SYLLABUS FOR
M. SC. COURSE IN ZOOLOGY
(With effect from the session 2007–2009)

DEPARTMENT OF ZOOLOGY
THE UNIVERSITY OF BURDWAN
BURDWAN 713 104
WEST BENGAL
THE UNIVERSITY OF BURDWAN  
SYLLABUS FOR M. SC. COURSE IN ZOOLOGY  
(With effect from the session 2007–2009)

TOTAL MARKS - 1200

Summary of the M.Sc. course in Zoology

<table>
<thead>
<tr>
<th>Semester</th>
<th>Theory &amp; term paper</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>II</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>III</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>IV</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marks Distribution</th>
<th>Theory</th>
<th>Term paper</th>
<th>Practical</th>
<th>Internal assessment</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester I</td>
<td>180</td>
<td>-</td>
<td>100</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>Semester II</td>
<td>180</td>
<td>-</td>
<td>100</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>Semester III</td>
<td>180</td>
<td>-</td>
<td>100</td>
<td>20</td>
<td>300</td>
</tr>
<tr>
<td>Semester IV</td>
<td>135</td>
<td>50</td>
<td>100</td>
<td>15</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>725</td>
<td>400</td>
<td>75</td>
<td></td>
<td>1200</td>
</tr>
</tbody>
</table>
THE UNIVERSITY OF BURDWAN  
SYLLABUS FOR M. Sc. COURSE IN ZOOLOGY  
(With effect from the session 2007 - 2009) 
Total Marks: 1200  
(Theoretical: 750 + Practical: 400 + Term paper: 50)

<table>
<thead>
<tr>
<th>Semester- I</th>
<th>F.M. 300</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theory</strong></td>
<td></td>
</tr>
<tr>
<td>TGZ: 101</td>
<td>Unit-I</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Biosystematics and Taxonomy</td>
</tr>
<tr>
<td></td>
<td>Unit-II</td>
</tr>
<tr>
<td></td>
<td>Evolution and Population Genetics</td>
</tr>
<tr>
<td>TGZ: 102</td>
<td>Unit-I</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Histology and Histochemistry</td>
</tr>
<tr>
<td></td>
<td>Unit-II</td>
</tr>
<tr>
<td></td>
<td>Comparative Anatomy</td>
</tr>
<tr>
<td>TGZ: 103</td>
<td>Unit-I</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Cytology</td>
</tr>
<tr>
<td></td>
<td>Unit-II</td>
</tr>
<tr>
<td></td>
<td>Genetics</td>
</tr>
<tr>
<td>TGZ: 104</td>
<td>Unit-I</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Biochemistry</td>
</tr>
<tr>
<td></td>
<td>Unit-II</td>
</tr>
<tr>
<td></td>
<td>Toxicology</td>
</tr>
</tbody>
</table>

**Internal assessment:**  
(F.M. 4×5=20)

<table>
<thead>
<tr>
<th><strong>Practical</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>PGZ: 105</td>
</tr>
<tr>
<td>(F.M. 50)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PGZ: 106</td>
</tr>
<tr>
<td>(F.M. 50)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester- II</th>
<th>F.M. 300</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theory</strong></td>
<td></td>
</tr>
<tr>
<td>TGZ: 201</td>
<td>Unit-I</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Ecology and Ethology</td>
</tr>
<tr>
<td>TGZ: 202</td>
<td>Unit-II</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Physiology</td>
</tr>
<tr>
<td>TGZ: 203</td>
<td>Unit</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Microbiology</td>
</tr>
<tr>
<td>TGZ: 204</td>
<td>Unit</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Immunology</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>SGZ: 205</td>
<td>Ecology and Soil Zoology &amp; Educational tour</td>
</tr>
<tr>
<td>(F.M. 40)</td>
<td></td>
</tr>
<tr>
<td>SGZ: 206</td>
<td>Unit-I Physiology</td>
</tr>
<tr>
<td>(F.M. 40)</td>
<td>Unit-II Microbiology and Immunology</td>
</tr>
</tbody>
</table>

**Semester- III**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGZ: 301</td>
<td>General Entomology</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGZ: 302</td>
<td>Parasitology and Vector Biology</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TGZ: 303</td>
<td>Ichthyology and Aquaculture</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSZ: 304</td>
<td>Special paper</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Semester- IV**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TGZ: 401</td>
<td>Unit-I Developmental Biology</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td>Unit-II Biostatistics and Bioinstrumentation</td>
<td></td>
</tr>
<tr>
<td>TSZ: 402</td>
<td>Special Paper</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSZ: 403</td>
<td>Special Paper</td>
<td>45</td>
</tr>
<tr>
<td>(F.M. 45)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSZ: 404</td>
<td>Term paper/Project work (based on special paper)</td>
<td>50</td>
</tr>
<tr>
<td>(F.M. 50)</td>
<td>Seminar Presentation – 40 (25+15) &amp; Discussion – 10</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Internal Assessment</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>PGZ: 405</td>
<td>Developmental Biology &amp; Computer Application</td>
<td>(F.M. 3×5=15)</td>
</tr>
<tr>
<td>PSZ: 406</td>
<td>Special paper</td>
<td>(F.M. 50)</td>
</tr>
</tbody>
</table>

Special papers offered:

1. **ENTOMOLOGY**
2. **AQUACULTURE & FISHERIES**
3. **PARASITOLOGY & MICROBIOLOGY**
4. **ECOLOGY & ENVIRONMENT**
5. **MOLECULAR BIOLOGY & GENETICS**
Unit – I: BIOSYSTEMATICS & TAXONOMY

Full Marks: 22.5  
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Taxonomy
- History and Importance

General concepts
- Micro- and Macro-taxonomy
- Levels of taxonomic study

Concepts of species
- Types –Typological, Biological and Evolutionary
- Kinds of species, Taxonomic types
- Hierarchy

New trends in taxonomy
- Biochemical, Cytological & Molecular

Zoological nomenclature
- Rules of Nomenclature.

Suggested readings:

Unit – II: EVOLUTION & POPULATION GENETICS

Full Marks: 22.5  
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Population Genetics
Molecular Population genetics
- Neutral theory
- Molecular evolution and Phylogenetics.

Variation and Evolution
- Genetic variation in population (Morphological, Chromosomal and biochemical)
- Quantification of genetic variation in populations
Quantitative genetics  
Hardy–Weinberg equilibrium – Testing population samples  
Factors affecting Hardy – Weinberg equilibrium.

Evolution  
Natural Selection  
Darwinian fitness  
Genetic burden or load  
Polymorphism and balancing Natural Selection  
Diversifying natural selection with examples.

Macro and Micro evolution  
Evolutionary pattern and rate  
Isolating mechanisms and speciation.  
Punctuated equilibrium

Suggested readings:

----------------------------------------------------------------------------------------------------------------------

TGZ: 102

Time: 2 hrs.  
Full Marks: 45
Unit – I: HISTOLOGY & HISTOCHEMISTRY  
Full Marks: 22.5
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Fixation and related procedures  
Types of fixation, Fixation process; fixation of whole tissue; fresh-frozen sections; Decalcification

Embedding  
Gum-sucrose/gelatin and paraffin wax embedding

Microtomy  
Methods, problems and remedies of microtomy including cryostat and freezing microtome


**Structure and function**

- Tongue, Intestine and Thymus 6L

**Biological dyes and stains**

- Properties, source and use of haematoxylin, eosin and carmine 8L

**Theoretical basis and application of following histochemical methods:**

- PAS/AB test for carbohydrates
- Fuelgen reaction for DNA
- Metallic and Azo dye methods for alkaline and acid phosphatase, adenosine triphosphatase 8L

---

**Suggested readings:**


---

**Unit – II: COMPARATIVE ANATOMY**

**Full Marks: 22.5**

**Lectures: 35**

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

**Comparative study of invertebrates**

- Digestive system 4L
- Nervous system 4L
- Reproduction and Larval forms 3L

**Comparative study of vertebrates**

- Stomach 2L
- Respiratory system 4L
- Brain and sense organs 8L
- Thyroid and Adrenal glands 4L

**Development, uses and comparative account in vertebrates**

- The integument and its derivatives (except glands) 6L

---

**Suggested readings:**

TGZ: 103

Time: 2 hrs.  
Full Marks: 45

Unit – I: CYTOLOGY  
Full Marks: 22.5  
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Gene and the genome  
6L  
Complexity of the genome: eukaryotic genome  
C–value enigma. DNA reassociation kinetics, Cot curves, Tm values  
Centromeric and telomeric DNA, Telomeric repeats and chromosome-end replication problem, rescue by telomerase.

