S. S. Jain Subodh P. G. (Autonomous) College,

Rambagh Circle, Jaipur –302004

SYLLABUS

For

Bachelor of Science (B.Sc. Hon.)

Subject- Zoology

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

DEPARTMENT OF ZOOLOGY

(Semester system, w.e.f. Academic Year 2023- 26)

I Semester (CBCS)

Max. Marks (Theory): 225

Max. Marks (Practical): 150

Paper Code	Paper No	Nomenclature	External / Theories	Internal / Theories	Total Max Marks
ZOH 101	Paper I	Life and Diversity of Non-Chordata I	54	21	75
ZOH 102	Paper II	Cell& Molecular Biology	54	21	75
ZOH 103	Paper III	Fundamental of Genetics	54	21	75
		Total Marks			225
ZOHP101	Practical	Practical Based on Theory papers	90	60	150

II Semester (CBCS)

Max. Marks (Theory): 225

Max. Marks (Practical):150

Paper Code	Paper No	Nomenclature	External / Theories	Internal / Theories	Total Max Marks
ZOH 201	Paper I	Life and Diversity of Non-Chordata II	54	21	75
ZOH 202	Paper II	Genetics & Evolutionary Biology	54	21	75
ZOH 203	Paper III	Biology of Parasitism	54	21	75

		Total Marks			225
ZOHP201	Practical	Practical Based on Theory papers	90	60	150

III Semester (CBCS)

Max. Marks (Theory): 225

Max. Marks (Practical):150

Paper Code	Paper No	Nomenclature	External / Theories	Internal / Theories	Total Max Marks
ZOH 301	Paper I	Life and Diversity Of Chordate	54	21	75
ZOH 302	Paper II	Physiology & Biochemistry	54	21	75
ZOH 303	Paper III	Basics of Radiation and Cancer Biology	54	21	75
		Total Marks	225		
ZOHP301	Practical	Practical Based on Theory papers	90	60	150

IV Semester (CBCS)

Max. Marks (Theory): 225

Max. Marks (Practical):150

Paper Code	Paper No	Nomenclature	External / Theories	Internal / Theories	Total Max Marks
ZOH 401	Paper I	Developmental Biology	54	21	75
ZOH 402	Paper II	Ecology & Ethology	54	21	75
ZOH 403	Paper III	Medical Entomology	54	21	75
		Total Marks	225		
ZOHP401	Practical	Practical Based on Theory papers	90	60	150

V Semester (CBCS)

Max. Marks (Theory): 225

Max. Marks (Practical):150

Paper Code	Paper No	Nomenclature	External / Theories	Internal / Theories	Total Max Marks
ZOH 501	Paper I	Research Methodology and Biostatistics	54	21	75
ZOH 502	Paper II	Microbiology &Immunology	54	21	75
ZOH 503	Paper III	Applied & Economic Zoology	54	21	75
ZOH 504	Paper IV	Wildlife conservation and Management	54	21	75
ZOH 505	Paper V	Project work and seminar	54	21	75
		Total Marks	225		
ZOHP5 01	Practical	Practical Based on Theory papers	90	60	150

VI Semester (CBCS)

Max. Marks (Theory): 225

Max. Marks (Practical):150

Paper Code	Paper No	Nomenclature	External / Theories	Internal / Theories	Total Max Marks
ZOH 601	Paper I	Bioinstrumentation & Bio-techniques	54	21	75
ZOH 602	Paper II	Environmental Toxicology	54	21	75
ZOH 603	Paper III	Basics of Medical Diagnosis and public Health	54	21	75
ZOH 604	Paper IV	Neuro-endocrinology	54	21	75
ZOH 605	Paper V	Project work and Seminar	54	21	75
		Total Marks	225		
ZOHP601	Practical	Practical Based on Theory papers	90	60	150

Scheme for Choice Based Credit System in B.Sc. (Hons) Zoology

S.No.	Subject Code	Course Title	Course Category	Credit	Contact Hours per week			ESE Duration (Hrs.)	
					L	T	P	T	P
Semester-I									
1.	ZOH101	Life and Diversity of Non-Chordata I	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH102	Cell & Molecular Biology	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH103	Fundamental of Genetics	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOHP101	Practical Based on Theory papers	DSCP	**6**	**-**	**-**	**12**	**-**	**4**
Semester-II									
2.	ZOH201	Life and Diversity of Non-Chordata II	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH202	Genetics & Evolutionary Biology	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH203	Biology of Parasitism	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOHP201	Practical Based on Theory papers	DSCP	**6**	**-**	**-**	**12**	**-**	**4**
Semester-III									
3.	ZOH301	Life and Diversity of Chordate	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH302	Physiology & Biochemistry	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH303	Basics of Radiation and cancer Biology	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOHP301	Practical Based on Theory papers	DSCP	**6**	**-**	**-**	**12**	**-**	**4**
Semester-IV									
4.	ZOH401	Developmental Biology	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH402	Ecology & Ethology	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH403	Medical Entomology	DSC	**3**	**3**	**-**	**-**	**3**	**-**
	ZOHP401	Practical Based on Theory papers	DSCP	**6**	**-**	**-**	**12**	**-**	**4**
Semester-V									
5.	ZOH501A	Research Methodology and Biostatistics	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH502B	Microbiology & Immunology	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH503C	Applied & Economic Zoology	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH504D	Wildlife conservation and Management	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH505E	Project work and seminar	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOHP501	Practical Based on Theory papers	DSCP	**6**	**-**	**-**	**12**	**-**	**4**
Semester-VI									
6.	ZOH601A	Bioinstrumentation & Bio-techniques	DSE	**3**	**3**	**-**	**-**	**3**	**-**

	ZOH602B	Environmental Toxicology	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH603C	Basics of Medical Diagnosis and public Health	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH604D	Neuro-endocrinology	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOH605E	Project work and Seminar	DSE	**3**	**3**	**-**	**-**	**3**	**-**
	ZOHP601	Practical Based on Theory papers	DSCP	**6**	**-**	**-**	**12**	**-**	**4**

Examination Scheme for Theory Paper

Part A-Question1 is compulsory comprises Seven very short questions from all units. Each question carries 2 marks.

7×2 mark each = 14 Marks

Part B- Comprises 4 questions (1question from each unit with internal choice). Each Question Carries 10 Marks.

4×10 mark each = 40 Marks

Total of End semester exam (duration of exam 3 hours) = 54 Marks
Internal Assessment = 21 Marks

Examination Scheme for Practical Paper

Max. Practical Marks = 150 Marks
Internal Practical Examination = 60 Marks
Marks External Practical Exam. (Duration: 4 hrs.) = 90 Marks

Note: 1. Each Candidate has to prepare his/ her practical record.
2. Each Candidate has to pass in Practical and Theory examination separately.

Semester-I

THEORY

Paper I - ZOO-101
[Life and Diversity of animals–Non Chordata-I]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

Unit I:

Principles of Taxonomy:

1.Nomenclature system: Binomial nomenclature, Trinomial nomenclature, Rules of nomenclature.

