S.S. Jain Subodh P.G. College, Jaipur

(Autonomous)

FACULTY OF SCIENCE

THREE YEAR UNDERGRADUATE PROGRAMME

IN

SCIENCE

SYLLABUS

Subject/Discipline: Zoology

(Syllabus as per NEP-2020 and Choice Based Credit System)

Medium of Instruction: Hindi/English

w.e.f. Academic Session 2023-24 Onwards

Contents:

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1. Eligibility:

10+2 with 48% from Rajasthan Board / CBSE from Rajasthan state and 60% for CBSE or any other equivalent recognized Board from other state in Science Stream with Physics, Chemistry and Biology.

2. Scheme of Examination

Sr.No.	Paper	ESE	CIA	Total
1.	Theory	70%	30%	100
2.	Practical	60%	40%	100

Each theory paper syllabus is divided into four units. Each theory paper has a 3-hour duration. Each practical/lab work has 4-hour duration.
The number of papers and the maximum marks for each paper/practical shall be shown in the syllabus for the paper concerned. It will be necessary for a candidate to pass in the theory part as well as the practical part of a subject separately.

Note: Maximum marks for a theory paper is 50 marks, which include 35 marks for ESE and 15 marks for internal assessment.

Examination Question Paper Pattern for all semester Exams.

Attempt all questions.
I. 10 Questions (very short answer questions) 7 x 1 Mark = 7
II. 4 Questions (1 question from each unit with internal choice) 4 x 7 Marks = 28
Total of End Sem. Exam - 35
Internal Assessment – 15
Maximum Marks - 50
Minimum Marks – 20

		Marks
Maximum Marks for a Theory Paper		50 Marks
End Semester Exam (ESE)		35 Marks
Internal Assessment		15 Marks
Examination Question Paper Pattern		
I. Very Short Answer Questions	10 Questions (7 x 1 Mark)	7 Marks
II. Questions with Internal Choice	4 Questions (1 from each unit, 4 x 7 Marks)	28 Marks
Total of End Semester Exam		35 Marks
Minimum Marks to Pass		20 Marks

3. Semester Structure

The details of the course with code, title and the credits assign are as given below.

Bachelor of Science

Zoology

Semester	Subject 1/ Discipline1 (DSC/DSE) (credits)	Subject 2 / Discipline 2 (DSC/DSE) (credits)	Subject 2 / Discipline 2 (DSC/DSE) (credits)	Generic Elective (GE) (credits)	Ability Enhancement Course (AECC) (credits)	Skill enhancement course (SEC) (credits)	Internship/ Apprentice-ship/Project/ Community	Value addition course (VAC) (credits)	Total Credits
I	DSC-1(2)	DSC-3(2)	DSC–5 (2)		English (2)			Chooseonefrom apoolof courses (0)	20 credits
	DSC-2(2)	DSC-4(2)	DSC–6 (2)						
	DSCP(2)	DSCP(2)	DSCP(2)						
II	DSC-7(2)	DSC-9(2)	DSC-11(2)		Hindi(2)			Chooseonefrom apoolof courses (0)	20 credits
	DSC-8(2)	DSC–10(2)	DSC–12(2)						
	DSCP(2)	DSCP(2)	DSCP(2)						
	Students on exit shall be awarded Undergraduate Certificate in Science after securing the requisite 40 credits in Semesters I and II.								***40+4***
III	DSC-13(2)	DSC–15 (2)	DSC-17(2)	Choose one from the pool of courses , GE -1 (2)**		Computer Science(2)		Choose one from a pool of courses (0)	22 credits
	DSC-14(2)	DSC–16 (2)	DSC–18 (2)						
	DSCP(2)	DSCP(2)	DSCP(2)						
IV	DSC-19(2)	DSC–21 (2)	DSC-23(2)	Choose one from the pool of courses GE - 2 (2)**		Env.Sc.and Sustainable Dev. (2)		Choose one from a pool of courses (0)	22 credits
	DSC-20(2)	DSC–22 (2)	DSC–24 (2)						
	DSCP(2)	DSCP(2)	DSCP(2)						
	Students on exit shall be awarded Undergraduate Diploma in Science after securing the requisite 84 credits on completion of Semester IV								***84+4***
V	Chooseonefrom apoolof courses , DSE – 1 (2)	Chooseonefrom apoolof courses , DSE – 3 (2)	Chooseonefrom apoolof courses , DSE – 5 (2)			Mental ability& reasoning (2)		Choose one from a pool of courses (0)	20 credits
	DSE–2(2)	DSE–4(2)	DSE–6(2)						
	DSEP (2)	DSEP (2)	DSEP (2)						
VI	Chooseonefrom apoolof courses , DSE-7(2)	Choose one from a pool of courses DSE–9(2)	Choose one from a pool of courses DSE–11(2)			Anandam - Joy of giving (2) or NCC/NSS/Rovers and Rangers/Red Ribbon Club/Sports/Extra-curricular and co-curricular activities (2)		Chooseonefrom apoolof courses (0)	20 credits
	DSE-8(2)	DSE–10(2)	DSE–12(2)						
	DSEP (2)	DSEP (2)	DSEP (2)						

