UNIVERSITY OF RAJASTHAN, JAIPUR

SYLLABUS

(Three/Four Year Undergraduate Programme)

B. Sc. (Zoology Hons.) I to VI Semester

Subject: Zoology

2024-27

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Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**Science**
Name of Discipline	**ZOOLOGY**
Type of Discipline	**Major**
List of Programme were offered as Minor Discipline	**Not Applicable**
Offered to Non-Collegiate Students	**No**

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0812 – Three/Four Year B. Sc. (Zoology)								
SN.	**Level**	**Semester**	**Type**	**ZOOLOGY**	**Credits**			
				Title	**L**	**T**	**P**	**Total**
1.	5	I	MJR	UG0812-ZOO-51T-151-Lower Invertebrates	4	0	0	4
2.	5	I	MJR	UG0812-ZOO-51P-152-Practical based on Lower Invertebrates	0	0	2	2
3.	5	I	MJR	UG0812-ZOO-51T-153-Higher Invertebrates	4	0	0	4
4.	5	I	MJR	UG0812-ZOO-51P-154-Practical based on Higher Invertebrates	0	0	2	2
5.	5	II	MJR	UG0812-ZOO-52T-155-Chordate Biology	4	0	0	4
6.	5	II	MJR	UG0812-ZOO-52P-156-Practical based on Chordate Biology	0	0	2	2
7.	5	II	MJR	UG0812-ZOO-52T-157-Comparative Anatomy & Developmental Biology of Vertebrates	4	0	0	4
8.	5	II	MJR	UG0812-ZOO-52P-158-Practical based on Comparative Anatomy & Developmental Biology of Vertebrates	0	0	2	2
9.	6	III	MJR	UG0812-ZOO-63T-251-Applied Zoology	4	0	0	4
10.	6	III	MJR	UG0812-ZOO-63P-252-Practical based on Applied Zoology	0	0	2	2
11.	6	III	MJR	UG0812-ZOO-63T-253-Cell Biology & Genetics	4	0	0	4
12.	6	III	MJR	UG0812-ZOO-63P-254-Practical based on Cell Biology & Genetics	0	0	2	2
13.	6	IV	MJR	UG0802-ZOO-64T-255-Animal Physiology	4	0	0	4

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SN.	Level	Semester	Type	ZOOLOGY	Credits			
				Title	L	T	P	Total
14.	6	IV	MJR	UG0802-ZOO-64P-256-Practical based on Animal Physiology	0	0	2	2
15.	6	IV	MJR	UG0802-ZOO-64T-257-Environmental Biology & Wildlife	4	0	0	4
16.	6	IV	MJR	UG0802-ZOO-64P-258-Practical based on Environmental Biology & Wildlife	0	0	2	2
17.	7	V	MJR	UG0812-ZOO-75T-351-Evolution	4	0	0	4
18.	7	V	MJR	UG0812-ZOO-75P-352-Practical based on Evolution	0	0	2	2
19.	7	V	MJR	UG0812-ZOO-75T-353-Nanobiotechnology	4	0	0	4
20.	7	V	MJR	UG0812-ZOO-75P-354-Practical based on Nanobiotechnology	0	0	2	2
21.	7	VI	MJR	UG0812-ZOO-76T-355-Immunology & Microbiology	4	0	0	4
22.	7	VI	MJR	UG0812-ZOO-76P-356-Practical based on Immunology & Microbiology	0	0	2	2
23.	7	VI	MJR	UG0812-ZOO-76T-357-Biochemistry & Biostatistics	4	0	0	4
24.	7	VI	MJR	UG0812-ZOO-76P-358-Practical based on Biochemistry & Biostatistics	0	0	2	2

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EXAMINATION SCHEME FOR REGULAR STUDENTS

Type of Examination	Course Code and Nomenclature	Duration of Examination (Hrs)		Maximum Marks		Minimum Marks	
Theory	UG0812-ZOO-51T-151-Lower Invertebrates	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-51P-152-Practical based on Lower Invertebrates	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-51T-153-Higher Invertebrates	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-51P-154-Practical based on Higher Invertebrates	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-52T-155-Chordate Biology	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-52P-156-Practical based on Chordate Biology	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-52T-157-Comparative Anatomy & Developmental Biology of Vertebrates	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-52P-158-Practical based on Comparative Anatomy & Developmental Biology of Vertebrates	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-63T-251-Applied Zoology	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical		CA	2	CA	10	CA	4

