

**DIBRUGARH UNIVERSITY**  
**UNDER GRADUATE SYLLABUS UNDER SEMESTER SYSTEM**  
**ZOOLOGY MAJOR PROGRAMME**

**Objective:** The main objective of the course is to provide in-depth knowledge about bio-diversity, their development and interaction with environment. The study of Physiology, Endocrinology, Cell Biology and Molecular Biology has been included to provide in-depth knowledge of the subject courses on instrumentation and techniques including Biostatistics, Biotechnology and Bioinformatics are included to provide the students with recent development in the field of biology.

**EXAMINATION:**

**There shall be 27 (twenty seven) papers; 14 (fourteen) theory and 13 (thirteen) practical papers in zoology. 20% of marks each of theory and practical papers shall be evaluated as Internal Assessment (IA). The distribution of courses and marks will be as follows:**

SEMESTER	PAPER	TITLE OF THE PAPER	MARKS		
			IA	End Sem	TOTAL
<b>I</b>	ZooMT- 101	Non-chordate diversity and Systematics	12	48	60
	ZooMP- 102	Practical based on ZooMT- 101	08	32	40
<b>II</b>	ZooMT- 201	Biochemistry	12	48	60
	ZooMP- 202	Practical based on ZooMT- 201	08	32	40
<b>III</b>	ZooMT- 301	Chordate diversity and Comparative Anatomy	12	48	60
	ZooMP- 302	Practical based on ZooMT- 301	08	32	40
	ZooMT- 303	Bioinstrumentation & Biostatistics	12	48	60
	ZooMP- 304	Practical based on ZooMT- 303	08	32	40
<b>IV</b>	ZooMT- 401	Cell Biology, Histology and Histochemistry	12	48	60
	ZooMP- 402	Practical based on ZooMT- 401	08	32	40
	ZooMT- 403	Developmental Biology	12	48	60
	ZooMP- 404	Practical based on ZooMT- 403	08	32	40
<b>V</b>	ZooMT- 501	Genetics and Evolution	12	48	60
	ZooMP- 502	Practical based on ZooMT- 501	08	32	40
	ZooMT- 503	Animal Physiology	12	48	60
	ZooMP- 504	Practical based on ZooMT- 503	08	32	40
	ZooMT- 505	Environmental Biology and Wildlife	12	48	60
	ZooMP- 506	Practical based on ZooMT- 505	08	32	40
	ZooMT- 507	Endocrinology	12	48	60
	ZooMP- 508	Practical based on ZooMT- 507	08	32	40
	ZooMT- 601	Parasitology and Ethology	12	48	60

<b>VI</b>	ZooMP- 602	Practical based on ZooMT- 601	08	32	40
	ZooMT- 603	Molecular Biology and Immunology	12	48	60
	ZooMT- 604	Biotechnology and Bioinformatics	12	48	60
	ZooMP- 605	Practical based on ZooMT- 603 and 604	13	52	65
		Project work	0	15	15
	ZooMT- 606	Economic Zoology	12	48	60
	ZooMP- 607	Practical based on ZooMT- 606	08	32	40
<b>Course Total marks = 1400</b>					

## SEMESTER-I

### **ZooMT- 101: Non-chordate diversity, Systematics and Evolution**

**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

- Unit-1: Protozoa- General characters and classification up to orders with examples; locomotion, nutrition and reproduction in protozoa, Porifera- General characters and classification up to orders with examples; skeletal and canal system in *Sycon*; Coelentrata: General characters and classification upto orders with examples; polymorphism and defensive mechanism in coelentereta; coral reefs and their formation.
- Unit-2: Helminthes: General characters and classification upto orders with examples; Annelida: General characters and classification upto orders with examples; excretion, reproduction and importance of *Pheretima*; coelom and metamerism in annelids.
- Unit-3: Arthropoda: General characters and classification upto orders with examples; mouth parts of insects; larval forms in crustacea; digestion, excretion and vision in arthropoda; affinity of Onychophora.
- Unit-4: Mollusca: General characters and classification upto orders with examples; digestive, respiratory and excretory system of *Pila*; shell diversity, torsion and detorsion in mollusca; Echinodermata: General characters and classification upto orders with examples; water vascular system in starfish, echinoderm larvae.
- Unit- 5: Systematics and classification, form and hierarchy of classification; Modern species concept; nomenclature – rules of zoological nomenclature; Modern concept in taxonomy (Molecular, chemotaxonomy, numerical taxonomy & cytotaxonomy).