DNA replication in Eukaryotes  
4L  
Components and mechanics.

Cell cycle Kinetics  
4L  
Labeling index and cell cycle duration measurement  
Cell synchronization and cell cycle inhibitors.

Cell-cell communication  
7L  
Cell signaling molecules  
Cell surface receptors and ion channels  
Signal transduction pathways (DAG and cAMP)

Cell cycle deregulation and cancer  
9L  
Hallmark features of cancer  
Cancer critical genes and their role in tumourgenesis  
Carcinogenesis-Two hit- model of Knudson and multi- hit model of Vogelstein  
Cancer-Multifactorial disease  
Hybridoma technology and its application in monoclonal antibody production

Cell and its environment  
5L  
Mutagens, clastogens, carcinogens and teratogens  
Mutagenicity test protocols, mammalian in vivo and in vitro test protocols
Unit – II: GENETICS

Full Marks: 22.5
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Techniques in molecular genetics
- Restriction endonuclease and cloning of genes;
- Cloning vectors; production of recombinant DNA molecules;
- Construction and screening of genomic and cDNA library; DNA sequencing;
- PCR and RT PCR.

Mutation
- Molecular basis
- Mutations in human
- Cystic fibrosis.

DNA repair and recombination
- NER, PR, SOS, PRR and MMR
- Recombination nodule
- Cleavage and rejoining of DNA molecules
- Gene conversion

Mitochondrial genome
- Comparison between mt-genome and human genome;
- mt-DNA and limited autonomy of mt-genome

Genomic imprinting
- DNA methylation; genetic basis of human disease: Huntington’s chorea.

Human genome project
- Methodologies
- Strategies and applications
- Ethics and social implications

Suggested readings:


---

**TGZ: 104**

**Time: 2 hrs.**

**Full Marks: 45**

**Unit – I: BIOCHEMISTRY**

**Full Marks: 22.5**

**Lectures: 35**

*Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.*

**Bioenergetics**

Laws of thermodynamics and its relevance to biological systems.
High-energy phosphate bonds and its role in energy capture and transfer

**Proteins**

Amino acid structure of protein
Primary and higher orders of protein
Protein folding
Nitrogenase system

**Enzymes**

Classification and general properties
Kinetics
Mechanisms of enzyme action (chymotrypsin)
Regulation of enzyme activities.

**Carbohydrates**

Carbohydrates of physiologic significance
Metabolism
Glycolysis & Krebs cycle: Pathway & regulation
Oxidative metabolism: electron transport chain, oxidative phosphorylation
Gluconeogenesis
Hexose monophosphate Shunt

**Lipids**

Lipids of physiologic significance, membrane lipids, cholesterol
Synthesis and Oxidation of fatty acids
Ketogenesis
General topics
Integration of metabolic pathways
Pumps and membrane channels

Suggested readings:

Unit – II: TOXICOLOGY

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Concept, history and scope of toxicology 2L
Fundamentals of toxicology 8L
Types of toxic substances (including natural toxins, concept of xenobiotics)
Disposition and biotransformation (phase I and phase II reactions)
Drugs as toxic substance (Paracetamol, Aspirin, Thalidomide)
Effects of toxic substances 4L
Biochemical and physiological effects
Interactive effects: additive effects, potentiation and synergism
Toxicity tests 4L
Dose, dosage, dose response
Acute toxicity tests: Bioassay, LC$_{50}$ and LD$_{50}$, Probit analysis and Significance.
Chronic toxicity tests: Methods, Significance.
Pesticides 7L
Concept and classification
Insecticides and herbicides: Types (including bioinsecticides), sources, effects and kinetics in the environment
Mechanism of action: Organochlorine, Organophosphate, Carbamates, Paraquat, Phenoxy herbicides
Metal toxicity and lighter elements (As, Se)

Metal chelation

Applied toxicology
Clinical toxicology
Forensic toxicology

Suggested readings:


INTERNAL ASSESSMENT

Full Marks: 4 Theory Papers × 5 = 20

PRACTICAL PAPERS

PGZ: 105

DISSECTION & TAXONOMY AND HISTOLOGY & HISTOCHEMISTRY Full Marks: 50

Unit – I: DISSECTION & TAXONOMY
Time: 5 Hrs. Full Marks: 25

1. DISSECTION: Dissection and display of anatomical systems in vertebrates and invertebrates
2. TAXONOMY: Identification of Prokaryotic and Eukaryotic specimens following taxonomic methods and principles
3. Laboratory note Book
4. Viva-voce

Unit – II: HISTOLOGY & HISTOCHEMISTRY
Time: 5 Hrs. Full Marks 25

1. HISTOLOGY
   a. Fixation, dehydration, embedding, section cutting, staining and mounting of different animal tissues. (Haematoxylin and Eosin, Mallory’s Triple)
   b. Identification of histological preparations of different animal tissues.
   c. SEM demonstration
2. HISTOCHEMISTRY
Histochemical reactions for: Carbohydrates, Protein, Lipid, DNA/RNA and Alkaline phosphatases
3. Submission of permanent slides prepared for histological and histochemical studies of different tissues
4. Laboratory records
5. Viva-voce

PGZ: 106

CYTOLOGY & GENETICS AND BIOCHEMISTRY & TOXICOLOGY Full Marks: 50

Unit – I: CYTOLOGY & GENETICS
Time: 5 Hrs. Full Marks: 25

1. CYTOLOGY
   a. Preparation of meiotic chromosomes from the Grasshopper testes: Identification of stages
   b. Preparation of somatic chromosome (untreated and treated) from mouse/rat: Identification of chromosomes and determination of mitotic index
   c. Preparation of polytene chromosomes from Chironomid/Drosophila/mosquito larvae: Identification of various landmarks
   d. Identification of slides on human chromosomal abnormalities and various genetic diseases

2. GENETICS
   a. Identification of mutants of Drosophila, setting up of genetic crosses (monohybrid, dihybrid, test crosses; Detection of lethal mutation
   b. Analysis of human pedigree and construction of pedigree chart
   c. Analysis of human karyotypes
   d. Isolation of DNA from Drosophila/mosquito/Rat/Goat (liver tissue)

3. Submission of prepared slides and Laboratory record.
4. Viva-voce

Unit – II: BIOCHEMISTRY & TOXICOLOGY

Time: 5 Hrs. Full Marks: 25

1. BIOCHEMISTRY
   a. Folin-Lowry method of protein assay
   b. Estimation of DNA by the diphenylamine
   c. Quantification of RNA
   d. Biochemical detection of sugars by Osazone formation test
   e. Separation of amino acids by paper chromatography

2. TOXICOLOGY
   a. Determination of LC$_{50}$ and LD$_{50}$
   b. Morphological deformities (study of symmetry) in biological organisms due to toxicant exposure.

