

University of Gour Banga

(Established under West Bengal Act XXVI of 2007)



**N.H.-34(Near Rabindra Bhawan), P.O.:Mokdumpur Dist.: Malda,
West Bengal, Pin-732103**

M.Sc. in Zoology

Two Years (Four Semesters) Syllabus

Main Feature of the Syllabus

M.Sc. in Zoology

Semester	Paper Code	Paper Name	Marks	Time
I	ZGT 101	Non-chordate Structure and Function	40	2.00 Hr
	ZGT 102	Cell Biology and Inheritance Biology	40	2.00 Hr
	ZGT 103	Parasitology and Immunology	40	2.00 Hr
	ZGT 104	Histology and Histochemistry	40	2.00 Hr
	ZGP 101	Practical (related to ZGT 101 - ZGT 104)	50	4.00 Hr
	ZGC 101	Class test (related to ZGT 101 - ZGT 104)	40	2.00 Hr
Total			250	
II	ZGT 201	Chordate Structure and Function	40	2.00 Hr
	ZGT 202	Ecology and Environmental Biology	40	2.00 Hr
	ZGT 203	Metabolic Regulation and Molecular Biology	40	2.00 Hr
	ZGT 204	Quantitative Biology and Bioinformatics	40	2.00 Hr
	ZGP 201	Practical (related to ZGT 201 - ZGT 204)	50	4.00 Hr
	ZGC 201	Class test (related to ZGT 201 - ZGT 204)	40	2.00 Hr
Total			250	
III	ZGT 301	Taxonomy and Evolution	40	2.00 Hr
	ZGT 302	Animal Physiology	40	2.00 Hr
	ZGT 303	Biophysical Principles and Instrumentations	40	2.00 Hr
	ZGT 304	Applied Zoology	40	2.00 Hr
	ZGP 301	Practical (related to ZGT 301 - ZGT 304)	50	4.00 Hr
	ZGC 301	Class test (related to ZGT 301 - ZGT 304)	40	2.00 Hr
Total			250	
IV	Elective courses	Students to opt either entomology or microbiology		
	Elective courses (Theoretical)	A + B	50 + 50 = 100	2.30+2.30=5 .00 Hr
	ZET 401A	General Entomology		
	ZET 401B	Agricultural and Medical Entomology		
	ZET 402A	Medical Microbiology		
	ZET 402B	Food and Environmental Microbiology		
	Elective courses (Practical)	Related to A and B	50	2.30+2.30=5 .00 Hr
	ZEP 401	General Entomology; Agricultural and Medical Entomology		
	ZEP 402	Medical Microbiology; Food and Environmental Microbiology		
	Elective courses (Class test)	Related to A and B	20	1.00 Hr
	ZEC 401	General Entomology; Agricultural and Medical Entomology		
	ZEC 402	Medical Microbiology; Food and Environmental Microbiology		
ZPR 401	Project work (related to elective courses)	50	6.00 Hr	
ZES 402	Seminar (related to elective courses)	30	4.00 Hr	
Total			250	
Grand Total			1000	

Elective courses:

Entomology: A: General Entomology; B: Agricultural and Medical Entomology

Microbiology: A: Medical Microbiology; B: Food and Environmental Microbiology

Detailed Syllabus

Semester I

ZGT 101 (Non-chordate Structure and Function)

40 marks

1. **Non-chordate: Diversity of forms**
2. **Feeding, digestion, nutrition and metabolism**
 - 2.1. Patterns of feeding and digestion in parasitic protozoans and lower metazoans
 - 2.2. Comparative accounts: helminths, arthropods, molluscs and echinoderms
3. **Respiration and circulation**
 - 3.1. Comparative accounts of structures in non-chordates
 - 3.2. Respiratory pigments
 - 3.3. Mechanism of respiration: Arthropoda and Mollusca
 - 3.4. Haemolymph and its significance; pulsatory mechanism
4. **Excretion**
 - 4.1. Comparative accounts of structures in non-chordates
 - 4.2. Excretory mechanism: Annelida, Arthropoda
 - 4.3. Osmoregulation in non-chordates
5. **Nervous system and sense organs**
 - 5.1. Evolution of nervous system and sense organs in non-chordates
 - 5.2. Organization in Crustacea and Insecta
 - 5.3. Chemical senses and animal orientation in non-chordates
 - 5.4. Photoreception and photosensitivity in insects
6. **Reproduction and development**
 - 6.1. Comparative accounts of structures in non-chordates
 - 6.2. Mode of reproduction in protozoans and helminths
 - 6.3. Reproductive hormones in non-chordates
 - 6.4. Metamorphosis and diapause in insects
 - 6.5. Moulting in Crustacea

ZGT 102 (Cell Biology and Inheritance Biology)

40 marks

Group A: Cell Biology

20 marks

1. **Cell membrane:** Membrane structure and fluidity, membrane lipids and proteins, transport across cell membrane
2. **Cell organelles (structure and function):** GERL system, mitochondria and plastids; cytoskeletons and molecular motors
3. **Cell-cell interaction:** Adhesion junctions, tight junctions and gap junctions
4. **Cell signaling:** Signaling molecules and their nature of receptors; pathways of signaling
5. **Eukaryotic cell cycle:** Steps in cell cycle of yeast and eukaryotes. Regulation of CDK – cyclin activities; molecular basis of cellular check points, licensing factors
6. **Eukaryotic chromosomes:** Structure of chromatin and chromosome, molecular anatomy of eukaryotic chromosomes – structure and organization of telomere, centromere and kinetochore, polytene and lampbrush chromosome
7. **Apoptosis:** Events and regulation of apoptosis; role of caspases 8. Cancer: Genetic rearrangement in progenitor cells, oncogenes, tumour suppressor genes, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth

