size, measurements of variation			1
17. Review risks of biodiversity extinctions, extinction vortex			1
18. Dynamic and spatial uncertainties, population fragmentation and metapopulation, level of genetic variation in metapopulation, metapopulation and extinction			2
19. Diversity in biogeographical regions and marine forms, theories on biodiversity dispersion			1
20. Rationale for wildlife conservation			1
21. Classification of wildlife according to severity of threats, CITES, WWF, BLI, IUCN, BNHS, IOBP, WLI			2
22. Laws, Policies and Institutions for Conservation (Biodiversity Act, Forest Protection Act, Wildlife Protection Act)			2
23. Models of wildlife management and conservation with special emphasis on Eastern Himalaya, Terai Wildlife & Sundarban Biosphere Reserve			2
24. In situ and Ex situ conservation, prospects and limitations			1
25. Socio-economic perspective of wildlife conservation.			1
<u>Books Recommended :</u>			
1. Principles of Systematic Zoology : E. Mayr			
2. Principles and Techniques of Contemporary Taxonomy : D. L. J. Quicke			
3. Principles of Systematic Zoology : E. Mayr & P. D.			

	<p>Ashlock</p> <ol style="list-style-type: none"> 4. Animal Taxonomy : V.C. Kapoor 5. Principles of Animal Taxonomy : A. Verma 6. Molecular Systematics : Li & Graur-Sinaeur Associates 7. Biodiversity : Krishnamoorthy 8. Biodiversity : Principles and Conservation : U. Kumar & M. J. Asija 9. Biodiversity : Swaminathan 10. Biodiversity : K. C. Agrawal 11. Biodiversity : Perception, Peril and Preservation : Maiti & Maiti 12. Biodiversity : Wilson 13. Global Biodiversity Assessment : UNEP 14. Ecology : Chapman & Reiss 15. Ecology : Ricklefs & Miller 16. Biodiversity & Conservation : M. J. Jeffries 17. A Primer of Conservation Biology : R. B. Primack 18. Conservation Biology : A Primer for South Asia : K. S. Bawa, R. B. Primack & M. A. Oommen 			
ZHT 402	<p>Evolutionary Biology & Population Genetics</p> <p><u>Evolutionary Biology :</u></p> <ol style="list-style-type: none"> 1. RNA world and origin of life 2. Genome Evolution : i) Evolution of Multigene Family, ii) Acquisition of new genes : Mechanisms and Exon Theory 3. Concerted Evolution and Molecular Drive 4. Emergence of Non-Darwinism : Neutral Hypothesis, Molecular clock 5. Speciation : Biological and Phylogenetic species concept, Patterns and Mechanisms of reproductive isolation; Genetic basis of Reproductive isolation; Models of Speciation : Allopatric, Parapatric, Sympatric 6. Macro evolution : Concepts, Phylogenetic gradualism, Punctuated equilibrium and Gold's hypothesis; Major trends in the origin of higher categories. 7. Emergence of land vertebrates 8. Origin and evolution of primates and man 	40	3	