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Type of Examination	Course Code and Nomenclature	Duration of Examination (Hrs)		Maximum Marks		Minimum Marks	
	UG0812-ZOO-63P-252-Practical based on Applied Zoology	EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-63T-253-Cell Biology & Genetics	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-63P-254-Practical based on Cell Biology & Genetics	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0802-ZOO-64T-255-Animal Physiology	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0802-ZOO-64P-256-Practical based on Animal Physiology	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0802-ZOO-64T-257-Environmental Biology & Wildlife	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0802-ZOO-64P-258-Practical based on Environmental Biology & Wildlife	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-75T-351-Evolution	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-75P-352-Practical based on Evolution	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-75T-353-Nanobiotechnology	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical		CA	2	CA	10	CA	4

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Type of Examination	Course Code and Nomenclature	Duration of Examination (Hrs)		Maximum Marks		Minimum Marks	
	UG0812-ZOO-75P-354-Practical based on Nanobiotechnology	EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-76T-355-Immunology & Microbiology	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-76P-356-Practical based on Immunology & Microbiology	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16
Theory	UG0812-ZOO-76T-357-Biochemistry & Biostatistics	CA	1	CA	20	CA	8
		EoSE	3	EoSE	80	EoSE	32
Practical	UG0812-ZOO-76P-358-Practical based on Biochemistry & Biostatistics	CA	2	CA	10	CA	4
		EoSE	4	EoSE	40	EoSE	16

* CA: Continuous Assessment EoSE: End of Semester Examination

Theory Question Paper Scheme:

The question paper will consist of **two** parts **A** & **B**.
PART-A: 20 Marks: Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.
PART-B: 60 Marks: Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

Practical Question Paper Scheme:

Regular Students: For regular students, the question paper will be of **40 Marks**, with an additional **10 Marks** allocated for internal assessment.
NC/Ex-Students: The practical examination will have a total of 50 marks for non-collegiate students or ex-students.
The detailed marking scheme can be found in the practical exam syllabus for the respective paper.

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SYLLABUS

UG0812-ZOO-51T-151-Lower Invertebrates
I-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	UG0812-ZOO-51T-151 UG0812-ZOO-51P-152	Lower Invertebrates Practical based on Lower Invertebrates				5	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
5	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		XII Pass					
Objectives of the Course:		By the end of this course, students will be able to: 1. To provide a comprehensive understanding of the phylogenetic relationships and classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, and Aschelminthes up to the class level. 2. To study the detailed characteristics, including locomotion, nutrition, and reproduction, of representative species like *Paramecium*, *Amoeba*, *Plasmodium*, *Sycon*, *Obelia*, *Hydra*, *Taenia*, *Ascaris*, and *Fasciola*. 3. To explore the functional biology of simple organisms, focusing on their structural and reproductive strategies. 4. To discuss the ecological and economic importance of the studied phyla, especially in understanding their					

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	roles in ecosystems and their relevance to human activities. 5. To conduct a comparative study of the life cycles of parasitic and free-living organisms, enhancing the understanding of their adaptive strategies. 6. To understand the concept of metagenesis in coelenterates, particularly through the study of Obelia. 7. To link theoretical knowledge with practical applications, helping students appreciate the relevance of these phyla in applied zoology.

Detailed Syllabus
ZOO-51T-151-Lower Invertebrates

Unit-I

Phylum: Protista / Protozoa

Salient features and classification of Protozoa up to Classes. **3 Lectures**

Paramecium (Salient Features, Locomotion, Nutrition, and Reproduction) **4 Lectures**

Amoeba (Salient Features, Locomotion, Nutrition, and Reproduction). **4 Lectures**

Plasmodium (Salient Features, Locomotion, Nutrition, and Reproduction). **4 Lectures**

Unit-II

Phylum: Porifera

Salient features and classification of Porifera up to Classes. **3 Lectures**

Sycon (Salient Features, Nutrition, Reproduction). **4 Lectures**

Canal system of Sponges. **4 Lectures**

Economic importance of Phylum Porifera. **4 Lectures**

Unit-III

Phylum: Coelenterata (Cnidaria and Ctenophora)

Salient features and classification of Cnidaria and Ctenophora up to Classes. **3 Lectures**

Obelia (Salient Features, Nutrition, Reproduction, Metagenesis). **5 Lectures**

Hydra (External features, Nutrition, Reproduction and Life cycle) **5 Lectures**

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Beroe (General features) **2 Lectures**

Unit-IV

Phylum: Platyhelminthes and Aschelminthes

Salient features and classification of Platyhelminthes and Aschelminthes up to Classes **3 Lectures**

Taenia (External features and lifecycle) **4 Lectures**

Ascaris (External features and lifecycle) **4 Lectures**

Fasciola (External features and lifecycle) **4 Lectures**

Suggested Books and References –

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

Course Learning Outcomes –

After successful completion of the course:

- Students will be able to classify Protozoa up to the class level and describe their salient features, understanding the diversity within this phylum.
- Students will gain detailed knowledge of *Paramecium*, *Amoeba*, and *Plasmodium*, including their locomotion, nutrition, and reproduction processes.
- Students will be able to classify Porifera up to the class level, describe the salient features, and understand the canal system of sponges.
- Students will be able to classify Cnidaria and Ctenophora up to the class level and understand their unique features, including metagenesis in Obelia.
- Students will develop a solid understanding of Platyhelminthes and Aschelminthes, including their classification, external features, and life cycles, with emphasis on species like *Taenia, Ascaris*, and *Fasciola*.