Group B: Inheritance Biology

20 marks

1. Concept of genes: Allele, multiple allele, pseudo allele, complementation tests
2. Mendelian principles: Dominance, segregation, independent assortment; deviation from Mendelian inheritance
3. Extensions of Mendelian principles: Codominance, Incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy
4. Genomic Imprinting: Prader Willi and Angelman syndrome
5. DNA repair mechanism: Types in prokaryotes and eukaryotes
6. Sex determination and Dosage compensation: Drosophila, C. elegans and man
7. Recombination: Homologous and non-homologous recombination, site-specific and transpositional recombination
8. Microbial genetics: Methods of genetic transfer- transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating

ZGT 103 (Parasitology and Immunology)

Group A: Parasitology

20 marks

1. **Types of parasites and hosts:** Basic concept of parasitism, symbiosis, phoresis, commensalism and mutualism
2. **Biological vectors:** Importance in transmission of parasites causing human diseases with special references to Chagas' disease, sleeping sickness, filariasis
3. **Human parasites:** Ultra structure and biology of Plasmodium spp., Leishmania donovani, Entamoeba histolytica; host range, mode of infection, clinical symptoms and pathogenesis, treatment protocol of clonorchiasis, taeniasis and cysticercosis, angiostrongyliasis
4. **Zoonotic diseases:** Toxoplasmosis, echinococcosis, toxocariasis with emphasis on their zoonotic mode of transmission, development and prevention and control
5. **Molecular parasitology**
 - 5.1. Molecular basis of antigenic variation and diversity in helminth and protozoan parasites
 - 5.2. Molecular organization and gene structure in Plasmodium falciparum
 - 5.3. Strategies of molecular cloning and protection against malaria
 - 5.4. Probe technology for parasite diagnosis

Group B: Immunology

20 marks

1. Key concept of immunology
2. **Innate immunity**
 - 2.1. Cells, tissues and organs of immune system
 - 2.2. Mechanism of phagocytosis and inflammation
 - 2.3. Complement system: components and pathways of complement activation
 - 2.4. Cytokines: family, examples and functions
3. **Adaptive immunity**
 - 3.1. Nature of antigens: epitopes, haptens and CD molecules
 - 3.2. Immunoglobulin classes
 - 3.3. Antigen-antibody reaction
 - 3.4. T cells and B cells: types and activation
4. **Hypersensitivity:** Type I and Type II
5. **Applied immunology:** Vaccination— types and characteristics; monoclonal antibody production and enzymelinked immunosorbent assay

ZGT 104 (Histology and Histochemistry)

Group A: Histology

20 marks

1. **Basic concepts of histological techniques:** Tissue fixation, embedding, microtomy, staining and mounting
2. **Epithelial tissue:**
 - 2.1. Characteristics and function of epithelial tissues
 - 2.2. Ultrastructure of transport, synthetic-secretory and specialized epithelial cells
3. **Muscle tissue:**
 - 3.1. Characteristics, ultrastructure and function of muscle proteins and cells
 - 3.2. Molecular aspects of muscle contraction
4. **Connective tissue:** Tropocollagen synthesis; glycosylation and post transcriptional modification and structure
5. of RNA
6. **Extra-cellular matrix:** Organization and chemistry; structure and composition

Group B: Histochemistry

20 marks

1. **Enzyme and non-enzyme histochemistry:** General idea
2. **Neurochemistry and immunohistochemistry:** Outlines and introduction
3. **Principles and methods:** Histochemical localization of carbohydrates, proteins, nucleoproteins and lipids in tissues
4. Use of colloidal gold in histochemistry
5. Inorganic constituents of tissues and organs
6. **Histophysiology of tissues and organs:**
 - 6.1. Vertebrate liver and invertebrate hepatopancreas
 - 6.2. Caudal neurosecretory system in fishes
 - 6.3. Bone marrow
7. Use and application of biopsy materials for diagnostic histochemistry and histophysiology

1. Non-chordate:

- 1.1. Dissection and display of anatomical system of cockroach/*Pila*
- 1.2. Identification of non-chordate specimens following taxonomic methods and principles
- 1.3. Study of haemocytes from non-chordate specimens
- 1.4. Slide preparation: whole/parts of non-chordate specimens

2. Cell Biology and inheritance biology:

- 2.1. Chromosome preparation from rat bone marrow/ preparation of meiotic chromosomes from

3. grasshopper testes: Identification of stages

- 3.1. Preparation of polytene chromosomes from *Chironomus/Drosophila* larvae
- 3.2. Protein gel electrophoresis (native and SDS)/agarose gel electrophoresis for DNA

4. Parasitology and Immunology:

- 4.1. Identification of protozoan and helminth parasites following taxonomic methods and principles
- 4.2. Study of smear preparation of gut contents of vertebrate/invertebrate hosts for protozoan

5. and helminth parasites: staining and identification

- 5.1. Human blood film for WBCs identification
- 5.2. Blood grouping and Rh factor determination

6. Histology and histochemistry:

- 6.1. Identification of mammalian tissue sections
- 6.2. Tissue fixation, microtomy and double staining of tissue sections
- 6.3. SEM demonstration
- 6.4. Histochemical reactions for DNA

7. Laboratory note book updating and submission of prepared slides

8. Viva-voce (20% weightage)

Semester II

ZGT 201 (Chordate Structure and Function)