	<p><u>Population Genetics :</u></p> <ol style="list-style-type: none"> 1. Variation : Causes of Genetic variation in the natural population, Genetic polymorphism, Measures of Genetic variation 2. Allele frequencies and Equilibrium : Hardy-Weinberg law – Assumption, Derivation & Application in population genetics, Equilibrium at two or more loci and X-linked loci 3. Destabilizing forces influencing allele frequencies <ol style="list-style-type: none"> i) Mutation & Estimation of mutation rates ii) Natural Selection : Gametic selection, Selection against recessive and recessive lethal, Selection against dominant, Heterozygote advantage iii) Migration iv) Genetic drift, Mutation-drift balance v) Mutation-Selection balance 4. Genetic structure of population : Optimum phenotype, Selection pressure, Fisher’s Theorem of Natural Selection, Canalization, Genetic Homeostasis, Genetic load, Genetic death, Mutational load 5. Inbreeding : Measures of inbreeding, inbreeding depression, Heterosis 6. Quantitative traits : Polygenic concept, Genotype-environment interaction, phenotypic variance, Heritability & its estimation, Quantitative trait loci. <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Evolutionary Biology : D. J. Futuyma 2. Evolution of vertebrates : E. H. Colbert 3. Introduction to Evolution : P. A. Moody 4. Evolution : Strickberger 5. Evolution : Bowler 6. Evolution : Ridley 7. Evolution and the diversity of life : E. Mayer 8. Genes & Evolution : Jha 9. Evolution & Genetics : Merrel 10. Evolutionary Genetics : M. Smyth 11. Molecular Evolution : Li & Graur 12. The Cambridge encyclopedia of Human evolution : Jones <i>et al.</i> 13. Sociobiology : Wilson 14. Species Evolution : Max King 15. Organic Evolution : V. B. Rastogi 			<p>1</p> <p>2</p> <p>2</p> <p>2</p> <p>1</p> <p>1</p>
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ZHT 403	Applied Biology & Biotechnology	40	3	
	<u>Applied Biology</u>			
	1. Cell and animal tissue culture			1
	2. Microbial fermentation and production of small and macro molecules; food-borne diseases			3
	3. Soil micro arthropods : types and their role in soil formation and soil fertility			1
	4. Vector Biology : Resurgence of Malaria, Major malaria vectors of India : their distribution, bioecology, potentiality and present susceptibility status			2
	5. Bioremediation and Phytoremediation			1
	6. Biosensors			1
	7. Vaccine development			1
	8. Modern hatcheries and management			1
	9. Organic farming : Organic farming in fish culture; Vermiculture : Vermicomposting, vermireactors; biogas production			2
	<u>Biotechnology :</u>			
	10. Biotechnology in Live stock manipulation : Fish breeding, hybridization, sex reversal, polyploidy			1
	11. Genetic Engineering; cloning strategies and application			1
	12. Transplantation Biology			1
	13. Forensic Entomology			1
	14. Medical Biotechnology : Disease diagnostic markers, gene therapy, mechanism of gene therapy (antisense, virus mediated, immunotherapy and stem cell therapy), drug delivery and targeting, forensic biotechnology			2
	15. Nanotechnology and radiation biology : concepts and application			1

	<p><u>Books recommended :</u></p> <ol style="list-style-type: none"> 1. Applied Zoology : N.Arumugam, T.Murugan, J. J. Rajeswar, R. Ram Prabu 2. Animal Cell Culture and Technology : M. Butler 3. Development of Vaccines : From discovery to clinical testing : Singh & Sreevastab 4. Concept of vaccine development : S.H.E. Kaufmann 5. Current concept of Forensic Entomology : Amnotdt, Goff, Campobasso, Grasdberger 			
	<i>Soft Core Theory</i>			
ZST 401	<p style="text-align: center;">Economic Zoology</p> <ol style="list-style-type: none"> 1. Apiculture : Species of Honey bees, Social organisation of Honey bee, Life history, Methods of Beekeeping, Products of Bee keeping, Bee Enemies, Bee-keeping Industry in India 2. Lac Culture : Species of Lac insect, Life history, Host plant, Cultivation of Lac, Processing of Lac, Composition & Properties of Lac, Economic Importance of Lac, Enemies of Lac Cultivation, Lac Industry in India 3. Sericulture : Species of Silkworm, Life history of Mulberry Silkworm, Rearing of Silkworm, Diseases of Silkworm, Composition & Economic importance of Silk, Sericulture Industry in India 4. Pearl Culture : Pearl Producing Molluscs, Pearl Formation, Artificial Pearl Production, Composition of Pearl, Pearl Producing Sites in India 5. Poultry : Fowl-House, Food & Feeding of Fowls, Breeds of Fowls, Breeding in Fowls, Rearing of Chickens, Incubation & Hatchery management, Poultry feeding, Housing & Equipments, Eggs & its preservation, Diseases of Poultry, Poultry Products, By-Products of Poultry 6. Dairy Farming (Cattle): Breeds of Cattles, Housing, Feeding, Management, Diseases, Processing of Milk, Milk Products 7. Leather Industry : Animals involved, Processing of Leather, Enemies of Leather 8. Wool and Fur Industry : Types of Wool in India, 	25	1	<p>3</p> <p>3</p> <p>3</p> <p>2</p> <p>3</p> <p>3</p> <p>1</p> <p>2</p>