### **ZooMP- 102: Practical based on ZooMT- 101**

**Marks: 8 (IA) + 32 (End Sem) = 40**  
**20 lecture hours**

1. Dissection of the following invertebrate system:  
Earthworm: Urinogenital system.  
*Pila/ Acatina*: Nervous system. Prawn-nervous system  
Cockroach: Digestive, nervous system and reproductive system.
2. Identification of following invertebrates with reason:  
*Paramaecium, Trypanosoma, Giardia, Trichomonous, Sycon, Trychympha, Globigerina, Porpita, Taenia solium, Ancylostoma duodenale, Wuchereria bancrofti, Chalinid sponge, Spongilla, Sea-anemone, Madrepora, Gorgonia, coral, Fungia, Pleurobranchia, Oxuris, Rotifer, Brachipid, Heteronereis, Chaetopterus, Pentobdella, Glycera, Limulus, Megascolex, Tubifex, Glossiphonia, Echiurus, Argulus, Ligia, Neptunus, Branchipus, Apus, Nauplius, Zoea, Megalopa, Millipede, Gryllus, Grylotalpa, Termites, Ephemerid, Larvae, Dragonfly larva, aphid, Ranatra, Bellostoma, Lady bird, Beetle, Ants, Rice-bug, Peripatus, Nautilus, Pearl Oyster, Mytilus, Limax, Solen, Planorbird, Heart -Urchin, Cake-Urchin, Brittle Star, Leaf insect, Stick insect.*

3. Preparation of permanent slides & mounting of minimum five suitable non-chordate specimens and their submission.
4. Study of morpho-taxonomy of locally available animal.

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Dissection	9
2. Preparation of permanent mounting	4
3. Identification	4
4. Morphotaxonomy	5
5. Practical record book	5
6. Viva voce	5
<b>Total</b>	<b>32</b>

<b>SEMESTER-II</b>
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**ZooMT- 201: Biochemistry**

**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

- Unit- 1: Laws of thermodynamics and their application in biochemistry; free energy change in biochemical systems; ATP and other high-energy phosphates as energy carrier; concept of redox systems Basic principles of biological chemistry; water, acid, base, p<sup>H</sup> and buffers.
- Unit- 2: Structure and classification of carbohydrates, proteins, amino acids and lipids; levels of organization of proteins.
- Unit -3: General concept of metabolism- Glycolysis; Krebs cycle; electron transport system (ETS) and ATP synthesis; β-oxidation of fatty acids
- Unit- 4: Enzymes- nomenclature, IUB classification, kinetics and mechanism of action; enzyme inhibition; Vitamins (source and functions) and co-enzymes.
- Unit -5: Structure and forms of DNA and RNA; DNA as genetic material, DNA replication, genetic code, Transcription

**ZooMP- 202: Practical based on ZooMT- 201**

**Marks: 8 (IA) + 32 (End Sem) = 40**  
**20 lecture hours**

1. Preparation of molar, normal and buffer solution.
2. Qualitative test for carbohydrate to identify the common monosaccharides and disaccharides.
3. Essay of enzyme urease/ peroxidase by titrimetric method.
4. Estimation of ascorbic acid in lemon/milk.
5. Separation of amino acid using paper chromatography.

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Biochemical test/ solution preparation	8
2. Biochemical estimation/ essay of enzyme	14
3. Practical record book	5

**SEMESTER-III**
**ZooMT- 301: Chordate diversity and Comparative anatomy**
**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

- Unit –1: General characters of Chordata and classification upto class; Classification of protochordata up to orders; general characters of hemichordata, urochordata and cephalochordata; larval forms and their significance in chordate phylogeny; affinities of protochordates.
- Unit –2: Distinctive characters of Petromyzontia, Chondrichthyes & Dipnoi; Classification of Osteichthyes upto orders with examples; Ammocoete larva and its importance in evolution; structures of gills, accessory/respiratory organs and swim bladders of fish; sense organs; locomotion, migration and parental care in fish.
- Unit –3: Distinctive characters and classification of Amphibia upto orders with examples; parental care, metamorphosis and neoteny in amphibia; distinctive characters and classification of Reptilia upto orders with examples; anatomical peculiarities and affinities of *Sphenodon*; poisonous snakes of India; biting mechanisms of poisonous snakes.
- Unit –4: General characters and classification of Aves upto super orders with examples; mechanisms of bird flight; perching mechanism; flight adaptation in bird; migration in birds; General characters and classification of Mammalia upto orders with examples; affinities of monotremata and marsupilia; dentition in mammals; echo-location in bats; adaptation of aquatic mammals.
- Unit –5: Comparative anatomy of integument- fish, reptile and mammals, pectoral and pelvic girdles of tetrapoda; brain and cranial nerves in amphibia and mammals; comparative account of alimentary, circulatory and reproductive system in reptiles, birds and mammals.