2. Five Kingdom Concept, Levels of Organization, Basis of classification (Number of Cells, Symmetry, Coelom, Embryogeny, Segmentation)

Phylum Protozoa

1. Salient features and classification of Protozoa up to Class

2. Type study – Paramecium (Salient Features, Locomotion, Nutrition, and Reproduction

Unit II:

Phylum Porifera

1. Salient features and classification of Porifera up to Class
2. Type study - Sycon (Salient Features, Nutrition, and Reproduction)
3. Canal system of Sponges

Phylum Coelenterata

1. Salient features and classification of Coelenterata up to Class
2. Type study– Obelia (Salient Features, Nutrition and Reproduction, Metagenesis)

Unit III

Phylum Ctenophora

1. Beroe (General features)

Phylum Platyhelminthes

1. Salient features and classification of Platyhelminthes up to Class
2. Type study - Taenia (External features and life Cycle)
3. Type study - Fasciola (External Features and Life Cycle)

Unit IV

Phylum Nemathelminthes

1. Salient features and classification of Nemathelminthes up to Class
2. Ascaris (External features and life cycle)
3. Parasitic adaptations in Helminths

Phylum Annelida

1. General characters and outline classification up to classes with examples.
2. Type-study: Nereis (External characters, Morphology, Digestive, Excretory, Nervous System, Development & Trochophore Larva)

Semester I
THEORY

Paper –II (ZOO - 102)
[Cell & Molecular Biology]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks

Unit I

1. Introduction to Cell, Cell theory, Prokaryotic and Eukaryotic cells.
2. Plasma Membrane: Various models of plasma membrane structure and functions.
3. Transport across membranes: Active and Passive transport.
4. Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Peroxisomes

Unit II

1. Mitochondria: Structure, function and biogenesis
2. Structure And Functions: Cilia And Flagella
3. Cell Cycle, Mitosis, Meiosis

Unit III

1. Structure Of Nucleus: Nuclear Envelope, Nuclear Pore Complex, Nucleolus, Chromatin: Euchromatin and Hetrochromatin and Packaging (Nucleosome)
2. Salient Features of DNA and RNA, Watson and Crick Model of DNA.
3. DNA Replication in Prokaryotes and Eukaryotes

Unit IV

1. Genetic Code
2. Transcription in Prokaryotes and Eukaryotes
3. Protein Synthesis in Prokaryotes and Eukaryotes

Semester I
THEORY

Paper –III (ZOO - 103)

[Fundamental of Genetics]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

Unit I

The Gene

1. Brief idea of Mendelian Genetics
2. Multiple Allelism: Inheritance of Blood group and Rh Factor
3. Sex Determination in man
4. Sex- Linked, Sex Influenced and Sex- Limited Inheritance Pattern in Man

Unit II

Chromosomal anomalies

1. Mutation: Gene Mutation
2. Chromosomal Mutation :
    a. Numerical Changes (Polyploidy, Aneuploidy) and associated disorders in human
    b. Structural Changes (deletion, duplication, translocation, inversion) and associated disorder in man
3. Pedigree Analysis

Unit – III

Genetic Disorders

1. Classification of genetic disorders
2. Single gene Disorders (Cystic Fibrosis, Thalessemia, Haemophilia; Albinism; Sickle cell anaemia)
3. Multifactorial disorders (Alzheimer's disease, Diabetes., Spina bifida)
4. Chromosomal Disorders (Down's syndrome, Klinefelter syndrome, Turner syndrome, Patau syndrome (trisomy 13), Edwards syndrome (trisomy 18) and Cri-du chat syndrome)

Unit IV

Genetic Counselling

1. Principles of genetic counselling
2. Causes and factors for seeking counselling
3. Ethical and legal issues in genetic counselling

Schemes for Genetic Disorders in India;

1. National Policy for Rare Diseases 2021; Rashtriya Bal Swasthya Karyakram (RBSK); Thalassemia Control Program; Public-Private Partnerships (PPPs)

Semester I

Practical

Paper – Practical (ZOO - PI)

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Section A: Life and Diversity of Animals Non-chordata–I

1. Microscopic Techniques

I. Organisation and working of optical microscopes: Dissecting and Compound Microscope

II. General methods of microscopical permanent preparations:

a. Fixatives and Preservatives - Formalin, Bouin's Fluid

b. Stains - Borax carmine, Acetocarmine, Acetoorcein, Haematoxylin, Eosin

c. Common Reagents: Normal saline, Ringer's solution, Acid water, Acid alcohol, Mayer's egg albumin.

2. Study of museum specimens (Classification of animals up to orders)

I. Protozoa: Euglena, Elphidium (Polystomella), Foraminiferous shell, Monocystis, Opalina, Paramoecium, Paramoecium showing Binary fission, Paramecium Conjugation, Balantidium, Nyctotherus, Vorticella

II. Porifera: Sycon, Leucosolenia, Hyalonema, Euplectella, Spongilla

III. Coelenterata: Obelia Colony & Medusa, Millepora, Physalia, Vellela, Aurelia, Alcyonium, Gorgonia, Pennatula, Metridium, Stone Corals

IV. Platyhelminthes: Planaria, Fasciola, Taenia

V. Aschelminthes: Ascaris, Drancunculus, Ancylostoma, Wuchereria

3. Study of Permanent Slides

I. Porifera: Sponge gemmules, Sponge spicules, V.S. Sycon, T.S. Sycon

II. Coelenterata: Obelia medusa, Obelia Colony

III. Platyhelminthes: Miracidium, Sporocyst, Redia and Cercaria, Metacercarial larvae of Fasciola, Hexacanth and Onchosphere larvae of Taenia solium, Scolex of Taenia, Mature and gravid proglottids of Taenia solium

4. External Features and Anatomy Through Audio-Visual Presentation

I. Earthworm: External features, Digestive, Nervous, and Reproductive System

II. Leech: External features, Digestive, Nervous, and Reproductive System

5. Mounting

I. Paramecium, Euglena

II. Spicules, spongin fibers, and Gemmules of Sponge

III. Obelia colony

6: Cell and Molecular Biology

1. Study of pictures of ultrastructure of prokaryotic cell & eukaryotic cell
2. Demonstration of mitotic cell division in onion root tips by squash method
3. Demonstration of meiosis through audio-visual presentation
4. Study of mitochondria in Buccal Epithelium
5. Demonstration of salivary gland chromosome in Chironomous larva
6. Use of colchicine in arresting anaphase movement (onion root tips)
7. Study of cell permeability using mammalian RBCs.

7. Fundamental of Genetics:

1. Study of Chromosomal Aberrations
2. Study of human karyotype (Normal and Abnormal)
3. Preparation of Polytene Chromosomes from salivary gland of Drosophila
4. A Project report on various programs run by Government organization / NGOs

Semester I

Scheme of Examination:

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.		**Max. Marks: 90**
1.	General Anatomy	16
2.	Permanent Preparation	12
3.	Exercise in Cell Biology	12
4.	Exercise in Genetics	12
5.	Identification & Comments on spots (1to 6)	18
6.	Viva-Voce	10
7.	Class Record	10
Total		**90**

Suggested Readings Practical:

1. A Manual of Practical Zoology Invertebrates – P.S. Verma
2. Dr. S.S. Lal Practical Zoology Invertebrates 9th edition, Rastogi Publication Meerut & Distributors, New Delhi

Suggested Readings for Life and Diversity of Animals– Non-Chordates

3. Barnes, R. (1981). Invertebrate Zoology. W.B. Saunders Co.
4. Barrington, E.W.J. (1969). Invertebrate Structure and Function. ELBS.
5. Barradaile L.A. & Potts F.A. The Invertebrate.
6. Jordan, E. L. & Verma, P.S. Invertebrate Zoology. S. Chand & Co.
7. Kotpal, Agrawal & Khetrapal. Modern Text Book of Zoology – Invertebrates.
8. Puranik P.G. & Thakur R.S. Invertebrate Zoology.
9. Majupuria T.C. Invertebrate Zoology.
10. Dhami & Dhami. Invertebrate Zoology.
11. Parker & Hashwell, Textbook of Zoology Vol. I (Invertebrates) A.Z.T.B.S. Publishers.
12. R.L. Kotpal – Phylum Protozoa to Echinodermata (series), Rastogi and Publication, Meerut.
13. Vidyarthi – Text Book of Zoology, Agrasia Publishers, Agra.
14. Marshal & Williams. Textbook of Zoology.
15. Boolotin & Stiles. College Zoology. MacMillan.

Suggested Readings for Cell Biology:

16. Alberts et al. (2001). Molecular biology of the cell. Garland publications.
17. De Robertis, E.D.P. & De Robertis, E.M.F. (1987). Cell and molecular biology. Lea & Febiger Intl. ed.
18. Powar, C.B. (1986). Cell biology. Himalaya Publ.

