Syllabus

M.Sc. in Zoology

(Four Semester course)

Revised on 15.04.2017

CHOICE BASED CREDIT SYSTEM (CBCS)

Department of Zoology, University of Kalyani

Effective from 2017-2018 Session

Semester -1

Course Name	Subject	Points	Credit	Hours/ Week
Hard Core Theory				
ZHT-101	Non Chordate and Insect Organization	75	3	4
ZHT-102	Parasitology and Ecology and environment	75	3	4
ZHT-103	Developmental Biology and Cytogenetics	75	3	4
ZHT-104	Animal Physiology and Biochemistry and Metabolic Processes	75	3	4
Hard Core Lab				
ZHL-101	Non Chordate and Insect Organization	25	1	3
ZHL-102	Parasitology , Ecology and environment	25	1	3
ZHL-103	Developmental Biology and Cytogenetics	25	1	3
ZHL-104	Animal Physiology and Biochemistry and Metabolic Processes	25	1	3
Library / Field Work / Class Test				2
Total points & Credits in Semester I		400	16	30

Semester - II

Course Name	Subject	Points	Credit	Hours/ Week
Hard Core Theory				
ZHT-205	Structure and Function of Chordates & Biosystematics and taxonomy	75	3	4
ZHT-206	Advanced Parasitology & Fish Biology	75	3	4
ZHT-207	Immunobiology & Human Population Genetics	75	3	4
ZOP 201	Applied Zoology (For students other than Department of Zoology)	100	4	4
Hard Core Lab				
ZHL-205	Structure and Function of Chordates & Biosystematics and Taxonomy	25	1	3
ZHL-206	Advanced Parasitology & Fish Biology	25	1	3
ZHL-207	Immunobiology & Human Population Genetics	25	1	3
Library / Field Work / Class Test				2
Total points & Credits in Semester II		400	16	30

Semester -III

Course Name	Subject	Points	Credit	Hours/ Week
Hard Core Theory				
ZHT-309	Arthropod of Economic Importance & Biodiversity and Resource management	75	3	4
ZHT-310	Environmental Toxicology and Endocrinology	75	3	4
Soft Core Theory <u>Any two</u>				
ZST-301	Applied Ichthyology	25	1	1
ZST-302	Developmental Dynamics	25	1	1
ZST-303	Human Molecular Genetics	25	1	1
ZST-304	Forest Entomology	25	1	1
ZST-305	Medical & Veterinary Parasitology	25	1	1
ZST-306	Reproductive Biotechnology	25	1	1
Hard Core Lab				
ZHL-309	Arthropod of Economic Importance & Biodiversity and Resource management	25	1	3
ZHL-310	Environmental Toxicology & Endocrinology	25	1	3
Elective Theory				
ZET-301	Fish and Fisheries Cytogenetics & Mol.Biology Endocrinology & Rep Biology Parasitology & Immunology Entomology Cell & Development Biology	50	2	3
ZET-302	Fish and Fisheries Cytogenetics & Mol.Biology Endocrinology & Rep Biology Parasitology & Immunology Entomology Cell & Development Biology	50	2	3
Elective Lab				
ZEL -301	Elective Lab	40	1.6	3
ZES- 301	Seminar	10	0.4	3
Field Study / Lab visit/ Library/ Class test				2
Total points & Credits in Semester III		400	16	30

Semester –IV

Course Name	Subject	Points	Credit	Hours /Week
Hard Core Theory				
ZHT-411	Animal Behavior and Vector Biology	75	3	4
ZHT-412	Molecular Biology & Biotechnology and Tools & Technique	75	3	4
Soft Core Theory <u>Any Two</u>				
ZST-407	Agricultural Entomology	25	1	1
ZST-408	Cancer Biology	25	1	1
ZST-409	Medical Embryology	25	1	1
ZST-410	Aquaculture Technology	25	1	1
ZST-411	Hormone and Signal Transduction	25	1	1
ZST-412	Parasite and Disease	25	1	1
Hard Core Lab				
ZHL-411	Animal Behaviour and Vector Biology	25	1	3
ZHL-412	Mol Biolgy & Biotechnology and Tools & Technique	25	1	3
Elective Theory				
ZET-403	Fish and Fisheries Cytogenetics & Mol.Biology Endocrinology & Rep Biology Parasitology & Immunology Entomology Cell & Development Biology	50	2	3
ZET-404	Fish and Fisheries Cytogenetics & Mol.Biology Endocrinology & Rep Biology Parasitology & Immunology Entomology Cell & Development Biology	50	2	3
Elective Lab				
ZEL -402	Elective Lab	40	1.6	3
ZEP -402	Project/Review work	10	0.4	3
Field Study / Lab visit/ Library/ Class test				2
Total points & Credits in Semester IV		400	16	30

Examination Pattern

Course	In Semester 20%	End Term 80 %	Total Points
Hard Core Theory	15 Attendance (2.5+2.5) Class test (5+5)	60	75
Hard Core Lab	5 Attendance (2)* Lab Note book + Viva (3)	20 (10+10)	25
Soft core theory	5 Class test (5)	20	25
Elective	10 Class test (5+5)	40	50
Elective Lab-I	10 Seminar	40	50
Elective Lab-II	10 Project/Review	40	50

*Attendance = 80 % and above = 4 ; 70 – 80 % = 3 ; 60 -69 % = 2 ; Less than 60 % = 1

Question Pattern

In Semester	End Term Examination
For written test only 2 Pt. X 5 (out of 6) = 10 (in each paper)	**For 20 Points** $2^{1/2}$ pt x 2 (out of 3) =5 3 pt x 3 (out of 4) = 9 6 pt x 1 (out of 2) = 6
	For 40 Points $2^{1/2}$ pt x 2 (out of 3) =5 3 pt x 3 (out of 4) = 9 5 pt x 2 (out of 3) = 10 8 pt x 2 (out of 3) = 16
	For 60 Points (for each section in each paper) 30X2=60 $2^{1/2}$ pt x 2 (out of 3) =5 5 pt x 3 (out of 5) = 15 10 pt x 1 (out of 2) = 10

SEMESTER –I

HARD CORE THEORY PAPERS

ZHT-101 : Non Chordate and Insect Organization	Points 75
Non Chordate	**Point 37**
1. Cell organelles in protozoa - Golgi, Mitochondria, Kinetoplast, Pellicle and Cuticle	**5**
2. Osmoregulation in Protozoa.	**4**
3. Cell association and cellular differentiation in protozoa	**4**
4. Sensory organelles and reaction for stimuli in protozoa	**4**
5. Insect blood : composition, functions, morphology of circulatory system	**3**
6. Morphology of excretory organs and their function in insects	**3**
7. Insect flight: structure concerned, functional mechanism.	**3**
8. Insect visual organs, their structure and functional mechanisms	**4**
9. Structure and function of sound producing organs in insects, significance of sound production. Uses of sound in plant protection	**4**
10. Photogenic organs in insects : structure, mechanism and significance of light production	**3**
Insect Organization	**Point 38 Lectures**
1. Modern classification of insects	**4**
2. General organization, segmentation, division of body:	
i) Head and mouth parts in general	**4**
ii) Thorax and thoracic appendages. Modification of legs and wings.	**4**
iii) Abdomen and abdominal appendages.	**4**
3. Integument: Basic structure and functions.	**4**
4. Digestive organs: Structure and functions; Peritrophic membrane, Filter chamber	**4**
5. Morphology of respiratory organs and mechanism of respiration	**4**
6. Morphology of central nervous system.	**4**
7. Metamorphosis: Basic concept (e.g. House fly),	**2**
8. Exocrine glands: Lac gland, Wax gland, Silk gland, Labial gland.	**4**

ZHT-102: Parasitology, Ecology and environment	**Points 75**
Parasitology	**Point 37 Lectures**
1. Classification of Protozoa and Helminths.	6
2. Mode of transmission of *{Plasmodium, Trypanosoma, Piroplasm)*	7
3. Zoonosis with particular reference to *Toxoplasma, Balantidium, Entamoeba, Schistosoma.*	7
4. Microspora: Structure and life history of *Nosema bombycis* - impact on sericulture.	5
5. Life cycle, biology, pathogenesis,, epidemiology and control of important human and veterinary helminthes - *Diphyllobothrium latum, Paragonimus westermani, Trichinella spiralis.*	6
6. Salient features of plant parasitic nematodes and life cycle patterns of i) *Heterodera rostochiensis,* ii) *Meloidogyne hapla, Anguina*	6
Ecology and Environment	**Point 38 Lectures**
Ecology	
1. The Ecosystem: concept, Gaia hypothesis, cybernetic nature and stability of the ecosystem, ecosystem management and optimization.	**3**
2. Niche theory : Niche concepts, niche width	**3**
3. Community: Structure and Gradient analysis	**3**
4. Biogeochemical cycle: Nitrogen and phosphorus cycle	**6**
5. Population attributes: Growth forms and mathematics of growth, Life Table - (Cohort and Static); survivorship curves, generation time, net reproductive rate. Life history strategies: Evolution of life history traits, strategies related to longevity; clutch size; life history optimization.	**6**
6. Metapopulation: Concept, models , structure and dynamics	**6**
7. Major terrestrial biomes; major biogeographical zones of India	**2**
Environment	
1. Concept of Environment: Structure, radiation balance, climate cycle.	**3**
2. Anthropogenic impact on environment: Green house gases, global warming, ozone depletion, UN movements on environment.	**3**
3. Environment and agriculture: Green revolution and its impact on environment, organic farming, participatory approach in agriculture.	**3**
4. Theory and analysis of conservation: Stochastic perturbations, population viability analysis, recovery strategy for threatened species.	