**ZooMP- 302: Practical based on ZooMT- 301**
**Marks: 8 (IA) + 32 (End Sem) = 40**  
**20 lecture hours**

1. Dissection of the following vertebrate system.  
Scoliodon: Efferent branchial vessels, internal ear, 9<sup>th</sup> and 10<sup>th</sup> cranial nerves; Weberian ossicles of carp/ catfish.
2. Identification of vertebrate specimens/models with reasons:  
*Pyrosoma, Salpa, Doliolum, Oikopleura, Myxine, Sting ray, Hammer headed shark, Pristis, Electric ray, Tiger shark, Pipe fish, Protopterus, Hemiramphus, Ribbon fish, Sucker fish, Mugil, Eel, Belephthalamus, Ichthyophis, Colisa, Scatophagus, Amphipneus, Glossogobius, Mystus, Harpodon, Tetraodon, Cryptobranchus, Axolotol larva, Ambystoms, Necturus, Amphiuma, Typhlops, Krait, Viper, Pit viper, Hydrophis, Natrix, Sea Snake, Tryonix, Chelone, Leathery, Turtle, Myna, parrot, crow, monotremes and marsupials, chiroptera, primates.*
3. Preparation of permanent slides & mounting of minimum five suitable slides of vertebrate's exoskeleton (scale, feather etc.)

4. Study of vertebral column of mammals; pectoral and pelvic girdle of reptiles, bird and amphibia.
5. Demonstration of digestive, circulatory, respiratory and urinogenital system of reptiles, bird and mammals through electronic media

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Dissection	10
2. Identification of museum specimens and bones	8
3. Preparation of slides	4
4. Practical record book	5
5. Viva voce	5
Total	<b>32</b>

**ZooMT- 303: Bioinstrumentation and Biostatistics**

**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

- Unit-1: Chromatography- details of paper, ion exchange and thin layer chromatography.  
 Unit-2: Microscopy- basic principle and applications of light, phase contrast and electron microscope.  
 Unit-3: Photometry- principle and uses of colorimeter and spectrophotometer.  
 Unit-4: Principles and uses of kymography, microtomy and ultramicrotomy; principles and practices of centrifugation; autoradiography.  
 Unit-5: Scope and utility of statistics in Bioscience; Sampling, collection and graphical representation of data ; measures of statistical average; mean deviation and standard deviation; Probability tests; Correlation and regression; Significance tests (t, F and X<sup>2</sup> tests)

**ZooMP- 304: Practical based on ZooMT- 303**

**Marks: 8 (IA) + 32 (End Sem) = 40**  
**20 lecture hours**

1. Separation of chlorophylls by paper chromatography
2. Demonstration of instruments as prescribed in syllabus
3. Statistical calculation of central tendency, deviations, correlation, regression & t test

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Statistical calculation & graphical representation/ correlation	10
2. Separation technique	8
3. Spotting (instruments)	4
4. Practical record book	5

5. Viva voce

5  

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Total 32

**SEMESTER-IV**

**ZooMT- 401: Cell Biology, Histology & Histochemistry**

**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

- Unit-1: Overview of prokaryotic and eukaryotic cells; structure and functions of cell organelles- mitochondria, endoplasmic reticulum, lysosome, ribosome, Golgi bodies, nucleus, structure and functions of plasma membrane (lipid bilayer model); extra cellular matrix; receptor mediated endocytosis.
- Unit-2: Structure and functions of chromosome; polytene and lamp brush chromosomes; chromatin- molecular organization, nucleosome, DNA packaging in prokaryotes and eukaryotes, heterochromatin and euchromatin; models of chromosomal movements.
- Unit-3: Cell cycle- molecular events in different phases, regulation of cell cycle; normal and malignant cell growth; cell division (mitosis and meiosis); programmed cell death (apoptosis).
- Unit-4: Basic concept of cell signalling (endocrine, paracrine and autocrine signalling); second messengers; function of cell surface receptors- G protein-coupled receptors and G-proteins.
- Unit-5: Histological methods- basic principles of fixation, dehydration, embedding, sectioning and spreading; types of staining; vital staining; classification and properties of dyes; metachromatic dyes and staining; animal tissues- types and functions; histological structure of muscles, epithelium, bone, lung, kidney, liver, stomach and intestine of mammals.