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- Students will be able to connect theoretical knowledge with practical applications, appreciating the relevance of the studied phyla in applied zoology.
- Students will be able to compare the life cycles and adaptations of parasitic and free-living organisms, enhancing their analytical skills in understanding evolutionary strategies.

UG0812- ZOO-51P-152-Practical based on Lower Invertebrates

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

Microscopic Techniques:

Organization and working of optical microscopes: Dissecting and Compound Microscope

General methods of microscopical permanent preparations:

Fixatives and Preservatives: Formalin, Bouin's Fluid

Stains: Borax carmine, Acetocarmine, Acetoorcein, Haematoxylin, Eosin

Common Reagents: Normal saline, Ringer's solution, Acid water, Acid alcohol,

Mayer's egg albumin

Study of museum specimens (Classification of animals up to orders):

Protozoa: *Euglena, Elphidium (*P*olystomella*), Foraminiferous shell, *Monocystis, Opalina, Paramecium, Paramecium* showing Binary fission, *Paramecium* Conjugation, *Balantidium, Nyctotherus, Vorticella*

Porifera: *Sycon, Leucosolenia, Hyalonema, Euplectella, Spongilla*

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

Platyhelminthes: *Planaria, Fasciola, Taenia*

Aschelminthes: *Ascaris, Dracunculus, Ancylostoma, Wuchereria*

Study of Permanent Slides:

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

Coelenterata: *Obelia* medusa, *Obelia* Colony

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

Mounting:

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Paramecium, Euglena, Spicules, spongin fibres, and Gemmules of Sponge, *Obelia* colony

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Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812 -ZOO-51T-153- Higher Invertebrates
I-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	UG0812-ZOO-51T-153 UG0812-ZOO-51P-154	Higher Invertebrates Practical based on Higher Invertebrates				5	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
5	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		XII Pass					
Objectives of the Course:		By the end of this course, students will be able to: 1. Understand the general characteristics and classification of Annelida, Arthropoda, Mollusca, and Echinodermata up to the class level with examples. 2. Learn about the evolution of coelom and metamerism in Annelida. 3. Explore the nutrition, excretion, and respiration processes in Annelida. 4. Study the anatomy and developmental stages of Nereis, including its external characters, morphology, and systems. 5. Examine the social behaviours and life cycles in arthropods, particularly in bees and termites.					

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Detailed Syllabus
ZOO-51T-153- Higher Invertebrates

Unit-I

Phylum: Annelida

General characters and outline classification up to classes with examples. **2 Lectures**

Evolution of Coelom and Metamerism **2 Lectures**

Nutrition, Excretion and Respiration in Annelida **6 Lectures**

Nereis (External features, Morphology, Digestive, Excretory, and Nervous System, Development & Trochophore Larva) **5 Lectures**

Unit-II

Phylum: Arthropoda

General characters and outline classification up to classes with examples. **2 Lectures**

Prawn (External characters, Morphology, Skeletal, Digestive, Respiratory, Nervous system, Excretion & Reproductive systems) **6 Lectures**

Metamorphosis in Insects, Types of Metamorphosis **3 Lectures**

Social life in bees and termites **3 Lectures**

Unit-III

Phylum: Mollusca

General characters and outline classification up to classes with examples. **3 Lectures**

Pila (External characters, Skeletal system, Digestive system, Respiration, Nervous system, Excretion) **8 Lectures**

Pearl formation in bivalves **2 Lectures**

Evolutionary significance of trochophore larva **2 Lectures**

Unit-IV

Phylum: Echinodermata

General characters and outline classification up to classes with examples. **3 Lectures**

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Asterias (External characters, Water Vascular System, Digestive system, Nervous system, Excretion & Reproductive systems **7 Lectures**

Water-vascular system in Echinodermata **2 Lectures**

Larval forms in Echinodermata, Affinities of Echinodermata with Chordates. **3 Lectures**

Suggested Books and References –

1. 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.
2. Jordan, E. L. & Verma, P.S. Invertebrate Zoology. S. Chand & Co.
3. Kotpal, Agrawal &Khetrapal. Modern TextBook of Zoology – Invertebrates. Puranik P.G. & Thakur R.S. Invertebrate Zoology.
4. Majupuria T.C. Invertebrate Zoology. Dhami & Dhami. Invertebrate Zoology.
5. Parker &Hashwell, Textbook of Zoology Vol. I (Invertebrates). A.Z.T.B.S. Publishers.
6. R.L. Kotpal – Phylum Protozoa to Echinodermata (series), Rastogi and Publication, Meerut. Vidyarthi – TextBook of Zoology, Agrasia Publishers, Agra.
7. Marshal & Williams. Textbook of Zoology. Boolotin& Stiles. College Zoology. MacMillan.