3. Laboratory note book
4. Viva-voce
SEMESTER - II

TGZ: 201

Time: 2 hrs. Full Marks: 45
Unit – I: ECOLOGY & ETHOLOGY

Full Marks: 22.5
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

The concept of ecosystem, the Gaia Hypothesis, stability in the ecosystem,
ecological habitat and niche

Factors of the environment

Concept of limiting factors
Biotic factors: effects of predators, parasites and symbionts
Abiotic factors: effects of temperature, moisture, light and fire

Population dynamics

Population attributes, growth forms, life tables,
Density-dependent and density-independent factors in the population regulation,
terspecific competition and coexistence,

Communities and biodiversity

Community organization and structure, relative abundance, species diversity,
diversity indices and ecosystem development

Ecoenergetics and biogeochemical cycles

Concepts of primary productivity and secondary production,
food–chains and food webs, energy flow through trophic levels;
Global cycling of water, carbon and nitrogen

A brief survey of major Indian biomes

Tropical Rain Forests
Mangrove ecosystem

Animal behaviour

Concepts of Ethology
Stereotyped and acquired behaviour
Social behaviour, altruistic behaviour, orientation and echolocation;
Biological rhythms

Environmental pollution

Sources and effects of primary and secondary air pollutants,
acid rain, green house effects, water pollution and its control,
anti–pollution laws

Conservation ecology

Conservation of natural resources and wildlife
in situ and ex situ conservations
Red Data Book
Conservation of wetlands

Suggested readings


**Unit – II: SOIL ZOOLOGY**

Full Marks: 22.5
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

**Soil as an ecosystem**

- Soil structure, development: types and factors involved in the development 5L
- Soil aeration and porosity 2L

**Soil profile**

- Nature, development and probable impact on soil fauna 3L
- Rhizosphere 2L

**Sampling, extraction, rearing, preservation and mounting of soil organisms**

3L

**Soils and soil fauna**

- Classification of soil fauna; interactions between soils and soil fauna 6L
- Litter decomposition and soil fertility 4L

**Vermiculture and vermicomposting**

4L

**Soil erosion and its control.**

2L

**Soil pollution and world’s food supply**

4L
**Suggested readings**


---

**TGZ: 202**

**PHYSIOLOGY**

**Time:** 2 hrs.  
**Full Marks:** 45  
**Lectures:** 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

**Basic concepts:** Homeostasis, Acclimatization and Adaptation  
2L

**Circulation**  
Blood cells: ultrastructure, pigments, and formation  
Hemostasis: platelet activation cascades, regulation  
Lymph: composition and dynamics  
8L

**Respiration**  
General idea: Total and partial air pressure,  
Gas solubility and diffusion in air and water.  
Aquatic: Gill architecture; ram ventilation, dual pump,  
gas exchange (counter current mechanism)  
Terrestrial: Lung ventilation (amphibians, reptiles, birds, mammals),  
Lung mechanics (human): Respiratory muscles, lung volumes,  
elastic properties, compliance, surface tension, pulmonary surfactants.  
Regulation (human): Respiratory centers, receptors, integration.  
8L

**Excretion & Osmoregulation**  
Mammalian kidney, Urea cycle and Aquaporins  
Ultra structure of nephron  
Urine formation – Glomerular filtration and tubular reabsorbtion,  
Importance as osmoregulatory organ.  
External osmoregulatory organs: Salt glands, Fish gills  
Water and electrolyte balance (Na, K, Mg), Acid-base regulation, Endocrine regulation  
8L
**Thermoregulation**  
Endothermy and Ectothermy  
Thermoregulatory organs, responses to high and low temperature  
Thermogenesis, Characteristics of fever  
Neural Control

**Sensory**  
Neuron: types; synapse (excitatory and inhibitory post synaptic potential)  
Genesis of membrane potential  
Neurotransmitters (Acetylcholine, GABA), chemical transmission through synapse

**Hormones**  
General classes of hormones, concept of receptors  
Mechanisms of hormone action – second messenger, IP₃ and DAG  
Neuroendocrine integration

**Hypothalamic and Pituitary hormones**  
Hypothalamic hormones – structure and functions  
Hypophyseal hormones – structure and functions

**Thyroid hormones**  
Biosynthesis and function of T₃/T₄  
Role of thyroid hormones in metabolism

**Pancreatic hormones**  
Structure and biosynthesis: insulin and glucagon  
Role of hormones in glucose metabolism

**Adrenal hormones**  
Structure and functions of cortical hormones  
Structure and functions of medullary hormones

**Reproductive hormones**  
Sex steroids: Structure, source, role and receptors

**Suggested readings**


Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

**History and development of Microbiology**
- Contributions of Leeuwenhoek, Koch, Pasteur, Jenner and Flemming

**Bacteria**
- Structure and function of capsule, pili, flagella, cell wall, cell membrane, outer membrane, reserve materials, cytoplasmic inclusions, plasmid and bacterial chromosome.

**Bacterial endospore**
- Structure, properties, spore formation and germination

**Virus**
- Structural organization of viruses
- Prions and Viroids
- Lytic cycle of bacteriophages with reference to *E. coli* and *T*4
- Lysogeny, lysogenic conversion, induction and significance

**Microbial genetics**
- Gene transfer in Bacteria: transformation, conjugation and transduction.
- Transcription and translation in *E. coli*
- Structure and life-cycle of λ Phage virus and control mechanism of lysogeny
- Auxotroph, Prototroph, Replica plating and Ames Test

**Control of microorganisms**
- Physical and chemical agents, chemotherapeutic agents: sulfa drugs and antibiotics

**General accounts of Mycoplasma, Actinomycetes and Rickettsias**

**Medical Microbiology**
- Microbial virulence
- Mode of transmission, pathogenicity and prevention of microbial diseases:
  - Air-borne (Tuberculosis and Influenza), Food and waterborne (Typhoid and Cholera) and Arthropod borne (Dengue, JE and Yellow fever)

**Environmental Microbiology**
- Inter-relationship of microorganisms in natural ecosystems
- Soil as a microbial habitat
- Microbial diversity in soil; Microorganisms as indicators of water quality, biofilm
- Bacteriological examination of water for potability

**Suggested readings:**

IMMUNOLOGY

Time: 2 hrs.  Full Marks: 45  Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Types of Immunity: Innate and Acquired  2L
Cells and Organs of the immune system  4L
Elements of Innate immunity  4L
Antigens and Immunogens  5L
  Definition and properties
  Antigenic determinants of immunoglobulin (Isotype, allotype & idiotype)
Antibodies  4L
  Structure, classes and biological activities
  Organization and expression of immunoglobulin genes  6L
T Cell receptors (TCR) and TCR Complex  6L
  Structure and roles
  Organization and rearrangement of TCR genes
Major histocompatibility complex (MHC)  4L
  General organization; Structure and Functions of MHC molecules
Cytokines  4L
  General properties and functional categories
Complement  5L
  Activation pathways, Biological functions and Regulation.
Maturation, activation and differentiation of T and B lymphocytes  8L
Immune effector mechanisms  5L
  Antibody mediated functions
  Cell mediated effector responses
Antigen–antibody interaction

Molecular basis
Secondary interactions – Agglutination, precipitation.

Hypersensitivity reactions

Vaccines and immunization

Suggested readings


INTERNAL ASSESSMENT

Full Marks: 4 THEORY PAPERS x 5 = 20

PRACTICAL PAPERS

PGZ: 205

ECOLOGY & SOIL ZOOLOGY AND EDUCATIONAL TOUR

Time: 5 hrs.

Full Marks: 50

ECOLOGY & SOIL ZOOLOGY

1. Quantitative estimation of some Physico-chemical parameters in the aquatic ecosystem: Temperature, pH, dissolved oxygen, carbon dioxide and chloride contents
2. Quantitative estimation of some factors of soil and the sediment: soil moisture, pH, nitrates, phosphates and organic matter
3. The study of aquatic and terrestrial habitats: Identification and characterization of zooplankton and ecotypes inhabiting terrestrial and aquatic environments
4. Laboratory note book and class records
5. Viva –voce

EDUCATIONAL TOUR

Full Marks: 10

PGZ: 206

PHYSIOLOGY AND MICROBIOLOGY & IMMUNOLOGY

Time: 5 Hrs.