**ZooMP- 402: Practical based on ZooMT- 401**

**Marks: 8 (IA) + 32 (End Sem) = 40**  
**20 lecture hours**

1. Study of mitosis in tadpole tail, onion root tip
2. Meiosis in testes of grass hopper or cockroach
3. Histochemical localization of following:
  - a. General lipid by Sudan black B method.
  - b. Metachromatic substances by Toluidine blue method.
4. Histological preparation of liver, stomach, intestine, kidney, pancreas, testes and ovary of vertebrates and submission of slides.

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Cell biology experiment	8
2. Preparation of histochemical slide	4
3. Spotting (histological slide)	6
4. Submission of histological slide	4
5. Practical record book	5
6. Viva voce	5
<b>Total</b>	<b>32</b>

### ZooMT- 403: Developmental Biology

Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours

- Unit-1: Gametogenesis- formation of gametes (spermatogenesis; oogenesis); structure, maturation and growth of sperm and ovum; vitellogenesis.  
Unit-2: Fertilization- types and mechanism of fertilization; mono and polyspermy; parthenogenesis.  
Unit-3: Cleavage and gastrulation- cleavage pattern, blastulation and gastrulation in chick; fate maps; fate of germ layers; primary organisers, induction, property and mechanism of action of inductive substances.  
Unit-4: Organogenesis – development of sense organs (eyes and ears).  
Unit -5: Extra embryonic membranes in birds and placentation in mammals.

### ZooMP- 404: Practical based on ZooMT- 403

Marks: 8 (IA) + 32 (End Sem) = 40  
20 lecture hours

1. Study of permanent slides of different embryonic stages of frog/toad.
2. Study of permanent slides of developmental stages in chick embryo.
3. Submission of permanent stained preparation of (at least two stages up to 72 hrs. development stages) chick embryo.

### SCHEME OF THE PRACTICAL EXAMINATION:

Time: 4 hrs.

1. Embryological slide preparation	10
2. Spotting (embryological slide)	10
3. Submission of slide	2
4. Practical record book	5
5. Viva voce	5
<b>Total</b>	<b>32</b>

### SEMESTER-V

A Project work carrying 15 marks be allotted to each student at the beginning of the 5<sup>th</sup> Semester. The Report to be submitted in the Paper ZooMP- 605 of 6<sup>th</sup> Semester.

- *The Project report will have to reflect the qualities of scientific investigations (experimental or observational) with specific Title, Aim and Objectives, Review of literature, Material and methods, Collection and analysis of data and its representation, Conclusion and Reference.*



## ZooMT- 501: Genetics and Evolution

Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours

- Unit-1: Mendel's law of inheritance and their critical analysis; gene and allele concept: Physical basis of heredity; interaction of genes, incomplete dominance, complementary factors, supplementary factors, epistasis, inhibitory factors, lethal factors; quantitative genetics.
- Unit-2: Linkage and crossing over; basic knowledge of gene mapping; determination of sex, sex-linked inheritance; cytoplasmic inheritance.
- Unit-3: Concept of gene and their fine structures; chromosomal (numerical and structural) and gene mutation, types, genetic significance of mutation and practical implications; Human genetics: human as a genetic material, autosome and sex chromosomes, recessive and dominant traits, inborn error in metabolism, human chromosome, human genome project.
- Unit-4: Evidences and theories of evolution- palaeo-biological and molecular evidences; Lamarckism, Darwinism, Neo Darwinism, Mutation theory and Modern Synthetic theory; origin of life (chemical and biological origin); variation- types and sources; isolation; speciation (sympatric, allopatric and peripatric); fossil and fossilization.
- Unit-5: Concept of population- gene pool and gene frequency (Hardy- Weinberg law); change in gene frequency (genetic drift, gene flow, genetic load); continental drift; parallel, divergent and convergent evolution; endemism and adaptive radiation

## ZooMP- 502: Practical based on ZooMT- 501

Marks: 8 (IA) + 32 (End Sem) = 40  
20 lecture hours

1. Polytene chromosome of chironomus or Drosophila larvae.
2. Simple calculation based on Mendel's monohybrid/dihybrid cross/test cross.
3. Study of chromosomal slides of suitable materials.
4. Study of materials/organisms of evolutionary significance (rocks, fossils and connecting links)

### SCHEME OF THE PRACTICAL EXAMINATION:

Time: 4 hrs.