19. Burke, J.D.C. (1970). Cell biology. William & Wilkins Company
20. Dr. S.P. Singh, Dr. B.S. Tomar. Cell Biology 9th revised edition, Rastogi Publication, Meerut
21. Gupta P.K., Cell and Molecular Biology, Rastogi Publication, Meerut
22. Veer Bala Rastogi. Introduction to Cell Biology, Rastogi Publication, Meerut
23. Verma and Agrawal. Concepts of Cell Biology
24. Cooper, GM. and Hausman R.E. (2009). The cell: A molecular approach. V edition.
25. Lodish Cell and Molecular Biology; Phillip Sheeler Donald E. Bianchi; John Wiley and Sons

Semester II

THEORY

Paper-I; ZOO-201
[Life & Diversity of Animals Non-Chordata-II]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

Unit I
Arthropoda:
1. General characters and outline classification up to classes with examples.
2. Type Study: Prawn (External characters, Morphology, Skeletal, Digestive, Respiration, Nervous, Excretion & Reproductive systems)

Unit II
Mollusca:
1. General characters and outline classification up to classes with examples.
2. Type Study:
a. Pila (External characters, Skeletal, Digestive, Respiration, Nervous, Excretion)

Unit III
Echinodermata:
1. General characters and outline classification up to classes with examples.
2. Type Study: Asterias (External characters, Water Vascular System, Digestive, Nervous, Excretion & Reproductive systems)

Unit IV
1. General characters and outline classification of Hemichordata up to classes with examples.
2. Salient features of Balanoglossus

Semester II
THEORY
Paper –II (ZOO - 202)
[Genetics and Evolutionary Biology]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

Unit I
1. Brief history of Genetics
2. Mendelism and Neo-mendelism:
    a. Mendelian Laws (significance and current status)
3. Genetic Interactions
    a. Duplicate, Epistasis, Inhibitory, Supplementary, Complementary Genes
    b. Multiple Allelic interactions: Blood group & Rh factor)
    c. Linkage and crossing over: (concept, types and theories)

Unit II
1. Mutation: Chromosomal Mutation
2. Cytoplasm inheritance (kappa particles in paramecium, Shell Coiling in Snail.)
3. Genetic disorders: Turner syndrome, Klinefelter's Syndromeand, Down's syndrome,

Unit – III
1. Basics and origin of life: Definition, Pre-Darwinian theories of evolution; Oparin-Haldane Concept of origin of life; Miller- Urey experiment of Chemical Evolution
2. Micro-evolution: Lamarckism; Darwinism; Neo-Darwinism
3. Product of Evolutionary Process: Speciation, concept of species, sub species, modes of speciation (allopatric, sympatric, peripatric)

Unit IV
1. Macro-evolution: Geological time scale, Continental Drift
2. Genetic basis of evolution: Hardy-Weinberg law, Gene Frequency, genetic drift, Factors affecting Hardy-Weinberg law, Sewall -Wright effect
3. Variation, Adaptations and Isolation, Mimicry, Fossils

Semester II

THEORY

Paper –III (ZOO - 103)
[Biology of Parasitism] Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

Unit I:

Introduction to Parasitism

1. Brief introduction of Parasitism,
2. Host parasite relationship (Commensalism, Symbiosis, Predatorism and Mutualism)
3. Parasite, Parasitoid and Vectors

Unit II:

Parasitic Protists

1. Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Plasmodium vivax*

Parasitic Platyhelminthes

1. Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Schistosoma haematobium*,

Unit III:

Parasitic Nematodes

2. Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Wouchereria bancrofti, Ancyclostoma duodenale*

Unit IV:

Parasitic Arthropods

1. Biology, importance and control of *Pediculus humanus* (head and body louse), *Xenopsylla cheopis* (Oriental rat flea)

Parasitic Vertebrates

2. A brief account of parasitic vertebrates.

Semester II

Practical

Paper – Practical (ZOO - PII)

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Section A: Life and Diversity of Animals – (Annelida to Hemichordata)

1. Study of Museum Specimens (Classification of Animals up to Orders)

I. **Arthropoda:** Pripatus, Lepus, Balanus, Sacculina, Squilla, Palemon, Eupagurus (hermit Crab), Carcinus (Crab), Scolopendra, Julus, Scorpion, Spider, Limulus, Cysticerca/Locust, Dragonfly, Praying Mantis, Queen Termite, Cymax, Moth/Butterfly

II. Mollusca: Chiton, Dentalium, Cyprea, Pila, Aplysia, Mytilus, Pincteda, Loligo, Sepia, Octopus, Nautilus

III. Echinodermata: Antedon, Asterias, Ophiothrix, Echinus, Holothuria

IV. Hemichordata: Balanoglossus

2. Study of Permanent Slides

I. Arthropoda: Crustacean Larvae - Nauplius, Zoea, Metazoea, Megalopa, Mysis

II. Mollusca: Veliger and Glochidium Larvae, T.S. of Unio Shell

III. Echinodermata: T.S. of arm of starfish

IV. Hemichordata: Balanoglossus through collar and proboscis

3. Audiovisual Demonstration

I. Prawn: Appendages, Digestive, Nervous, and Reproductive System, Statocyst, Hastate Plate

II. Pila: Nervous System, Osphradium, Gills, Radula

4. Mounting - Study via Chart/Model/Fig.

Daphnia, Hastate Plate, Statocyst of Prawn; Gill lamella, Osphradium, and Radula of Pila

Section B: Genetics and Evolutionary Biology

I. Lifecycle of Drosophila; Identification of male and female drosophila; Study of mutant forms in Drosophila

II. Bar eye, white eye, yellow body, sepia eye, curled wing, vestigial wing

III. Identification of blood groups & Rh. Factor

IV. Study of fossils from models/pictures

V. Study and verification of Hardy-Weinberg Law by chi-square analysis

Section C: Biology of Parasitism (permanent slides/micro photographs)

1. *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani* and *Plasmodium vivax*
2. *Fasciolopsis buski, Schistosoma haematobium, Taenia solium and Hymenolepis nana*
3. *Ascaris lumbricoides, Ancylostoma duodenale,Wuchereria bancrofti* and *Trichinella spiralis*
4. Study of plant parasitic root knot nematode, Meloidogyne from the soil sample
5. Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius*
6. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market)
7. Study of nematode / cestode parasites Submission of a brief report on parasitic vertebrates

Semester II

Scheme of Examination:

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.		**Max. Marks: 90**
1.	General Anatomy	16
2.	Permanent Preparation	12
3.	Exercise in Genetics & Evolutionary Biology	12
4.	Exercise in biology of Parasitism	12
5.	Identification & Comments on spots (1to 6)	18
6.	Viva-Voce	10
7.	Class Record	10
Total		**90**

Suggested Readings for Life and Diversity of Animals – Non-Chordates

1. Barnes, R. (1981). Invertebrate Zoology. W.B. Saunders Co.
2. Barrington, E.W.J. (1969). Invertebrate Structure and Function. ELBS
3. Barradaile L.A. & Potts F.A. The Invertebrate
4. Jordan, E. L. & Verma, P.S. Invertebrate Zoology. S. Chand & Co.
5. Kotpal, Agrawal & Khetrapal. Modern Textbook of Zoology – Invertebrates.
6. Puranik P.G. & Thakur R.S. Invertebrate Zoology
7. Majupuria T.C. Invertebrate Zoology
8. Dhami & Dhami. Invertebrate Zoology
9. Parker & Hashwell, Textbook of Zoology Vol. I (Invertebrates) A.Z.T.B.S. Publishers
10. R.L. Kotpal – Phylum Protozoa to Echinodermata (series), Rastogi and Publication, Meerut
11. Vidyarthi – Textbook of Zoology, Agrasia Publishers, Agra
12. Marshal & Williams. Textbook of Zoology.
13. Boolotin & Stiles. College Zoology. MacMillan
14. Suggested Readings for Practical
15. A manual of Practical Zoology Invertebrates – P.S. Verma
16. Dr.S.S. Lal Practical Zoology Invertebrates 9th edition, Rastogi Publication Meerut &

Distributors, New Delhi

Suggested Readings for Genetics

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Com.