Course learning outcomes –

- Students will be able to classify Annelida, Arthropoda, Mollusca, and Echinodermata up to the class level.
- Students will understand the evolution and significance of coelom and metamerism in Annelida.
- Students will describe the anatomy, nutrition, excretion, and respiration mechanisms in Annelida, with a focus on Nereis.
- Students will explain the external and internal structures of Arthropoda, particularly in prawns, and understand the types of metamorphosis in insects.
- Students will understand the anatomical features and physiological systems of Mollusca, with a focus on Pila, and explain the process of pearl formation in bivalves.
- Students will be able to analyze the structure and function of the water-vascular system in Echinodermata.

UG0812-ZOO-51P-154-Practical based on Higher Invertebrates

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

Study of museum specimens (Classification of animals up to orders):

Arthropoda: *Peripatus, Lepus, Balanus, Sacculina, Squilla, Palemon, Eupagurus* (hermit

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Crab), *Carcinus* (Crab), *Scolopendra, Julus*, Scorpion, Spider, *Limulus*, *Schistocerca*/*Locusta*, Dragonfly, Praying mantis, Queen Termite, *Cimex*, Moth/ Butterfly,
Mollusca: *Chiton, Dentalium, Cypraea, Pila, Aplysia, Mytilus, Pinctada, Loligo, Sepia, Octopus, Nautilus*
Echinodermata: *Antedon, Asterias, Ophiothrix, Echinus, Cucumaria*

Study of permanent slides:
Arthropoda: Crustacean Larvae - Nauplius, Zoea, Metazoea, Megalopa, Mysis
Mollusca: Veliger and Glochidium larvae, T.S. of *Unio* Shell
Echinodermata: T.S. of arm of starfish
Hemichordata: *Balanoglossus* through collar and proboscis

Audio-visual demonstration:
Prawn: Appendages, digestive, Nervous and Reproductive system, Statocyst, Hastate Plate
Pila: Nervous system, Osphradium, Gills, Radula

Mounting - Study via chart / Model / Fig.:
Daphnia, Hastate Plate, Statocyst of Prawn; Gill lamella, Osphradium, and Radula of *Pila*

External Features and Anatomy:
Earthworm: External features, Digestive, Nervous, and Reproductive System

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.

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3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-52T-155-Chordate Biology
II-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	UG0812-ZOO-52T-155 UG0812-ZOO-52P-156	Chordate Biology Practical based on Chordate Biology				5	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
5	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		I Semester					
Objectives of the Course:		1. To understand the general characteristics and classification of chordates, including the origin theories and evolutionary affinities of protochordates and other related groups. 2. To gain knowledge about the anatomy, larval forms, and metamorphosis of protochordates, particularly Urochordata and Cephalochordata. 3. To explore the classification, characteristics, and adaptations of various vertebrate classes such as Agnatha, Pisces, Amphibia, Reptilia, Aves, and Mammals. 4. To study the evolutionary adaptations, including parental care, migration, and osmoregulation, in fishes, amphibians, reptiles, birds, and mammals. 5. To examine the specialized features and evolutionary significance of various groups, such as the development of cleidoic eggs in reptiles, flight adaptations in birds, and dentition in mammals.					

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Detailed Syllabus
ZOO-52T-155-Chordate Biology

Unit-I

General characteristics and outline classification of Chordata. Dipleurula concept and the Echinoderm theory of origin of chordates. **4 Lectures**

Protochordata: General characteristics of Urochordata and Cephalochordata; Comparison of habit, external features and anatomy of *Herdmania* and *Branchiostoma* (excluding development). **4 Lectures**

Study of larval forms in protochordates; Ascidian tadpole larva and its metamorphosis. **4 Lectures**

Affinities of Hemichordata, Urochordata and Cephalochordata. **3 Lectures**

Unit-II

General characteristics of Agnatha: General characteristics and classification of cyclostomes up to classes. **4 Lectures**

Habit, habitat and salient features of Petromyzon and its Ammocoete larva. **4 Lectures**

Pisces: General characteristics and Classification up to order. Parental care in fishes and Migration in fishes. Aquatic adaptation in fishes; Osmoregulation in fishes. Evolutionary significance of Dipnoi. **4 Lectures**