ZHT 103: Developmental Biology and Cytogenetics	Points 75
Developmental Biology	**Point 37 Lectures**
1. Basic concepts in Developmental Biology: potency, commitment, specification, induction, competence, determination and differentiation, morphogenetic gradient and fate map	10
2. Stem cells: embryonic stem cells and adult stem cells; stem cell niches	2
3. Sex, Gametes and Fertilization: i) Germ cell migration ii) Gametogenesis iii) Gamate recognition, contact and fertilization, prevention of polyspermy.	8
4. Axis specification in vertebrates: i) Early patterning in vertebrates - Symmetry breaking, Nieuwkoop center. Wnt and cadherin signaling ii) Left- right asymmetry in vertebrates - Asymmetric gene expression	8
5. Metamorphosis and organogenesis: Axes, compartment formation and pattern formation in *Drosophila;* Homeobox genes and development; development and metamorphosis of tadpole larve; limb development and regeneration in vertebrates	7
6. Concept on aging and senescence.	3
Cytogenetics	**Point 38 Lectures**
1. Organization and structure of genomes - size, complexity, gene-complexity, virus and bacterial genomes, organelle genome, architecture of mitochondrial genome, conserved chloroplast DNA; organization and nature of nuclear DNA in eukaryotes; transposable elements, retro-transposons, SINE, LINE, Alu and other repeat elements, pseudogenes, segmental duplications ; super coiling of DNA	13
2. Cell cycle, apoptosis and cancer : Phases of cell cycle. Regulation of cell cycle: Discovery of MPF, cyclins and cyclin dependent kinases, Check points- role of Rb and p53 ; Cancer: Types and stages. Tumor suppressor genes and protooncogenes. Molecular basis of cancer.; Apoptosis: Neurotrophic factors, caspases, Pathways of apoptosis; cell senescence, telomerase	15
3. DNA replication: nature, enzymology of replication, replication fork; fidelity of replication; extrachromosomal replicons; leading and lagging strands; Okazaki fragments; termination of replication	10

ZHT 104: Animal Physiology & Biochemistry and Metabolic Processes	Points 75
Animal Physiology	**Point 38 Lectures**
1. Respiratory function of blood: a) Respiratory pigments - distribution and brief chemistry b) Function of hemoglobin-i) in adult and ii) during embryonic life c) Environmental influences.	10
2. Physiology of muscles: a) Chemical nature of contractile elements b) Role of structural and regulatory proteins in muscular contraction c) ATP and signal molecules in muscular contraction	10
3. Physiology of excretion: Formation of urine: glomerular filtration; tubular function; counter current mechanism and urine formation	10
4. Synaptic and functional transmission; a) Pre-and postsynaptic structure and function b) Chemical transmission of synaptic activity	8
Biochemistry and Metabolic Processes	**Point 37 Lectures**
1. Proteins: Protein folding and protein stability.	4
2. Bioenergetics and oxidative metabolism:	4
3. Thermodynamic principles and steady-state conditions of living organism; standard free energy change in a reacting system; energy change for ATP hydrolysis.	
4. Amino acid metabolism a. Amino acid classification b. Urea cycle	3
5. Carbohydrate and lipid metabolism a. Biosynthesis and transport of cholesterol b. Glycolysis, glycogenolysis, gluconeogenesis, interrelationship between different carbohydrate metabolism	3 8
6. Enzymes: a. Kinetic analysis of enzyme-catalyzed reaction b. Regulation of enzyme activity c. Allosteric control of enzyme activity	5 6
7. Intracellular protein traffic for secretary and non-secretary cells: protein synthesis, intracellular transport, packaging, storage and release	4

CORE LAB

ZHL 101: Non Chordate & Insect Organization	Point 25
Dissection (Non Chordate) 1. Grasshopper : Reproductive; Air sacs 2. Cockroach: Male reproductive 3. Crab : Digestive and Nervous 4. Honey bee: Poison apparatus **Dissection (Insect Organization)** 1. Mosquito : Head,mouth parts and wing 2. Housefly: Head, mouth parts and wing 3. Honey bee : Pollen basket 4. Drosophila: Arista	
ZHL 102: Parasitology & Ecology and environment	**Point 25**
Parasitology 1. Collection, fixation, staining and preservation of protozoa by wet and dry method. 2. Staining ureeolarid ciliate by Kelin's silver impregnation technique 3. Collection and preservation of endohelminthes of vertebrates. 4. Laboratory records **Ecology** 1. Determination of Primary Productivity of water 2. Determination of orthophosphate of water 3. Determination of organic carbon of soil 4. Laboratory records	
ZHL 103: Developmental Biology & Cytogenetics	**Point 25**
Developmental Biology	

1. Preparation of Whole mounts of 24 and 48 hrs. Chick/ Koel embryos. 2. Study of serial section of chick embryo of 48 & 72 hrs (emphasis to be given on Brain, Eye, Gut and tail bud region). 3. Identification of different developmental stages of Amphibia. 4. Influence of temperature and teratogenes on animal development. **Cytogenetics** 1. Study of mutant phenotypes of Drosophila. Demonstration of law of segregation using Drosophila mutants. 2. Chromosome preparation from mice bone marrow cells- a. Chromosome banding (C, G, H banding). b. Study the differences in number, shape and size of chromosomes in normal vs. tumor cells, or normal vs. irradiated cells. 3. DNA extraction	
ZHL 104: Animal Physiology & Biochemistry & Metabolic Processes	**Point 25**
Animal physiology 1. Blood pressure and pulse rate - Effect of exercise. 2. Estimation of rate of 0_2 consumption, $C0_2$ release and RQ in cockroach/mice Laboratory records **Biochemistry & Metabolic Processes** 3. Action of insulin on blood glucose level in rat 4. Kinetic study of an enzyme - urease/ catalase	

SEMESTER -II

HARD CORE THEORY PAPERS

ZHT-205 : Structure and Function of Chordate & Biosystematics and taxonomy	**Points 75**
Structure and Function of Chordate	**Point 37 Lectures**
1. Blood and cardiovascular system: Hematopoiesis and blood volume regulation; Comparative anatomy of heart structure; Cardiac cycle; neural and chemical regulation of functions of heart. 2. Respiratory system: Comparative account of respiratory system; transport and exchange of gases. 3. Nervous system: Gross neuroanatomy of brain and spinal cord; neural control of muscle tone. 4. Thermoregulation: Body temperature – Physical, chemical, neural regulation; acclimation and acclimatization.	10 9 9 9
Biosystematics and Taxonomy	**Point 38 Lectures**
1. Species concept: Evolutionary and biological species concept; difficulties in application of biological species concept. 2. Theories of biological classification**:** classification and phylogeny-types of classification, hierarchic classification; zoological nomenclature, basic knowledge of naming genus and species 3. Phenetic method of classification, numerical phonetics and numerical taxonomy, preparation of data matrix and similarity matrix using distance method (Manhattan distance and Euclidian distance); Cluster analysis (different methods). 4. Cladistic method of classification, difference in the application of phenetic and cladistic classification; cladistic and cladogram, eludistic methods, application of parsimony. 5. Morphological taxonomy and molecular taxonomy; Construction of phylogenetic trees using molecular data.	8 8 10 8 4

ZHT 206: Advanced Parasitology and Fish Biology	**Points 75**
Advanced Parasitology	**Point 37 Lectures**
1. Physiology of parasitic amoebae of man. 2. Mode of transmission, pathogenicity and prevention of tetanus and rabies 3. Physiology, immunopathology *of Plasmodium sp.*\ immunity of *Plasmodium sp.* 4. Fish parasites and its control 5. Parasites of edible oysters	8 9 8 8 4
Fish Biology	**Point 38 Lectures**
1. Excretion and osmoregulation in fish. 2. Reproduction in fish : reproductive strategies, oviparity, viviparity, ovo-viviparity, parental care, maturity stages, breeding cycle 3. Structure and physiology of endocrine glands in fishes 4. Electroreception in fish 5. Determination of age of fish by scale and hard parts. 6. Poisonous and venomous fish. 7. Fish migration: Types, Theories and Significances	4 8 6 4 6 4 6