Suggested Readings for Evolution

1. Ridley, M (2004) Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
4. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Suggested Books

1. Textbook of Zoology; Shivapuri, Jacob, D. and Vyas, D.K.; Ramesh Book Depot.
2. Textbook of Invertebrate Zoology I; Sandhu, G.S. and Bhaskar, H; Campus Books
3. Modern textbook of Zoology-Invertebrates; Kotpal; Rastogi Publications.
4. Invertebrate Diversity of Life: Rounds H. Genera
5. Zoology: Storer, T.I. and Using, K.L.: Tata McGraw Hill Publishing Co., New Delhi.

Suggested Readings for Biology of Parasitism:

1. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group
4. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and color Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi
5. Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
6. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
7. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

Semester III
THEORY

Paper –I (ZOO- 301)
[Life and diversity of Chordates]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT - I

1. General characters of Urochordata and Cephalochordata; Retrogressive metamorphosis
2. **Cyclostomata:** Peteromyzon, Ammocoete larva
3. **Pisces**: General characters of Chondrichthyes and Osteichthyes and classification up to order.

UNIT - II

1. **Amphibia:** General characters and classification up to order
2. **Reptilia:** General characters and classification up to order;
3. **Aves:** General characters and classification of Aves up to order; Flight adaptations; Archaeopteryx.

UNIT - III

4. **Mammals:** General characters and classification up to order
5. Comparative anatomy: Integument. Alimentary canal. Respiratory organs.

UNIT –IV

1. Comparative anatomy: Heart, Brain and cranial nerves
2. Comparative structure of urinogenital system

Semester III
THEORY

Paper –II (ZOO- 302)
[Physiology and Biochemistry]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT – I (Physiology)

I. Digestion: Digestion of Carbohydrate, Protein and Lipid.
II. Respiration: Respiratory pigments; Mechanism of Breathing, Transport of O2 and CO2, Bohr's Effect, Chloride Shift;
III. Renal Physiology: Structure of Mammalian Kidney, Mechanism of urine formation; Counter Current Mechanism of Urine Formation

UNIT- II

I. Circulatory system: Mechanism of Blood Clotting, Structure and function of Mammalian heart, Cardiac Cycle
II. Nervous System: Structure and types of Neurons, Physiology of Transmission of nerve impulse, Synaptic transmission; Reflex action
III. Muscle: Structure and types of Muscle Fibers, Mechanism of Skeletal Muscle contraction

UNIT -III

I. Reproductive System: Histology and Physiology of male and female reproductive system
II. Endocrine System: Hypothalamus and Pituitary, Thyroid, Adrenal, Parathyroid, Ovary, and Testes

UNIT-IV

I. Carbohydrate Metabolism: Glycolysis, TCA, Glycogenesis, Glycogenolysis, Gluconeogenesis
II. Lipid Metabolism: Beta oxidation of Lipid
III. Protein Metabolism: Transamination, Decarboxylation, Deamination, Urea Cycle/ Ornithine Cycle

Semester III

Paper –III (ZOOH - 303)
[Basics of Radiation and Cancer Biology]

Max. Marks: 75

Scheme Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT- I

Types of radiation, Ionization and excitation, Linear energy transfer, Direct and indirect effects of radiation, Interaction of radiation with matter, Radiation chemistry of water, biological effects of radiation.

UNIT -II

Chromosomal aberration, Survival curves, Concept of Radiosensitivity and radioresistance, Radiation carcinogenesis, Concept of radiotherapy of cancer. Health Physics: Radiation detection & instrumentation; Exposure to radiation, Dosimetry; Concept of Radiation protection and shielding; Medical imaging and radiation protection; Concept of waste disposal: Radioactive waste disposal, Bio-medical waste disposal, Incineration

Unit III: Cancer Epidemiology

1. Definition and global aspect of cancer
2. General Properties of Cancer
3. Benign and malignant tumors.
4. Sarcoma and carcinoma.
5. Leukaemia and lymphoma.
6. Epithelial and Nonepithelial Tumors
7. Teratocarcinoma (Specialized Tumor)

Unit IV: Causation, Diagnosis and Treatment of Cancer

1. Chemical Carcinogenesis
2. Radiation Carcinogenesis
3. Viral Carcinogenesis
4. Hormone and Cancer
5. Tumor markers, Histological and Cytological methods, Modern aids in tumor diagnosis
6. Surgery, Radiation Therapy, Chemotherapy, Hormone Therapy, Immune Therapy

Semester III

Practical

Paper – Practical (ZOO - PIII)

Maximum practical Marks = 150 marks
Internal marks = 60 Marks
External marks = 90 Marks

I. Life and Diversity of Chordates

A. Study of Specimen

a) Protochordata: Herdmania, Ciona, Salpa, Doliolum, Amphioxus

b) Lower Chordates: Petromyzon, Myxine/Bdellostoma, Ammocete larva,

c) Pisces: Sphyrna, Trygon (Stingray), Pristis (SawFish), Raja (Skate), Torpedo, Chimaera (Rat Fish), Acipenser, Amia, Lepidosteus, Notopterus, Labeo, Clarius, Anguilla (eel), Exocoetus, Hippocampus, Echenesis Sucker Fish), Protopterus,

d) Amphibia: Ichthyophis, Cryptobranchus, Ambystoma (Tiger Salamander), Axolotl Larva, Salamandra, Proteus, Siren, Alytes, Pipa, Hyla, Rhacophorous (Flying Frog)

B. Study of Slides

a) Tadpole larva of Herdmania, Herdmania Spicules, T.S. of Amphioxus (Through Oral hood, Pharyngeal, Intestinal, and Caudal regions)

b) V.S. of Skin of Scoliodon, Amphibia

C. Mounting

a) Herdmania Spicules, Placoid Scale

D. Dissection: [Through demonstration by chart/CAL/Video]

Major: *Afferent branchial vessels; Efferent branchial vessels; Cranial nerves of Scoliodon.*

Minor: *Internal Ear; Eye Muscles; Ampulla of Lorenzini*

D.Biochemistry

i. Biochemical detection of carbohydrates, proteins, and lipids in a given sample
ii. Calorimetric estimation of glucose/Protein in a given solution

E.Physiology (through study of Permanent Slides)

i. Histological Slides: Bone, Cartilage, Striated Muscle Fibre
ii. Endocrine Glands: Pituitary, Thyroid, Parathyroid, Thymus, Adrenal cortex, Adrenal Medulla, ovary, testis
iii. To study the knee jerk reflex in man
iv. Demonstration of ptyalin enzyme activity
v. Estimation of hemoglobin content; RBC Counting, WBC Counting; Hematocrit value, and ESR of a given blood sample
vi. Histological Slides of mammalian T.S. of spinal Cord, stomach, duodenum, ileum, liver, lung, kidney

Radiation and Cancer Biology

1. Knowledge and use of the various instruments. Geiger-Muller counter, Scintillation counters, Survey meter, Single-channel gamma spectrometer, Cobalt camera.
2. Finding out the operating voltage of the G-M tube.
3. Calculation of Inverse Square Law
4. Determination of the resolving time of the G-M tube.
5. Absorption of beta and gamma rays
6. Determination of Back scattering factors
7. Histopathological, histochemical and biochemical studies of various tissues after external irradiation.
8. Histopathological study of various cancerous tissues (Oral cancer, Prostate cancer, Breast cancer)

Semester III

Scheme of Examination:

Time: 4hrs.		**Max. Marks: 90**
1.	Anatomy	16
2.	Permanent Preparation	12
3.	Exercise in Biochemistry/ Physiology	12
4.	Exercise in Basics of Radiation and Cancer Biology	12
5.	Identification & Comments on spots (1to 6)	18
6.	Viva-Voce	10
7.	Class Record	10
Total		**90**

Suggested Readings:

Chordates:

1. Colbert's Evolution of the Vertebrates; Colbert, E.H; John Wiley & Sons
2. Textbook of Chordate Zoology vol. II; Sandhu, G.S. and Sandhu, G.S; Campus Books.
3. Modern textbook of Zoology-Vertebrates; Kotpal, Rastogi Publication.
4. Vertebrate Zoology; Rastogi, V.B.; Ramnath & Kedarnath.
5. Young, O.Z.: The Life of Vertebrates, Oxford University Press, Oxford.
6. Young, J.Z: The life of vertebrates. Oxford University Press London 1962 (Low Priced Text Reprint English Language Book Society London, 1962).
7. Barrington, E.J.W.: The Biology Hemichordata & Protochordata, Oliver & Boyd, London, 1965
8. Young J. Z: The life of mammals, Oxford University Press London 1963

Biochemistry:

1. Stryer, I. (1988). Biochemistry II. Freeman and Co.
2. Plummer, L. (1989). Practical biochemistry. Tata McGraw.
3. Murray, R.K. et al (1995). Harper's biochemistry, 24th ed. Prentice Hall.
4. Lewin, B. (2000). Gene. John Wiley & sons.
5. Strikburger, M.W. (1994). Genetics. Macmillan Publ. Co.
6. Russel, P.J. (1998). Genetics. The Benjamin Cummins Publishing Co.
7. Lehninger (2004). Principles of biochemistry 4th ed.
8. Gilbert, F. (2000). Basic concepts in biochemistry: A student's survival guide. 2nd ed. McGrawHill

Physiology:

1. Ganong: Review of Medical Physiology (22nd ed. 2005, Lange Medical)
2. Guyton and Hall: A textbook of Medical Physiology (11th ed. 2006, Saunders).
3. Keele & Neil: Samson Wright's Applied Physiology (13th ed. 1989, Oxford)
4. K.V. Shastri: Physiology
5. William S. Hoar, 1976. General and Comparative Physiology, Prentice

Suggested Readings:

1. Biology of Cancer by Robert A Weinberg
2. Principles of Cancer Biology by Kleinsmith
3. Cancer Biology" by Raymond W Ruddon
4. Biology of Cancer (Pearson Special Topics in Biology)" by PALLADINO and PHILLIS
5. "The Biology of Cancer: A New Approach" by P R Burch

Semester IV
THEORY

Paper –I (ZOO - 401)
[Developmental Biology]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT- I

1. Historical review and Scope of embryology
2. Gametogenesis: Spermatogenesis, Structure of sperm, Oogenesis, Structure of egg, Types of Egg.
3. Fertilization,Parthenogenesis

UNIT- II

1. Planes and Patterns of Cleavage, Blastulation, Gastrulation, Morphogenetic Movements, Fate Map
2. Concept of embryonic induction; Primary organizers, differentiation and competence.
3. Extra embryonic membranes, Placentation in Mammals

UNIT- III

1. Structure of hen's egg, Development of chick up to 96 hrs stage.
2. Metamorphosis in amphibians and insects
3. Regeneration

UNIT- IV

1. Stem cells: Sources, types and their use in human welfare; Cloning
2. Elementary Idea of Teratogenesis, and Ageing
3. Elementary Idea of Artificial insemination, cryopreservation, amniocentesis, IVF, GIFT, ZIFT

Semester IV
THEORY

Paper –II (ZOO - 402)
[Ecology and Ethology] **Max. Marks: 75**

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

Unit I

- Basic concepts in ecology, its meaning, and history. Concepts of limiting factors.
- Ecosystem: Biotic and abiotic factors.
- Concepts of food chain, food web, trophic structure, ecological pyramids.
- Ecosystem: Homeostasis. Functional aspects. Productivity concepts and its determination, Ecotone, Edge Effects, Niche.
- Population Ecology: Density, Natality, Mortality, Age distribution, Growth, Dispersion, and Biotic Potential.

Unit II

- Community Ecology: Interspecific interactions – Negative (Antibiosis, Competition, Parasitism, and Predatism) and Positive (Commensalism, Proto-Cooperation, and Mutualism).
- Pollution: Elementary idea of air, water, soil, and noise pollution.
- Current Environmental Issues: Introduction, Impact, and Mitigation/control measures
  a) Greenhouse effect b)Global warming - Ozone layer depletion

Unit III - ETHOLOGY (ANIMAL BEHAVIOUR)

- Introduction and history of Ethology.
- Concepts and patterns of behavior: FAP, Sign Stimulus, Innate Releasing Mechanism (IRM), Action Specific Energy (ASE), Concept of motivation.
- Learning: Learned behavior and types of learning; Imprinting.

Unit IV

- Methods of studying Brain Behavior: Laboratory Techniques (Neuroanatomical, Physiological, and Neurochemical Technique); Field Study Techniques (Ad Libitum, Focus Sampling, Scan Sampling, One-Zero, and All Occurrence Sampling).
- Elementary idea of Pheromones.

Social behavior:

- Social behavior in Insects – Honey Bees and Termites.
- Social system in Primates: Monkeys.
- Parental care: Fishes and Amphibians.

Semester IV

THEORY

Paper –II (ZOO - 403)
[Medical Entomology]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT I

Introduction to medical entomology; Classification of Arthropod borne diseases; Hematophagy, disease transmission and epidemiology; flies (Diptera) of medical Importance; moth flies: Leishmaniasis and Bartonellosis; biting midges (Ceratapogonidae).

UNIT II

Mosquito taxonomy, biology, and behaviour; mosquito viruses: Yellow fever,mosquito surveillance; malaria; black flies of medical Importance; filariasis: mansonellosis, onchocerciasis.

UNIT III

Lice of medical importance; rickettsial diseases: epidemic typhus. mites: rickettsial pox; mites and acariasis: mange, scabies, chiggers; spiders and scorpions; fleas (Siphonaptera) ofmedicalimportance; plague and murine typhus.

UNIT IV

Ticks of medical importance; lyme disease, rocky mountain spotted fever, tularemia; true bugs (Hemiptera): kissing bugs and bedbugs; chagas disease; tsetse flies; Lepidoptera and Hymenoptera of medical importance.

Semester IV

Practical

Paper – Practical (ZOO – P IV)

Zoology Practical

Maximum practical Marks = 150 marks
Internal marks = 60 Marks
External marks = 90 Marks

Developmental Biology

1. Study of Development of Chick

a. Whole mounts: 18 Hours (Primitive streak stage), 21 hrs, 24 hours, 33 hrs, 48 hours, 72 hours, and 96 hours.

b. Study of the embryo at various stages of incubation in vivo by making a window in eggshell.

Ethology

1. Locomotory Behaviour of Tribolium: Effects of light intensity and light quality on the rate of locomotion.
2. Study of Individual and Social Behavioural Patterns of a troop of monkeys through visual aids.
3. Antennal Grooming in Cockroach

Ecology

1. Determination of population density in a terrestrial community or hypothetical community by quadrate method.
2. Study of life table and fecundity table plotting of the three types of survivorship curves from hypothetical data.
3. Estimation of Soil Parameters- pH, chlorides, and water vapor quantity.
4. Estimation of Water Parameters-
   - Dissolved oxygen, Salinity, pH, free CO_2 in water samples.
5. Plankton Study in Freshwater
6. Study of Natural Ecosystem and Field Report

Visit to a National park and Sanctuary (candidates are required to submit the report of the visit).