40 marks

1. Vertebrate body plan

- 1.1. Biological design of vertebrate body
- 1.2. Mechanics of body support and movement
- 1.3. Mechanics of swimming, diving, flying and gliding

2. Origin of jaws and its suspension

- 2.1. Functional and evolutionary significance
- 2.2. Cranial kinesis in feeding mechanisms

3. Respiration and cardiovascular system

- 3.1. Respiratory system in vertebrates and its evolution
- 3.2. Embryonic development of cardiovascular system
- 3.3. Structure and function of lymphatic system

4. Nervous system and sensory organs

- 4.1. Evolution and functions of peripheral nervous system
- 4.2. Functional associations of parts of central nervous system in vertebrates
- 4.3. Lateral line system and electroreception
- 4.4. Organs of olfaction and taste
- 4.5. Echolocation in bat
- 4.6. Evolution of vestibular system

5. Comparative anatomy: Brain, kidney, heart and aortic arches in vertebrates

1. Principles in ecology

- 1.1. Ecosystem, food chains, food web, ecotone and edge effect, energy flow in ecosystem, mesocosm, noosphere
- 1.2. limiting factors: temperature and light
- 1.3. Animal association: parasitism and symbiosis
- 1.4. Habitat and niche: habitat and microhabitat; niche concept

2. Population ecology

- 2.1. Life tables and survivorship curves
- 2.2. Population cycles in discrete time logistic population models — recruitment functions, qualitative behaviour of difference equations;
- 2.3. Population regulation: density-dependent and density-independent mortality factors and their interactions
- 2.4. Predation : predator and prey models, oscillation in population size (prey population growth rate, predator population growth rate, joint predator-prey population growth rate)
- 2.5. Ecological modeling: concept, components and application

3. Metapopulation: metapopulation concept, models, structure and fluctuations; effect of migration and local population demographics on metapopulation, genetic variation in a metapopulation

4. Ecoenergetics and biogeochemical cycles

- 4.1. Concepts of primary and secondary productivity, measurement of ecosystem productivity (satellite and other methods), limits to primary and secondary production, patterns in primary production, temporal and spatial variations in primary production
- 4.2. Global cycling of water, carbon, sulfur, and nitrogen

5. Pollution: Source and effects of air, sound, soil and water pollution and their control; solid waste management

6. Biome and conservation ecology: Concept of biome, conservation of natural resources and wildlife, *in situ* and *ex situ* conservations; Red Data Book; conservation of wetlands; methods of cryopreservation

7. Fresh water ecology: Characteristics, limiting factors, nutrient status, classification of fresh water organisms, fresh water biota, lentic and lotic communities, zonation of rivers/streams and wetlands

8. Animal behavior: Concepts of ethology, stereotyped and acquired behaviour (classical conditioning, instrumental learning, habituation and imprinting); social behaviour, altruistic behaviour, biological rhythms

9. Biomonitoring and bioremediation

- 9.1. Biological agents as marker of environmental pollution
- 9.2. Pesticide remediation using bacterial system

ZGT 203 (Metabolic Regulation and Molecular Biology)

Group A: Metabolic Regulation

20 marks

1. **Carbohydrate:** Forms and functions; glucose metabolism pathways and regulation (role of class IIa histone deacetylases)
2. **Protein:** Amino acids: structure and classification; primary, secondary, tertiary and quaternary structures of protein; Ramachandran plots; transamination and deamination
3. **Lipids:** Classification and metabolism; β -oxidation of fatty acid
4. **Enzymes:** Classes, action, activation energy; factors affecting enzyme action; inhibition of enzyme action; enzyme kinetics: Michaelis-Menten equation; ribozyme
5. **Molecular signaling:** Toll-like receptor signaling pathway; signal transduction pathway mediated by *ras* protooncogenes; notch signaling pathway in *Drosophila*
6. **Bioenergetics:** Principles of bioenergetics, oxidative phosphorylation, electron transport system
7. **Biotransformation:** Metabolism of xenobiotic compounds

Group B: Molecular Biology

20 marks

1. Basic principles in molecular biology and recombinant DNA technology

- 1.1. DNA replication, transcription and translation in eukaryotes
- 1.2. Restriction endonucleases: types and functions; role in restriction map construction
- 1.3. Cloning vectors: types, characteristics and function; construction of rDNAs and cloning
- 1.4. Molecular techniques: southern blot analysis, site directed mutagenesis, cDNA library, DNA sequencing, DNA profiling, Si RNA

2. Molecular biology of viruses: Assembly pathway of ϕ X 174; λ DNA: cloning with λ phage; genetic map and gene products of M13; SV 40 genome; replication cycle: polyoma virus, adenovirus, retrovirus (HIV)

3. Molecular basis of mutation

- 3.1. Base pair substitution, addition and deletion
- 3.2. Changes in genetic information (sickle-shaped RBC)
- 3.3. Mutations induced by chemicals (Ames test to screen mutagenicity) and radiation
- 3.4. Molecular characterization of human colon and rectal cancer

4. Molecular medicine and gene therapy

- 4.1. Stem cell: definition, characteristics, types and sources; stem cell therapy in humans; cancer stem cells; molecular biology of cancer: cells of origin in cancer and cancer immunotherapy
- 4.2. Thalassaemia (α and β): aetiology (molecular basis) and therapeutic aspects
- 4.3. Ubiquitin proteasome system— role in development of Alzheimer's disease, Parkinson's disease and muscle wasting