Full Marks: 50
Unit – I: PHYSIOLOGY
1. Detection of haemoglobin percent, C.T. and B.T.
2. Quantitative estimation of Ascorbic acid by titration.
4. Total count of RBC and WBC
5. Submission of Laboratory Records
6. Viva-voce

Unit – II: MICROBIOLOGY & IMMUNOLOGY
Time: 5 Hrs.
1. MICROBIOLOGY:
   a. Preparation of liquid media (broth) and solid media for routine cultivation of bacteria
   b. Preparation of slant and stab
   Pure culture techniques: Spread plate, pour plate and streak plate
   c. Isolation and enumeration of bacteria from natural sources: soil, air and water
   d. Simple staining of bacteria and study of cell types; differential staining: Gram staining, endospore staining and acid-fast staining
   e. Biochemical tests for characterization: Catalase, Nitrate reduction, Indole production, Methyl red and Voges-Proskauer test
   f. Sugar fermentation test
2. IMMUNOLOGY:
   a. Agglutination reactions: Direct and indirect agglutination tests.
   b. Precipitation reactions: Precipitation in liquid media; precipitation in gels – single and double diffusion
3. Submission of slides
4. Laboratory note book
5. Viva-voce
TGZ: 301

GENERAL ENTOMOLOGY

Time: 2 hrs.  
Full Marks: 45  
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

General characters of Class Insecta, diversity and adaptive features of insect  3L
Outline classification up to orders with examples  10L
Structure of insect  15L

- Structure of head - sutures - types of head in various insects
- Thorax, its structure, segmentation, sclerites, modification
- Components of mouthparts and types
- Structure of leg - articulation - modification with reference to mobility
- Structure and modifications of eyes and antenna
- Origin and development of wings - venation – types and modifications – mechanism of flight - wing coupling
- Structure of abdomen - genital and pregenital abdominal appendages
- Formation and modification of cuticle

Internal organs  12L

- Digestive structure and their modifications and functions
- Circulatory system
  - Organs of circulation
  - Haemolymph
  - Haemocytes with functions
  - Mechanism of circulation
  - Fat-Body
- Excretory system
  - Principal organs
  - Physiology of excretion
  - Excretory products

Metamorphosis  6L

- Introduction – Types with examples
- Larva and pupa – structure and types

Insect behaviour  4L

- Feeding behaviour: types of feeding and damage, host range, Specialisation and host selection
- Reproductive behaviour: mate location, mating frequency and oviposition

Social Insects  8L

- Life cycle and Social organization of termites, honeybees and ants

Sound production  6L

- Structure of the organs
- Mechanism of sound production
- Significance

Bioluminescence  6L

- Structure of organs
- Brief mechanism of light production
- Significance
Suggested readings:


---

**TGZ: 302**

**PARASITOLOGY & VECTOR BIOLOGY**

**Time:** 2 hrs.  
**Full Marks:** 45  
**Lectures:** 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

- **General idea on parasitism**  
  2L
- **Classification of parasitic protozoa**  
  2L
- **Intestinal Sarcodina and Flagellates**  
  7L  
  General account, structure, life cycle, pathogenicity and control of *Entamoeba histolytica* and *Giardia lamblia*
- **Haemoflagellates**  
  8L  
  Ultrastructure and morphological stages; morphology, life cycle, clinical features and control of *Trypanosoma cruzi* and *Leishmania donovoni*
- **Haemosporina**  
  6L  
  Zoonosis
  Evolution of malarial parasites
  Morphology, life cycle, clinical features and control of *Plasmodium falciparum*
- **Classification of parasitic helminthes**  
  2L
- **General morphology (including ultrastructure) of parasitic Platyhelminthes.**  
  6L
- **Morphology, life history, pathogenicity and control**  
  12L  
  *Paragonimus westermani, Schistosoma haematobium, Taenia saginata, Trichinella spiralis, Dracunculus medinensis, Ancylostoma duodenale*
- **Biology, importance and control**  
  20L  
  Sand fly, Black fly, Tabanid flies *Anopheles*, Ticks and Mites
- **Vector- microbe interaction**  
  5L  
  Symbiotic association of microbes with vectors
  Role of microbes as controlling agents of vectors
Suggested readings

TGZ: 303
ICHTHYOLOGY & AQUACULTURE
Time: 2 hrs. Full Marks: 45 Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Ichthyology
Classification of fishes 15L
Principles of classification, extinct fish groups
Detailed study of major fish orders: Cypriniformes, Clupeiformes, Ophiocephaliformes, Perciformes, Mastacembeliformes.
Structure, development, comparative account and functions 9L
Bioluminescent organ
Poison gland
Acoustico-lateralis system
Structure and functions 10L
Digestive systems, olfactory organ and chemoreception, Osmoregulatory and Circulatory systems, Electric organs, Endocrine glands (Pituitary and Thyroid), Caudal neurosecretory organ
Reproduction and Development 8L
Structure and functions of reproductive organs, Types of reproduction, Breeding and Parental care
Fish migration – types and regulation 2L
Aquaculture
Inland fisheries 6L
Pond management for carp culture, induced breeding of prawn and air breathing fishes, Composite culture of air breathing fishes
Shell fisheries
   Edible oysters, chank fishery, pearl fishery

Ornamental fish culture and aquarium management.

Fish biotechnology: Production of transgenic fish.

Marine fisheries
   Resources, Hilsa fishery, pomfrets and flat fishes
   Elasmobrach fishery (major groups, fishery methods, importance)

Suggested readings

John Wiley & Sons.

TSZ: 304

SPECIAL PAPER: ENTOMOLOGY

Time: 2 hrs.  Full Marks: 45
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Insect Anatomy

Morphology and Biology of the orders 15L
   Collembola, Orthoptera, Thysanoptera, Hemiptera, Siphonaptera,
   Lepidoptera, Coleoptera, Diptera, Strepsiptera & Hymenoptera

Integument 8L
   Structure and functions of cuticle
   Cuticular modifications
   Moulting

Head 8L
   Head segmentation and evolution
   Generalized Pterygote Head
   Modified Mouthparts (Orthopteroid, Hemipteroid and Neuropteroid)

Thorax 8L
   Generalized thoracic structure
   Structure and morphological variation of wing
   Appendages of thorax

Abdomen 6L
   Segmentation
   Skeletal composition
Vision
The dorsal ocelli
The stemmata
Structure of compound eye
Formation of image

Perception
Chemoreception: structure of cuticular and contact receptors, distribution & functions
Mechanoreception: Structure and functions of cuticular, cellular, proprioceptors. chordotonal and tympanal organs.

Exocrine glands
Important exocrine glands: origin, structure and functions

Suggested readings:
Wigglesworth, V. B. (1972). *Principles of Insect Physiology*. ELBS (Methuen & co.)

*TSZ: 304*

**SPECIAL PAPER: PARASITOLOGY AND MICROBIOLOGY**

**Time: 2 hrs.**  
**Full marks: 45**  
**Lectures: 70**

*Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.*

**Molecular Parasitology**
*Basic techniques for molecular analysis of parasitic systems*
- Isolation of DNA and RNA
- Hybridisation
- ELISA
- Blotting techniques
- DNA sequencing
- Amplification of DNA by polymerase chain reaction
Molecular probes in diagnosis, epidemiology and taxonomy  
General consideration and specific applications of DNA probes (Leishmaniasis, Malaria, Lymphatic filariasis).

Parasites and the immune system  
Immunity and the immune response  
Evasion and suppression of the immune response.