Different types of scales and fins of Pisces. Origin of fins. Accessory respiratory organs in Pisces **3 Lectures**

Unit-III

Amphibia: General Characteristics and Classification up to orders; Neoteny; Parental care in Amphibians. **5 Lectures**

Reptilia: General characteristics and Classification up to orders; Affinities of *Sphenodon*; Evolution of cleidoic eggs. **5 Lectures**

Identification of Poisonous and non-poisonous snakes; Poison apparatus and Biting mechanism in snakes **5 Lectures**

Unit-IV

Aves: General Characteristics and Classification up to orders; *Archaeopteryx* - a connecting link. **4 Lectures**

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Types of feathers; Flight adaptations and Migration in birds. **4 Lectures**

Mammals: General characteristics and Classification up to orders; Affinities of Prototheria. **4 Lectures**

Dentition in Mammals; Adaptive radiation in mammals. **3 Lectures**

Suggested Books and References –

1. Kotpal RL; Modern Textbook of Zoology –Vertebrates; Rastogi Publications - Meerut; 2016 edition
2. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
3. Tiwari SK (2006) Fundamentals of World Zoogeography, Sarup & Sons
4. Pough H. Vertebrate life, VIII Edition, 2007 Pearson International.
5. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
6. Hickman CP, Roberts LS, Keen S, Larson A, I'AnsonH, Isenhour DJIntegrated
7. Principle of Zoology, 14th edition, 2008, McGraw Hill publication
8. Verma PS and Srivastava PC. (2011)Advanced Practical Zoology. S Chand Publication.

Suggested E-Resources –

1. https://www.fisheries.noaa.gov/educational-resources/fish-anatomy-interactive
2. https://www.khanacademy.org/science/health-and-medicine/histology/muscle-tissue/v/muscle-tissue
3. http://www.pathologyoutlines.com/topic/hematologybloodsmear.html
4. https://en.wikipedia.org/wiki/Lancelet
5. https://www.fishbase.de/
6. https://animaldiversity.org/

Course Learning Outcome:

- Students will be able to classify chordates and understand their general characteristics, including their evolutionary origins.
- Students will gain knowledge of the anatomy and life cycle of protochordates, with a focus on Urochordata and Cephalochordata.
- Students will develop an understanding of the classification and unique adaptations of vertebrates such as cyclostomes, fishes, amphibians, reptiles, birds, and mammals.
- Students will learn about the evolutionary significance of various adaptations in vertebrates, including osmoregulation in fishes, neoteny in amphibians, and flight adaptations in birds.
- Students will be able to identify and differentiate between poisonous and non-poisonous snakes and understand the mechanisms of their venom apparatus.
- Students will understand the evolutionary links and specialized features of vertebrates, such as the transition from reptiles to birds and adaptive radiation in mammals

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UG0812-ZOO-52P-156-Practical based on Chordate Biology

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

Anatomy of Edible Fish:

1. External Features and General Viscera: Description and identification of external features and internal organs arrangement in any edible fish (e.g., *Wallago*, *Labeo*).

2. Branchial Blood Vessels: Study of afferent and efferent branchial blood vessels in edible fish.

3. Eye Muscles and Innervations: Analysis of the eye muscles in edible fish.

4. Brain, Cranial Nerves (identification of cranial nerves), and Internal Ear.

Permanent Slide Preparations:

5. Muscle Fibres: Study of permanent slide preparations of striped and smooth muscle fibres.

6. Scales and Hair: Examination of scales of edible fish and hair of humans through permanent slide preparations.

7. Blood Film: Observation and study of blood films from any vertebrate through permanent slide preparations.

Microscopic Slide Studies:

8. Amphioxus and Larvae: Whole mounts and transverse sections (T.S.) of various regions of *Amphioxus*, oral hood, velum, pharyngeal wall, and tadpole larva of *Ascidia.*

9. Other Marine Organisms: Whole mounts of marine organisms such as *Salpa*, *Doliolum*, and *Oikopleura*.

Museum Specimen Studies:

10. Early Chordates and Fishes: Study of museum specimens including *Ascidia*, *Ciona*, *Botryllus*, *Ammocoete* larva, *Petromyzon*, *Myxine* or *Bdellostoma*, *Zygaena* (*Sphyrna*), *Torpedo*, *Chimaera*, *Acipenser*, *Amia*, *Lepidosteus*, *Labeo*, *Clarias*, *Anguilla*, *Hippocampus*, *Exocoetus*, *Echeneis*, *Pleuronectes* , *Protopterus*.