Abbreviations Used

Course Category

DSC: Discipline Specific Core
DSCP: Discipline Specific Core Practical
DSE: Discipline Specific Elective
DSEP: Discipline Specific Elective Practical
GE : General Elective
AEC: Ability Enhancement Course
AECC: Ability Enhancement Compulsory Course
SEC: Skill Enhancement Course
SEM: Seminar PRJ: Project Work
RP: Research Publication

Contact Hours

L: Lecture
T: Tutorial
P: Practical or Other
S: Self Study

Duration: 6 Semesters (3 Years)

Paper Code	Paper	Nomenclature Core Course (CC) Elective Course (EC)	Marks	Credits	Total Credits
Sem I	Theory (CC)	Life and Diversity of Non-Chordata I	50	2	6
	Theory (CC)	Cell & Molecular Biology	50	2	
	Lab	Practical based on theory papers	50	2	
Sem II	Theory (CC)	Life and Diversity of Non-Chordata II	50	2	6
	Theory (CC)	Genetics & Evolutionary Biology	50	2	
	Lab	Practical based on theory papers	50	2	
Sem III	Theory (CC)	Life and Diversity of Chordates	50	2	6
	Theory (CC)	Physiology & Biochemistry	50	2	
	Lab	Practical based on theory papers	50	2	
Sem IV	Theory (CC)	Developmental Biology	50	2	6
	Theory (CC)	Ecology& Ethology	50	2	
	Lab	Practical based on theory papers	50	2	
Sem V	Theory (EC) Select any two	Research Methodology and Biostatistics	50	2	6
		Microbiology & Immunology	50	2	
		Applied & Economic Zoology	50	2	
		Research Project /Training	50	2	
	Lab	Practical based on theory papers	50	2	
Sem VI	Theory (EC) Select any two	Bioinstrumentation & Bio-techniques	50	2	6
		Environmental Toxicology	50	2	
		Basics of Medical Diagnosis and public Health	50	2	
		Research Project /Training	50	2	
	Lab	Practical based on theory papers	50	2	

****Note: The medium of instruction and examination shall be Hindi/English.***

***Students have to choose any two elective papers out of three in fifth and sixth semester.**
****Department will offer theory elective papers for the students based on options submitted by the students and availability of Faculty to teach the course.**
Marks Break up: End Semester Exam 35 Marks + Internal Assessment 15 Marks = 50 Marks per paper.

Practical Marks: External Practical's 35 Marks + Internal Practical 15 marks = 50

Theory Classes: Three hrs per week for each of the paper: end semester exam duration of 3 hrs for each of the papers
Practical Classes: Four hrs.Practical classes per week: End semester Practical examination of Fourhrs duration

B. Sc. Semester I

S.No.	Subject Code	CourseTitle	Course Category	Credit	Contact Hours Per Week			ESEDuration (Hrs.)	
					L	T	P	Theory	P
1.	ZOO101	Life and Diversity of Non Chordata- I	DSC	2	2	-	-	3	-
2.	ZOO 102	Cell & Molecular Biology	DSC	2	2	-	-	3	-
3.	ZOOP 101	Practical based on theory papers	DSCP	2		-	2	-	4

B. Sc. Semester -II

S. No.	Subject Code	Course Title	Course Category	Credit	Contact Hours Per Week			ESEDuration (Hrs.)	
					L	T	P	Theory	P
1.	ZOO201	Life and Diversity of Non Chordata- II	DSC	2	2	-	-	3	-
2.	ZOO202	Genetics & Evolutionary Biology	DSC	2	2	-	-	3	-
3.	ZOOP 201	Practical based on theory papers	DSCP	2	-	-	2	-	4