	<p>Properties of Wool, Processing of Wool Manufacture, Fur Manufacturing, Fur Farming in India</p> <p><u>Books recommended :</u></p> <ol style="list-style-type: none"> 1. Economic Zoology – G.S. Sukla & V.B.Upadhyay 2. A Handbook on Economic Zoology – J. Ahsan, 3. Introduction to Economic Zoology – B.S. Tomar. 4. An Introduction to Sericulture – G.Ganga & J.S. Chetty. 5. The world of the honey bee - A.S. Atwal. 6. Bees and beekeeping in India – D.P. Abrol. 7. Perspectives in Indian Apiculture – R.C. Mishra. 8. Beekeeping – E.F. Phillips. 9. Pleasure and Profit : Beekeeping – M.Naim. 10. Introduction to Lac and Lac Culture – S. Chattopadhyay. 11. Lac Culture in India – N. Ghorai 12. Poultry Production – R.A.Singh. 13. Rearing of Cattle – L.M.Mondal. 			
ZST 402	<p>Parasitic diseases & Management</p> <ol style="list-style-type: none"> 1. Amoebiasis, Trichomoniasis, Giardiasis, Trypanosomiasis, Leishmaniasis, Schistosomiasis, Filariasis, Fascioliasis, Hookworm disease, Onchocerciasis, Taeniasis, Cysticercosis, Coccidiosis, Strongyloidiasis, Chagas disease, Enterohepatitis, Toxoplasmosis, Ascariasis, Dracunculiasis, Pediculosis, Myiasis, Tick paralysis, Dengue 2. Life history, physiology and biochemistry of malarial Parasites 3. Diseases: Symptoms, treatment and management <p><u>Books recommended :</u></p> <ol style="list-style-type: none"> 1. The Biology Of Nematodes: Donald L. Lee 2. Protocols In Protozoology: Lee and Soldo 3. Biology Of Parasitism: Tschudi and Pearce 4. Practical Exercises in Parasitology: Halton, Marshall 	25	1	10 2 4
ZST 403	<p>Genetic diseases/disorders & Management</p> <ol style="list-style-type: none"> 1. Chromosomal abnormalities Autosomal changes : [Down Syndrome, Edward Syndrome, Patau's Syndrome] Sex chromosomal changes : [Kline Filter, Turner, Super Female, Super Male] 	25	1	2 2

	<p>2. Single gene disorder Autosomal Recessive :[Sickle Cell Anaemia, PKU, alkaptonuria, albinism, thalassemia, cystic fibrosis] Autosomal Dominant :[Huntingtons Chorea, Marfan Syndrome, Polydactyly]</p> <p>Sex Linked Recessive : [Hemophilia, Colour Blindness]</p> <p>3. Multifactorial Traits : [Cancer, Diabetes, Heart Diseases]</p> <p>4. Genetic counseling-methods</p> <p><u>Books Recommended:</u></p> <ol style="list-style-type: none"> 1. Molecular Cell Biology: J. Darnell <i>et al.</i> 2. Molecular Cell Biology: Lodish <i>et al.</i> 3. Molecular Biology of The Cell: Alberts <i>et al.</i> 4. Cell Biology: Cooper 5. Cell and Molecular Biology: De Roberties and De Roberties 6. Cell and Molecular Biology: G. Karp 7. Molecular Biology: Pollard 8. Gene VIII: Lewin 9. Molecular Biology Of The Gene: Watson 			2
				2
				2
				1
ZST 404	Tools & Techniques	25	1	
	<p>1. General instructions on using The Laboratory; Biosafety; Some useful tips regarding Weights, Measurements, Solution Preparation and Calculations</p> <p>2. Microscopy : Light microscopy, Fluorescence, Scanning & Transmission Electron Microscopy, Confocal Microscopy</p> <p>3. Principles and uses of analytical instruments :</p> <ol style="list-style-type: none"> i. Colorimetry : Principles and uses ii. Spectrophotometer, Spectrofluorometer, Mass Spectrometry iii. Chromatography : Principles, Column Chromatography, GLC, HPLC, Ion-exchange chromatography, Gel exclusion chromatography, Affinity chromatography iv. Electrophoresis : Basic Principles, PAGE, Agarose gel electrophoresis, 2-D gel electrophoresis v. Centrifugation : Basic principles of Sedimentation, Differential and Density gradient centrifugation vi. Crystallography and X-ray diffraction, Basic idea of NMR 			2
				2
				1
				1
				2
				1
				1