1. Slide preparation of chromosome	10
2. Simple genetic calculation	4
3. Spotting (chromosomal slides & materials of evolutionary importance)	8
4. Practical record book	5
5. Viva voce	5
<b>Total</b>	<b>32</b>

### ZooMT- 503: Animal Physiology

Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours

- Unit-1: Muscle and its contraction- molecular composition of myofilaments; sarcoplasmic reticulum and T- tubules; mechanism of muscle contraction; characteristic of muscle twitch- isometric and isotonic contractions; summation and tetanus.
- Unit-2: Digestion- site and sequence of digestion; digestive secretions and their regulation; mechanism of digestion and absorption of carbohydrates, proteins and lipids; role of gastro-intestinal hormones, balanced diet
- Unit-3: Excretion- structure and functions of nephron; renal blood supply; mechanism and regulation of urine formation; renal failure and dialysis
- Unit-4: Circulation- coronary circulation; origin and conduction of cardiac impulse; cardiac cycle; cardiac output and its regulation; disorders of cardio-vascular system; haemostasis; respiration- structure and functions of haemoglobin; O<sub>2</sub> and CO<sub>2</sub> transport by blood; regulation of respiration; carbon monoxide poisoning; tracheal respiration in insects.
- Unit-5: Nervous system- neurons, resting membrane potential and its basis, action potential and its propagation in myelinated and non-myelinated nerve fibre; types of synapses and synaptic transmission; neuro-transmitters- their release and action; neuro-muscular junction; types of reflexes; reflex activity; reflex arc; physiology of vision; addictive drugs-types; drug addiction- causes, physiological effects; social implications.

### ZooMP- 504: Practical based on ZooMT- 503

Marks: 8 (IA) + 32 (End Sem) = 40  
20 lecture hours

1. Determination of R.Q. of cockroach/Goroi fish.
2. Recording of heart beat of frog by kymograph.
3. Preparation of haemin crystals.
4. Demonstration of knee jerk reflex.
5. Demonstration of osmosis using toad/frog urinary, bladder/alimentary canal.
6. Recording of muscle twitch.
7. Qualitative test of salivary amylase.
8. RBC and WBC counting by haemocytometer.

### SCHEME OF THE PRACTICAL EXAMINATION:

Time: 4 hrs.

1. Physiological experiment I	12
2. Physiological experiment II (blood)	10
3. Practical record book	5
4. Viva voce	5
<b>Total</b>	<b>32</b>

## ZooMT- 505: Environmental Biology and Wildlife

Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours

- Unit-1: Concepts pertaining to ecosystem, species, community, biome and ecotone; biotic and abiotic environmental factors and their effect on animals; trophic relations and energy flow.
- Unit-2: Shelford's law of tolerance; Liebig's law of minimum; concept of productivity; population structure and dynamics; exponential and logistic growth; **r** and **k** strategies and multidimensional niche concept; Lotka-Volterra model; natality and mortality; predator & prey relationship.
- Unit-3: Biogeochemical cycles (carbon, nitrogen, phosphorus and hydrological cycles); Renewable and non-renewable resources of N.E. India and strategy for their sustainable utilization; basic concept of remote sensing and EIA.
- Unit-4: Environmental pollution (water, air and soil); bioindicators in pollution studies; ecological succession; ecological backlash; greenhouse effect; ozone layer depletion and its impact.
- Unit-5: IUCN status of species category; important endangered species of N.E. India - rhinoceros, tiger, golden langur, dancing deer, river dolphin, pigmy hog, white winged wood duck and golden mahseer (*Tor* spp.); threats to biodiversity; man-wildlife conflict; *ex-situ* and *insitu* conservation strategies; major national parks of NE India; concept of biosphere reserve and biodiversity hot spot; Indian Wildlife Protection Act, 1972.

## ZooMP- 506: Practical based on ZooMT- 505

Marks: 8 (IA) + 32 (End Sem) = 40  
20 lecture hours

1. Estimation of the size of the population by capture-recapture method (any vertebrate/invertebrate).
2. Find out the abundance and density of insect pests in some essential food commodities.
3. Determination of dissolved Oxygen/CO<sub>2</sub>/Alkalinity in the water samples.
4. Find out the abundance and densities of terrestrial invertebrates/macrophyte associated fauna by Quadrant method.
5. Study of structural components of an aquatic/ grassland ecosystem
6. Field study: To visit a National park/ Wildlife Sanctuary to study the habitat/ forest types and prepare a full note on it.