ZHT 207: Immunobiology & Human Population Genetics	**Points 75**
Immunobiology	**Point 38 Lectures**
1. Basic concepts of immune system; primary and secondary lymphoid organs; Tissue cells, molecules of immune system	7
2. Innate immunity: Overview, features, neutrophils, macrophage functions inflammation NK cells	6
3. Humoral immune system: Structure and class switching of antibodies, B cell function, maturation and development.	8
4. Complement system and diseases	7
5. Antigen presentation: APC, Dendritic cells, MHC genes and gene products	10
6. Vaccination and immunization: natural and artificial immunization; active immunization, vaccines.	
Human Population Genetics	**Point 37 Lectures**
1. Basic concept of human genetics: introduction to the structure of human genome; human genome and mapping.	10
2. Human karyotype; karyotype and nomenclature of metaphase chromosome bands;	
3. Chromosome anomalies and diseases- autosomal amd sex chromosomal abnormalities; chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor);	10
4. Genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits;	
5. Human genetics and society: genetic testing; human rights; gene therapy.	7
6. Quantitative genetics; variance; heritability and its measurement; inbreeding and cross breeding; QTL.	10

ZOP 201:Optional paper: Applied Zoology	**Points 100**
Wild life and Conservation	**Point 50 Lectures**
Concept of wild life and its conservation a) Categories of wild life. b) Wild life and wild life habitat in India: Wild life wealth of India c) Wild life management: Distribution, status , habitat utilization pattern, threats and survival of – Royal Bengal Tiger, Rhinoceros, Olive Ridley turtles d) National and International efforts for conservation: CITES, IUCN, CBD, Protected area concept.	50
Ecological principles and application	**Point 30 Lectures**
1. Concept of habitat and niche 2. Ecological principles. 3. Community ecology: nature of communities; levels of species diversity and its measurements 4. Biogeographical zones of india 5. Environmental management: solid waste management with vermicomposting; Bioremediation; Bioreactors in Environment monitoring. 6. Organic farming 7. Insect pollinators in agriculture	5 5 5 5 5 5
Current knowledge on pisciculture	**Point 10**
1. Integrated fish farming 2. Induced breeding	5 5
Medical Zoology	**Point 10**
1. Genetics of Neurological Diseases; Pharmacogenetics and application 2. Preliminary knowledge on zoonotic diseases 3. Immunodiagnostics: Basic of immunology and its application	5 5

HARD CORE LAB

ZHL 205: Structure and Function of Chordate & Biosystematics and Taxonomy	**Point 25**
Anatomy of Chordates 1. Cranial nerves of teleosts. 2. Accessory respiratory organs of fish, 3. Excursion and collection of specimens **Biosystematics and Taxonomy** 3. Preparation of materials for taxonomic study; Identification of nematodes 4. Identification, preparation of taxonomic keys and taxonomic studies of insects 5. Collection, fixation and staining of protozoa for taxonomic studies 6. Identification from prepared slides	
ZHL 206: Advanced Parasitology and Fish Biology	**Point 25**
Advanced Parasitology 1. Staining and mounting of platyhelminth parasites 2. Protozoan parasites of freshwater fish and Insects of economic importance. 3. Identification of some parasitic protozoa. **Fish Biology** 1. Reproductive system in teleost fishes 2. Study of scales and otolith in fish age determination 3. Display of pituitary gland of fish	
ZHL 207: Immunobiology and Human Population Genetics	**Point 25**
Immunobiology 1. Analysis of blood group A,B,AB, **O** and Rh factor 2. Antigen antibody reaction; immunodiffusion . 3. Raising of antibody 4. Identification of lymphoid organs **Human Population Genetics** 1. Demonstration of human chromosomes and preparation of karyotypes 2. Chromosome aberration, micronuclei, sperm head anomaly study 3. Solving problems on linkage and chromosomal mapping; population genetics	

SEMESTER -III

HARD CORE THEORY PAPERS

ZHT-309 : ARTHROPOD OF ECONOMIC IMPORTANCE AND BIODIVERSITY AND RESOURCE MANAGEMENT	**Points 75**
ARTHROPOD OF ECONOMIC IMPORTANCE	**Point 37 Lectures**
1. Insect pests: pest fauna (names only) of stored grains; Morphology, bionomics and control of: stored rice grain moth *{Corcyra cephalonica)* and stored pulse beetle *(Callosobruchus chinensis)*	**8**
2. Pest management Mechanical; Chemical ; Biological; Integrated	**4**
3. Lac culture: Life-history of lac insect, culture method, lac processing, lac products, natural enemies of lac insect and their control.	**8**
4. Sericulture: Indigenous races, pure races and commercial races of mulberry silk moth; Rearing of mulberry silk moth (moriculture excluded)	**8**
5. Parasitic insects and Acarines: a) General remarks on *Phlebotomous*, *Glossina*, *Tabanus* and head louse in relation to morphology, habit, habitat, life-cycle and disease caused by them, mode of transmission;	**5**
b) General remarks on ticks in relation to morphology, habitat, life-cycle and diseases caused by them.	**4**
BIODIVERSITY AND RESOURCE MANAGEMENT	**Point 38 Lectures 16**
1. Meanings of Biodiversity: Levels of species diversity and relationship; geographic distribution of biological diversity; biological hotspots; measuring biodiversity; interrelationship between diversity measures; pattern of local and regional biodiversity.	
2. Threats to species diversity; natural and human induced threats and vulnerability of species extinction; Red data book; rarity,endemism,effective and minimum viable population, fragmentation of population and metapopulation; problems of genetic diversity ; bottleneck; genetic drifts; inbreeding depression.	**12**
3. Biodiversity Resource Management: values and uses of biological diversity, invertebrate diversity as bioindicator; putting a price on biological diversity; pollinating insect diversity and their management and utilization in sustainable agriculture; Vermiculture: Types of earthworms and their utilization; use insustainable agriculture.	**10**

ZHT-310: ENVIRONMENTAL TOXICOLOGY AND ENDOCRINOLOGY	Points 75
ENVIRONMENTAL TOXICOLOGY	**Point 37 Lectures**
1. Basic concept of toxicology : Scope, division, toxicants and toxicity, factors, dose- response relationship,	5
2. Toxicity testing : Bioassays, LC_{50}, LD_{50}, ED_{50}, Synergism, Antagonism, Additive Effect	6
3. Toxicants of public health hazards: Pesticides, Heavy metals, Radiation, food and additives	7
4. Toxicokinetics: Absorption, distribution, elimination	5
5. Organ toxicity: Hepato, Nophro, Respiratory, Reproductive.	5
6. Plant Allelochemicals .types and its role in insect-plant interaction.	5
7. Plant signaling chemicals, insect response.	4
ENDOCRINOLOGY	**Point 38 Lectures**
1. Classification of hormones; general principles and nature of hormone action , nature of hormone receptor	5 10
2. Biosynthesis, secretion and regulation of hormones: biosynthesis of protein and peptide hormones (Growth Hormone and Insulin), Post-Translational event und release; biosynthesis of steroid hormones and their regulations; biosynthesis of T_3 and T_4 and their regulation	8
3. Neuroendocrine system and neurosecretion: neural control of glandular secretion; hypothalamic pituitary unit, neuroendocrine feedback	8
4. Physiological role of hormones: hormonal regulation of mineral metabolism and fluid volume	7
5. GI tract hormone source, composition and function	

SOFT CORE THEORY

ZST 301: APPLIED ICHTHYOLOGY	**Point 25 Lectures**
1. Biology and importance of finfish and shellfish Finfish: Indian major carps, freshwater catfish, oil sardines, Hilsha, Bombay Duck, Shellfish: Prawns and shrimps.	5
2. Composition and nutritive value of fish, fish as source of protein in developing countries.	5
3. Nutrition offish : Anatomical modification in relation to feeding habits, natural foods, prepared feed, types of feed, feed storage, energy and growth, food conversion ratio and food conversion efficiency.	5
4. Aquaculture methods : concept and significance : Different systems of aquaculture for carps and shrimps : Extensive, Semi-intensive, Intensive,	5
5. Ornamental fish culture : background of ornamental fish culture and trade, classification, culture and breeding of ornamental fish, common diseases and control.	5
ZST 302: DEVELOPMENTAL DYNAMICS	**Point 25 Lectures**

1. Common features of development: Genomic equivalence; Cloning of animals;	5
2. Developmental processes: Cellular differentiation; Pattern formation; Induction.	5
3. Techniques for the study of development: i) Cell labeling ii) Cell sorting	5
4. Model organism : *Xenopus* i) Embryonic development, fate maps ii) Experimental methods - for establishing gene product in development iii) Regional specification	5
5. Stem cells: i) Embryonic stem cells, ii) Stem cell niches iii) Transdifferentiation	5

ZST 303: Human Molecular Genetics	**Point 25**
1. Human population genetics and evolution: Basic attributes and polymorphic structures in human protein coding genes. Mitochondrial DNA polymorphism. Y-chromosome polymorphism and Single nucleotide polymorphism (SNP), Basic concept in Molecular phylogenetics	**10**
2. Genetics in forensic science: Protein comparisons, DNA comparisons, RFLPs, genetic finger-printing, VNTRs, Genetic profiles. Unique correlation, Sociobiology, Alltruism, Kin selection and inclusive fitness, Haplodiploidy, Imprinting phenomena.	**10**
3. Human genome project and the age of genomics	**5**