	<p>4. Radioisotope techniques : Radioactivity and half life, radioisotopes, units of radioactivity, G-M counter, solid and liquid scintillation counter, Metabolic labelling, Applications of radioisotopes in biology</p> <p>5. Immunological techniques based on antigen-antibody interactions ; Enzyme Linked Immuno-sorbent Assay (ELISA)</p> <p>6. Blotting techniques</p> <p>7. Polymerase chain reaction (PCR technique)</p> <p>8. Cell culture techniques a) Design and functioning of animal tissue culture laboratory b) Cell proliferation measurements c) Cell viability testing d) Culture media preparation and cell harvesting methods</p> <p>9. Preparation of liquid and solid microbial culture media; Gram staining Technique; Determination of microbial quality of milk</p> <p>10. Chromosome karyotyping</p> <p>11. Preparation and staining of thin blood film; Determination of blood groups; Estimation of Haemoglobin, TLC, TEC</p> <p><u>Books Recommended :</u></p> <p>1. Biophysical Techniques : Fryfelder 2. Animal Cell Culture – A Practical Approach : R.W. John (Ed.) 3. Introduction to Instrumental Analysis : R. Braun 4. A Biologists Guide to Principles and Techniques of Practical Biochemistry : K. Wilson & K. H. Goulding 5. Biotechnology : H. D. Kumar 6. Practical Biochemistry : Wilson & Wilmer 7. Biochemical Calculations : Segel 8. Biochemistry & Molecular Biology : W. H. Elliot & D. C. Elliot 9. Text Book of Biochemistry with clinical correlation : T. M. Devlin 10. Lehninger’s Principles of Biochemistry : D. L. Nelson & M. M. Cox 11. Biochemistry : L. Stryer 12. Biochemistry : Voet & Voet 13. Experimental Biology : A Laboratory Manual : A Dutta</p>			<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>2</p> <p>1</p> <p>2</p>
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	14. Laboratory Techniques in Modern Biology : N. Swarup <i>et al.</i>			
	<i>Hard Core Lab</i>			
ZHL 401	Taxonomy, Biodiversity & Wildlife including Field Training 1. Taxonomic key preparations (Insect/Fish as a model) 2. Estimation of species density, diversity index – Shannon Index, Richness Index, Relative abundance, Species evenness, Similarity Index 3. Dominance diversity analysis 4. Sampling and census technique for wildlife study 5. Pug mark analysis 6. Use and application of global positioning system (GPS) and laser range finder in the study of biodiversity 7. Field Trip to any one (terrestrial/aquatic) habitat for assessment of Biodiversity, submission of Field report 8. Sessional & Viva	40	2	1 1 1 1 1 1
ZHL 402	Comprehensive Viva	20	1	
	<i>Elective Theory</i>			
ZET 402	Ecology & Environmental Biology 1. Ecological Modelling 1.1 Ecosystem modelling 1.2 Prey Predator System Modelling 2. Autecology of Species 2.1 Photoperiodism, Biological clock, Circadian rhythm 3. Habitat Ecology 3.1 Fresh water Ecology 3.2 Marine Ecology 3.3 Estuarine Ecology 3.4 Terrestrial Ecology 3.5 Desert Ecology 4. Ecotoxicology & Public Health 4.1 Impact of Heavy metals, Pesticides, Sewage on	50	4	2 2 8 8