### SCHEME OF THE PRACTICAL EXAMINATION:

Time: 4 hrs.

1. Ecological experiment	8
2. Estimation	7
3. Field study	7
4. Practical record book	5
5. Viva voce	5
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**Total 32**

**ZooMT- 507: Endocrinology**

**Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours**

- Unit-1: Comparative anatomy of pituitary, thyroid, adrenal and pancreas in fish, amphibia, birds and mammals.  
Unit-2: Hormones secreted by endocrine glands (pituitary, thyroid, adrenal and pancreas) and their functions in mammals.  
Unit-3: General characters of hormones; mechanism of action of hormones; regulation of hormone secretion; hypothalamo-hypophysial system; disorders associated with hypo and hyper secretion of hormones.  
Unit-4: Roles of hormones in reproductive cycle, pregnancy, parturition and lactation; methods of contraception; amniocentesis and IVF.  
Unit-5: Neuroendocrine system in insects; role of hormones in growth and development of insects.

**ZooMP- 508: Practical based on ZooMT- 507**

**Marks: 8 (IA) + 32 (End Sem) = 40  
20 lecture hours**

1. Histological preparation of thyroid, adrenal, pancreas and gonads.
2. Dissect and display the following endocrine gland in fish/birds: pituitary, thyroid, adrenal
3. Study of permanent slides of endocrine glands
4. Submission of chart/models related to endocrinology

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Dissection and display of endocrine gland	8
2. Stained slide preparation	5
3. Spotting	6
4. Submission of slides	3
5. Practical record book	5
6. Viva voce	5
<b>Total</b>	<b>32</b>

**SEMESTER-VI**

**ZooMT- 601: Parasitology and Ethology**

**Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours**

- Unit-1: Parasitism; types of parasites, hosts and vectors; parasitic adaptations and effects on hosts; life history and mode of infection and pathogenicity of *Entamoeba histolytica*, *Trypanosoma* spp., *Leishmania donovani*, *Giardia intestinalis*, *Trichomonas vaginalis* & *Plasmodium* spp.
- Unit-2: General organizations and pathogenicity of bacteria & viruses (*Rickettsia*, *Borrelia*, *Treponema* & *Leptospira*); life history, parasitic adaptation and pathogenicity of *Taenia solium*, *Fasciola hepatica*, *Ancylostoma duodenale* and *Wuchereria bancrofti*.
- Unit-3: Vectors of human diseases- Malaria, Yellow fever, dengue, haemorrhagic fever, filariasis, Japanese B-encephalitis & dengue; measures of control of the vectors.
- Unit- 4: Introduction to animal behaviour; brief history of ethology; patterns of behaviour; sense organs and behaviour; genetical and ecological aspects of behaviour.
- Unit-5: Different types of orientation and communication in animals; comparative aspects of learning, offensive and defensive behaviour; social behaviour in insects.

**ZooMP- 602: Practical based on ZooMT- 601**

**Marks: 8 (IA) + 32 (End Sem) = 40**  
**20 lecture hours**

1. Identification of mosquito species causing malaria, encephalitis and dengue fever.
2. Study of protozoan parasites (permanent slides)
3. Study of geotactic, phototactic, chemotactic and sociotactic behaviour of earthworm, cockroach, *Paramecium* and fish.
4. Study of habituation in mosquito larvae.

**SCHEME OF THE PRACTICAL EXAMINATION:**

**Time: 4 hrs.**

1. Parasitology	12
2. Ethology	10
3. Practical record book	5
4. Viva voce	5
<b>Total</b>	<b>32</b>

**ZooMT- 603: Molecular Biology and Immunology**

**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

- Unit-1: Genome organization in prokaryotes and eukaryotes, DNA as genetic material, structure and functions of DNA & RNA; Watson & Crick Model of DNA; other forms of DNA (A & Z).
- Unit-2: Replication and transcriptions; genetic code; Wobble hypothesis; protein biosynthesis in prokaryotes.
- Unit-3: Recombination in prokaryotes; transformation, conjugation and transduction; concept of transposons and plasmids; regulation of gene expression in prokaryotes, operon concept (Lac operon).

Unit-4: Types of immunity; cells and organs involved in immunity; lymphoid organs; antigens, properties of antigens, adjuvant and haptens; antigen-antibody reaction; vaccines and vaccinations.