ZST 304: FOREST ENTOMOLOGY	**Point 25** **Lectures**

1. Indian Forest types, their distribution and importance, Forest insects (pests) - damage and sign categories	**4**
2. Insect pests of Timber yielding trees (Sal - *Shorea robusta;* Teak - *Tectona grandis;* Mahogony- *Swietenia macrophylla*) Bionomics and nature of damage of Borers - *Haplocerambyx spinicornis,* Defoliators - *Hapalea machaeralis,*	**8**
3. Soil insects and their damage to forest plants and their management. Role ofinsects in tropical forest ecosystem.	**5**
4. General issues in forest entomology: a) Insect damages in plantation *vs* natural forest, b) Pest problems in plantation of indigenous *vs* exotic species. C) Pest problems in monboculturo VA* mixed plantations.	**6**
5. Management of tropical insect forest pests.	**2**
ZST 305: MEDICAL AND VETERENARY PARASITOLOGY	**Point 25 Lectures**
1. *Leishmania donovani* and Leishmaniasis	**4**
2. Structure, Pathobiology prophylaxis and diagnosis of *Babesia, Anaplasma* and *The*il*eria*	**6**
3. *Trypanosoma cruzi* and Chagas disease, *Tricomonas foetus* in cattle	
4. Malarial parasites of man, *Eimeria* sp., *Toxoplasmd gondii* - outline structure and life cycles.	**6**
5. Life cycle, biology, pathogenesis, epidemiology and control of Loa loa, Dracunculus medinensis	**4**
	5

ZST 306: REPRODUCTIVE BIOTECHNOLOGY	**Point 25 Lectures**

1. Cell culture laboratory design and equipments, media and reagents 2 *In vitro* fertilization, cryo-preservation and frozen egg transfer, embryo transfer, Intra Cytoplasmic Sperm Injection (ICSI) 3. *In vitro* embryo culture 4. Assisted Reproductive technology 5. An overview of Cloning techniques 6. Gene Replacement and Transgenic Technology 7. Disease diagnostic markers and gene therapy	**3** **3** **4** **2** **2** **2** **3** **3** **3**

HARD CORE LAB

ZHL 309: ARTHROPOD OF ECONOMIC IMPORTANCE AND BIODIVERSITY AND RESOURCE MANAGEMENT	**Point 25**
Arthropods of Economic Importance 1. Identification of pests and their damage symptoms of agricultural crops and stored grains from theoretical course. 2. Sericulture (Mulberry): Silk worm, silk cocoon.	
Biodiversity & Resource management 1. Preparation of PBR 2. Quadrate analysis	
ZHL 310: ENVIRONMENTAL TOXCOLOGY AND ENDOCRINOLOGY	**Point 25**
Environmental Toxicology 1. Determination of LC50 / LD50 and 95% Confidence limit of any toxicant to a selected aquatic/ terrestrial organism. 2. Effects of toxicants on blood parameters offish. 3. Instrumentation AAS/ HPLC for residue analyses of toxicant	
Endocrinology 4.Performance of castration and ovariectomy in rat /mice 5. *in vitro* study of motility of epididymal spermatozoa. 6. Evaluation of hypothyroidic stages of rat/ chick comb biopsy.	

ELECTIVE THEORY-I

ZET 301: FISH AND FISHERIES	Point 50 Lectures
Unit-I **Inland capture Fisheries Resources of India** 1. Introduction to inland capture fisheries resources; estuarine fisheries with special reference to biology and fluctuation of *Tenualosa ilisha*	**9**
2. Fisheries of Lakes and reservoirs: Distribution , commercial exploitation of major freshwater lakes and reservoirs, brackishwater lakes.	**9**
3. Cold water fisheries: Definition, principal zones of cold water fisheries of India, important cold water fisheries of India, food and feeding habit; reproduction and seed resources of Mahaseers	**10**
Unit-II **Limnology** 1 . Limnological characteristics of lentic and lotic water systems, morphoedaphic index	**4**
2. Biological characteristics of inland waters: common planktonic forms algal blooms, zooplankton, zoobenthos, significance.	**8**
3. Biology and culture of some important fish food organisms: Blue green algae, diatoms, rotifers, chironomids, tubifex, brine shrimps	**10**

ZET 301: CYTOGENETICS AND MOL.BIOLOGY	Point 50 Lectures

Unit I. **Genome organization and gene expression** **1.** Eukaryotic chromosome organization: Packaging of DNA in eukaryotic cell; chromatin structure; histones and nonhistones; nucleosome; higher order structure of chromatin; domains and scaffold; organization of active chromatin and assembly of chromatin during replication. 2. Mapping genomes - physical maps, EST, SNPs as physical markers, radiation hybrids, FISH, optical mapping, gene maps, integration of physical and genetic maps; sequencing genomes: high-throughput sequencing, strategies of sequencing, recognition of coding and non-coding regions and annotation of genes, quality of genome-sequence data, base calling and sequence accuracy. 3. Large scale mutagenesis and interference - genome wide gene targeting; systematic approach, random mutagenesis, insertional mutagenesis, libraries of knock-down phenocopies created by RNA interference; transcriptome analysis, DNA micro-array profiling, data processing and presentation, expression profiling, proteomics - expression analysis, protein structure analysis, protein-protein interaction. 3. Protein folding and processing: Chaperones and folding; enzymes and protein folding, protein cleavage, glycosylation, attachment of lipids. **Unit II.** **Genome and signaling** 1. Current development of chromosome banding techniques and SCE. **2.** Microbial genetics: organization of prokaryotic genome; single stranded DNA phages; RNA phages; cycle and gene expression in SV40 virus; Lytic and lysogenic phage morphogenesis; bacterial conjugation, transduction and transformation. **3.** Cell signaling: Modes of cell-cell signaling; steroid hormones and steroid hormone superfamily, neurotransmitters; peptide hormones and growth factors; eicosanoids, functions of cell surface receptors; G-protein coupled receptors, tyrosine kinases, cytokine receptors; pathways of intercellular signal transduction, camp, C GMP pathways; Phospholipids and Ca ion, Ras, Raf and MAP kinase pathway, JAK/STAT pathway	**10** **8** **8** **4** **8** **12**
ZET 301: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY	**Point 50** **Lectures**

Unit-I **Hormone chemistry and metabolism** 1. Nature of hormone action; identification, quantification and purification of hormone receptors. Hormone receptor interaction, hormonal regulation through differential gene expression	4 6
3. Prostaglandin type, chemical nature, biosynthesis and major action 4. Posterior pituitary hormones and neuroendocrine modulation **Unit-II** **Hormonal control of growth and calcium homeostasis** 1. Physiological action of GH and other hormones regulating growth 2. Peptide growth factors: Chemical nature, function and mechanism of action of EGF, IGFs, FGF, TGF-oc and TGF-p. 3. Hormonal regulation of calcium and phosphate metabolism: Parathyroid gland, related to kidney, bone and intestine; mechanism of action of PTH. **4.** Hormonal regulation of glucose metabolism **5.** Adrenocorticotropic hormones: biosynthesis, structure and function **6.** Adrenomedullary hormones biosynthesis structure and functions	5 4 4 4 6 6 6
ZET 301: PARASITOLOGY AND IMMUNOLOGY	**Point 50 Lectures**
Unit-I **Classification and General organization** **1.** Classification of Apicomplexa 2. Origin of parasitic protozoa 3. Some general consideration of protozoan parasites: a) Population & Communities b) Ecological niche c) Temperature and Climate , d) Mutualistic intestinal Protozoa 4. Arthropods as blood suckers and disease transmitters. **Unit- II** **Protozoology &Host-parasite interaction** 5. Primary amoebic meningoencephalitis. 6. Parasite -host specificity with reference to protozoan parasites. 7. Immunity & resistance with reference to protozoan infection	 **4** **4** 4 4 4 4 **6** **6** **4** **4**

ZET 301: ENTOMOLOGY	**Point 50 Lectures**

Unit-I **Classification and structural organization** 1 Classification up to order in general and up to families of selected orders : Coleoptera, Homoptera, Orthoptera Diptera and Hymenoptera; Characters of important families of insects of economic importance. 2. Origin of insects: Different theories	10 3

3. Insect fossils: a) Source of evidence: ' b) Extinct insect orders and their characters: 4. Origin and Evolution of wings-couplings 5. Integument: a) Chemical properties, functions; b) Changes during moulting. 6. Mechanorcceptors 7. Chemoreceptors **UNIT II :** **Anatomy and physiology** 1. Digestion a) Microorganisms: Types, their role and transmission b) Digestion of special substances; c) Nutritional requirements 2. Structure and function of neuroendocrine system. 3. Composition of urine, mechanism of excretion through malpighian tubules 4. Pheromones: Source, chemical nature, transmission, perception and application 5. Osmoregulation	4 4 4 2 2 8 3 4 3 3
ZET 301: CELL AND DEVELOPMENT BIOLOGY	**Point 50 Lectures**