	<p>ecosystems</p> <p>4.2 Bioremediation : An Emerging Biotechnology for environmental clean up</p> <p>4.3 Biosensors</p> <p>4.4 Xenobiotic : Absorption, transformation and translocation, excretion of toxic substances</p> <p>4.5 Effect of toxicants on gene</p> <p>4.6 Endocrine disruptors</p> <p>5. Environmental Monitoring & Impact Assessment</p> <p>5.1 Bioindicators and environmental monitoring</p> <p>5.2 Environmental Impact Assessment</p> <p>5.3 Environmental Risk Assessment</p> <p>5.4 Environmental Biomonitoring – methods and tools</p> <p>6. Management of Environmental Quality</p> <p>6.1 Basic objectives of Environmental Management</p> <p>6.2 Strategy of Environment Management</p> <p>6.3 Environmental Education</p> <p>6.4 Environmental Quality Monitoring (Air, Water, Soil, Food)</p> <p>6.5 Environmental Organizations and Agencies</p> <p><u>Books Recommended :</u></p> <p>1. Ecology : M.L.Cain</p> <p>2. Concept of Ecology : E.J.Kormondy</p> <p>3. Ecology Principles and applications : J.L.Chapman & M.J.Reiss</p> <p>4. Ecology : M.Begon, C.R.Townsend, J.L.Harper</p> <p>5. Ecology : Recliffs and Miller</p> <p>6. Ecology : J.Krebs</p> <p>7. Ecology : N.S. Subrahmanyam 7 A.V.S.S. Sambamurty</p> <p>8. Fundamentals of Ecology : M.C.Dash</p> <p>9. Ecology and Environment : P.D. Sharma</p> <p>10. Environment – Problems & Solutions : D.K.Asthana & M. Asthana</p> <p>11. An Introduction to Environmental Studies : K.P. Srivastava</p> <p>12. Fundamentals of Environmental Science : Dhaliwal <i>et al.</i></p> <p>13. Environmental Science : T.K.Khan</p>			<p>4</p> <p>8</p>
	<p align="center">Parasitology & Immunology</p> <p>1. Pathogenicity and control of some human parasites (<i>Plasmodium, Leishmania, Toxoplasma, Ancylostoma and Wuchereria.</i>) and viral (HIV) infections</p> <p>2. Autoimmunity and associated diseases- Rheumatoid</p>	<p align="center">50</p>	<p align="center">4</p>	<p align="center">10</p> <p align="center">3</p>

	<p>arthritis and lupus</p> <ol style="list-style-type: none"> 3. Congenital and acquired immunodeficiency 4. TLR – structure, function and signalling pathways. 5. Virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis 6. Antigenic determinants of Immunoglobins (Isotype, Allotype & Idiotype). 7. Cytokines (source & function of IL-1, IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, IL-12, Interferons, Tumour Necrosis Factors, Tumour Growth Factors, GM-CSF, M-CSF) and Chemokines (source & function of common chemokine ligands and receptors) 8. Application of immunological principles, vaccines, diagnostics tools. <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Outlines & Highlights For Human Parasitology : Roberts and Janovy 2. Parasitology : Bogitsh, Carter and Alteman 3. Outlines & Highlights For Human Parasitology : Bogitsh 4. NMS-Immunology : R. Hyde, Williams and Wilkins 5. Basic Immunology : Functions and disorders : Abbas and Litchman 6. Kuby’s Immunology : Goldsby, Kindt and Osborn 			<p>1</p> <p>2</p> <p>2</p> <p>2</p> <p>4</p> <p>3</p>
	<p style="text-align: center;">Entomology</p> <p><u>Insect Pests & Management & Industrial Entomology</u></p> <ol style="list-style-type: none"> 1. Insect Pests : Classification 2. Concepts of Economic Injury Levels : Pest surveillance, sampling methods and forecasting; Economic threshold and injury level; Determination of EIL & Calculation of Economic decision level; Insecticide resistance management in pest 3. Insect Control : Chemical control – nature, mode of action and resistance mechanism of some common insecticides (Organochlorines, Organophosphates, Carbamates and botanical insecticides, organic pesticides); Biological and Cultural control methods, Biotechnology in insect control, IPM 	50	4	<p>2</p> <p>1</p> <p>3</p>