B. Sc. Semester -III

S.No.	Subject Code	CourseTitle	Course Category	Credit	Contact Hours Per Week			ESEDuration (Hrs.)	
					L	T	P	Theory	P
1.	ZOO301	Life and Diversity of Chordates	DSC	2	2	-	-	3	-
2.	ZOO302	Physiology & Biochemistry	DSC	2	2	-	-	3	-
3.	ZOOP301	Practical based on theory papers	DSCP	2	-	-	2	-	4

B. Sc. Semester -IV

S.No.	Subject Code	CourseTitle	Course Category	Credit	Contact Hours Per Week			ESEDuration (Hrs.)	
					L	T	P	Theory	P
1.	ZOO401	Developmental Biology	DSC	2	2			3	
2.	ZOO402	Ecology & Ethology	DSC	2	2			3	
3.	ZOOP401	Practical based on theory papers	DSCP	2			2		4

In Fifth Semester and Sixth Semester, students can choose any two electives. Departments will offer two theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.

B. Sc. Semester -V

S.No.	Subject Code	Course Title (Any two from A/B/C)	Course Category	Credit	ContactHours Per Week			ESEDuration (Hrs.)	
					L	T	P	Theory	P
1.	ZOO501	Research Methodology and Biostatistics	DSE	2	2	-	-	3	-
2.	ZOO502	Microbiology and Immunology	DSE	2	2	-	-	3	-
3.	ZOO503	Applied & Economic Zoology	DSE	2	-	-	2	-	4
4.	ZOO504	Research Project/ Training	DSE	2	-	-	2	-	4
5.	ZOOP501	Practical based on theory papers	DSEP	2	-	-	4	-	4

B. Sc. Semester –VI

S.No	Subject Code	CourseTitle (Any two from A/B/C)	Course Category	Credit	ContactHours Per Week			ESEDuration (Hrs.)	
					L	T	P	Theory	P
1.	ZOO601	Bioinstrumentation & Bio-techniques	DSE	2	2	-	-	3	-
2.	ZOO602	Environmental Toxicology	DSE	2	2	-	-	3	-
3.	ZOO603	Basics of Medical Diagnosis and public Health	DSE	2	-	-	2	-	4
4.	ZOO604	Research Project /Training	DSE	2	-	-	2	-	4
5.	ZOOP601	Practical based on theory papers	DSEP	2	-	-	4	-	4

*Departments will offer minimum three and maximum five theory elective course for the semester based on options submitted by students and availability of faculty to teach the course.

Marking Scheme for CBCS Curriculum

B.Sc. Semester-I

Max. Marks: Theory- 100 **Practical- 50**

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
ZOO101	Paper I	Life and Diversity of Non Chordata- I	35	15	50	18
ZOO102	Paper II	Cell & Molecular Biology	35	15	50	18
				Total	100	36
ZOOP 101	Lab	Practicalbased on theory papers	30	20	50	18

B.Sc. Semester-II

Max. Marks: Theory- 100 **Practical- 50**

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
ZOO 201	Paper I	Life and Diversity of Non Chordata- II	35	15	50	20
ZOO202	Paper II	Genetics & Evolutionary Biology	35	15	50	20
				Total	100	40
ZOOP 201	Lab	Practicalbased on theory papers	30	20	50	18

B.Sc. Semester-III

Max. Marks: Theory- 100 **Practical-50**

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
ZOO301	Paper I	Life and Diversity of Chordates	35	15	50	20
ZOO302	Paper II	Physiology & Biochemistry	35	15	50	20
				Total	100	40
ZOOP 301	Lab	Practical based on theory papers	30	20	50	20

B.Sc. Semester-IV

Max. Marks: Theory- 100 **Practical- 50**

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
ZOO401	Paper I	Developmental Biology	35	15	50	20
ZOO402	Paper II	Ecology & Ethology	35	15	50 100	20
				Total	100	40
ZOOP 401	Lab	Practical based on theory papers	30	20	50	20

B.Sc. Semester-V

Max. Marks: Theory- 100 **Practical- 50**

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
ZOO501	Paper A	Research Methodology and Biostatistics	35	15	50	20
ZOO502	Paper B	Microbiology and Immunology	35	15	50	20
ZOO503	Paper C	Applied and Economic Zoology	35	15	50	20
Total (Choose any two)					100	40
ZOO504	Paper D	Research Project/ Training	35	15	50	20
ZOOP 501	Lab	Practical based on theory papers	30	20	50	20