11. Amphibians and Reptiles: Study of museum specimens including *Ichthyophis* or blind-worm, *Proteus*, *Ambystoma*, *Axolotl*, *Siren*, *Alytes*, *Hyla*, *Testudo*, *Chelone*, Fresh Water Tortoise, *Sphenodon*, *Hemidactylus*, *Phrynosoma*, *Draco*, *Chameleon*, *Eryx*, *Hydrophis*, *Naja*, *Vipera*, *Crocodylus*, Alligator.

12. Birds and Mammals: Study of museum specimens including *Archaeopteryx*, any Running Bird, *Pavo cristatus*, *Choriotis nigriceps*, *Ornithorhynchus*, *Tachyglossus*, *Didelphis*, *Macropus*, Bat, *Loris*, and Scaly anteater.

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Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-52T-157-Comparative Anatomy & Developmental Biology of Vertebrates
II-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
II	UG0812-ZOO-52T-157 UG0812-ZOO-52P-158	Comparative Anatomy & Developmental Biology of Vertebrates Practical based on Comparative Anatomy & Developmental Biology of Vertebrates	5	6

Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
5	Major	4	2	6	No	Lectures and Practical

List of Programme Codes in which Offered as Minor Discipline	NA
Prerequisites	I Semester
Objectives of the Course:	1. The course offers a complete understanding about anatomy of vertebrate animals. 2. Thorough understanding of essential and evolutionary aspects of comparative anatomy will be developed through pictorial presentation of different anatomical details. 3. The course will also provide a glimpse of scope and historical background of developmental biology to the students, impart knowledge regarding basic concepts of differentiation, morphogenesis and pattern formation and insight into IVF, stem cells and cloning. 4. Detailed understanding of essential events of developmental biology will be imparted through proper explanation of gametogenesis, and stages of embryonic development and foetal formation.

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Detailed Syllabus
ZOO-52T-157-Comparative Anatomy & Developmental Biology of Vertebrates

Unit - I

Comparative Anatomy: Pisces (Scoliodon), Amphibia (Frog), Reptilia (Varanus) and Mammalia (Rabbit)

Integumentary System: Structure and function of integument, Derivatives of integument glands. **4 Lectures**

Skeletal System: Overview of skeleton; Brief account of jaw suspensorium and visceral arches. **4 Lectures**

Digestive System: Brief account of alimentary canal and digestive glands. **4 Lectures**

Respiratory System: Brief account of gills, lungs, air sacs and swim bladder. **3 Lectures**

Unit –II

Comparative Anatomy: Pisces (Scoliodon), Amphibia (Frog), Reptilia (Varanus) and Mammalia (Rabbit)

Circulatory System: Evolution of heart and aortic arches. **4 Lectures**

Urinogenital System: Succession of kidney, Evolution of urinogenital ducts. **4 Lectures**

Nervous System: Comparative account of brain**.** **4 Lectures**

Sense Organs: Types of receptors, Visual receptors in man**.** **3 Lectures**

Unit -III

History and Early Developmental Biology

Scope and History of Developmental Biology; Concepts of Epigenesis, Preformation, Specification, Determination, Differentiation, Morphogenesis, Embryonic induction. **5 Lectures**

Early Embryonic Development: Gametogenesis: Spermatogenesis and Oogenesis in mammals; Parthenogenesis: Definition, types and mechanism; Fertilization: Definition, types (External and Internal) and mechanism of fertilization, blocking mechanisms to Polyspermy. **5 Lectures**

Cleavage: Definition, types, planes and patterns of cleavage; Blastulation; Types of morphogenetic movements; Early development of frog (up to gastrula) and chick (up to 96 hrs.); Fate maps, Fate of germ layers**.** **5 Lectures**

Unit-IV

Late Developmental Biology

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Late Embryonic Development: Metamorphic events in life cycle of frog and its hormonal regulation. **5 Lectures**

Study of Extra embryonic membranes in chick; Placenta: Definition, formation, types and functions of placenta. **5 Lectures**

Applied Aspects of Developmental Biology: Stem cells, Cloning, Assisted Reproductive Techniques (ART). **5 Lectures**

Suggested Books and References –

1. Kent, G.C. and Carr R.K. (2000) Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
2. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education 29
3. Gilbert, SF (2014) Developmental Biology. X Edition. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.ISBN: 9780878939787
4. Balinsky, B.I. (2008). An Introduction to Embryology. International Thomson Computer Press.
5. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy. Tata McGraw Hills
6. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure. John Wiley and Sons
7. Wolpert, L & Tickle, C (2011) Principles of Developmental Biology (4th edition). Oxford University Press, ISBN: 9780198792918