	<p>4. Distribution, biology, nature of damage and management strategies of major pests of Paddy, Wheat, Jute, Sugarcane, Vegetables, Mango, Tea, Stored grain and Forest products</p> <p>5. Medical, veterinary and Forensic Entomology :</p> <p>5.1 Vector Biology : Morphology, behavior, life cycle, disease transmission and control strategies of Sand fly, Mosquitoes and Fleas; Myiasis : Morphology and biology of Myiasis causing flies</p> <p>5.2 Insects associated with cadavers</p> <p>5.3 Poisonous insects</p> <p>5.4 Role of insects as decomposer</p> <p>5.5 Insects and arthropods causing harm to livestock</p> <p>5.6 Ticks and mites of public health importance: Soft and hard ticks – morphology, behaviour, life cycle, mode of transmission, pathogenesis and control measures; Mite causing disease : Scabies & Scrub Typhus : Morphology and life cycle of causative agents, mode of transmission, pathogenesis and control measures; General account of allergy causing mites</p> <p>6. Genetics of Mulberry Silk Moth in reference to voltinism, breeding strategies in Mulberry Silkworms & its diseases</p> <p>7. Honey bee : Role in Pollination and production of honey, propolis and bee-wax; extraction and preservation of honey</p> <p>8. Lac insect : Life history, hosts, composition, properties and uses of lac, local cultivation practices of lac, scientific method of lac cultivation, enemies of lac insects, lac production in India</p> <p>9. Insect based drugs, dyes, food for man, fish, poultry and aesthetics</p> <p><u>Books Recommended :</u></p> <p>1. Text Book of Applied Entomology : K. P. Srivastava</p> <p>2. Entomology And Pest Management : L.P.Pedigo</p> <p>3. Insect Pest Control : Using Plant Resources : S. Ignacimuthu, s.j.</p> <p>4. Agricultural Pests of South Asia And Their Management : A.S.Atwal & G.S. Dhaliwal</p> <p>5. Integrated Pest Management : Concepts and Approaches : G. S. Dhaliwal & R. Arora</p> <p>6. Medical Entomology : A.K.Hati</p> <p>7. Science of Forensic Entomology : D. B. Rivers & G. A. Dahlem</p>			<p>4</p> <p>6</p> <p>2</p> <p>2</p> <p>3</p> <p>2</p>
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	8. Current Concepts in Forensic Entomology : J.Amendt, C.P.Camobasso, M.L.Goff, M. Grassberger 9. A manual of Forensic Entomology : K.G.V. Smith 10. Forensic Entomology : An Introduction : D. Gennard 11. Forensic Entomology : The Utility of Arthropods in Legal Investigations : J.H.Byrd and J.L.Castner 12. Sericulture : P.Venkatanarasaiah 13. An Introduction to Sericulture : G.Ganga & J.S.Chetty 14. The world of the honey bee : A.S.Atwal 15. Bees and beekeeping in India : D.P. Abrol 16. Perspectives in Indian Apiculture: R.C.Mishra 17. Beekeeping – E.F.Phillips. 18. Pleasure and Profit : Beekeeping : M.Naim 19. Introduction to Lac and Lac Culture – S.Chattopadhyay. 20. Lac Culture in India – N. Ghorai			
	<p style="text-align: center;">Cytogenetics & Molecular Biology</p> 1. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. 2 2. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. 2 3. Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. 2 4. Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications. 1 5. Recombination : Homologous and non-homologous recombination including transposition. 1 6. Molecular Biology and Recombinant DNA methods: Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. 3 7. Expression of recombinant proteins using bacterial, animal and plant vectors. 1 8. Isolation of specific nucleic acid sequences 1	50	4	

	<p>9. Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.</p> <p>10. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.</p> <p>11. Protein sequencing methods, detection of post translation modification of proteins.</p> <p>12. DNA sequencing methods, strategies for genome sequencing.</p> <p>13. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques</p> <p>14. Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques</p> <p>15. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Molecular Cell Biology: J. Darnell <i>et al.</i> 2. Molecular Cell Biology: Lodish <i>et al.</i> 3. Molecular Biology of The Cell: Alberts <i>et al.</i> 4. Cell Biology: Cooper 5. Cell and Molecular Biology: De Roberties and De Roberties 6. Cell and Molecular Biology: G. Karp 7. Molecular Biology: Pollard 8. Gene VIII: Lewin 9. Molecular Biology Of The Gene: Watson 			<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>2</p> <p>2</p> <p>2</p>
	<p style="text-align: center;">Aquaculture & Fisheries</p> <ol style="list-style-type: none"> 1. Nutrition and supplementary feeding: Nutritional requirements; Intermediary metabolism and bioenergetics; Feed types, composition, ingredients, formulation; Feeding schedules, feed dispensing methods; Storage and quality control of feed 2. Present status of brackish water fish farming in India : Mixed culture of brackish water fish species; Estuarine fisheries 3. Basic cultural aspects of Ornamental fishes; Air-breathing fishes, Freshwater prawns and their prospects. 	50	4	<p>2</p> <p>2</p> <p>2</p>