B.Sc. Semester-VI

Max. Marks: Theory- 100 **Practical- 50**

Teaching Hours per week for every paper: 3

Paper code	Paper	Nomenclature	External	Internal	Total Max. Marks	Total Min. Marks
ZOO601	Paper A	Bioinstrumentation & Bioinformatics	35	15	50	20
ZOO602	Paper B	Environmental Toxicology	35	15	50	20
ZOO 603	Paper C	Basics of medical diagnosis and public health	35	15	50	20
Total (Choose any two)					150	40
ZOO 604	Paper D	Research Project/ Training	35	15	50	20
ZOOP601	Lab	Practical based on theory papers	30	20	50	20

SEMESTER-I
THEORY

Paper I - ZOO-I01:
Life and Diversity of Non Chordata-I

Max. Marks: 50

Scheme of Examination: There will be two parts in the end-semester theory paper. Part A of the paper shall contain seven short-answer questions of 7 marks. Each question will carry one mark for the 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 7 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, 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, 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 lifecycle)
    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 lifecycle)
    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)

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

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

Max. Marks: 50

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 7 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 7 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. itochondria: 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 DNAand 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

Suggested Readings for Cell Biology:

1. Alberts et al. (2001). Molecular Biology of the Cell. Garland Publications.
2. De Robertis, E.D.P. & De Robertis, E.M.F. (1987). Cell and Molecular Biology. Lea &Febiger Intl. ed.
3. Powar, C.B. (1986). Cell Biology. Himalaya Publ.
4. Burke, J.D.C. (1970). Cell Biology. William & Wilkins Company.
5. Dr. S.P. Singh, Dr. B.S. Tomar. Cell Biology 9th revised edition, Rastogi Publication, Meerut.
6. Gupta P.K., Cell and Molecular Biology, Rastogi Publication, Meerut.
7. Veer Bala Rastogi. Introduction to Cell Biology, Rastogi Publication, Meerut.
8. Verma and Agrawal. Concepts of Cell Biology.
9. Cooper, GM. and Hausman R.E. (2009). The cell: A molecular approach. V edition.
10. Lodish Cell and Molecular Biology; Phillip Sheeler Donald E. Bianchi; John Wiley and Sons.

SEMESTER I
PRACTICAL

Paper – Practical (ZOO - PI)

SectionA: Life and Diversity of Animals - Nonchordata–I

1. **. Microscopic Techniques**
    a. **Organisation and working of optical microscopes:** Dissecting and Compound Microscope
2. **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
3. **Study of museum specimens (Classification of animals up to orders)**
    a. **Protozoa:** Euglena, Elphidium (Polystomella), Foraminiferous shell, Monocystis, Opalina, Paramoecium, Paramoecium showing Binary fission, Paramecium Conjugation, Balantidium, Nyctotherus, Vorticella
    b. **Porifera:** Sycon, Leucosolenia, Hyalonema, Euplectella, Spongilla
    c. **Coelenterata:** Obelia Colony & Medusa, Millepora, Physalia, Vellela, Aurelia, Alcyonium, Gorgonia, Pennatula, Metridium, Stone Corals
    d. **Platyhelminthes:** Planaria, Fasciola, Taenia .
    e. **Aschelminthes:** Ascaris, Dracunculus, Ancylostoma, Wuchereria
    f. **Annelids:** Nereis, Heteronereis,Earthworm,Pontobdella
4. **Study of Permanent Slides**
    a. **Porifera:** Sponge gemmules, Sponge spicules, V.S. Sycon, T.S. Sycon, II.
    b. **Coelenterata:** Obelia medusa, Obelia Colony
    c. **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
5. **External Features and Anatomy Through Audio-Visual Presentation**
    a. **Earthworm:** External features, Digestive, Nervous, and Reproductive System
    b. **Leech:** External features, Digestive, Nervous, and Reproductive System
6. **Mounting**
    a. Paramecium, Euglena
    b. Spicules, spongin fibers, and Gemmules of Sponge
    c. Obelia colony
    d.

Section B: Cell 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 audiovisual 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

SEMESTER I
SCHEME OF EXAMINATION:

Scheme of Practical Examination and Distribution of Marks

Time: 4 hrs.