Practical

7. Identification of Arthropod Classes, Orders, and Families of Medical Importance
8. Collection, Segregation, Curing Insect and Arachnid Specimens, Their Preservation
9. Management of Insect and Mite Pests of Medical Importance
10. Study of Practical Aspects in Forensic Entomology

Semester IV
Scheme of Practical Examination

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.		**Max. Marks: 90**
1.	Exercise in Developmental Biology	16
2.	Permanent Preparation	12
3.	Exercise in Ethology and Ecology	12
4.	Exercise in Medical Entomology	12
5.	Identification & Comments on Spots (1to 6)	18
6.	Viva-Voce	10
7.	Class Record	10
Total		**90**

Developmental Biology:

1. Gilbert, S. T. (2000). Developmental Biology, 6th ed. Sinauer, Sunderland.
2. Hoar, W. S. (1983). General and Comparative Physiology. Prentice Hall.
3. Balinsky, B. I. (1976). An Introduction to Embryology, 6th ed. W. B. Saunders & Co.
4. Prosser, C. L. Comparative Animal Physiology.
5. Saunders, J. W. Developmental Biology: Patterns/Principles/Problems. MacMillan Publ.
6. Wilson, J. A. Principles of Animal Physiology. Collins MacMillan Publ.
7. Sandhu, T. B. Principles of Embryology.
8. Armugam, T. B. Principles of Embryology.
9. Pattern. Early Embryology of Chick.
10. Verma & Agrawal. Chordate Embryology.
11. Tomar. Chordate Embryology.

Ecology:

1. Odum, E. P. (1996). Ecology: A Bridge Between Science and Society. Sinauer Associates Inc.
2. Chapman, J. L., & Reiss, M. J. (1992). Ecology, Principles and Applications. Cambridge University Press.
3. Verma, P. S., & Agarwal, V. K. (1983). Environmental Biology (Principles of Ecology). S. Chand & Co.
4. Singh, J. H. et al. (2006). Ecology, Environment and Resource Conservation. Anamaya Publ. N. Delhi.

Medical Entomology:

1. David BV and Ramamurthy VV. (2011). Elements of Economic Entomology, 6th Edition. Namrutha Publications, Chennai.
2. Gullan PJ and Cranston PS. (2010). The Insects: An Outline of Entomology, 4th Edition. WileyBlackwell, West Sussex, UK & New Jersey, US.
3. Mullen G and Durden L. (2018). Medical and Veterinary Entomology, 3rd Edition. Academic Press.

Semester V

THEORY-Elective

Paper –I (ZOO - 501)
[Research Methodology and Biostatistics]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.

Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT I

1. Meaning, Objectives, Motivation: Research Methods vs Methodology
2. Types of Research
    - Analytical vs. Descriptive
    - Quantitative vs. Qualitative
    - Basic vs. Applied
3. Need for Research Design
    - Features of good design
    - Important concepts related to good design
        - Observation and Facts
        - Prediction and Explanation

UNIT II

1. Observation and Collection of Data
    - Methods of data collection
    - Sample and sampling
2. Concept of Research Articles, Research Papers, Reviews, Scientific Popular Articles, Technical Reports, and Thesis Writing
    - Preparation of Tables and Bibliography
3. Ethical Issues
    - Intellectual Property Rights
    - Commercialization
    - Copyright, Royalty, Patent Law
    - Plagiarism
    - Citation
    - Acknowledgment

UNIT III

1. Introduction, Definition, and Scope of Biostatistics

2. Concepts of Descriptive and Inferential Statistics
3. Data: Types, Presentation of Data
    - Tabular (Frequency Distribution Table; Continuous and Discontinuous Series)
    - Diagrammatical (Line, Bar, Ogive, and Pie Diagram)
    - Graphical (Histogram, Frequency Polygon, Frequency Curve)

UNIT IV

1. Measures of Central Tendency
    - Mean, Median, and Mode and their Significance
2. Measures of Dispersion
    - Mean Deviation & Standard Deviation
    - Standard Error
3. Test of Hypothesis
    - t-test
    - Null and Alternate Hypothesis

Semester V

THEORY-Elective

Paper –II (ZOO- 502)
Microbiology and Immunology

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT –I

1. **Microbiology:** The scope of Microbiology: Characterization, Classification and identification
2. **Microorganisms;** History and landmark events in Microbiology: Working of A.V. Leeuwenhoek, Louis Pasteur, Robert Koch, Germ Theory of diseases.
3. **General Morphology of Protozoa Parasitic Protozoans**: life cycle, pathogenesis and disease caused by Entamoeba; Plasmodium, Trypanosome, Leishmania, fungi – Molds and Yeasts

UNIT-II

1. Bacteria; The World of Bacteria – Morphology of Bacteria; Difference between Gram-positive and Gram-negative Bacteria
2. Growth and nutrition: Microbial Nutrition, Growth and Control: Nutritional requirements (macro&; micronutrients), Factors affecting growth of bacterial culture; Basic idea of Culture: Types of culture media, uptake of nutrients, Maintenance of pure cultures.
3. Growth; Reproduction: Bacterial division, growth curve, generation time, measurement of growth. Asepsis, sterilization with physical and chemical agents; Reproduction- Asexual and sexual

UNIT-III

1. Virus: Structure, Classification; Life Cycle- Lytic and Lysogeny; A Bacteriophage
2. Hepatitis: Structure and types of causative agent, Precaution, Prevention and Control
3. HIV and AIDS: Epidemiology, prevention, control and treatment. Applied Microbiology: Fermented Food production (Dairy Products, Alcoholic Beverages); Microbial spoilage and techniques of Food Preservation

UNIT-IV

1. Immunity: Types and Mechanism of Innate and Adaptive Immunity; Antigens; Immunogens, Adjuvants and haptens, epitopes
2. Immunoglobulin; Structure and functions of different classes of immunoglobulins
3. Antigen antibody interactions, Immunoassays (ELISA and RIA)
4. Structure and functions of MHC molecules, Complement System

Semester V
THEORY-Elective

Paper –III (ZOO-503)
[Applied and Economic Zoology]

Max. Marks: 75

Scheme of Examination: There will be two parts in end semester theory paper. Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry one mark for correct answer. Part B of the paper will contain eight questions, out of which four questions are to be attempted from each unit with internal choice. Each question will carry 10 marks.

UNIT I: Economic Entomology - Insects of Economic Importance

- Sericulture:
    - Types of Silkworm.
    - Lifecycle and rearing of Bombyx mori.
    - Brief idea of cocoon processing for silk fabric.
        - Cocoon boiling, reeling, winding, doubling, twisting, and weaving.
- Apiculture:
    - Types of honeybees.
    - Lifecycle and culture.
    - Bee product and its economic importance.
- Lac-culture:
    - Lac-insect, Laccifer lacca.
    - Life Cycle.
    - Lac processing.
    - Lac products and Economic Importance.

UNIT II: Economic Entomology

- Chemical Control of Insecticides:
    - Pyrethroids, Carbamate, and HCN (mode of action, merits, and demerits).
- Biological Control of Pests:
    - Biological agents (predators and parasites; merits and demerits).
- Crop Pests:
    - Lifecycle, damage, and control of Cotton spotted bollworm - Earias vitella.
- Stored Grain Pests:
    - Rice Weevil, Sitophilus oryzae.
- Animal Pests:
    - Lifecycle, damage, and control of Housefly – Musca nebulo.
    - Stablefly – Stomoxys calcitrans.

UNIT III: Aquaculture (Economic Importance)

- Pisciculture:
    - Techniques of induced breeding.

    - Edible Fishes.
    - By-Products of Fishing and its commercial values.
- Prawnculture:
    - Culture techniques of freshwater Prawn (Macrobrachium rosembergii) & Marine water Prawn (Penaeus monodon).
- Pearl Culture:
    - Formation and nature of Pearls.
    - Commercial importance of Pearl Culture in India.

UNIT IV: Economic Importance of Other Animals

- Vector-Borne Diseases:
    - A brief account of insect vectors affecting the health of man and domestic animals.
- Animal Husbandry:
    - Introduction to common dairy animals.
    - Techniques of dairy management.
- Vermiculture:
    - Vermitechnology, Bio-Fertilizers.
- Future Strategies for Livestock Development:
    - Transgenic Animal Technology.
    - Genetic improvement for best breeds.
    - Economic importance of Dairy, Leather, Wool, Fur.

Semester V

Paper –III (ZOH 601)
Wildlife Conservation and Management (Elective)

Max. Marks 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT - I

Introduction to Wild Life

Definition, Concept, importance and perspective - need for wildlife management in India, Wildlife ecology; habitat, climate and food availability, biodiversity

UNIT-II

Indian Forests

Characteristics, composition and distribution with reference to major types of vegetation, Healthcare of wildlife; major infectious and non - infectious diseases, causes and the control measures.