Antigens of parasitic helminths  
Protection and pathology

Microbial Taxonomy  
Characters used in microbial taxonomy  
Classical and molecular taxonomy  
Species concept

Bacteriology  
Bacterial nutrition  
Nutrition and nutritional types of bacteria  
Types of culture media: natural, synthetic, semi-synthetic and selective

Bacterial Growth  
Phases of growth, Kinetics of growth, generation time  
Batch culture, continuous culture and synchronous culture  
Chemostat and turbidostat  
Pure culture techniques  
Preservation of bacteria

Environmental factors influencing growth  
Temperature, pH, salt concentration, oxygen, osmotic concentration

Mode of transmission, pathogenicity and prevention of bacterial diseases  
Anthrax, Tetanus, Diphtheria and Botulism

Virology  
Cultivation and assay of animal viruses  
Morphology, chemical composition and mode of reproduction  
Herpes simplex virus, Poliovirus and HIV

Mode of transmission, pathogenicity and prevention of viral diseases  
Common cold, Mumps, Measles and Rabies

Applied Microbiology  
Biofertilizers

Bio-insecticides  
Bacillus thuringiensis,  
Bacillus sphaericus  
Nuclear polyhedrosis virus

Bioremediation

Industrial production  
Beer and wine  
Antibiotic (Penicillin)

Suggested readings:

SPECIAL PAPER: AQUACULTURE AND FISHERIES

Time: 2 hrs.  
Full Marks: 45  
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

**Fresh Water Aquaculture**

*Inland fisheries resources in India and their principal species.*

Indian Major carps: *Catla catla, Labeo rohita, Cirrhinus mrigala*

Exotic carps: *Hypophthalmichys molitrix, Ctenopharyngodon idella, Cyprinus carpio*

Cat fishes: *Clarias batrachus, Heteropneustes fossilis*

Other groups: *Anabas testudineus, Channa striatus, Etroplus suratensis*

*Fish culture practices*

Collection of spawn, fries and fingerlings and their subsequent transport

Culture of air-breathing fishes

Integrated aquaculture: crop-livestock-fish farming

Paddy-cum-fish culture

Sewage-fed fish culture

Impact of invasive fish species

Cold water fisheries: resources, management and development.

*Fish breeding*

Neuro-endocrine control of fish reproduction

Induced breeding in carps and catfishes

Ecological requirements for induced breeding

*Hybridization and genetic manipulation*

Selective breeding (Intergeneric, interspecific)

Ploidy manipulation, Androgenesis, Gynogenesis

Transgenesis: Transgene delivery, integration, expression
Suggested readings:


*********************************************

TSZ: 304

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

Time: 2 hrs. Full Marks: 45
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Evolution of the biosphere/ecosphere 5L
The biosphere, climate and vegetation, stability of the atmosphere, cybernetic nature and stability in the ecosystem, environmental perspectives and human development

Physical aspects of the environment 8L
Lotic and lentic environments, marine biota and zonations, estuarine biota and productivity, terrestrial biota, soil sub-systems, vegetational sub-system

Concept of productivity 6L
Biomass, Primary and secondary productivity patterns, tropic structure and ecological pyramids, ecological efficiencies

Populations in communities 8L
Species diversity, similarities and divergence, ecological guild, ecotone and edge effect, interspecific competition and co-existence, diversity indices, ecotypes, keystone species

Behavioural ecology 10L
Natural selection and social behaviour, territorial behaviour and habitat selection, domestication, ecology of sex, signals and mating; colonizing ability, distance movements and dispersal, altruism and reciprocal altruism, eusociality, colouration and mimicry, photoperiodism and circadian rhythms

Development and evolution of ecosystem 8L
Ecosystem development, concept of climax, micro-evolution and macro-evolution, co-evolution
Chemical ecology and adaptations
Feeding preferences, biochemical basis for food plant selection by insects; feeding attractants, feedings deterrents, oviposition stimulants in insects, pheromones, plant toxins and their effects (types and fate in animals), cyanogenic glycosides, cardiac glycosides, pyrrolizidine alkaloids, utilization of plant toxins by animals, allelochemicals and environment

Ecological energetics
The entropy law, energy transfer across trophic links, energy budget, chemolithoautotrophs and hydrothermal vents

Biogeochemistry and reactions
Patterns and basic types of biogeochemical cycles, global cycling of carbon, nitrogen, phosphorus and water, watershed studies, nutrient cycling in the tropics, recycling pathways and recycling index

Suggested readings:

TSZ: 304

SPECIAL PAPER: MOLECULAR BIOLOGY AND GENETICS

Time: 2 hrs. Full Marks: 45
Lectures: 70 hours

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Genetic inheritance
Mendelian principles and its deviation, extension of Mendelian principles – codominance, incomplete dominance, gene interactions, pleitropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linked, sex-limited and sex-influenced character. Sex determination, dosage compensation in Drosophila, Caenorhabditis elegans and mammals.
Gene concept and gene function analysis


Recombinant DNA technology and animal cloning


RNA interference and antisense technology

siRNA, shRNA, miRNA, therapeutic use of RNA interference.

Molecular detection and gene therapy

Detection of Sickle cell anaemia, thalassemia, cystic fibrosis, haemophilia, muscular dystrophy.
Gene therapy: Ex vivo and in vivo therapy, strategies and delivery.

Molecular biology techniques

PCR, RT-PCR, Real time PCR, Restriction mapping, RAPD, RFLP. AFLP. Chromosome walking, site directed mutagenesis. Gel retardation assay, RNase protection assay, Protein sequencing, in situ localization - FISH and GISH, Microarray technique.

Suggested readings:

INTERNAL ASSESSMENT

Full Marks: 4 THEORY PAPERS x 5 = 20

PRACTICAL PAPERS

PGZ: 305
ENTOMOLOGY, PARASITOLOGY & Ichthyology
Time: 5 Hrs. Full Marks: 50

1. Digestive system of Grasshopper / Dragonfly / Honey bee
2. Nervous system of Grasshopper / Dragonfly / Honey bee
3. Mouthparts of mosquito and Dragonfly
4. Study of buccopharynx and gut content analysis in relation to food habits in teleosts.
5. Urinogenital system of teleosts
6. Efferent branchial system of teleosts
7. Smear preparation and staining of parasitic protozoa
8. Drawing and staining of blood films for parasitic protozoa and microfilaria
9. Whole mount preparation of trematode and arthropod parasites
10. Staining of Scolex and proglottids of cestodes
11. Histological preparation of testis, ovary, kidney and intestine of fish
12. Identification of common pests, vectors and fishes
13. Laboratory notebook and submission of prepared slides
14. Viva-voce

PSZ –306

SPECIAL PAPER: PRACTICAL: ENTOMOLOGY
Time 5 hrs. Full Marks: 50

1. Anatomy
   a. Cockroach: Sympathetic Nervous and male reproductive system
   b. Blue bottle fly: Digestive and Nervous systems
   c. Mounting: antenna, scales, spiracles and tympanum
2. Taxonomy
   a. Study of insect collecting devices
   b. Identification (up to family) with reasons of Apterygote and Exopterygote (Hemimetabolans) insects
   c. Study of insects of economic importance (5 species).
3. Physiology
   a. Preparation insect blood smear and identification of blood cells under microscope after proper staining
   b. Detection of amino acids by chromatography
4. Toxicology
   a. Preparation of insecticidal formulation (emulsion, dust and suspension)
5. Field Entomology
   Laboratory Note Book and submission of collected Apterygote and Exopterygote (Hemimetabolans) insects
6. Viva-voce

------------------------------------------------------

**PSZ –306**

**SPECIAL PAPER PRACTICAL: PARASITOLOGY AND MICROBIOLOGY**

**Time: 5 hrs.**

1. Determination of bacterial load of different water sources by standard plate count method
2. Determination of potability of water (presumptive test)
3. Microbiological examination of curd sample.
4. Enrichment culture of spore formers.
5. Microbiological examination of milk (Methylene blue reductase test)
6. Antibiotic sensitivity test.
7. Study on Physiological and bio-chemical characteristics: Starch hydrolysis,
   Gelatin hydrolysis, Fat hydrolysis, Tryptophan hydrolysis, Urea hydrolysis,
   Citrate utilization.
8. Study of bacterial growth; Study of different factors (temperature, pH, osmotic concentration and heavy metal) on bacterial growth.
9. Isolation of asymbiotic (free living) nitrogen fixing bacteria in soil.
10. Isolation of plasmid DNA from bacteria
11. Electrophoretic separation of DNA
12. ELISA
13. Identification
14. Laboratory notebook
15. Viva-voce

------------------------------------------------------

**PSZ: 306**

**SPECIAL PAPER PRACTICAL: AQUACULTURE AND FISHERIES**

**Time 5 hrs.**

1. Dissection of different organ systems.
2. Studies of life histories of cultivated freshwater fishes, preparation and mounting of the various stages and their identification.
3. Techniques of induced breeding.
4. Detection of food and feeding habit by analyzing gill rakers, buccopharynx and gut content.
5. Systematic identification of fishes.
6. Separation of amino acids by paper and thin layer chromatography.
7. Field study, Laboratory Note Book and class records.
8. Viva-voce.