Sr.no.	**Exercise**	**Max. Marks: 30**
1.	General Anatomy	02
2.	Permanent Preparation	03
3.	Exercisein cell biology	03
4.	Identification & Comments on spots(1to 6)	12
5 6..	VivaVoce ClassRecord	05 05
Total		**30**

List of Recommended Books 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

SEMESTER II
THEORY

Paper-I: ZOO-201
Life &Diversity of Non Chordata-II

Max. Marks: 50

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 7 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 7 marks

Unit I: Arthropoda

1. General characters and outline classification up to classes with examples.
2. Type Study: Prawn
   - External characters
   - Morphology
   - Skeletal system
   - Digestive system
   - Respiration
   - Nervous system
   - Excretion & Reproductive systems

Unit II: Mollusca

1. General characters and outline classification up to classes with examples.
2. Type Study: Pila
   - External characters
   - Skeletal system
   - Digestive system
   - Respiration
   - Nervous system
   - 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 system
   - Nervous system
   - Excretion & Reproductive systems

Unit IV: Hemichordata

- General characters and outline classification up to classes with examples.
- Salient features of Balanoglossus

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

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

Paper –II (ZOO - 202)
Genetics and Evolutionary Biology

Max. Marks: 50

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 7 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 7 marks

Unit I

1. Brief history of Genetics
2. Mendelism and Neomendelism:
    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)
    d. Sex determination (Drosophila, birds & man)

Unit II

1. Mutation: Gene Mutation, Chromosomal Mutation
2. Cytoplasm inheritance (kappa particles in paramecium, Shell Coiling in Snail.)
3. Genetic disorders: Turner syndrome, Klinefelter'sSyndromeandDown's syndrome, Thalassemia, Sickle Cell Anaemia, Phenylketonurea, Diabetes mellitus.

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

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 Co.
6. Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.
7. *Genetics; Winchester, A.M.; Oxford and IBH Publishing Co.*
8. *Genetics; Strickberger W.M.; Prentice Hall of India.*
9. *Principles of Genetics; Gardener, E. J.; Wiley eastern, New Delhi.*
10. *A Textbook of Genetics; Rastogi, V.B.; Ramnath and Kedarnath*
11. *Molecular Biology of the gene; Watson, J.D; Benzamin/Cummings.*
12. *Biochemistry; Voet & Voet; John Wiley & Sons.*
13. *Cytology and Genetics. Dyansagar, C.R. Tata McGraw Hill Publ. Co. New Delhi.*
14. *Cell Biology: Dyson, R.D. Allen and Bacon, New York.*
15. *Genetics. Verma, P.S. and Agrawal V.K. S.Chand and Co., New Delhi.*
16. *Cell Biology and Genetics; Kohli, K.S; Ramesh Book Depot.*
17. *Genetics; Winchester, A.M; Oxford and IBH Publishing Co.*
18. *Cell and Molecular Biology; DeRobertis and DeRobertis; Saunders College.*
19. *Genetics; Strickberger; Macmillan, Prentice Hall of India.*
20. *Molecular Biology of the cell; Bruce Alberts, Julian Lewis, James D. Watson; Garland Publishings.*
21. *Invertebrate Zoology; Barns, R.D; W.B. Saunders Co.*

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.
5. Snustad. S *Principles of Genetics*.
6. Pevsner, J (2009). *Bioinformatics and Functional Genomics*. II Edition. Wiley Blackwell.

SEMESTER II
PRACTICAL

Paper – Practical (ZOO - PII)

Maximum practical Marks	50 marks
Internal marks	20 Marks
External marks	30 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

1. Lifecycle of Drosophila; Identification of male and female drosophila; Study of mutant forms in Drosophila (Bar eye, white eye, yellow body, sepia eye, curled wing, vestigial wing)
2. Identification of blood groups & Rh Factor
3. Study of fossils from models/ pictures
4. Study and verification of Hardy-Weinberg Law by chi-square analysis

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

SEMESTER II
SCHEME OF EXAMINATION:

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.	**Exercise**	**Max. Marks:30**
1.	General Anatomy	02
2.	Permanent Preparation	03
3.	ExerciseinGenetics& Evolutionary Biology	03
4.	Identification & Comments on spots(1to 6)	12
5 6..	VivaVoce ClassRecord	05 05
Total		**50**

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.*

Invertebrate Diversity of Life: Rounds H. Genera.