Unit-I **Separation and Estimation of macromolecules** **1.** Separation and identification of materials i) Chromatography : Gel chromatography, Ion - exchange Chromatography, Affinity chromatography, High-performance liquid chromatography. ii) Electrophoresis: PAGE, SDS-PAGE, Agarose Gel Electrophoresis of double stranded DNA, Isoelectric Focusing, Immunoeleptrophoresis. 2. Spectroscopic methods : Colorimetry, Spectrophotometry, Atomic Absorption Spectrophotometry. 3. Sedimentation : Instrument for Ultra centrifugation, Zonal Centrifugation through Density Gradients. **Unit-II** **Tools and Techniques** **1**. Direct observation: i) Light microscopy, Phase contrast microscopy, Interference Microscopy Polarization microscopy, Fluorescence Microscopy ii) Electron microscopy: i) Transmission ii) Scanning **2.** Fixation & staining: **i)** Solutions : Definition, Composition, Expression, Ideal & non-ideal Solution ii) Chemical & physical effects of some primary fixatives: Formalin, alcohol, picric acid, acetic acid, iii) Source and chemical composition of some dyes: Basic fuchsin, carmine, hematin, eosin. 3. Special application: Finger printing, Southern, Northern & Western transfers	8 6 8 6 6 4 4 4 4

ELECTIVE THEORY-II

ZET 302: FISH AND FISHERIES	Point 50 Lectures
Unit-I **Aquaculture** **1.** Different systems of aquaculture: Monoculture, polyculture, extensive and intensive fish farming. 2. Integrated fish farming: Definition, importance and types 3. Design, criteria and construction -offish farms (carps) : principles of selection, soil characteristics and other parameters 4. Preparation and management of ponds for culture: use of chemical fertilizers and organic manures, control of weeds, pests and predators, fish toxicants, control of aquatic insects. 5. Fish pathology: Immune system of fish; environment and fish health; fin fish diseases and their control. **Unit-II** **Fin fish breeding and biotechnology** 6. Role of pituitary and gonadotropins, natural breeding, environmental control of spawning, natural collection offish seeds, bundh breeding. b) Induced breeding care of brood fish, secondary sex characters, hypophysation, HCG, pheromones, GnRH, LH-RH and their analogues, new generation drugs, induced breeding and multiple breeding, environmental factors, limitations-inbreeding depressions. 7. Concept of biotechnology; biofertilization; bioprocessing and biofiltration in aquaculture; cryopreservation of garnets ; transgenesis	**6** **4** **6** **8** **6** **12** **8**
ZET 302: CYTOGENETICS AND MOL.BIOLOGY	**Point 50 Lectures**

Unit I. **Cancer mutagenesis and DNA repair**	
1. Cancer monoclonal origin; differences of normal cells and cancer cells; cell transformation and factors for cell proliferation; DNA and RNA tumor viruses; concept of oncogene and their role in cancer; tumor suppressor and apoptotic genes. Chromosomal basis of human cancer	10
2. Mutations and mutagenesis types of mutation; biochemical basis of mutations; mutagenesis; spontaneous and induced mutation; reversion as a means of detecting mutagens and carcinogens.	8
3. DNA repair and retrieval; repair of spontaneous and induced mutations; mechanism of DNA repair; repair by direct reversion; excision repair; SOS response.	8
Unit II **Human cytogenetics and behavioral genetics**	
1. Human genetics: karyotype and sex chromosomes; sex determination; role of Y-chromosome; sex mosaics; sex chromosome anomalies; sex influenced and sex limited genes.	10
2. Behavioral genetics influence of single defects on behavior; Genetic analysis of behavior in experimental animals, chromosome anomalies and insight into human behavior.	8
3. Environmental effects and gene expression: effects of external and internal environment; phenocopies; twin studies; concordance and discordance; identical and fraternal twins.	**6**

ZET 302: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY	**Point 50 Lectures**

Unit-I	
Endocrine techniques	
1. Gel electrophoresis in endocrine research, Immunodiffusion, immunochemistry, immunofluorescence, electrophoretic mobility shift assay technology in endocrine reserch.	4
2. Recombinant DNA technology- its application in endocrine research A). Principles and techniques of Southern, Northern and Western Blotting	5
B). Polymerase Chain reaction (PCR), definition, technique and application	5
3. Principles of radio-immuno Assay (RIA) and ELISA	6
4. Flow cytometry: FACS in endocrine research	
Unit-II	
Molecular Biology of endocrine signaling	
1. Signaling of peptide hormone and epinephrine a). G-protein coupled receptors and their effectors- mechanism of receptor binding, bacterial toxin that modify the G-protein b). Activation of Adenylate-cyclase system	12
2. Receptor Tyrosine kinases (RTKs), Ras and Raf a). Auto-phosphorylation of RTKs b). Role of adapter protein and guanine nucleotide exchange factor in activation of Ras	8
3. MAP kinase pathway, multiple MAP kinase pathways.	
4. Thyroid hormone synthesis and regulation and incidence of pathophysiology. Thyroid hormone and cell immunity	3
5. Signaling of cytokines and growth hormones.	3
6. Steroid and hormone signaling	4

ZET 302: PARASITOLOGY AND IMMUNOLOGY	**Point 50 Lectures**
Unit-I	
Helminthes	
1. Classification of helminth.	6
2. Origin and evolution of parasitic helminth	6
3. Life cycle pattern in trematoda, cestoda, and nematoda	8
4. Biology, pathogenesis and control of : *Diphyllobothrium latum, Echinoccocus granulosus and Loa loa*	8

Unit-11 **Epidemiology and Protozoa** 5. Epidemiology: General and landscape Malaria, Leishmania and filarial. 6. Nosology in relation to protozoa. 7. Leishmaniasis with reference to drug resistance. 8. Immunity in human trypanosomiasis	8 4 5 5
ZET 302: ENTOMOLOGY	**Point 50 Lectures**
Unit I: Reproduction and Development 1. Different types of. reproduction , and accessory reproductive organs. 2. Castration, oviposition, factors controlling fertility and fecundity 3. Metamorphosis a) Types of metamorphosis, b) Role of hormones in metamophosis, c) Reversal of metamorphosis, d) Prothetely and metathetely. 4. Hormonal control of reproduction 5. General idea (Up to the formation of three germinal layers) on embryonic development **UNIT II: Insect response and behavior** 1. Parental care: Types; examples. 2. Polymorphism: a) Polymorphism and polyphenism; examples from different orders; significance. b) Polymorphism in aphids: significance; factors controlling polymorphism. 3. Insect predation and parasitism: a) Prey and host location, b) acceptance, c) manipulation, d) selection and specificity of host/prey. 4. Insect societies: a) Subsociality and eusociality: b) Evolution of eusociality 5. Insect defence: Defence by hiding, secondary lines of defence, mechanical defence; chemical defence (classification, nature and source of chemicals); defence by mimicry; collective defence.	4 4 8 4 8 2 4 4 4 4 4
ZET 302: CELL AND DEVELOPMENT BIOLOGY	**Point 50 Lectures**

Unit-I **Developmental ramifications** **1.** Morphogenesis: Meaning of morphogenesis, morphogenetic processes, cell shape, Cell death, morphogenetic movements, cell sorting, morphogenetic field, regionalization. 2. Teratogenesis: Genetic teratology, Environmental teratology, Developmental mechanism, Contribution of teratology to Developmental Biology. 3. Ageing: Cellular basis of aging, Causes of aging, Free Radical Theory of Aging, Ageing of connective tissue	9 7 9

Unit-II **Differentiation** 4. Differentiation: i) Processes, determination, induction, competence, mechanism of differentiation, ii) Reversibility of differentiated state, criteria for dedifferentiation, metaplasia and transdifferentiation, modulation. 5. Neural crest cell migration basnd differentiation 6. Cartilage: a. Structure, differentiation. b. Experimental induction of cartilage and proteoglycan synthesis	5 5 5 5 5

ELECTIVE LAB

FISH AND FISHERIES	
ZEP 301:LAB	**Point 30**
1. Assessment of Field studies (Fish Farm, Market, Co-operative societies etc.) 2. Limnological parameters of water: Organic carbon, Plankton, Algal Blqom, Bottom Biota 3. Preparation of pituitary extracts and induced breeding. 4. Identification of fish	
ZES 301: Seminar	**Point 20**

CYTOGENETICS AND MOLECULAR BIOLOGY	
ZEP 301:LAB	**Point 30**
1. Somatic meiotic chromosome preparation of mouse and/or fish by air drying technique and study of chromosome aberration. 2. Setting up of genetic crosses and solving genetical problems. 3. PCR analysis, RFLP/RAPD- genetic polymorphism (demonstration) 4. DNA gel, Southern blot (demonstration)	
ZES 301: Seminar	**Point 20**

ENDOCRINOLOGY AND REP BIOLOGY	

ZEP 301:LAB	Point 30
1 . Preparation of cryo-cut sections and histochemical demonstration of lipid / cholesterol / 3P-HSD in adrenal of mammal / bird 2. Chromaffin reaction in the section of adrenal gland of bird. 3. Effect of epinephrine on blood glucose levels in rat. 4. Demonstration of steroid RIA/ELISA 5. Thjyroid and adrenalectomy in mice/rat 6. SDS-PAGE for separation of protein 7 Assay of protein phosphorylation catialysed by cAMP dependent protein kinase.	
ZES 301: Seminar	**Point 20**