Unit-5: Immunoglobulin: basic structure, classes and functions; clonal selection theory; polyclonal and monoclonal antibodies; major histocompatibility complex- structure and functions; immune system in health and disease; basic concept of immunodiagnostic techniques (immunodiffusion, RIA and ELISA); AIDS.

### **ZooMT- 604: Biotechnology and Bioinformatics**

**Marks: 12 (IA) + 48 (End Sem) = 60**  
**42 lecture hours**

Unit-1: Introduction, history and scope, basic knowledge of genetic engineering, protoplast fusion and somatic hybridization technique; Basic principles of recombinant DNA technology, cutting, joining and visualization of DNA fragments, cloning vectors and gene cloning; application of DNA technology in agriculture and health; industrial biotechnology with special reference to production of alcohol and antibiotics.

Unit-2: Introduction of Omics: basic concept of structural and functional genomics, DNA sequencing, Human genome project; introduction to proteomics and transcriptomics.

Unit-3: Regulation of biotechnology: production and application of transgenic animals and plants, Genetically modified Organism, their benefits and risk assessment; IPR, patents and ethical issues related to biotechnology.

Unit-4: Fundamentals of bioinformatics: introduction, history and scope of bioinformatics; sources of information, internet world wide web and web browsers; Biological database: introduction, basic concepts of primary and secondary databases; Nucleic acid and protein sequence database (NCBI, gene bank and SWISS- PROT); Data mining and data mining tools (ENTREZ).

Unit-5: Database search and sequence alignment, Tools of sequence alignment – FASTA and BLAST; methods of sequence alignment; phylogenetic analysis: basic concept, steps in evaluation of phylogeny and constructing phylogenetic trees.

### **ZooMP- 605: Practical based on papers ZooMT- 603 and ZooMT- 604**

**Marks: 13 (IA) + 52 (End Sem) = 65**  
**Project Work =15**  
**Total= 80**  
**30 lecture hours**

1. Determination of blood group and Rh factor
2. Preparation and demonstration of ball and stick model of Nucleotides.
3. Detection / estimation of RNA.
4. Immunodiffusion / Blood grouping (Ag-Ab reaction).
5. Study of Blood Cell types in blood smear slides.
6. Histological study of Lymphoid organs.
7. Different e-resources and database search.
8. Similarity search in sequence such as BLAST / FASTA.
9. Creation of databases.

**SCHEME OF THE PRACTICAL EXAMINATION:****Time: 6 hrs.****Marks = 52 + 15 (project work) = 67**

1. Molecular biology	15
2. Immunology	10
3. Biotechnology and Bioinformatics	7
4. Practical record book	10
5. Viva voce	10
6. <u>Project work</u>	<u>15</u>
<b>Total =</b>	<b>67</b>

**ZooMT- 606: Economic Zoology****Marks: 12 (IA) + 48 (End Sem) = 60  
42 lecture hours**

Unit-1: Major insect pests of paddy, tea and stored grains and their biology; Pest management- chemical, cultural and biological; integrated pest management.

Unit-2: Life histories of silkworm (eri, muga and mulberry); culture technique of silkworms; diseases of silkworms and its prevention

Unit-3: Life history of honey bee (*Apis india*); rearing techniques of honeybee; Biology and culture of lac insect.

Unit-4: Principles and practices in aquaculture; fish and prawn culture; preparation and management of different types of ponds for fish culture; induced breeding and hybridization technique in fishes; fish preservation methods; fish by-products.

Unit-5: Piggery: management and practices of pig rearing; poultry: selection of breed (chicken and duck) and their scientific rearing methods; poultry diseases and its prevention/control.

**ZooMP- 607: Practical based on ZooMT- 606****Marks: 8 (IA) + 32 (End Sem) = 40  
20 lecture hours**

1. Identification of silkworms (eri, muga & mulberry), immature and adult stages.
2. Submission of life cycles of eri/ muga/ mulberry silkworms.
3. Study of important pests of paddy, tea plants and stored grains and their submission.
4. Identification of economically important fish and prawn available locally.
5. Identification of common aquatic weeds, plankton and insects.
6. Demonstration of induced breeding in fish.
7. Apiculture- culture of honey bee and extraction of honey.
8. Analysis of nutrients (Carbohydrate, Protein and Lipid) of Honey.