4. *Zoology: Storer, T.I. and Using, K.L.; Tata McGraw-Hill Publishing Co., New Delhi.*
5. *D. Reinhold, New York (Indian reprint: Affiliated East-West Press, New Delhi).*
6. *The Invertebrates. Vol. 1. Protozoa through Ctenophora, Hyman, L.H. McGraw-Hill Co., New York.*
7. *Student Textbook of Zoology. Vol. I, II, and III. Sedgwick, A.*
8. *Textbook of Zoology. Parker, T.J., Haswell, W.A. Macmillan Co., London.*

SEMESTER III
THEORY

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

Max. Marks: 50
Credits-2

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 7 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 7 marks

UNIT - I

1. General characters of Urochordata and Cephalochordata; Retrogressive mtamorphosis
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

Paper –II (ZOO- 302)
Physiology and Biochemistry

Max. Marks: 50
Credits-2

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 7 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 7 marks

UNIT – I (Physiology)

1. **Digestion :** Digestion of Carbohydrate, Protein and Lipid; Absorption of Lipid
2. **Respiration**: Respiratory pigments; Mechanism of Breathing, Transport of O_2 and CO_2, Bohr' s Effect, Chloiride Shift
3. **Renal Physiology**: Structureof Mammalian Kidney, Mechanism of urine formation; Counter Current Mechanism of Urine Formation

UNIT- II

1. **Circulatory system:** Mechanism of Blood Clotting, Structure and function of Mammalianheart,Cardiac Cycle
2. **Nervous System:**Structure and types of Neuron, Physiology of Transmission of nerve impulse, Synaptictransmission;Reflex action
3. **Muscle**: Structure and types of Muscle Fibers, Mechanism of Skeletal Muscle contraction

UNIT -III

1. **Reproductive System :** Histology and Physiology of male and female reproductive system
2. **Endocrine System :**Hypothalamas and Pituitary, Thyroid, Adrenal, Parathyroid, Ovary and Testes)

UNIT-IV

1. **Carbohydrate Metabolism**: Glycolysis, TCA, Glycogenesis, Glycogenolysis, Gluconeogenesis
2. **Lipid Metabolism**: Beta oxidation of Lipid
3. **Protein Metabolism :** Transamination, Decarboxylation, Deamination, Urea Cycle/ Ornithine Cycle

SEMESTER III
PRACTICAL

Paper – Practical (ZOO - PIII)

ZoologyPractical

Maximum practical Marks	50 marks
Internal marks	20 Marks
External marks	30 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), Acipensor, Amia, Lepidosteus, Notopterus, Labeo, Clarius, Anguilla (eel), Exocoetus, Hippocampus, EchenesisSuckerFish), Protopterus d) **Amphibia:**Icthyophis, Cryptobranchus, Ambyostoma (Tiger Salamander), Axolotl Larva, Salamandra, Proteus, Siren, Alytes, Pipa, Hyla, Rhacophorous (Flying Frog)

Reptilia: Chelone, Trionyx, Testudo, Sphenodon, Hemidactylus, Draco,Phrynosoma, Chamaeleon, Python, Eryx (Sand Boa), Bungarus, Naja, Vipera, Hydrophis, Crocodylus, Alligator
Aves: Archeopteryx, Pavo cristatus, Psittacula (parrot), Great Indian Bustard,Saras crane) Mammals: Echidna (Tachyglossus/ Spiny Anteater), Ornithorhyncus (Duck- billed Platypus), Macropus (Kangaroo), Bat, Dolphin

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

Biochemistry:

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

Physiology: I. **Study of Permanent Slides:**

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

SEMESTER III
Scheme of Examination:

Scheme of Practical Examination and Distribution of Marks

Time: 4hrs.	Exercise	Max. Marks: 35
1.	Anatomy	02
2.	Permanent Preparation	03
3.	Exercisein Biochemistry/ Physiology	03
4.	Identification & Comments onspots(1to 6)	12
5.	VivaVoce	05
6.	ClassRecord	05
Total		**30**

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.
9. Price, N.E. & Stevens, L. (1982). Fundamentals of enzymology. OUP.

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).

SEMESTER IV
THEORY

Paper –I (ZOO - 401)
Developmental Biology

Max. Marks: 50
Credits-2

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 7 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 7 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

Paper –II (ZOO - 402)
Ecology and Ethology

Max. Marks: 50
Credits-2

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 7 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 7 marks.