PARASITOLOGY AND IMMUNOLOGY	
ZEP 301:LAB	**Point 30**
1. Standardization of Microscope; Drawings of protozoan to scale: of protozoan specimen, measurements 2. Fixation,staining and identification of a cephaline gregariana of annelid & insect 3. Blood parasites of birds and fishes 4. Myxozoan parasites of fishes. 5. Ciliate parasites of fishes. 6. Coccidia of birds 7. Parasites of toads and frogs 8. Disease transmitting arthropod parasites 9. Identification	
ZES 301: Seminar	**Point 20**
ENTOMOLOGY	
ZEP 301:LAB	**Point 30**
1 Dissection: Cockroach (male reproductive, sympathetic), Blue bottle fly (digestive, nervous), Grasshopper (nervous, reproductive), Chrysocoris (digestive, nervous, reproductive), Honey bee (digestive, nervous, reproductive, sting apparatus), wasp (digestive, nervous, sting apparatus), Butterfly (digestive, nervous, reproductive), Housefly (digestive, nervous), Mosquito (digestive). Termite (digestive) (subject to availability of specimens). 2. Mounting: Types of antenna, genitalia, wings, legs, mouth parts, tympanum, internal organ system of available insects. 3. Morphometry: I) use of micrometers, ii) use of camera lucida. 4. Taxonomic key preparation 5 Physiological experiments: i) Estimation of digestive and other enzymes ii) Studies on haemocytes iii) Determination of chitin. 6. Toxicology: i) Toxicological appliances (sprayers, dusters etc)	
ZES 301: Seminar	**Point 20**

CELL AND DEVELOPMENTAL BIOLOGY	
ZEP 301:LAB	**Point 30**

1 Separation methods: a) Electrophoresis: SDS-PAGE for separation of proteins. b) Agarose gel electrophoresis separation of RNA 2. Methods of measurement (Colorimetric) i) Estimation of carbohydrates by anthrone method ii) Quantitative estimation of glycogen iii) Quantitative estimation of proteins by Folin-Lowry method: a) Preparation of standard curve b) Estimation of unknown protein 3. Nucleic acid isolation : a) Isolation of RNA and its quantitative measurement b) Isolation of DNA and its quantitative measurement 4. Determination of viscosity of unknown solution	
ZES 301: Seminar	**Point 20**

SEMESTER -IV

HARD CORE THEORY PAPERS

ZHT-411 : ANIMAL BEHAVIOUR AND VECTOR BIOLOGY	Points 75
ANIMAL BEHAVIOUR	**Point 38 Lectures**
1. Introduction to animal behavior : History, foundation, approaches and methods	**5**
2. Learning and memory : Forms of learning, learning and habitat selection - migration, navigation and orientation	**8**
3. Kinship: Relatedness, inclusive fitness? selfishness, altruism	**6**
4. Conflict: Sexual selection, aggression, competition dominance, Infanticide.	**6**
5. Communications: Channels, functions, origin and modification of signal, signal receiving mechanism.	**7**
6. Evolution of feeding behavior: optimal foraging theory.	**6**
VECTOR BIOLOGY	**Point 37 Lectures**
Life cycle, mode of transmission, control and importance of:	
1. Anopheles sp., Culex sp., Aedes sp.	7
2. Ticks and mites.	6 6
3. Sand flies	6 6
4. Tabanid fly	6
5. Black fly	
6. Flea	

ZHT-412: MOLECULAR BIOLOGY AND BIOTECHNOLOGY AND TOOLS AND TECHNIQUE	Points 75
MOLECULAR BIOLOGY AND BIOTECHNOLOGY	**Point 38 Lectures**
1. transcriptional control of gene expression- positive and negative regulations, RNA polymerases, promoters and regulatory sequences, activators and repressors of transcription, transcription initiation by RNA polymerases, regulation of transcription factor activity, elongation and termination of transcription.	**5**
2. Post-transcriptional gene control and nuclear transport-t ypes of introns and their splicing, evolution of introns, catalytic RNA, alternative splicing and proteome diversity, regulation of Pre-mRNA Processing, micro RNA and other non-coding RNAs, degradation of RNA.	**5**
3. Transport across the nuclear envelope and stability of RNA- structure of nuclear membrane and nuclear pore complexes, processes of nuclear import and export and their regulation, degradation of RNA. Translational machinery and translational control - energetics of amino acid polymerization, tRNAs and their modifications, aminoacyl tRNA synthetases, accuracy during aminoacylation of tRNA, regulation of initiation of translation in eukaryotes, elongation and its control, inhibitors of translations.	**5**
4. Basic recombinant DNA techniques, cutting and joining DNA molecules, restriction modification systems, various enzymes used in recombinant DNA technology, restriction maps and mapping techniques; nucleic acid probes, blotting techniques, DNA fingerprinting, footprinting, methyl interference assay. Polymerase chain reaction– methods and applications.	**8**
5. Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors and other advanced vectors in use. Gene cloning strategies: methods of transforming E. coli and other cells with rDNA; methods of selection and screening of transformed cells; construction of genomic and cDNA libraries; strategies of expressing cloned genes; phage display.	**5**
6. Manipulating genes in animals: gene transfer to animal cells, genetic manipulation of animals, transgenic technology, application of recombinant DNA technology; genetically modified organisms: gene knockouts, mouse disease models, gene silencing, gene therapy, somatic and germ- line therapy.	**5**

TOOLS AND TECHNIQUE	Point 37 Lectures
1. Techniques for Cell Study:	
i) Fluorescent Microscopes, Confocal microscopy, Phase Contrast Microscopy, Dark- Field Microscopy.	4
ii) Electronic Imaging Systems- Electron Microscopy, TEM Vs. SEM.	8
Iii) Basic concept of flow cytometry	7
2. Cell Fractionation Methods:	
i) Preparative Ultracentrifugation	
ii) Gradient Centrifugation	8
3. Separation of Cell Costituents:	
i) Chromatography: ion exchange; gel filtration and HPLC	
ii) Electrophoresis-PAGE, SDS-PAGE (One and Two dimentional).	4
4. Spectroscopy: Spectrophotometer.	3
5. Blotting Methods: Southern, Northern & Western blotting	3
6. Pesticide formulation.	
7. Database search tool; Sequence alignment and database searching; Computational tools and biological databases, NCBI, EBL, Sequence similarity tools; Blast and FASTA	

SOFT CORE THEORY

ZST 407: AGRICULTURAL ENTOMOLOGY	Point 25 Lectures

1. Important insect pests (names only) of: Tea, Vegetables ,Paddy and Sugarcane and damages caused by them	4
2. Morphology, bionomics and management of: i) Ricebrown plant hopper (*Nilaparvata lugens)* ii) Sugar cane top borer (*Scirpophaga nivella) iii)* Tea mosquito bug *(Helopeltis theivora)* *i)* Brinjal fruit and shoot borer *(Leucinodes orbonalis)* 3.	7
Plant protection techniques	5
4. Natural enemy diversity of agricultural pests in India and their potentiality	3
5. Economic decision levels for pest population; a) Concepts of economic levels b) Dynamics of economic injury levels c) Calculation of economic decision levels using economic levels	6 7
ZST408: CANCER BIOLOGY	**Point 25 Lectures**
1. Cancer monoclonal origin; differences of normal cells and cancer cells; cell transformation and factors for cell proliferation; DNA and RNA tumor viruses; concept of oncogene and their role in cancer; tumor suppressor and apoptotic genes. Chromosomal basis of human cancer Major causes of cancer: carcinogens; chromosome and genetic abnormalities associated with cancer 2. Oncogenes and genetic causes of cancer; tumor suppressors and apoptotic genes 3. Diagnosis and treatment: Gene therapy; drug delivery problems; 4. Concept of nanotechnology and nanomedicine in cancer treatment	10 5 5 5
ZST409: MEDICAL EMBRYOLOGY	**Point 25 Lectures**
1. Medical implications : Infertility- Diagnostic infertility, causes of infertility	3
2. Assisted Reproductive Technologies : Sperm and ova bank; Artificial Insemination donor (AID); in *vitro* fertilization (IVF), procedures, variations of IVF, Success rates and complications; Gamete Intrafallopian transfer (GIFT), Intracytoplasmic sperm Injection (ICSI), Surrogate mothers.	7
3. Genetic errors of human development- Down syndrome, Fragile X syndrome.	5
4. Future of medicine: Differentiation therapy, gene therapy *(Ex Vivo* and *In vivo),* germ line gene therapy.	5
5. Techniques used in Medical Embryology : i) Amniocentesis ii) Chorionic villus sampling iii) Ultrasonography iv) DNA Finger	5