- 1. Preliminary concept:** Importance of statistics in biology and important terminologies: variable, population, data, and quantitative inheritance
- 2. Graphical representation of data:** Charts (histogram/Ogive curve/frequency curve)
- 3. Central tendency:** Mean, median and mode
- 4. Variability:** Mean deviation and standard deviation, co-efficient of variation
- 5. Frequency distribution**
 - 5.1. Concept of probability
 - 5.2. Binomial and Poisson distribution
 - 5.3. Normal distribution, computation of best fitting normal distribution; skewness, Kurtosis and moments
- 6. Hypothesis testing and test of significance:** *t* test, χ^2 -test, *Z*-test, *F*-test and *r*-test; *p*-value determination
- 7. Quantitative genetics**
 - 7.1. 7.1. Continuous variation and quantitative inheritance, statistical analysis of polygenic traits; additive alleles
 - 7.2. 7.2. Heritability: broad sense and narrow sense heritability
 - 7.3. Laws of probability in genetic events: application of binomial theorem
 - 7.4. χ^2 -analysis: role in evaluating the influence of chance on genetic data
- 8. Bioinformatics**
 - 8.1. Bioinformatics and its scope
 - 8.2. Turning DNA into proteins: genomics and proteomics
 - 8.3. History of sequence analysis; sequence analysis programs: genetics computer group and Omega
 - 8.4. Molecular biology software: sequence similarity searching with FASTA, multiple sequence alignment using CLUSTAL W and CLUSTAL X, phylogenetic analysis using PHYLIP, annotating sequence data using genotator
 - 8.5. Web-based resources: NCBI and EBI; database (virtual library): MEDLINE and SC/

1. Chordate

- 1.1. Dissection and display of anatomical system of white rat/fresh water fish
- 1.2. Identification of chordate specimens following taxonomic methods and principles
- 1.3. Study of rat blood film for blood cells
- 1.4. Slide preparation of different types of scales in fishes

2. Ecology and environmental Biology

- 2.1. Estimation of soil micro-arthopods
- 2.2. Estimation of pH of soil/ polluted water
- 2.3. Determination LC_{50} / LD_{50} of chemical /biological agents against aquatic bioforms
- 2.4. Estimation of dissolved oxygen/carbon dioxide in pond water
- 2.5. Preparation of peoples biodiversity register (PBR) for a particular region (following the guideline of West Bengal Biodiversity Board)

3. Metabolic regulation and molecular biology

- 3.1. Estimation of protein by Bradford/Lowry method
- 3.2. Qualitative determination of bioactive compounds (saponin/ glycoside/ flavonoid/ steroid/ terpenoid/ alkaloid) from medicinal plants
- 3.3. Isolation of bacterial plasmid DNA/genomic DNA
- 3.4. Restriction enzyme digestion of DNA
- 3.5. Determination of molecular weight of plasmid DNA by agarose gel electrophoresis

4. Quantitative biology and bioinformatics

- 4.1. Brief introduction to programming languages used in bioinformatics
- 4.2. Building phylogenetic trees
- 4.3. Computing data charts/diagrams
- 4.4. Determination of regression curve/probit analysis

5. Laboratory note book updating and submission of prepared slides

6. Viva-voce (20% weightage)

Semester III

ZGT 301 (Taxonomy and Evolution)

Group-A: Taxonomy

20 marks

- 1. Elementary idea of taxonomy:** definition, basic concept and importance of systematics and taxonomy
- 2. Taxa and species**
 - 2.1. Phylogenetic groups, monophyly, polyphyly and paraphyly
 - 2.2. Problem with parthenogenetically and asexually reproducing individuals
- 3. Taxonomic procedure**
 - 3.1. Collections, preservation and method of identification of animals
 - 3.2. Taxonomic keys; importance of classification
- 4. Methodologies in systematics**
 - 4.1. Morphology based taxonomy, numerical taxonomy
 - 4.2. Cytotaxonomy and chemotaxonomy, molecular systematics
 - 4.3. DNA fingerprinting and molecular markers for detection/evaluation of polymorphism, RFLP and RAPD
- 5. Theories of biological classification:** Essentialism, nominalism, empiricism, cladism and evolutionary classification, their merits and demerits
- 6. Phenetic methods:** Similarity and distance measure using continuous data
- 7. Biodiversity and management:** Definition, indices and levels, biodiversity indicators— surrogate species, taxon based biodiversity indicators
- 8. Zoological nomenclature**
 - 8.1. Process of typification and different zoological types
 - 8.2. International code of zoological nomenclature (ICZN)
 - 8.3. Binominal and trinominal nomenclature

Group B: Evolution

20 marks

1. Evidences of evolution from homeotic genes, oncogenes and transposons
2. **Origin of life:** modern theories - DNA and RNA world
3. **The origin of genetic variation:** Genes and genomes, gene mutations, mutation as a random process, recombination and variation, karyotypic alterations
4. **Variation:** Sources of phenotypic variation, Hardy-Weinberg principle, frequencies of alleles, genotype and phenotype, inbreeding, variation among populations
5. **Species and speciation:** Biological and phylogenetic species concept, genetic basis of reproductive barriers, models of speciation: allopatric, peripatric, parapatric and sympatric
6. Origin and evolution of bird and man
7. Gradualistic vs. non-gradualistic theories, founder principle, punctuated equilibrium theory, neutral theory, endosymbiotic theory, genetic load, genetic drift, and bottle neck principle
8. **Evolution of social behavior:** Costs and benefits of social life; altruism and reciprocity, cooperation, costs and benefits of group living, prisoner's dilemma game theory; Kin selection and Hamilton's kinship theory; selfish behaviour and origin of selfish herd
9. **Evolution of reproductive behavior:** Theories of male ornamentation and striking courtship displays; sexual selection
10. **Parental care and investments:** Parent-offspring conflicts; polyandry and polygynous mating system