------------------------------------------------------
PSZ: 306

SPECIAL PAPER PRACTICAL: ECOLOGY & ENVIRONMENT

Time: 5 hrs.  
Full Marks: 50

1. Sampling and measurement of factors (air/water/soil)
   (a) Light; illumination and intensity; Transparency (Secchi disc method)
   (b) Primary productivity in an aquatic ecosystem (light and dark bottle method)
   (c) Minerals dissolved in water - Temporary and permanent hardness
   (d) Total dissolved solids (TDS), total phosphorus, and total silica in freshwaters
   (e) Moisture contents of the soil and stored-grain samples

2. Field-works and Quantitative/numerical studies
   (a) Estimation of population density (direct counts, marking capture-recapture methods)
   (b) Use of statistical methods (standard deviation, Pie diagram, Histogram, Bar diagram, Scattergram etc.)
   (c) Population dispersion
   (d) Life table estimation
   (e) Biodiversity measurement

3. Ecotypes of terrestrial, freshwater and marine habitats
   (a) Characterization and identification of different ecotypes inhabiting terrestrial,
       freshwater and marine habitats
   (b) Identification of different tools/instruments used in Ecology and Environmental
       sampling and analysis

4. Laboratory Note Book and field records

5. Viva-voce

SPECIAL PAPER PRACTICAL: MOLECULAR BIOLOGY AND GENETICS

Time 5 hrs. (2 days)  
Full Marks: 50

1. Basic principle of experimental animal handling and ethical issues and bio-
   safety for molecular biology work.
2. Identification of different embryonic stages of Drosophila, Preparation of
   Drosophila food.
3. Karyotype and idiogram preparation (G, C banding), human lymphocyte
   culture.
4. Extraction of DNA from animal tissue/blood.
5. Extraction of RNA from animal tissue.
6. Preparation of culture media, E. coli culture preparation and plasmid isolation.
7. Agarose gel electrophoresis for plasmid, genomic DNA and RNA.
8. PCR and RT-PCR.
9. Separation of protein from mouse/rat tissue on native and /denaturation gel
   (PAGE) and western blotting.
10. Laboratory Note Book.
11. Viva voce.
Time: 2 hrs.  
Full Marks: 45

Unit – I: DEVELOPMENTAL BIOLOGY  
Full Marks: 22.5
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Overview  
3L
Scope of Developmental Biology & Future impact
Totipotency
Cell surface proteins, Extra cellular matrix
Signaling

Techniques & experimental biology  
5L
Cell labeling & genetical methods
Model systems (Dictyostelium, C. elegans, Drosophila & Chick)

Gametogenesis  
4L
Spermatogenesis: phases, cellular changes
Oogenesis: types, stages, ooteleosis & luteinization

Fertilization in mammals  
3L
Recognition of gametes and acrosomal reaction
Gamete fusion
Activation of egg

Cleavage  
2L
Mechanism: molecular aspects

Gastrulation  
5L
Cell lineages
Gastrulation in vertebrate embryos
Formation of germ layers in amphibia and birds
Induction, Determination and Differentiation

Pattern formation  
4L
Anterior-Posterior & Dorsal- Ventral polarity in Drosophila;
Molecular control of segmentation and homeotic genes.
Gap genes, HOX genes in vertebrate, Nieuwkoop centre & ventral organizer
Neurogenesis and Neural tube in vertebrates

General Topics  
9L
Mesoderm induction & patterning
Regeneration
In vitro fertilization in human
Embryonic stem cell & their application

Suggested readings


Unit – II: BIOSTATISTICS & BIOINSTRUMENTATION

Full Marks: 22.5
Lectures: 35

Three questions (out of five) of 1.5 marks each, two questions (out of four) of 4 marks each and one question (out of two) of 10 marks are to be answered.

Biostatistics

Measures of dispersion

Concepts and applications - measures of dispersion, range, mean deviation, skewness and kurtosis, coefficient of variation, variance, Standard deviation, Quartile deviation and standard error

Testing of hypotheses

Concepts of Normal, Binomial and Poisson distribution; Student’s – t distribution, G-tests; Concepts of Null hypothesis and alternative hypothesis, degrees of freedom Level of significance, errors of inference; one-way ANOVA – applications in biology Concepts and applications of correlation and regression

Bioinstrumentation

Microscopy

Light, Fluorescence and Confocal microscopy, TEM, SEM

Centrifugation

Basic principles and application
Types of rotors
High speed and Ultracentrifugation

Spectroscopy

UV-vis absorption spectrophotometry - principles, instrumentation (single and double beam) and applications

Chromatography

Planar chromatography (paper & TLC)
Gas chromatography
High Performance Liquid chromatography

Electrophoresis

Principle
PAGE, Agarose Gel electrophoresis, Isoelectric focussing of proteins
Blot techniques: Southern, Northern & Western.
Suggested readings:

Cambridge Low-price Ed.
& Co.
and Discovery. Academic Press.
2nd ed. Pearson Prentice Hall.
5th ed. Cambridge University Press.

TSZ: 402

SPECIAL PAPER: ENTOMOLOGY
Time: 2 hrs.  Full Marks: 45
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and
two questions (out of four) of 10 marks each are to be answered.

Insect Physiology
Digestive system
The alimentary canal
The salivary glands
Mechanism of digestion
Micro-organisms and their role in digestion
Nutritional requirements

Respiratory system
Structure of respiratory organs
Mechanism of gaseous exchange
Aquatic respiratory organs
Physiology of gill and plastron respiration

Excretory system
Types of excretory systems
Organs of excretion
Accessory organs of excretion
Physiology of excretion
Composition of insect urine
Vitamins in Malpighian tubules

Nervous system
The neurons
The central nervous system
The brain
The Sympathetic nervous system

Reproduction 10L
Male and Female reproductive system
Special types of reproduction
Factors controlling fecundity and fertility
Swarming and oviposition
Egg maturation

Development 8L
The insect egg
Embryonic development and dynamics
Post-embryonic development and metamorphosis

Endocrine system 8L
Anatomical organization
Structure and hormones
Endocrine control of metamorphosis, diapause

Gall formation 8L
Insects involved in formation of galls
Mechanism of galls formation
Importance of galls

Suggested readings:

Wigglesworth, V. B. (1972). Principles of Insect Physiology. ELBS (Methuen & co.)
TSZ: 402

SPECIAL PAPER: PARASITOLOGY & MICROBIOLOGY

Time: 2 hrs.  Full Marks: 45
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

General Parasitology & Protozoology

Microenvironment and the phases of parasitism
The vertebrate alimentary canal, blood, tissues and the other habitats

Parasite host specificity

Protozoan Parasites
Origin and evolution of parasitic protozoa
Haemoflagellates
General morphology and morphological stages
Life cycle and pathogenicity of Trypanosoma brucei gambiense
Physiology and biochemistry of Haemoflagellates

Apicomplexa
Ultrastructure of apical complex
Biology and pathogenicity of Toxoplasma gondii
General biology. Characteristic of species and Indian vectors of Plasmodium; Immunopathology associated with malaria;
Biochemistry and physiology of Plasmodium and Babesia

Ciliophora
General morphology with special reference to parasitic forms;
Structure, Life cycle and pathogenicity of Balantidium coli

Suggested readings:


---------------------------------------------------------------------------------------------------------------
Special Paper: Aquaculture & Fisheries

Time: 2 hrs.  
Full Marks: 45  
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Fresh Water & Brackish Water Aquaculture

Nutrition and supplementary feeding
- Nutritional requirements
- Intermediary metabolism and bioenergetics
- Feed types, composition, ingredients, formulation
- Feeding schedules, feed dispensing methods
- Storage and quality control of feed

Maintenance of Fish Farm
- Productivity of freshwater bodies
- Limnological methods and their application (oxygen and carbon-di-oxide)
- Pond fertilization
- Control of aquatic weeds, insects, predatory and weed fishes

Aquaculture hazards
- Common diseases of fish: Causative organisms, effects and control
- Shrimp diseases and treatment
- Pollution: sources, effects and control.