ZST 410 AQUACULTURE TECHNOLOGY	**Point 25 Lectures**

1. Stock Improvement Induced breeding and bundh breeding, sex reversal and sterility, Selective breeding, Androgenesis and Gynogenesis, Polyploidy, Hybridization, Shell fish reproduction : Endocrine control of reproduction , role of neurotransmitters. 2. Non conventional aquaculture technology Raceways and recirculatory system, Cages and pen culture, Wastewater aquaculture Organic aquaculture 3. Coastal aquaculture: Status of coastal aquaculture in India, Culture of prawn : major cultivable species, techniques of larval rearing, growout Technology.Culture of shrimp: major cultivable species Reproduction and rearing Grow out of shrimp	10 5 10
ZST 411: HORMONE AND SIGNAL TRANSDUCTION	**Point 25 Lectures**
1. Signaling molecules and cell surface receptors 2. Subclasses of nuclear receptor ligand, Nuclear Receptor Signaling Mechanism 3. Cytokine Receptor 4. Neuroendocrine regulation of immune system; Stress hormones and immune responses; Melatonin 5. Immune response and cancer therapy 6. Neuroendocrine disorders; genetic versus environmental cause.	4 4 4 4 4 5
ZST 412: PARASITE AND DISEASE	**Point 25 Lectures**
1. Primary amoebic meningoencephalitis. 2. Important Myxozoan genera of fishes - Structure and life history of any *Myxobolus* sp. 3. Important genera of fish parasitic ciliates - *Icthyopthirius* sp. 4. Some common helminthes of freshwater fishes and their life cycle patterns: a) *Proteocephalus* sp., *b)Camallanus* sp. 5. Structure, Pathobiology prophylaxis and diagnosis of causative agents of filariasis . 6. Parasitic insects: *Cimex lectularius and Xenopsylla cheopis*	4 4 4 4 4

HARD CORE LAB

ZHL 411: ANIMAL BEHAVIOUR AND VECTOR BIOLOGY	**Point 25**
Animal Behavior **1.** Demonstration of behavioral change of fish /chick in relation to toxicant / chemicals. 2. Study of habituation to light stimulus in the earthworm. 3. Demonstration of photo tactic response of house fly.	Point 12.5

Vector Biology 4. Mouthparts of Anophees mosquito and Tabonid fly 5. Mothparts of Culex mosquito 6. Mouthparts of Aedes fly **7.** Whole mount of Ticks and Mites	Point 12.5
ZHL 412: MOL BIOLGY AND BIOTECHNOLOGY AND TOOLS & TECHNIQUE	**Point 25**
Molecular Biology and Biotechnology 1. Setting up and solving of genetic crosses 2. Demonstration of short term tissue culture. 4. Plasmid DNA isolation: minipreps; Agarose gel electrophoresis of isolated plasmid. 5. Restriction enzyme digestion of plasmid DNA	Point 12.5
Tools and Techniques 1. Centrifugation technique: Differential centrifugation for separation of nuclei, cell debris, mitochondria. **2.** Colorimetric estimation of Protein, DNA/RNA **3.** Demonstration of PAGE	Point 12.5

ELECTIVE THEORY-I

ZET 403: FISH AND FISHERIES	**Point 50** **Lectures**
Unit-I **Fishing crafts and** gears	
1 . Crafts: Terminology of fishing boats; Inland and Marine crafts, types, mechanization of crafts, trawlers, techniques of trawling.	8
2. Gears: Basic knowledge of mesh aid knots, fishing gear materials, different types of nets and their operation, Rods and lines.	8
	8
Unit-II **Post harvest technology**	
1 . Spoilage of fish- microbial changes, changes in amino acids, protein, oil, Breakdown products, rigor mortis	8
2. Preservation, processing and curing offish.	8
3. Fish by products.	10

ZET 403: CYTOGENETICS AND MOL.BIOLOGY	Point 50 Lectures
Unit I **Epigenetics** 1. A brief history of epigenetics - overview and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in *saccharomyces cerevisiae,* position effect variegation, heterochromatin formation, and gene silencing in *Drosophila,* fungal models for epigenetic research: *Schizosaccharomyces pombe* and *Neurospora crassa*; RNAi and heterochromatin assembly, role of noncoding RNAs; epigenetic regulation in plants. 2. Chromatin structure and epigenetics marks - transcriptional silencing by polycomb group proteins , transcriptional regulation by trithorax group proteins, histone variants and epigenetics , epigenetic regulation of chromosome inheritance, epigenetic regulation of the X chromosomes in *C.elegans,* dosage compensation in *Drosophila,* dosage compensation in mammals; types mechanism of chromatin remodeling. 3. Epigenetics and genome imprinting - DNA methylation in mammals, genomic imprinting in mammals, nuclear transplantation and the reprogramming of the genome. epigenetics and human disease, epigenetic determinants of cancer. **Unit II** **Transposons and Extra-nuclear inheritance** 1. Mobile genetic elements: Characteristics of transposable elements in prokaryotes and eukaryotes; AC/DS system in maize; P element in *Drosophila;* Salmonella phase variation; retrosposons 2. Extra-nuclear inheritance: Streptomycin resistance in chlamydomonus; Kappa particles; criteria for extra-chromosomal inheritance, infectious heredity.	12 8 12 18
ZET 403: ENDOCRINOLOGY AND REP BIOLOGY	**Point 50 Lectures**

Endocrinology and Reproductive Physiology **Unit-I** 1. Hormonal regulation of spermatogenesis 2. Suppression of testicular activity by steroidal and non-steroidal agents 3. Biosynthesis and metabolism of androgen and influence of androgen on accessory sex organ	6 6 6 6
Unit-II 1. Biosynthesis and metabolism of ovarian hormone. 2. Regulation of ovarian follicular development in primates: follicular growth; factors regulating follicular growth; pattern of follicular atresia; follicular selection and dominance. 3. Endocrine role in normal development of breast and lactation. 4. Endocrinology of pregnancy	6 6 6 ~~8~~
ZET 403: PARASITOLOGY AND IMMUNOLOGY	**Point 50 Lectures**
Unit-I **Biology of Parasitic Protozoa** 1. Structure and biology of *Trichomonas vaginalis* *2.* Structure and biology of *Trypanosoma evansi* and Surra disease 3. Structure, life-cycle, pathology and Control of Myxozoa in fishes and	5 5
Microspora in insects 4. General consideration of amoebae in man 5. Coccidia and coccidjosis in birds (with special reference to *Eimeria tenella)* **Unit-II** **Zoonosis and vector biology** 6. Avian and simian malarial parasites. 7. Comparative characterization of human malaria parasites 8. Zoonoses with special reference to Japanese Encephalitis and Toxoplasmosis 9. Ultra structure of Trypanosomes 10. Structure, biology and control of: Sand fly, anopheles, tick.	5 5 5 5 5 5 5 5 5

ZET 403: ENTOMOLOGY	**Point 50**

Applied Entomology Unit-I **Insects of Agricultural and Medical Importance** 1. Morphology, life history and control of major pests of (two of each): Cotton, mango 2. Morphology, biology of gall insects (only two sp.) and their control; mechanism of gall formation; significance of gall formation; gall - insects association 3. Locust: different sp., their distribution, biology and control 4. Role of insects and acarine in transmission of human diseases 5. Life history, structures involved and mode of transmission of diseases by the *Xenopsylla cheopis* . 6. Medicinal insects. 7. Biological note on Dengue and malaria (Vector and pathogen); Mode of transmission and symptoms	4 4 4 4 4 4
Unit-II **Insect management** **1.** Chemical insecticides: classification, properties, pharmacology and mode of action of some commonly used insecticides. 2. Chemosterilants and hormonal analogues **3.** Fumigants: Chemical nature, properties, toxicity, mode of action, application and operational precautions. 4. Biological control: classification, ecological consideration, bioagents, method of bioagerit introduction; examples: merits, demerits 5. advantages and disadvantages. 6. Integrated pest management: importance; components;phases; method of implementation; Example; merits and demerits Antifeedants, attractants, repellejits and biopesticides: uses,	4 4 4 4 4 4

ZET 403: CELL AND DEVELOPMENT BIOLOGY	Point 50 Lectures
Unit-I	
Paradigm of gene expression	
1. Nucleocytoplasmic interaction in '	8
i) In early development; Importance and role of cytoplasm, biochemical evidence for functional state of genome, hybridization experiments, nature of changes in nuclei, cell hybridization and nuclear transplantation experiments	
2. Biological specificity : Transplantations and rejection	8
Unit-II	
Growth and regeneration	8
1. Growth: Definition, Relative growth of parts, growth gradients	
2. Regeneration: origin of regenerating cells and their potentialities, Field action in regeneration	8
3. Proteins during development:	
i) Lens crystalline: Classification, ontogeny of crystalline in fish, chick and mammals	8
ii) Hemoglobin: structure, heterogeny and ontogeny	
iii) LDH : structure, function, ontogeny, heterogeny, control of isozyme patterns	10
4. Statistics in biology :	
i) Test of hypothesis: Chi- square test, Paired 't' – test Non-parametric tests : Spearman's Rank correlation, Wilcoxon Signed Rank test.	