UNIT-III

Biodiversity

Definition, Principle of biodiversity, Threats to biodiversity, major causes, extinction's, vulnerability of species to extinction, IUCN threat categories, Red data book. Strategiesfor biodiversity conservation, biodiversity conservation in-situ and ex-situ conservationstrategies, theory of reserve design.

UNIT-IV

Management of Habitats

Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats

Protected Areas

National parks & sanctuaries, Community reserve; Important features of protected areas in India;Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

Semester V

Practical

Paper – Practical (ZOO – P V)

Maximum Practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Practical's for Elective I - Research Methodology and Biostatistics

1. Education and Research Resources on Net:
    - Encyclopedia, Wikipedia.
    - On-Line Tutorials and Lectures.
    - Virtual Labs, Open Course-wares.
    - Electronic Journals, E-Books, Digital Libraries.
    - Searching research information.

Professional Written Communication:

- Students prepare E-mails, Letters, Memos, Proposals, Formal and Informal Reports.

2. **Report Writing and Presentation:**
    - Research Report, Types, and Significance.
    - Structure of research report.
    - Ethical issues in research.
    - Presentation of the report.
3. **Construction of Frequency Table, Histograms, Polygons, Pie Charts**
4. **Exercise on Mean, Mode, Median, Std. Deviation, Std. Error, Probability**

Practicals for Elective II - Microbiology & Immunology

1. Preparation and Use of Culture Media for Microbes
2. Study of Microbes in Food Material (milk, curd, etc.)
3. Identification of Protozoan Parasites from Permanent Slides:
    - Trypanosoma (epimastigote or trypomastigote form).
    - Leishmania (promastigote and amastigote form).
    - Plasmodium (sporozoites and signet ring).
    - Giardia.
    - Entamoeba (trophozoites).

Identification of Helminth Parasites and Larva from Permanent Slides

4. **Study of Histological Slides of Organs of Immune System:**
    - Thymus, Lymph nodes, and Spleen.

Practicals for Elective III - Applied & Economic Zoology

1. Study of Prepared Slides/Specimens:
    - Honey Bee, Silk Worm, Termite.
    - Earthworm types (any two): *Drawida modesta, Pheretima posthuma.*
    - Fish parasites, Larvivorous fishes (Guppy, Gambusia).
2. Economic Importance of Commonly Occurring Insect Pests:
    - Preparation of the lifecycle of these pests.
3. Study of Beneficial Insects and Their Life Stages

Semester V

Scheme of Practical Examination

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.		**Max. Marks: 90**
1.	Exercise from Elective I- Major	12
2.	Exercise from Elective I- Minor	5
3.	Exercise from Elective II	10
4.	Exercise from Elective III	10
5.	Identification & Comments on spots (1to6)	18
6.	Student Project work	15
7.	Viva Voce	10
8.	Class Record	10
Total		**90**

Suggested Readings of Books:

Research and Methodology:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman& Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

Microbiology and Immunology

1. Mani, A., Selvaraj, A.M., Narayanan, L.M. & Arumugam, N. (1996).
   - *Microbiology.* Saras Publications, Nagercoil, India.
2. Sharma, P.D. (1998).
   - *Microbiology.* Rastogi Publications, Meerut, India.
3. Subba Rao, N.S. (1999).
   - *Soil Microbiology.* Oxford IBH Co., New Delhi, India.
4. Sullia, S.B. & Santharam, S. (2004).
   - *General Microbiology.* Oxford IBH, India.
5. Meenakumari, S. (n.d.).
   - *Microbial Physiology.* MJP Publications, Chennai, India.
6. Purushotam Kaushik (2005).
   - *Microbiology.* S. Chand & Co., New Delhi, India.
7. Vijaya Ramesh (2005).
   - *Environmental Microbiology.* MJP Publications, Chennai, India.
8. Vijaya Ramesh (2007).
   - *Food Microbiology.* MJP Publications, Chennai, India.
9. Rajan, S. (2007).
   - *Medical Microbiology.* MJP Publications, Chennai, India.
10. Purohit, S.S. (2007).
    - *Microbiology.* Agrobios Publications, India.
11. Trivedi, P.C. (2008).
    - *Applied Microbiology.* Agrobios Publications, India.
12. Prescott (2009).
    - *Industrial Microbiology.* Agrobios Publications, India.
13. Parihar, L. (2008).
    - *Advances in Applied Microbiology.* Agrobios Publications, India.
14. Agarwal, A.K. (2008).
    - *Industrial Microbiology.* Agrobios Publications, India.
15. Bohra, A. (2006).
    - *Food Microbiology.* Agrobios Publications, India.

Economic Zoology

1. Shukla and Upadhyaya (1999-2000).
   - *Economic Zoology.* Rastogi Publishers.
2. Shrivastava (1991).
   - *Textbook of Applied Entomology, Vol. I & II.* Kalyani Publishers.
3. Mani (2006).
   - *Insects.* NBT, India.
4. Jabde (2005).
   - *Textbook of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture, Agricultural Pests and their Control.* Vedams eBooks (P) Ltd. New Delhi.

Wildlife Conservation and Management

1. Caughley, G., and Sinclair, A.R.E. (1994).
   - *Wildlife Ecology and Management.* Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005).

- *People and Wildlife, Conflict or Coexistence?* Cambridge University.

3. Bookhout, T.A. (1996).
    - *Research and Management Techniques for Wildlife and Habitats, 5th edition.* The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000).
    - *The Conservation Handbook: Research, Management, and Policy.* Blackwell Sciences.
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008).
    - *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory.* Blackwell Publishing.

Semester –VI
THEORY-Elective

Paper –I (ZOO - 601)
[Bioinstrumentation and Bio-techniques]

Max. Marks 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT - I

1. Concepts of sterilization: Filtration, autoclaving, dry heat sterilization, wet sterilization and radiation
2. Separation of biomolecules: Centrifugation (Sedimentation, density gradient)
3. Chromatography (Elementary idea of Paper – ascending and Circular, thin layer, gel filtration and ion exchange- Principles and applications)
4. Electrophoresis: Agarose Gel Electrophoresis, SDS-PAGE

UNIT -II

1. Fixation, dehydration, clearing, embedding & section cutting
2. Difficulties encountered during section cutting (causes and remedies)
3. Double staining with Haematoxylin and Eosin
4. Histochemical staining techniques for carbohydrates (Periodic acid schiff), proteins (Mercury-bromophenol blue) and lipids (Sudan Black-B)

UNIT -III

1. Microscope: Principle of Microscopy and types
2. Principles of colorimeter
3. Principles of spectrophotometers

UNIT -IV

1. Bioinformatics: Definition, Scope, Basic concepts in bioinformatics, importance and role of bioinformatics in life sciences
2. Bioinformatics databases- introduction, types of databases
3. Nucleotide sequence databases, Elementary idea of protein databases
4. BLASTA, FASTA, PHYLOGENY TREE Analysis

Semester VI
THEORY-Elective

Paper –II (ZOO - 602)
[Environmental Toxicology]

Max. Marks 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT -I

1. Definition, history, scope & sub-divisions of toxicology
2. Principles of Environmental Toxicology and the Dose-Response Relationship
3. Classification of toxic agents, natural toxins, animal toxins, plant toxins, food toxins, genetic poisons and chemical toxins

UNIT -II

1. Ecotoxicology- Examples of ecotoxicology, Scientific approach to ecotoxicology
2. Entry, movement, and fate of pollutants in ecosystems
3. Biomarkers and Biomonitoring

UNIT -III

Environmental pollution I: General outline and various types of pollution of water, air and soil

UNIT -IV

Environmental pollution II: Sources and remedies for noise, radiation, industrial chemicals, agrochemicals, insecticides and pesticides and household pollutants

Semester VI
THEORY-Elective

Paper –III (ZOO - 603)
[Medical Diagnostics, Public Health & Hygiene]

Max. Marks 75

Scheme of Examination: There will be two parts in end semester theory paper.

Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT-I

Diagnostics Methods Used for Analysis of Blood Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

UNIT-II

Diagnostic Methods Used for Urine Analysis Urine Analysis: Physical characteristics; Abnormal constituents

UNIT-III

Non-infectious Diseases Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

UNIT-IV

Infectious Diseases Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis Tumours Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CTScan (using photographs).

Semester VI
THEORY- Elective

Paper –IV (ZOO - 604)
[Neuro-endocrinology]

Max. Marks 75

Scheme of Examination: There will be two parts in end semester theory paper.
Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.
Part B of the paper will contain eight questions, one from each unit with internal choice, out of which four questions are to be attempted. Each question will carry 10 marks.

UNIT- I
Introduction: definitions, a brief history of endocrinology. classes of hormones, cascades and feedback loops. Hormone sources, synthesis, receptors and target tissues.
Neuroendocrinology: Structure and function of hypothalamus, pituitary, median eminence, Hypophysiotrophic hormones; Posterior Pituitary & Imp; Neurohormones. neuroendocrine control of pituitary hormones; Neuron as target cells for hormone action.

UNIT-II
Pineal gland & neuroendocrine regulation of biological rhythms; Metabolic regulation of hypothalamic function. The steroid hormones: sources, structure, synthesis, regulation, receptors and effects on target tissues.

UNIT-III
Thyroid hormones: structure, control, release and function. Pancreatic hormones: Insulin and glucagon Special Topic: Diabetes. The adrenal glands: glucocorticoids, structure and function Special Topic: Stress hormones and interactions with other regulatory pathways.

UNIT-IV
Androgens Special topic: Androgens, gonadal differentiation and free-martins Estrogens and the endocrinology of pregnancy Special topic: Neuroendocrinology of reproduction.

Semester VI

Practical

Project Work (Elective)

Maximum practical Marks	=	150 marks
Internal marks	=	60 Marks
External marks	=	90 Marks

Practicals for Elective I - Bioinstrumentation and Bioinformatics

1. Separation of Amino Acids by Paper Chromatography and TLC
2. Separation of Proteins by Electrophoresis Technique
3. Double Staining Method
4. Demonstration of Carbohydrates, Proteins, and Lipids by Histochemical Methods
5. Introduction to Basic Laboratory Instruments and Equipment
    - Autoclave
    - Centrifuge
    - pH Meter
    - Micropipettes
    - Digital Balance
    - Homogenizer
    - Electrophoresis Apparatus
    - Molar and Normal Solutions Calculations
6. Use of Internet for Survey of Literature Using Protein and Nucleotide Databases (NCBI)
7. Use of Softwares like Microsoft Office, BLASTA, FASTA

Practicals for Elective II - Environmental Toxicology

1. Determination of Alkalinity and Acidity of Water
2. Determination of Dissolved Oxygen in Water
3. Determination of Chloride in Water
4. pH Estimation of Water
5. Estimation of Nitrogen and Phosphorus in Water Sample
6. Determination of Total Dissolved Solids in Waste Water Sample
7. Determination of Chemical Oxygen Demand in Waste Water Sample
8. Analysis of Total Hardness of Waste Water Sample
9. Analysis of Waste Water/Sludge for Heavy Metals

Practicals for Basics of Medical Diagnosis and Public Health

1. Microbiology - Basic Aseptic Techniques and Media Preparation
    - Spread Plate, Streak Plate
    - Gram Staining
    - Microbial Growth Curve

- Culture
- Antibiotic Susceptibility Testing

2. Haematological Methods
    - Blood Grouping
    - TBC, WBC, RBC Count
3. Biochemistry
    - Glucose Estimation
    - Liver Function Tests
4. Estimation of Haemoglobin
5. Immunology
    - Ouchterlony Double Diffusion
    - ELISA
6. Molecular Biology
    - Protein Estimation by Biuret, Bradford, and Folins Lowry Method
7. Environmental Measures: Water Quality Testing

Practical's for Neuroendocrinology

1. Neurochemical Studies
    - TLC, Silica Gel Chromatography, DBH Analysis.
    - Isolation of Neurotransmitters.
    - Analysis of Neurotransmitters by Fluorometry, HPLC.
2. Study of Permanent Slides
    - Histological Slides: Bone, Cartilage, Striated Muscle Fiber
3. Endocrine Glands
    - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal Cortex, Adrenal Medulla, Ovary, Testis
4. To Study the Knee Jerk Reflex in Man

Semester VI

Scheme of Examination:

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.		**Max. Marks: 90**
1.	Exercise from Elective I- Major	12
2.	Exercise from Elective I- Minor	5
3.	Exercise from Elective II	10
4.	Exercise from Elective III	10
5.	Identification & Comments on spots (1to6)	18
6.	Student Project work	15
7.	Viva Voce	10
8.	Class Record	10
Total		**90**

Suggested Readings:

Biotechniques and Microtechnique

1. Animal Tissue Technique – Humason
2. Histological Technique – Devenport
3. Microtechnique – Jiwaji & Patki
4. Microtechnique – Wankhede
5. Biophysical Chemistry – Upadhyay, Upadhyay, and Nath
6. Techniques in Life Sciences – D. B. Tembhare
7. Pearse: Histochemistry - Theoretical and Applied, Volume I-III (1980-1993, Churchill Livingstones)

8. Plummer: An Introduction to Practical Biochemistry (1989, McGraw Hill)
9. Wilson & Walker: Experimental Biochemistry (2006, Cambridge)

Bioinformatics

1. Mount W. (2004). Bioinformatics and Sequence Genome Analysis, 2nd Edition. CBS Pub., New Delhi.
2. Bergman, N.H. (2007). Comparative Genomics. Humana Press Inc., Part of Springer Science+Business Media.
3. Baxevanis, A.D., Ouellette, B.F.F. (2009). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John-Wiley and Sons Publications, New York.
4. Campbell A.M. and Heyer, L.J. (2007). Discovering Genomics, Proteomics, and Bioinformatics, 2nd Edition. Benjamin Cummings.
5. Des Higgins and Willie Taylor (2000). Bioinformatics: Sequence, Structure and Databanks. Oxford University Press.
6. Rashidi H.H. and Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press, London.
7. Gibas Cynthia and Jambeck P. (2001). Developing Bioinformatics Computer Skills. Shroff Publishers and Distributors Pvt. Ltd. (O'Reilly), Mumbai.

Basics of Medical Diagnosis and Public Health

1. Andrews, H.L.: Radiation Biophysics. Prentice-Hall, Engel-Wood Cliffs. New Jersey. 1974 or Later Edition.
2. Avena, V.: Ionizing Radiation and Life. Mosby, S1. Lonis. 1971 or Later Edition.
3. Baverstock, K. of Staltar, J.: Low Dose Radiation Biological Bases of Risk Assessment. Taylor of Francis, 1989.
4. Broil, A.B.: Low level Radiation Effects. A fact Book. Society of Nuclear Medicine, USA, 1982.
5. Bulokav EB., V. Naiitel, and J.B. Reitan.: Radiobiological Consequences of Nuclear AccidentsContamination Radioecology, Radiobiology, and Health.
6. Chase, GD. and Robinowitz, J.L.: Radioisotope Methodology. Burgess Publishing Co. rd Minneapolis, Minn, USA. 3 Edition, 1967 or Later.
7. Coggle, J.E.: Biological Effects of Radiation. Taylor and francis Ltd., London, 1988 or Later Edition.
8. Dalrymple, G.V., Ganldev, M.E., Kollmorgen, G.M., and Vogel, H.J.: Medical Radiation Biology. Saunders. Philadelphia, 1973 or Later Edition.
9. Duncan, R.C., Knapp., R.G., and Miller III, M.C.: Introductory Biostatistics for the Health Sciences. John Wiley and Sons. Inc., New York, 1977 or Later Editon.
10. Fobrikant, J.I.: Radiobiology. Year book med., Chicago, 1972 or Later Edition.