Present status of brackish water fish farming in India
- Mixed culture of brackish water fish species
- Esturine fisheries

Spoilage of fresh water and brackish water fishes
- Aminoacid changes
- Breakdown products indicative of spoilage
- Other substances

Development strategies
- Fish conservation
- Fish marketing: imports and exports.

Suggested readings:

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

Time: 2 hrs.  \hspace{2cm} \text{Full Marks: 45}
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

**Stresses on ecosystem structure and function**
- Advent of stress, long-term chronic stress, alleviation of stress;
- biological indicators and their use in monitoring pollution;
- bioaccumulation and biomagnification

**Ecotoxicology**
- Basic concept, Background concentration in the environment, naturally occurring contaminants and their ecological effects;
- anthropogenic source of toxic elements; movement, distribution and fate of toxins; minimizing toxic effects;
- xenobiotics; pesticides, heavy metals, industrial effluents, organic pollutants, radio-active pollutants; food additives and contaminants, bioassay and safety evaluations

**Air pollution**
- Emission, transformation and toxicity of air pollutants;
- impacts of air pollution on human health; ozone hole, greenhouse effects; global climate change and plant growth;
- acid rain; monitoring and control of air pollution

**Water, soil and noise pollution**
- Types, sources, characteristics, effects and control

**Waste disposal & Treatments**
- Solid waste disposal; sewage disposal and treatments;
- toxic wastes and their disposal

**Radiation and warfare ecology**
- Nuclear concepts, impacts of nuclear warfare and radiation effects at the ecosystem level, fallout problems, destruction of conventional warfare

**Urbanization ecology**
- Urban land use and growth, urban structure and crisis,
- urban planning, urban regeneration, open space, green belts and parks; ecotourism

**Suggested readings:**

Special Paper: Molecular Biology and Genetics

Time: 2 hrs. Full Marks: 45
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Cellular organization
15L
Membrane structure and transport of small molecules, electrical properties of membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, structure and function of cytoskeleton and its role in motility, cell junction, cell adhesion and extracellular matrix.

Cell signaling
10L
Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial two-component signaling systems, bacterial chemotaxis and quorum sensing.

Cancer
10L
Oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth. Tumor angiogenesis.

Programmed cell death
5L
Apoptosis, aging and senescence.

Methods of cell and tissue culture:
5L
Monolayer and Suspension culture, co-culture, Cell Freezing. Embryonic stem cell culture.

Host cell-pathogen interaction
10L
Recognition and entry process of bacteria and virus in to host cell, alteration of host cell behaviour by pathogens, virus induced cell transformation, cell-cell fusion in both normal and abnormal cells.

Molecular biology instrumentation
15L
**SPECIAL PAPER: ENTOMOLOGY**

**Time:** 2 hrs.  
**Full Marks:** 45  
**Lectures:** 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

**Applied Entomology**

*Crop Husbandry*  
10L  
Morphology, Bionomics and Management of pests of paddy, wheat, jute, sugarcane, mango, oil-seed crops, pulses, vegetables and stored grains  
Distribution, bionomics and control of polyphagous pests: locusts and termites

*Control/Management of insect pests*  
20L  
Integrated pest Management:  
Concept of injury level, Economic level of injury, Economic threshold level, IPM.  
Chemical control: Organochlorines, Organophosphates, Carbamates, Pyrethroids and Botanicals  
Biological Control: Predators, Parasitoids and Nematodes  
Hormonal control: Concept, use of juvenoids, ecdysoids and Insect growth regulators (IGRs)  
Genetic control: Methods of genetic manipulation and field trials.  
Biotechnological control - use of transgenic plants, transgenic agents and impact of environment on the method.

*Non-insecticidal method*  
Insect attractants, fumigants, repellents and antifeedants

*Forest Entomology*  
5L  
Insects common to forests and their damage  
Defoliators, borers and sapsuckers.

*Forensic Entomology*  
5L  
Insects associated with the corpses and carrions  
Forensic entomological techniques

*Industrial Entomology*  
10L  
Non-Mulberry sericulture-Tasar, muga and eri.  
Lac culture: Lac insects, Life history, Industrial importance.  
Honey bees and Apiculture

*Medical Entomology*  
10L  
Insects of medical importance - naming with its status in Entomology  
Morphology of mosquitoes, house flies, human lice and rat fleas with role in disease transmission and control

*Insect molecular genetics*  
10L  
Insect genome organization  
Transgenic pest and application

**Suggested readings:**


TSZ: 403

SPECIAL PAPER: PARASITOLOGY & MICROBIOLOGY

Time: 2 hrs. Full Marks: 45
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

HELMINTHOLOGY AND VECTOR BIOLOGY:

Helminth Parasites

- General organization and outline classification of Platyhelminthes
- Nematoda and Acanthocephala with reference to parasitic forms 4L
- Origin and evolution of Parasitic helminths 5L
- Structure and Composition of cuticle in helminths 4L
- Structure of Scolex in Cestodes 3L
Reproductive system, mating behavior, fertilization and egg formation in helminths

Larval development and patterns of life cycle in Digenea, Cestoda and Nematoda.

Carbohydrate, protein and lipid metabolism in Nematoda

Biology, Pathogenicity and Control:
  Opisthorchis sinensis, Diphyllobothrium latum,
  Echinococcus granulosus, Loa loa

Gastrointestinal nematode infection in man and ruminants and their antihelmintic treatment

Human lymphatic filariasis and its transmission dynamics

Zoonoses in nematodes and cestodes

General organization and life cycles in Acanthocephala

Vector Biology
  Biology, importance and control:
    Chrysops, Tse-tse fly, Fleas, Lice and mosquitoes (Aedes and Culex)

Suggested readings:


Marine Fisheries

General survey of marine fisheries in India
Marine biology and oceanography in relation to fisheries
Principal marine fisheries and exploited species
- Oil sardine and lesser sardines, Indian Mackerel, Bombay duck,
  Pomfrets, Prawns, Molluscs
Fishing crafts and Gears
- Types of Indigenous crafts and gears, designing
  Modernization of craft, Preservation
Life in sea
- Phytoplankton, Zooplankton
  Nekton and fisheries
Fluctuation in marine fisheries
- Causes of fluctuation, overfishing problem
  Rational exploitation of fisheries
Preservation and processing
- Chemical composition of fish
  Drying and salting, Chilling and freezing, Smoking and canning
Mariculture
- Cultivable fin-fishes, Cultivable crustaceans, Cultivable mollusca
Fish in human nutrition
- Nutritive value of fish protein,
  Fish oils, fatty acids and nutrition
  Fish as a source of mineral, Fish as a source of vitamins
Fish by-products, Marketing of fish and aquaculture products
Conservation of marine environment through establishing National marine reserves

Suggested readings:

SPECIAL PAPER: ECOLOGY & ENVIRONMENT

Time: 2 hrs.  
Full Marks: 45  
Lectures: 70

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

Population ecology
- Intrinsic rate of natural increase, ‘r’ and ‘k’ selections, life-history traits and tactics, human demography, dynamics of metapopulations

Resources
- Renewable and non-renewable resources, fossil fuel, nuclear fuels, biogas, solar energy, food production trends, agriculture and forestry

Conservation and management
- Principles of conservations, conservation of natural resources, mineral resources, endangered species, wetlands management, ecological principles to pest managements, ecology of biological invasion, restoration ecology

Environmental policy
- Social forestry, economic and legal aspects, enforcement of anti-pollution laws, environment awareness - role of government, media and voluntary groups, Green Bench

Man-environment interaction
- Global population size, management of energy utilization, public health, human right, animal rights and human wrongs, important movements on environmental issues

Environmental health and Ecological Economics
- Environmental health hazards and laws, capital and reserves, Population, technology and scarcity, natural resources accounting, trade development and jobs, green designs and the environment

Systems analysis and modeling in ecology
- Types of systems models - dioristic, component, strategic, management and statistical; basic mathematical tools in model building, analysis and simulation in models, deterministic and stochastic models, differences and differential models

Society and environmental sociology
- Politics, economics, and ethics; western philosophy and ethical compromise, social environment, modernism and post-modernism, Malthus and Marx today

Suggested readings:

-----

**TSZ: 403**

**SPECIAL PAPER: MOLECULAR BIOLOGY AND GENETICS**

**Time: 2 hrs.**
**Full Marks: 45**
**Lectures: 70**

Five questions (out of eight) of 2 marks each, three questions (out of five) of 5 marks each and two questions (out of four) of 10 marks each are to be answered.