ELECTIVE THEORY-II

ZET 404: FISH AND FISHERIES	Point 50 Lectures
Unit-I	
Marine Fisheries	
1. Survey of marine fisheries: offshore, deep sea, divisions	8
2. Coastal fisheries: Coastal zones, features, EEZ,CRZ.	
3. Mangrove Ecosystem: Definition, importance, structure and function with special reference to Sundarban, Inda; Problem and management.	8 8
4. Remote sensing: Concept, role in marine fisheries resource management and exploitation.	
Unit-II	8
Marketing and conservation	8
1. Marketing: fish markets in India, strategy, structure, price formation.	10
2. Cooperative societies: principle, organization and function.	
3. Conservation of fisheries: Declining stock, endangered fish fauna of India, causes of decline, methods of conservation, fisheries act and environment act.	

ZET 404: CYTOGENETICS AND MOL.BIOLOGY	Point 50 Lectures
Unit I **Developmental genetics and Genomics**	
1. Genetic regulation during development: Gradients in early embryogenesis in Drosophila. Cell fate & signaling pathways. Gap genes; segment polarity genes; axis formation; homeotic genes; homeo-domains; Hox genes & HOM-c genes.	**8** **8**
2. Structural genomics: High resolution chromosome map-RFLP RAPD, fluorescence in situ hybridization; radiation hybrid mapping ; physical mapping of genomes ; genome sequencing	**8**
3. Functional genomics: Study of gene interaction by the yeast two hybrid system; study of developmental regulation by using DNA-chips	**8**
4. Comparative genomics: Orthologuos, paraloguos and Gene displacement, Phylogenetic finger printing.	**8**
Unit II **Population genetics**	
1. Inbreeding and heterosis: measurement of inbreeding; panmictic index, inbreeding depression; heterosis; theories of heterosis.	**4**
2. Genetic structure of populations: Fisher's fundamental theorem of natural selection; genetic variability in natural population; genetic homoeostatis; genetic load and genetic death.	**6**
3. Speciation and evolution at the molecular level: evolution of proteins and nucleotide sequences; regulatory genes and some evolutionary consequences; molecular evolution in the test tube; evolution of genetic systems.	
4. Gene frequencies and equilibrium: gene frequencies; gene frequencies, gene pool, conservation of gene frequencies.	

ZET 404: ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY	Point 50 Lectures
Unit - I	
1. Infertility in males and females and their remedial measures.	**5**
2. Induction of ovulation and spermeation: Oocyte and sperm maturation substances ; their probable mode of action.	**5**
3. Fertility control i) ovulation suppression by oral and injectable steroidal contraceptive ii) use of implants and IUDs.	**5**
Unit - II	**5**
1. Photoperiodism and endocrinology of photo-sexual activity by pineal gland hormones.	**5**
2. Neuro endocrine-immune interactions: chemical nature and signaling of cytokines; neuron endocrine regulations of immune processes and immune regulatory effects of HCG and neuropeptides.	**5**
3. Hormonal manifeatations of malignancy	**5**
4. Hormonal control of stem cells: Role of stem cell biology in different organ; roles in malignancy.	**7**
	8

ZET 404: PARASITOLOGY AND IMMUNOLOGY	Point 50 Lectures
Unit-1	
Parasite physiology, biochemistry	
1. Membrane transport mechanism in parasites.	**6**
2. Reproductive physiology in parasites.	**6**
3. Energy metabolism in parasitic protozoa and helminths	**6**
Unit-II	
Immunoparasitology	
4. Principles of immunity in relation to virus, bacteria, protozoa, helminths	**6**
5. Structure and function of antibody	**6**
6. T-cell receptor organ and functions of immune response	**6**
7. Antigen-antibody reaction and its role in clinical parasitology	**6**
8 Basic immunological changes due to parasitic infection, antigen vaccination, immunopathology	**8**
ZET 404: APPLIED ENTOMOLOGY	**Point 50 Lectures**

Unit-I Plant protection and insect host relationship	
1. Plant protection appliances: sprayers and dusters; heir merits and demerits	**6**
2. Insect and plant diseases: insect as vector , insect borne viruses causing plant diseases; insect yector-plant virus relationship.	**6**
3. Insect plant interaction: a) mechanism of host selection (host habitat finding, host finding, host recognition; host acceptance); b) role of nutritional component in host selection; c) allelochemicals and host selection.	**6**
4. Co-evolution in insect and plant: types; co-evolution with pollinating insect; mimicry.	**6**
Unit- II Population, forensic and soil entomology	
1. Principles of population studies:' sampling, objectives and practical application.	**6**
2. Factors controlling population: abiotic (temperature, moisture, rain fall and photoperiodism), biotic (food and natural enemies)	**6**
3. Forensic entomology: types; importance of medico legal forensic entomology, stages of death; importance of insects in medico criminal investigation; estimation of time of death using insects; common arthropods associated with dead body; application and case study.	**8**
4. Population study method: intrinsic rate of increase (rm); life table construction and its application.	
5. Soil insects: types; important role of edaphic factors (moisture, temperature and pesticide) on soil insects.	
ZET 404: CELL AND DEVELOPMENT BIOLOGY	**Point 50 Lectures**

Unit-I **Cell Synchronization** 1. Physiology of cell division: Cell Cycle, synchrony in cell division, inhibition of cell division, source of energy. 2. Cell signaling: General principles, role of cell surface receptors in cell 4 signaling. 3. Cancer: Characteristics of tumor cells; Oncogenes and their proteins, classification and characteristics of chemical carcinogen; role of radiation and DNA repair in carcinogenesis. **Unit-II** **Neurobiology** 1. Cell -cell adhesion: types of cell binding, adhesive proteins, their role in cell-cell interaction, morphogenesis, differentiation movement of leucocytes into tissues. 2. Molecular neuron biology; General. organization of nerve fibers, Axon Ultra structure, Neurotubules and neurofilaments.Neurosecretary cell: Occurrence, staining behavior, neurosecretion in invertebrates	**10** **10** **10** **10** **10**

ELECTIVE LAB

FISH AND FISHERIES	
ZEL 402: Lab	**Point 30**
1. Physico-chemical analyses of soil: pH and available phosphate 2. Gut content analyses of fish 3. Feed formulation	
ZES 402: Project / Review	**Point 20**

CYTOGENETICS AND MOLECULAR BIOLOGY	
ZEL 402: Lab	**Point 30**
1. Localization of Ag- NORs, C-heterochrornatin in mouse chromosomes 2. Isolation of membrane proteins from mammalian cells through different chromatographic techniques. Separation of proteins using native and SDS gel electrophoresis. 3. Demonstration of ELISA, tissue culture, cancer cell line 4. Model scientific paper writing general rules	
ZES 402: Project / Review	**Point 20**

ENDOCRINOLOGY AND REPRODUCTIVE BIOLOGY	
ZEL 402: Lab	**Point 30**

1. Bio-assay of LH by OAAD test 2. lipids steroid separation by TLC 3. Oocyte maturation in fish using germinal vesicle breakdown test by the induction of maturation-inducing steroid 4. Determination of the stages of spermatogenesis in rat testis by PAS-Haematoxyline technique, or Cyclic changes in the exfoliate cytology of vaginal epithelium in rat 5. Examination and submission of slide testis, ovary, epididymis, prostate and uterus and seminal vesicles	
ZES 402: Project / Review	**Point 20**

PARASITOLOGY AND IMMUNOLOGY	
ZEL 402: Lab	**Point 30**
l. Isolation and identification of peritoneal macrophages of rat. 2. Parasites of fishes 3. Identification of lymphoid tissue (spleen, thymus and lymph node, Bursa of Fabricious.)	
4. Blood parasites of birds and fishes 5. Deposition of collected materials and laboratory note book	
ZES 402: Project / Review	**Point 20**

ENTOMOLOGY	
ZEL 402: Lab	**Point 30**
1. **Study of field and stored grain insects (at least 10 examples)** **2. Ecology:** i) Ecological instruments ii) Soil insects: a) Methods of extraction b) Sorting of material and their identification c) Plotting of results in tables and diagrams. iii) Terrestrial insects : a) light trap b) net sweeping c) Aspirator method v) Estimation of population, frequency, relative density, abundance using Quadrate and Mark and release methods vi) Determination of Diversity index of a field population, vii) Estimation of nature of damage and loss of plants and produce. 3. **Collection of social insects and their nests** 4. **Taxonomy:** Collection and identification of insects up to family 5 **Submission of field reports, Life cycles, specimens**.	
ZES 402: Project / Review	**Point 20**

CELL AND DEVELOPMENTAL BIOLOGY	
ZEL 402: Lab	**Point 30**
1 . Study on development of chick embryo 2. Examination and submission of slides of chick liver, kidney, testis / ovary, brain of different stages of development. 3. Determination, of enzyme activity: Effect of pH, Temperature, Substrate concentration and Time (Titration or Colorimetric method). 4 Study of proteins during embryonic development. 5 Review on recent developments in cell and developmental biology	
ZES 402: Project / Review	**Point 20**