	<p>4. Maintenance of Fish Farm: Productivity of freshwater bodies; Limnological methods and their application (oxygen and carbon-di-oxide); Pond fertilization; Control of aquatic weeds, insects, predatory and weed fishes</p> <p>5. Mariculture : Definition, culture method and scope (Pearl and edible oysters)</p> <p>6. Aquaculture hazards : Common diseases of fish : Causative organisms, effects and control; Shrimp diseases and treatment, Ideas on air embolism, Sunburn; Spoilage of fresh water and brackish water fishes; Pollution: sources, effects and control.</p> <p>7. Development strategies: Fish in human nutrition; Fish conservation; Fish marketing: imports and exports</p> <p><u>Books Recommended :</u></p> <ol style="list-style-type: none"> 1. Aquaculture Bardach, J. E. & Ryther, J. H. 2. Fish Nutrition in Aquaculture : De Silva, S. S. & Anderson, T. A. 3. Nutrition and Feeding of Fish and Crustaceans : Guillaume J., Kaushik S., Bergot P. & Metailler, R. 4. Fish Nutrition : Halver J. E. 5. Fish and Fisheries of India : Jhingran V. G. 6. Aquaculture : Pillay T.V.R. 7. Fish Biology : Srivastava C. B. L. 8. A Text Book of Fishery Science & Indian Fisheries : Srivastava C. B. L. 			2
				2
				2
				2
	<i>Elective Lab</i>			
ZEL 402	Ecology & Environmental Biology	40	3	
	1. Productivity determination of different ecosystem – Lindman's efficiency			2
	2. Evaluation of Diversity Index of Communities Terrestrial/Aquatic			2
	3. Statistical methods and use of different software for ecological analysis			2
	4. Field study methods for wildlife study			2
	5. Field excursion and estimation of biodiversity of any terrestrial or aquatic ecosystem			
	6. Sessional & Viva			

	Parasitology & Immunology	40	3	
	<ol style="list-style-type: none"> 1. Whole mount preparations of trematodes and cestodes 2. T, B cell and macrophage preparation from PBL/isolation of peritoneal macrophage from rat/mice 3. Immunofluorescence and FACS-Sample preparation and staining (Demonstration) 4. Camera Lucida drawing and its measurement up to the scale of different cells involved in immunity (Normal and Transformed) 5. Raising of Antisera in an animal 6. Laboratory Visit and Report Preparation 7. Sessional & viva 			<p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
	Entomology	40	3	
	<ol style="list-style-type: none"> 1. Collection, preservation and identification of pests of major crops/stored grain pests and submission (at least 5) 2. Identification of insect vectors and parasites of public health importance (<i>Culex</i>, <i>Aedes</i> and <i>Anopheles</i> mosquitoes, tick, mite, flea, louse from whole mount dry specimens) 3. Study of insect population density (any one species) 4. Study of appliances used in insect control 5. Determination of LD₅₀/LC₅₀ values of pesticides using a pest species 6. Study of life stages of social insects 7. Study of life cycle of a pest/vector & submission of life stages (at least one) 8. Field study on insect diversity & submission of Field Report 9. Sessional & Viva 			<p>2</p> <p>2</p> <p>3 months</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
	Cytogenetics & Molecular Biology	40	3	
	<ol style="list-style-type: none"> 1. Chromosome preparation from <i>Drosophila</i> larva & 			2

	<p>camera lucida drawing</p> <p>3. Meiotic chromosome study of Grasshopper</p> <p>3. Genetic Crosses in <i>Drosophila</i></p> <p>4. SDS PAGE</p> <p>5. Genetic Crosses and Pedigree Analysis</p> <p>6. Laboratory Visit & Report Preparation</p> <p>7. Seesional & Viva</p>			<p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>1</p>
	<p style="text-align: center;">Aquaculture & Fisheries</p> <p>1. Aquarium management; setting of aquaria; breeding and rearing of ornamental fishes, Disease control.</p> <p>2. Limnological studies: Physico-chemical properties of water, primary productivity; qualitative and quantitative estimation of phyto and zooplankton.</p> <p>3. Determination of Calorific Value of fish muscle by Wet-oxidation method.</p> <p>4. Histological studies of different tissues and their identification.</p> <p>5. Biochemical estimation of protein, lipid and carbohydrate from fish tissues.</p> <p>6. Sessional & Viva</p>	40	3	<p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p>
ZEL 403	Dissertation/Project/Review/Laboratory Exchange Programme	20	1	