1. Cellular physiology

- 1.1. Basic structure and function
- 1.2. Transport across the membrane
- 1.3. Neurons and transmission of nerve impulse

2. Physiology of blood

- 2.1. Blood constituents and functions
- 2.2. Erythrocyte development and destruction, leucocyte production
- 2.3. Blood coagulation: Intrinsic and extrinsic clotting pathways
- 2.4. Blood groups and transfusion

3. Cardiovascular physiology

- 3.1. Heart as a pump: cardiac cycle and cardiac output
- 3.2. Electrical activity of heart (ECG)
- 3.3. Cardiovascular homeostasis in health and diseases

4. Physiology of respiration

- 4.1. Respiratory pigments
- 4.2. Mechanism of respiration and its regulation
- 4.3. Gaseous exchange and transport (CO₂ and O₂)
- 4.4. Respiratory disorders

5. Endocrine Physiology

- 5.1. Functions and clinical implication of hormones secreted from thyroid, pancreas, adrenal, testes and ovary
- 5.2. Biosynthesis and metabolism of steroid hormone(s)

6. Neurophysiology

- 6.1. Electrical activity of brain (EEG)
- 6.2. Sleep-wake cycle and sleep disorder
- 6.3. Speech, learning and memory
- 6.4. Neurotransmitters
- 6.5. Hypothalamic regulation of hormonal function (with emphasis on pituitary hormones) and clinical implication

7. Special senses

- 7.1. **Physiology of vision:** Components of visual pathway and mechanism of vision in mammals; defects and correction of vision
- 7.2. **Physiology of hearing:** Vestibular pathway and mechanism of hearing; hearing defects and tests

ZGT 303 (Biophysical Principles and Instrumentations)

40 marks

1. **Principles and uses of analytical instruments:** Colorimeter, spectrophotometer, ELISA, flow cytometry and FACS
2. **Microscopy:** Light microscopy, phase-contrast microscopy, fluorescence microscopy, confocal microscopy, SEM and TEM
3. **Chromatographic techniques:** Column chromatography, TLC, GC-MS, HPLC, HPTLC, Ion-exchange chromatography, gel exclusion chromatography and affinity chromatography
4. **Electrophoresis:** PAGE (native and SDS), agarose gel electrophoresis, 2-D gel electrophoresis and isoelectric focusing
5. **Centrifugation:** Basic principles of sedimentation, differential and density gradient centrifugation
6. Crystallography and X-ray diffraction, Basic idea of NMR, Endoscopy, USG, CT scan and MRI
7. **Polymerase chain reaction:** Types and their applications

ZGT 304 (Applied Zoology)

40 marks

1. Apiculture

- 1.1 Types and castes of honey bees, structure of hive, and bee flora
- 1.2 Equipments for bee culture and honey extraction
- 1.3 Composition of honey, wax and their economic importance; processing and preservation of honey
- 1.4 Disease and enemies of bees

2. Sericulture

- 2.1 Types of silk moths and their distribution in India, life cycle of silk moth
- 2.2 Moriculture and its management
- 2.3 Rearing of silk moth: rearing equipments and CSB recommended low cost rearing house, strategies of silk worm breeding and quality control
- 2.4 Reeling of silk from cocoon; chemistry of silk and commercial importance of sericulture
- 2.5 Disease and enemies of silk moth and their control

3. Lac culture

- 3.1 Lac insect and their distribution in India; life cycle of lac insect, factors affecting life cycle
- 3.2 Process of scientific cultivation of lac insect and processing of lac; chemistry and use of lac
- 3.3 Cultivation of food plant and its management
- 3.4 Disease and enemies of lac insect and their control

4. Aquaculture

- 4.1 Fisheries resources in India (inland and off-shore)
- 4.2 Important ichthyofauna in West Bengal; exotic fishes, their commercial merits and demerits
- 4.3 Induced breeding, composite fish culture and cage culture; hybridization techniques
- 4.4 Methods of processing and preserving fish
- 4.5 Fish by-products and their economic importance
- 4.6 Biology and commercial importance of oil sardines/mackerels/Bombay duck
- 4.7 Prawn culture: important Indian species; culture techniques; diseases and management
- 4.8 Pearl culture: pearl oysters in India and their cultivation, biological process of pearl formation, economic importance of pearl

5. Poultry farming

- 5.1 Common indigenous and exotic breeds and their characteristics
- 5.2 Tools and techniques for poultry bird rearing
- 5.3 Poultry feed and poultry diseases

6. Dairy farming

- 6.1 Cattle breeds in India, their economic importance and management
- 6.2 Cattle breeding: techniques, merits and demerits
- 6.3 Cattle feed: processing and nutritive values
- 6.4 Dairy products

7. Vermiculture

- 7.1 Types of earthworm species and their distribution in India
- 7.2 Biological process and techniques of vermicomposting
- 7.3 Importance of vermicomposting: application and limitation

ZGP 301 (Practical; Related to ZGT 301 – ZGT 304)

50 Marks

1. Taxonomy

Key preparation to different categories (up to order) of museum specimen/ locally collected samples

2. Animal physiology

- 2.1. Determination of total RBC/WBC/platelet count from rat/human blood
- 2.2. Determination of ESR/PCV of rat blood
- 2.3. Determination of reticulocyte count from rat blood
- 2.4. Determination of DLC in human
- 2.5. Recording of blood pressure in normal human subject and after exercise
- 2.6. Comparative study of WBC counts in blood film of fishes (Tilapia, Koi and Lata)