Unit I

- **Basic Concepts in Ecology:**
  - 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.
    - Greenhouse effect.
    - 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 Behaviour:**
  - Laboratory Techniques (Neuroanatomical, Physiological, and Neurochemical Techniques).
  - Field Study Techniques (Ad Libitum, Focus Sampling, Scan Sampling, One-Zero, and All Occurrence Sampling).

Elementary Idea of Pheromones:

Social Behaviour:

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

SEMESTER IV
PRACTICAL

Zoology Practical

Paper: Practical (ZOO – P IV)

Zoology Practical

Maximum Practical Marks: 50 marks
Internal Marks: 20 Marks
External Marks: 30 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
   - 96 hours. b. Study of the embryo at various stages of incubation in vivo by making a window in the 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 behavioral patterns of a troop of monkey through visual aids.**
3. **Antennal Grooming in Cockroach**

Ecology:

1. **Determination of Population Density:**
   - In a terrestrial community or hypothetical community by quadrat method.
2. **Study of Life Table and Fecundity Table:**
   - Plotting of the three types of survivorship curves from the hypothetical data.
3. **Estimation of:**
   - pH, chlorides, and water vapor quantity in soil.
4. **Estimation of:**
   - Dissolved oxygen, salinity, pH, free CO2 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).

SEMESTER IV
SCHEME OF PRACTICAL EXAMINATION

Scheme of Practical Examination and Distribution of Marks:

Time: 4 hrs.
Max. Marks: 35

1.	**Permanent Preparation:** **03**	
2.	**Exercise in Ethology:**	**02**
3.	**Exercise in Ecology:** **02**	
4.	**Identification & Comments on Spots (1 to 6):**	**12**
5.	**Viva Voce:** **05**	
6.	**Class Record:** **05**	
	TOTAL	**35**

Suggested Readings:

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. of Embryology
8. Armugam, T.B. 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. And Reiss, M.J. (1992). Ecology, principles and applications. Cambridge University Press.
3. Verma, P.S. & Agrawal, 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

SEMESTER V
THEORY-ELECTIVE

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

Max. Marks: 50
Credits-2

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 7 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 7 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 and Presentation:**
   - 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: 50
Credits-2

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 7 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 7 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. Leeuvenhock
     - Louis Pasteur
     - Robert Koch
     - Germ Theory of Diseases
3. **General Morphology of Protozoa:**
   - Parasitic Protozoans
   - Life Cycle
   - Pathogenesis
   - Diseases caused by Entamoeba, Plasmodium, Trypanosome, Leishmania
4. **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 and 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
    - Bacteriophage
2. **Hepatitis:**
    - Structure and Types of Causative Agents
    - Precaution, Prevention, and Control
3. **HIV and AIDS:**
    - Epidemiology
    - Prevention
    - Control and Treatment
4. **Applied Microbiology:**
    - Fermented Food Production (Dairy Products, Alcoholic Beverages)
    - Microbial Spoilage and Techniques of Food Preservation

UNIT-IV

- Immunity: Types and Mechanism of Innate and Adaptive Immunity
- Antigens: Immunogens, Adjuvants, and Haptens
- Immunoglobulins: Structure and Functions of Different Classes of Immunoglobulins
- Antigen-Antibody Interactions: Immunoassays (ELISA and RIA)
- Structure and Functions of MHC Molecules
- Complement System

SEMESTER V
THEORY-ELECTIVE

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

Max. Marks: 50
Credits-2

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 7 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 7 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
    - Weaving
- **Apiculture:**
  - Types of Honeybees.
  - Lifecycle and Culture.
  - Bee Products and Their Economic Importance.
- **Lacculture:**
  - Lac Insect, Lacciferlacca.
  - Lifecycle.
  - 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 - Eariasvitella.
- **Stored Grain Pests:**
  - Rice Weevil, Sitophilus oryzae.
- **Animal Pests:**
  - Lifecycle, Damage, and Control of Housefly – Musca nebulo.
  - Stable Fly – Stomoxyscalcitrans.