Suggested E-resources –

1. http://courses.missouristate.edu/dennishughes/Comparative%20Vertebrate%20Anatomy.htm
2. Respiratory System - Encyclopedia Britannica https://www.britannica.com/science/respiratory-system-anatomy-and-physiology
3. Development and Evolution of the Heart - Nature https://www.nature.com/scitable/topicpage/development-and-evolution-of-the-heart-24792709/
4. Comparative Anatomy of the Nervous System - Wiley Online Library https://onlinelibrary.wiley.com/doi/full/10.1002/cphy.c090036
5. Developmental Biology - Stanford University https://web.stanford.edu/group/Urchin/biolreprodsite/Development.html

Course Learning Outcome:

Upon completion of the course, students will be able to:

- Know about the levels of organization among different groups of vertebrates.
- Understand that different organs and organ systems integrate with each other to impart proper regulation of a particular function.
- Understand how the various organs evolved during the course of evolution through succession. Know the evolution of different concepts in developmental biology.

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- Be able to understand the process of gamete formation from stem cell population to mature ova and sperm.
- Be able to comprehend the sequence of steps leading to the formation of gametes and
- development of embryo.
- Learn the mechanisms underpinning cellular diversity and specificity in animals
- Study the methods and tools related to developmental biology which help to understand different processes of embryogenesis.

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UG0812-ZOO-52P-158-Practical based on Comparative Anatomy & Developmental Biology of Vertebrates

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

I. Osteology: Frog, Varanus, Fowl and Rabbit
Frog: Skull, vertebral column, ribs, sternum, appendicular skeleton (Bones of fore limb and hind limb).
Varanus: Skull, vertebral column, ribs, sternum, appendicular skeleton (Bones of fore limb and hind limb).
Fowl: Skull, vertebral column, ribs, fercula, appendicular skeleton (Bones of fore limb and hind limb).
Rabbit: Skull, vertebral column, ribs, sternum, appendicular skeleton (Bones of fore limb and hind limb).

II. Anatomy:
Wallago/Labeo: External features, general viscera, afferent and efferent branchial blood vessels, brain, cranial nerves.

III. Study of the following through Permanent Slide preparations:
Striped muscle fibers; Smooth muscle fibers, scales of Wallago/ Labeo, feather of birds, hair of different animals, blood film of any vertebrate.

IV. Exercises on Developmental Biology
Frog - Study of developmental stages whole mounts and sections through permanent slides - cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
Study of Chick Embryo: Developmental stages of 18 hrs, 21 hrs, 24 hrs, 33 hrs, 48 hrs, 72 hrs and 96 hrs of incubation. Study of the embryo at various stages of incubation in vivo by making a window in the egg-shell

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	

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	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-63T-251-Applied Zoology
III-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	UG0812-ZOO-63T-251 UG0812-ZOO-63P-252	Applied Zoology Practical based on Applied Zoology				6	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
6	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		II Semester					
Objectives of the Course:		1. Gain knowledge about silkworms rearing and their products, Bee keeping equipment and apiary management. 2. Acquaint knowledge on dairy animal management, the breeds and diseases of cattle and learn the testing milk quality. 3. Acquaint the knowledge about basic procedure and methodology of Vermiculture. Learn various concepts of lac cultivation. 4. Learn the various pests, diseases and their management strategies. 5. Students can start their own business i.e. self-employments and Get employment in different applied sectors					

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Detailed Syllabus
ZOO-63T-251-Applied Zoology

Unit I

Sericulture: Silkworm species, types of silk, economic importance of silk, Moriculture: life cycle of mulberry silkworm, silk production, processing of silk, associated enemies, diseases and their management. **4 Lectures**

Lac culture: Life cycle of lac insect, general practices and management of lac cultivation, processing of lac, composition, properties and products of lac, associated enemies, diseases and their management. **4 Lectures**

Apiculture: Species of domesticated honey bee, life cycle of honeybees, indigenous and artificial bee hives, by-products, associated enemies, diseases and their management. **4 Lectures**

Prawn culture: Culturable species, prawn hatcheries, culture practices, associated diseases and their management. **3 Lectures**

Unit II

Vermiculture and Vermicomposting: Suitable species to conventional and commercial vermiculture, harvesting, processing, problems related to vermicomposting. **3 Lectures**

Pearl culture and industry: Pearl producing molluscs, pearl formation (natural and artificial), harvesting, properties and composition of pearls. **3 Lectures**

Pisciculture: Culturable species, seed production, hatcheries, feeding of fishes, by-products of fish culture, associated diseases and their management. **5 Lectures**

Poultry keeping: Indigenous and exotic breeds of poultry, housing system of poultry, common poultry management practices, associated diseases and their management. **4 Lectures**

Unit III

Protozoan diseases: Malaria, African sleeping sickness, amoebic dysentery, Leishmaniasis. **3 Lectures**