3. Biophysical principles and instrumentations

- 3.1. Demonstration of Southern/Northern/Western blot analysis
- 3.2. Demonstration of RAPD-PCR
- 3.3. Demonstration of TLC/HPLC, Kymograph, Mosso's ergograph, BP machine (sphygmomanometer), ECG machine, agarose- and vertical gel electrophoresis, UV Transilluminator, gel documentation system, rotary evaporator, lyophilizer, UV-Vis spectrophotometer, ELISA plate reader

4. Applied zoology

- 4.1. Pituitary gland extraction from head of carps and catfishes and its preservation
- 4.2. Determination of age in fish using scale
- 4.3. Determination of calorific value of fish muscle by wet-oxidation method.
- 4.4. Morphometric observation of the silk gland of mulberry and non-mulberry silk worm.
- 4.5. Determination of carbohydrate content of haemolymph of silk moth
- 4.6. Detection of pebrine spores in silk moth eggs
- 4.7. Quality determination of poultry eggs
- 4.8. Antioxidant activity in honey
- 4.9. Qualitative determination of cow milk

5. Laboratory note book updating and submission of prepared slides

6. Viva-voce (20% weightage)

Semester IV

[Students to opt either entomology or microbiology]

Elective course (Theoretical)

ZET 401A (General Entomology)

50 marks

1. Basic idea of entomology

- 1.1. Elementary idea on entomology: scope, objectives and its prospect
- 1.2. Structure and functional distinctiveness of insect responsible for high species diversity and numerical dominance
- 1.3. Origin, evolution, adaptive radiation and ecological fitness of insects

2. Insect classification

- 2.1. Principles of insect classification
- 2.2. Major insect orders: classification up to the families

3. Integument

- 3.1. Basic structure, chemistry and biosynthesis, sclerotization and its regulation
- 3.2. Derivatives of integument and evolutionary advantages

4. External morphology

- 4.1. Segmentation and division of body
- 4.2. General morphology and related modification of head, mouth parts, antennae, thorax and abdomen
- 4.3. Structure of wing, venation and morphological variation
- 4.4. Pre and post genital appendages

5. Maintenance system

5.1. Digestion and assimilation:

- 5.1.1. Gut structure, digestive enzymes and physiology of digestion
- 5.1.2. Dynamics of insect plant interaction in respect of chemical environment of plant and nutritional strategies of insect
- 5.1.3. Extra intestinal digestion
- 5.1.4. Role of microbes in digestion

5.2. Circulation:

- 5.2.1. Basic plan of body circulation
- 5.2.2. Structure of heart and vessels
- 5.2.3. Composition of haemolymph and function
- 5.2.4. Haemocytes, cellular and humoral immunity

5.3. Excretion:

- 5.3.1. Basic physiology of insect excretion and excretory products
- 5.3.2. Structure of malpighian tubules and its function, cryptonephridial condition
- 5.3.3. Salt and water balance

5.4. Respiration:

- 5.4.1. Basic structure of trachea, tracheoles, air-sacs, spiracles
- 5.4.2. Respiratory pigments
- 5.4.3. Ventilation mechanism and their control

5.5. Reproduction:

- 5.5.1. Basic organization of male and female insect
- 5.5.2. Reproductive strategies including parthenogenesis
- 5.5.3. Differentiation of body pattern of insect during embryonic development
- 5.5.4. Distinctiveness of life cycle of insect

6. Control system

6.1. Nervous system and sense organ:

6.1.1. Structure of brain, ganglia, nerves and receptors

6.1.2. Reception and transmission of stimuli

6.1.3. Mechanism of sound and light production

6.2. Endocrine and exocrine glands:

6.2.1. Structure of neurosecretory cells and endocrine glands

6.2.2. Insect hormones, types, functions, mechanism of action and regulation of titres

6.3. Muscular system:

6.3.1. Structure of muscle and disposition in body

6.3.2. Neuromuscular junction and muscular activity

6.3.3. Muscle development and maintenance

7. Ethology and behaviour

1.1. Social behaviour with reference to honey bee, termite and ant

1.2. Behaviour of borer, leaf miner and gall forming insects

1.3. Aerodynamics and migration

1.4. Intra-specific and interspecific chemical communication in insects

1.5. Camouflage, warning colouration and defensive behavior

1.6. Reproductive behavior and parental care

1.7. Photoperiodism

1.8. Insect as decomposer

Elective course (Theoretical)

ZET 401B (Agricultural and Medical Entomology)

50 marks

1. Origin of agricultural insect pest and their categories

2. Concept of threshold levels

- 2.1 Economic threshold level and economic injury level (EIL), determination of EIL and calculation of economic decision level
- 2.2 Pest surveillance, sampling methods and forecasting, importance of GIS tool for pest management, generation of pest forecasting equation

3. Some major pests

- 3.1 Insect pests of rice, jute, mango, banana, litchi, their bionomics, damage symptoms, consequences of damage and suggested protection procedure
- 3.2 Stored grain pests: stages of life cycle, damage symptoms, consequences of damage and suggested protection procedure