UNIT III: Aquaculture (Economic Importance)

- **Pisciculture:**
- Techniques of Induced Breeding.
- Edible Fishes.
- By-Products of Fishing and Their Commercial Values.
- **Prawn Culture:**
- Culture Techniques of Freshwater Prawn (Macrobrachiumrosembergii) & 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
PRACTICAL

Paper – Practical (ZOO – P V)

Maximum practical Marks	=	50 marks
Internal marks	=	20 Marks
External marks	=	30 Marks

1. **Education and Research Resources on the Net:**
   - Explore Encyclopedia, Wikipedia, Online Tutorials, Virtual Labs, Open Coursewares, Electronic Journals, E-Books, Digital Libraries, and Techniques for Research Information Retrieval.
   - Professional Written Communication: Practice preparing E-mails, Letters, Memos, Proposals, Formal, and Informal Reports.
2. **Report Writing and Presentation:**
   - Understand the Components of a Research Report, Different Types, Significance, Structure, and Ethical Considerations.
   - Learn the Art of Effectively Presenting Research Findings.
3. **Construction of Frequency Tables and Graphs:**
   - Hands-on Experience in Creating Frequency Tables, Histograms, Polygons, and Pie Charts.
4. **Statistical Analysis:**
   - Perform Exercises on Descriptive Statistics - Mean, Mode, Median, Standard Deviation, Standard Error, and Probability.

Practicals for Elective II - Microbiology & Immunology

1. **Preparation and Use of Culture Media for Microbes:**
   - Understand the Formulation and Application of Culture Media for Microbial Growth.
2. **Microbial Analysis in Food Materials:**
   - Study Microbial Presence in Food Items Such as Milk and Curd.
3. **Identification of Protozoan Parasites:**
   - Examine Permanent Slides for Trypanosoma, Leishmania, Plasmodium, Giardia, and Entamoeba.
4. **Identification of Helminth Parasites:**
   - Analyze Permanent Slides for Various Helminth Parasites and Larvae.
5. **Histological Study of Immune System Organs:**
   - Explore Thymus, Lymph Nodes, and Spleen through Histological Slides.

Practicals for Elective III - Applied & Economic Zoology

1. **Study of Prepared Slides/Specimens:**
   - Examine Specimens of Honey Bee, Silk Worm, Termite, and Earthworm Types (Drawidamodesta, Pheretimaposthuma).
   - Study Fish Parasites and Larvivorous Fishes (Guppy, Gambusia).
2. **Economic Importance of Insect Pests:**
   - Explore the Economic Significance of Common Insect Pests and Prepare the Lifecycle Diagrams for These Pests.
3. **Study of Beneficial Insects:**
   - Examine Different Life Stages of Beneficial Insects and Understand Their Importance.

SEMESTER V
Scheme of Practical Examination

Scheme of Practical Examination and Distribution of Marks

Time: 4 hrs.	Exercise	Max. Marks: 30
1.	Exercise from Elective I	04
2.	Exercisefrom Elective II	04
3.	Identification&Commentsonspots(1to6)	12
4.	VivaVoce	5
5.	ClassRecord	5
Total		**30**

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.

Microbiology References:

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. (Microbial Physiology). MJP Publications, Chennai, India.
6. Kaushik, P. (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 References:

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.

SEMESTER –VI
THEORY-ELECTIVE

Paper –I (ZOO - 601)
Bioinstrumentation and Biotechniques

Max. Marks: 50
Credits-2

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 7 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 7 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: 50

Credits-2

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 7 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 7 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:

1. 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: 50
Credits-2

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 7 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 7 marks.

UNIT-I

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

UNIT-II

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

2. UNIT-III

3. 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

4. UNIT-IV

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

SEMESTER –VI
PRACTICAL

Semester VI - Practical Project Work (Elective)

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 the internet for a survey of literature using protein and nucleotide databases (NCBI).
7. Use of software like Microsoft Office, BLAST, FASTA.

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 a 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.

Elective III - 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 hemoglobin.
5. Immunology: Oucterlony Double Diffusion, ELISA.
6. Molecular biology: Protein estimation by Biuret, Bradford, and Folins Lowry method.
7. Environmental measures: Water quality testing.

SEMESTER –VI
Scheme of Examination:

Scheme of Practical Examination and Distribution of Marks

Time: 4 hrs.	**EXCERSISE**	**Max. Marks: 30**
1.	Exercise from Elective I	04
2.	Exercisefrom Elective II	04
3.	Identification&Commentsonspots(1to6)	12
4.	VivaVoce	5
5.	ClassRecord	5
Total		**30**

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., Ouellate, 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.