**SCHEME OF THE PRACTICAL EXAMINATION:****Time: 4 hrs.**

1. Identification	10
2. Collection and submission	6
3. Qualitative analysis	6
4. Practical record book	5
5. Viva voce	5
<b>Total =</b>	<b>32</b>

## BOOKS RECOMMENDED (for all Papers)

1. Arora, D.R. and B. Arora: Medical Parasitology.
2. Austin, C.R. and R.V. Shoot : Reproduction in Mammals, Cambridge Univ. Press.
3. Ayyar: A manual of Zoology Part I.: L.
4. Ayyar: A Manual of Zoology Part II : E.
5. Bailey, N.T.J.: Animal Taxonomy, English Language Society, 1959.
6. Blackwelder, R.E.: A Text and Reference Book: Taxonomy, John Wiley, N. Y. 1967.
7. Chandler, A.C. and C.P. Read: Introduction to Parasitology, Wiley East Prittd.
8. Colber: Evolution of Vertebrate.
9. Conn, B.E.E. and E.H. Cordes: Outline of Biochemistry.
10. Croxton, E.E.: Elementary statistics with application in Medicine and Biological Sciences, Doner publication.
11. Cunningham, W.P. and B.W. Saigo: Environmental Science, McGraw hill. 1989.
12. De Roberts, E.D. P. and E.M.F. De Roberts.: Cell & Molecular Biology
13. Gardner, E.J.: Principles of Genetics, John Wiley, N.Y. 1972.
14. Garg, K. , I. Bahl & M.A. Kaul: Text Book of Histology, CBS publishers.
15. Ghose, M.R.: Concept of Insect Control, Wiley Eastern Ltd. New Delhi 1989.
16. Giese, A.C.C. : Cell Physiology, Boxwood, 1975.
17. Gilbert, S.F.: Developmental Biology, Sinaeur Associates Inc. Publishers, 2003.
18. Guiton, A.C.: Functions of Human Body, 6<sup>th</sup> Edn. W.B. Saunders Co. Tokyo.
19. Haucourt, Cohn: Elements of Cytology.
20. Jordan, E.L.: Zoology of Chordates.
21. Kent, G.C. and R.K. Carr: Comparative Anatomy of the Vertebrates, Tata McGraw Hill.
22. Kobil, E. (eds): Physiology of Reproduction, Raven Press Ltd.
23. Kormondy, B.J.: Concept of Ecology, Prentice Hall, ND 1976.
24. Kotpal, R. L., A. Agarwal and Khetrapal: Modern Text Book of invertebrate Zoology.
25. Lodish, H. et al : Molecular Cell Biology, W.H. Freeman & Co. Tokyo.
26. Lull, R.S.: Organic Evolution, Light & Life Publishers, New Delhi, 1976..
27. Mahler, H.R. and E.H. Cordes Biological Chemistry.
28. Marshall, A.J. and W.D. Williams: Text Book of Zoology Vol. I Invertebrates.
29. Mayer, E.: Principles of Systematic Zoology, McGrew Hill, NY, 1969.
30. Miller, S.A. and J.B. Harley: Zoology, Tata McGraw Hill Publ. Co.
31. Mody, P.A.: Introduction to Evolution, Harper & Raw, NY 1964.
32. Odum, B.P. : Fundamental of Ecology, W.B. Saunders, Toftan Co. Tokyo
33. Odum, Eugene, P.: Fundamentals of Ecology, W.B. Saunders 1971.
34. Parker, T.J. and W.A. Haswall: Text Book of Zoology (Vertebrates); ELBS & McMillan, 1995.
35. Pedigo, L.P.: Entomology & Pest Management, Prentice Hall, New Delhi, 1996.
36. Prasad, S.N.: Chordate Zoology, Kitab Mahal.
37. Primrose, T.O.: Principles of Gene Manipulation, Blackwell, Oxford, 2003.
38. Pritom, R.: Biology of Human Reproduction, University Science Books.
39. Ridely, M.: Evolution, Blackwell Science, USA, 1996.
40. Roberts, E.D.P., W. Nowiski and F. Saez: Cell Biology, W.B. Saunders Co. London.
41. Shetty, N.: Immunology: Introduction Book, New Age International, 1996.
42. Strickburger, M.W.: Genetics, Mc Millan, NY 1968.
43. Taylor, N.B.: The Living Body: A Text Book of Human Physiology.
44. Trechan, K.: Biochemistry, Wiley Eastern Ltd., New Delhi.
45. Weiohert, E.K.: Comparative anatomy of Chordates, McGraw Hill, NY.
46. Winester, A.M.: Genetics, Oxford & IBH.

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