4. Insecticides and their application

- 4.1 Classification of insecticides, important types of insecticides, formulations, mode of action, insecticide residues in environment, phyto-toxicity of insecticidal formulations, first aid antidotes, insecticide act-1968: important provisions
- 4.2 Evaluation of insecticide toxicity, insecticide synergism, potentiation and antagonism, factors affecting the toxicity of insecticides, insecticide compatibility and selectivity
- 4.3 Insecticide metabolism, pest resistance to insecticides, insect pest resurgence, history of pest outbreak and its probable causes
- 4.4 Pest control by insecticides, sources, mode of action, bio-accumulation, application of bio-rational insecticides
- 4.5 Safe use of insecticides, diagnosis of insecticide poisoning and first aid antidotes

5. Concept of pest management strategy

- 5.1 Outline of different categories of pest management strategies and their limitations
- 5.2 Integrated pest management (IPM): concept and components, tactics and strategies, brief histories of successfully implemented IPM, community IPM, low input sustainable agriculture
- 5.3 Methods of pest suppression with suitable agronomic practices, importance of traditional knowledge for pest suppression
- 5.4 Molecular tools for pest control: insect growth regulators, semiochemicals
- 5.5 Brief note on autocidal process for insect pest control
- 5.6 Outline of insect repellents, anti-feedants and attractants
- 5.7 Compounds of plant origin for pest control
- 5.8 Importance of beneficial insect diversity associated with agricultural field, necessity of its conservation, pest control by bio-agents
- 5.8 Quarantine and legislative measures for preventing spread of pests

6. Economic and commercial entomology

- 6.1 Introduction to some commercially important insects and their useful products
- 6.2 Introduction to house hold insects such as of books and papers, pantry, textile, woodwork and furniture; their damages and control
- 6.3 Mass production of bio-control agents and bio-rational insecticides

7. Medical entomology

- 7.1 Zoonotic diseases- Plague, leishmaniasis and human African trypanosomiasis- causes and remedies
- 7.2 Vector biology: Important vectors in India, mode of transmission of pathogens by vectors and control strategies with special reference to mosquito, sand flies and fleas
- 7.3 Myiasis: Causes, pathogenicity and remedy
- 7.4 Insects associated with cadavers

- 7.5 Insects for forensic study
- 7.6 Poisonous insects and the nature of toxins

Elective course (Practical)

Paper-ZEP 401

Group A

40 marks

1. Dissection and mounting

- 1.1. Dissection: *Apis*: Stringing apparatus, digestive and nervous systems
Grasshopper: Nervous and reproductive systems
- 1.2. Mounting: Wings, mouth parts, antennae, genitalia, scale and medically important insects

2. Taxonomy and classification

- 2.1. Preparation of keys up to
 - 2.1.1. Order level
 - 2.1.2. Family level for major orders
- 2.2. Collection and identification of pests and natural enemies of rice, jute and mango
- 2.3. Identification of stored-grain pests

3. Population biology

- 3.1. Study of insect population density (any one species)
- 3.2. Comparison of variance of populations of a pest species from different locations and at different time
- 3.3. Study of species diversity of insect community from crop/forest/grassland/soil habitats

4. Life cycle and behaviour

- 4.1. Study of life cycle of a pest/vector
- 4.2. Study of the behavior of any one predator/pest
- 4.3. Host plant/seed preference study
- 4.4. Estimation of biochemical changes in host plant/seed due to pest attack
- 4.5. Foraging behaviour in ants - orientation to food

5. Biochemistry and estimation

- 5.1. Quantification of water soluble protein in insect egg
- 5.2. Qualitative analysis of salivary/gut enzymes
- 5.3. Detection of haemolymph amino acids by chromatography/PAGE
- 5.4. Whole insect analysis for nitrogen, moisture, fat, ash, amino acid and chitin
- 5.5. Assessment on insect haemolymph
- 5.6. Determination of sericin and fibroin content from silkworm cocoon shell

6. Toxicology

- 6.1. Preparation of insecticide formulations
- 6.2. Assessment on compatibility and toxicity of insecticides on plants
- 6.3. Field evaluation of bio-efficacy of insecticides

7. Laboratory note book updating Laboratory note book updating and submission of prepared slides

8. Viva-voce (20% weightage)

Group B

10 marks

- 1. Institutional/field training

Elective Course (Theoretical)

ZET 402A (Medical Microbiology)

50 marks

1. General aspects of medical microbiology

- 1.1. Pathogenic agents: protozoa, bacteria, fungi and viruses
- 1.2. Pandemic, epidemic and endemic
- 1.3. Host-microbes interaction (molecular basis)

2. Microbiological media and culture techniques

- 2.1. Bacterial culture media: Types and composition
- 2.2. Culture media for fungi
- 2.3. Bacteria culture techniques: Streak dilution and pour-plating; mixed and pure culture

3. Antimicrobial agents and chemotherapy

- 3.1. Classification of antibacterial agents, mechanism of action and development of resistance
- 3.2. Antifungal and antiviral drugs
- 3.3. Antibiotic susceptibility testing: agar dilution, disk diffusion and E-test methods; MIC, FIC and MBC determination

4. Microbial diseases

- 4.1. Tuberculosis: clinical stages or states of *Mycobacterium tuberculosis* infection; biomarkers and diagnostics; immune response, vaccine and vaccination strategies
- 4.2. Cholera: aetiology, transmission, clinical spectrum, diagnosis, treatment protocol; cholera vaccine
- 4.3. Hepatitis: virus biology and evolution; infection and disease manifestation; laboratory diagnosis, treatment, and prevention and control
- 4.4. H1N1 infection: origin and evolution of H1N1 virus infecting humans; clinical features, treatment and control
- 4.5. Deep fungal skin diseases: systemic mycoses, subcutaneous mycoses and opportunistic infection

5. Zoonoses: zoonotic mode of infection, pathogenesis and clinical features, diagnosis, treatment and control of the followings:

- 5.1. Viral zoonosis: rabies
- 5.2. Bacterial zoonosis: leptospirosis
- 5.3. Protozoan zoonosis: toxoplasmosis
- 5.4. Helminthic zoonosis: cystic echinococcosis

6. Microbial diseases of body system (pathogenicity and treatment): nematode infection to eyes, dental caries and periodontal disease, peptic ulcer

7. Clinical Immunology: sampling and serological detection of microbial infection

8. Epidemiology and public health microbiology

- 8.1. Disease transmission: mode of transmission of microbial agents
- 8.2. Vector biology of dengue, chikungunya and malaria
- 8.3. Nosocomial infection: types, factors and prevention; important bacteria associated with hospital infection; problems associated with MRSA infection
- 8.4. Strategies controlling microbial infection: chemotherapy, vector control and vaccination programs

Elective Course (Theoretical)

ZET 402B (Food and Environmental Microbiology)

50 marks

1. Microbial diversity

- 1.1. Characteristics and outline classification of protozoa, bacteria, fungi and virus
- 1.2. General criteria for the identification of bacteria: morphological, biochemical, serological and molecular consideration
- 1.3. Bacterial growth, metabolism and genetics, and gene swapping

2. Microorganisms in food processing

- 2.1. Fresh and processed meats and seafoods; vegetable and fruit products; milk, fermented and nonfermented dairy products
- 2.2. Role of microorganisms in food preservation; plant essential oils in food preservation—their role in controlling food spoilage bacteria

3. Food Poisoning caused by microorganisms: bacterial food poisoning; clinical features, diagnosis and treatment of bacterial food poisoning; parameters of foods affecting microbial growth

4. Probiotics: characteristics, sources and medical importance; selective enumeration of probiotic microorganisms in food; factors influencing the functionality of probiotic bacteria in dairy products

5. Food borne and water borne diseases

- 5.1. Botulism: aetiology, transmission and epidemiology, clinical features, diagnosis and treatment
- 5.2. *Clostridium difficile* -associated disease: transmission, clinical spectrum, diagnosis, therapeutic management, control measures
- 5.3. Amebiasis: aetiology, transmission, clinical features, diagnosis, treatment and control
- 5.4. Cyclosporiasis: aetiology, transmission and outbreaks, clinical features, diagnosis, treatment and control.
- 5.5. Viral diarrhea: aetiological agents, transmission, clinical features, and treatment and control

6. Air borne diseases

- 6.1. Diphtheria and Pertussis: aetiology, transmission, clinical features, treatment and control
- 6.2. SARS and measles: disease transmission, clinical features, treatment and control

7. Marine microbes and climate change: impact of climate change on the marine bacterioplankton communities; bacterial activity and temperature; climate and plankton ecology; linking bacteria to climate changes; potential impacts of climate change on bacterioplankton diversity and structure

8. Environmental monitoring using microorganisms: enzyme-based biosensors; whole cell-based biosensors; immunosensors; DNA-based biosensors; biomems, biomimetics; biotransformation of toxic heavy metals

9. Control of microorganisms in food and environment: control of access (cleaning and sanitation) and means of controlling food microorganisms; antimicrobial preservatives, irradiation, novel processing technologies, and combination of methods (Hurdle concept). Physical methods of controlling environmental microorganisms and use of disinfectants

10. Biological warfare and bioterrorism: microorganisms as potential agents of warfare or terror, defense against bioterrorism.

Elective course (Practical)

ZEP 402 (Medical & Food and Environmental Microbiology)

Group A

40 Marks

1. Media preparation and sterilization: liquid media (nutrient broth and MacConky broth), solid/agar media (nutrient agar, McConkey agar, blood agar and SS agar), preparation of slant, stab and culture plates, fungus culture media
2. Isolation of Gram- positive/Gram-negative bacteria from environmental/clinical samples
3. Culture techniques: mixed culture and pure culture, broth culture, streak dilution and pour plating
4. Dilution of bacteria broth culture and colony counting by pour plate technique, and growth curve
5. Biochemical characterization of bacteria (*Escherichia coli*, *Proteus* spp., *Pseudomonas* spp., *Staphylococcus* spp.): indole production, H₂S production, sugar fermentation, oxidase, catalase and other specific tests related to the microorganism
6. Antibiotic susceptibility tests for bacteria: preparation of antibiotic discs, discs diffusion susceptibility test (Kirby-Bauer), determination of MIC of test antibiotics by spot culture technique/E-test/ broth dilution method
7. Isolation and biochemical characterization of lactobacillus from clinical/environmental samples
8. Isolation of fungus from clinical/environmental samples
9. Isolation and biochemical characterization of root nodule bacteria/sewage bacteria/soil bacteria
10. Testing β -lactamase production in bacteria
11. Testing of virulence factors: lipase/amylase, etc.
12. Isolation of bacteria from diseased/normal fish and pathogenicity testing
13. Separation of biomolecules from plant/animal tissues by HPLC/TLC
14. Detection and identification of bacteria from clinical/environmental samples by serological/molecular (PCR) techniques
15. (a) Isolation of bacterial membrane/cellular protein and plasmid/genomic DNA (b) Electrophoretic analysis of protein/DNA (c) Restriction endonuclease digestion of DNA and their separation by agarose gel electrophoresis
16. Detection and identification of bacteria by PCR and subsequent BLAST analysis of amplified sequences
17. **Laboratory note book updating and submission of prepared slides**
18. **Viva-voce (20% weightage)**

Group B

10 Marks

1. Institutional visit/field training