**Complex traits and quantitative genetics** 10L
Heritability and its measurements, oligogenic trait, polygenic trait, multifactorial trait, threshold trait; QTL mapping. LOD score and linkage testing.

**DNA replication (prokaryotes and eukaryotes), repair and recombination:** 10L
Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, licensing factors, DNA damage and repair mechanisms.

**Chromatin structure** 10L
Nucleosome structure, chromatin activation and inactivation, heterochromatin, chromatin binding proteins, Histone modification, DNA methylation, polycomb and trithorax group of proteins.

**Gene expression and its regulation** 20L
The operon, regulatory circuits, phage strategies, promoters and enhancers, activating transcription – transcription factors and machinery, Histone acetylation and deacetylation, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing and editing.

**Protein synthesis process**
ribosome, initiation complex and their regulation, chain elongation, termination, genetic code aminoacylation of tRNA, tRNA identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post translational modification, protein trafficking, signal transduction, protein sorting, chaperons.
Microbial genetics
Transformation, conjugation, transduction and sex-duction; life cycle and reproduction in retroviruses, adenoviruses; prion and their pathogenecity. Gene expression and regulation (at transcription and translation level) of prokaryotic – phages and viruses.

Bioinformatics:
Basic concept of Bioinformatics, sequence Databases, Sequence formats- FASTA, Gene Bank, Database searching and pair wise comparison of sequence, BLAST, Multiple sequence Alignment, clustal W/X, Protein analysis tool-Expasy, data mining methods for sequence analysis.

Suggested readings (TSZ 402 & TSZ 403):

Mount D.V. Bioinformatics – Sequence & Genome analysis . CBS publishers
TSZ – 404

Full Marks: 50

Term Paper / Project Work (based on special paper)

[Submission (within 10,000 words) & Seminar presentation – 40 (=25+15); Discussion – 10]

INTERNAL ASSESSMENT

Full Marks: 3 THEORY PAPERS x 5 = 15

PRACTICAL PAPERS

PGZ – 405

DEVELOPMENTAL BIOLOGY & COMPUTER APPLICATION

Time: 5 hrs.

Full Marks: 50

1. Developmental Biology
   a. Culture and Regeneration of Hydra
   b. Morphological studies on the developmental stages of snail, fish, frog, chick and mouse
   c. Histological slides of various organs and systems during development using stained serial sections
   d. Identification of whole mounts and histological sections of embryos larvae, pupae and nymphs
   e. Submissions of preparations of different stages of development.

2. Computer Applications
   a. Basics of computers
      CPU & I/O units, Operating systems
   b. Computer networking
      Internet & Email, Home pages, Web pages, WWW, URL
   c. Software packages
      MS word, MS Excel, MS Power point, Photoshop, and SPSS
   d. Scope, application of Bioinformatics

3. Laboratory records

4. Viva voce.
PSZ: 406

**SPECIAL PAPER PRACTICAL: ENTOMOLOGY**

**Time: 5 hrs.**

Full Marks: 50

1. Anatomy
   a. Butterfly: Digestive and Reproductive system
   b. Any coleopteran: Nervous system
   c. Mounting: wings (small insects-at least 5 types), legs (at least 5 types) and mouthparts at least two types

2. Taxonomy
   a. Methods of insect collection and preservation
   d. Identification (up to family) with reasons of Endopterygote (Holometabolans) insects

3. Physiology - Chitosan test of cuticle

4. Toxicology
   a. Study of insect infestations (at least 5) in grains and forest trees.
   b. Study of LC\textsubscript{50} of two common insecticides against any two pests (graphical representation).

5. Study (life cycle, damage etc.) of at least 2 types of pests.

6. Laboratory Note Book and

7. Submission of collected endopterygote insects (Holometabolans)

8. Viva-voce.

=====================================================================================

PSZ: 406

**SPECIAL PAPER PRACTICAL: PARASITOLOGY & MICROBIOLOGY**

**Time: 5 hrs.**

Full Marks: 50

1. Autopsy of hosts for parasitic infection.
2. Permanent preparation of protozoan parasite.
3. Fixation and preservation of helminth parasites.
4. Staining and mounting of trematode and cestode.
5. Histological preparation of helminth parasites.
6. Cytochemical and histochemical studies on protozoa and helminth parasites-DNA, polysaccharides, Protein, Lipid, Alkaline and Acid phosphatases.
7. Clinical parasitological techniques.
8. En-face view preparation of nematode parasites.
9. Whole mount preparation of arthropod parasites and vectors.
10. Identification
11. Submission of parasitological preparation
12. Laboratory notebook
13. Viva-voce

=====================================================================================
PSZ: 406

SPECIAL PAPER PRACTICAL: AQUACULTURE & FISHERIES

Time: 5 hrs.  
Full Marks: 50

1. Histological studies of different tissues and their identification.
2. Limnological studies.
4. Qualitative and quantitative detection of digestive enzymes.
5. Identification and mounting of some common freshwater Zooplankton, benthos, aquatic weeds and insects.
7. Laboratory Note and class records, submission of prepared slides.
8. Viva voce.

PSZ: 406

SPECIAL PAPER PRACTICAL: ECOLOGY & ENVIRONMENT

Time: 5 hrs.  
Full Marks: 50

1. Quantitative analysis of some inorganic and organic materials in the environment
   a. Chemical Oxygen Demand (COD)
   b. Biochemical Oxygen Demand (BOD)
   c. Organic Matter (OM)/Organic carbon (OC) in the soil/sediment
2. Animal energetics
   a. Bomb-calorimetry - Invertebrate/Vertebrate tissue
   b. Material drying (gravimetric) and pellet forming techniques
   c. Computation of energy budget and energy flow diagrams
   d. Determination of ash-free biomass of invertebrate and vertebrate samples (Muffle-furnace technique)
3. Air sampling and air analysis
   a. Temperature - Minimum and Maximum; Relative Humidity (RH)
   b. Particulate matters (Electrostatic precipitation method)
   c. Nitrogen oxides (monochromatic method), Sulfur dioxide (New- Castle method)
   d. Hydrocarbons in exhaust gases
4. Animal feeding and nutrition
   a. Measurement of consumption and assimilation rates
   b. Chemical composition of animals body and its food (e.g. carbohydrates, proteins, lipids and polyphenolics)
   c. Respirometry of some terrestrial animals
5. Ecotypes of terrestrial, freshwater and marine habitats
   a. Characterization and identification of different ecotypes inhabiting terrestrial, freshwater and marine habitats
   b. Identification of different tools/instruments used in Ecology and Environmental sampling and analysis
6. Laboratory Note Book and field records
7. Viva-voce
PSZ: 406

SPECIAL PAPER PRACTICAL: MOLECULAR BIOLOGY & GENETICS

Time: 8 hrs. (2 days)  
Full Marks: 50

1. Sex chromatin study  
2. Gene expression study by GFP / lac Z staining/immunostaining  
3. Cloning of gene  
4. Monolayer and/suspension cell culture  
5. Visit to R & D laboratory  
6. Submission of laboratory notebook  
7. Viva voce