Helminth diseases: Diseases caused by Platyhelminthes and Aschelminthes. **3 Lectures**

Arthropod-borne diseases: Tick-borne diseases, Mite infestation, Insect-borne diseases. **4 Lectures**

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Pest and their management: agricultural pests, stored grain pests, household pests, Integrated pest management. **5 Lectures**

Unit IV

Pollination: Introduction to pollination, abiotic and biotic agents for pollination, Mechanism, significance. **3 Lectures**

Wool and fur industry: Wool and fur producing animals, production and processing of wool and fur. **3 Lectures**

Leather industry: Processing and tanning in leather industry, associated enemies: loss in commercial value. **3 Lectures**

Piggery: Breeds of pigs; breeding management; care, feeding and housing management of pigs; associated diseases and their management. **3 Lectures**

Dairy industry: Breeds of animals for dairy industry, production and processing of dairy by-products, preservation, associated diseases and their management. **3 Lectures**

Suggested Books and References –

1. Invertebrate Zoology, Kotpal RL. Rastogi Publication, Meerut.
2. Vermicomposting for Sustainable Agriculture, Gupta P. K, Agrobios India 2003
3. A Hand Book of Economic Zoology, Ahshan and Singh, S Chand.
4. Perspectives in Indian Apiculture, Mishra R C. Allied Scientific Publ. Bikaner India 1999.
5. A Textbook of Applied Entomology,Srivastava, K. P., 1988. Publ. Kalyani Publishers, New Delhi.
6. The Anophelines of India, Rao, T. R., 1984. Publ. by Malaria Research Centre, Delhi.
7. Text Book of Applied Entomology Vol. I & II by K. P. Srivastava.
8. General Applied Entomology by B V David and T N Anathakrishnan.
9. Destructive and Useful Insects by C. L. Metcalf.
10. Application and Economic Zoology, Shukla and Upadhayay,Rastogi Publication, Meerut.

Suggested E- Resources –

1. https://vidyamitra.inflibnet.ac.in/content/index/6018e55f8007bec1c22166b0/ET
2. https://vidyamitra.inflibnet.ac.in/content/index/6018e69d8007be8bc42166af/ET
3. https://vidyamitra.inflibnet.ac.in/index.php/content/index/5fd9f1678007bef4453de567
4. https://vidyamitra.inflibnet.ac.in/index.php/content/index/6018dbb48007be63c12166ae
5. https://en.wikipedia.org/wiki/Sericulture

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6. Text Book of Applied Zoology: https://g.co/kgs/FfcLa8a
7. AppliedZoology:https://www.amazon.in/APPLIED-ZOOLOGY-II-Semester-Zoology-ZO-242-ebook/dp/B0971Q4XJD
8. https://www.sscasc.in/wp-content/uploads/downloads/Zoology/Applied-Zoology.pdf

Course Learning Outcome –

1. Understand the economic importance of non-chordates and chordates and their significance in the ecosystem.
2. Learners would comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment and apply simple preventive measures for the same.
3. Learners would gain knowledge on animals useful to mankind and the means to make the most of it.
4. Learners would learn the modern techniques in various industries of beneficial animals.
5. Learners would be pursuing entrepreneurship as careers
6. Promote shared learning through practical classes, class room presentations and projects.

UG0812-ZOO-63P-252-Practical based on Applied Zoology

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

1. Study of Microscopic Slides/ models/ photographs of the following: *Plasmodium,* mosquitoes, *Phlebotomus argentipes*, *Musca domestica*, *Tribolium, Taenia solium, Fasciola hepatica, Ascaris*, *Wuchereria.*
2. Study of Museum specimens/ photographs/ models of following: silkmoth species, Prawn, Pearl oyster, honey bee, edible fishes.
3. Study of different types of silk moths, their life cycle and cocoons and different types of silk yarns.
4. Study of different equipments used in sericulture.
5. Study of life cycle of bees and Langstroth's bee hive,
6. Qualitative analysis of honey.
7. Study of different types of lacs (button lac, shellac, etc.)
8. Study of equipment and devices for vermicomposting and construction of vermicomposting bins.
9. Study to differentiate between original and artificial pearls.
10. Study of fishing gears, and products from the fishing industry.
11. Study of different types of wool.
12. MBRT test for milk quality analysis.

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13. Educational tour: Visit to any Dairy/Food processing factory/ research and training Institute/ Apiary/ Piggery/ Poultry farm/ Aquaculture and report submission.

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Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-63T-253-Cell Biology & Genetics
III-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	UG0812-ZOO-63T-253 UG0812-ZOO-63P-254	Cell Biology & Genetics Practical based on Cell Biology & Genetics				6	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
6	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		II Semester					
Objectives of the Course:		1. The students would be able to understand about the cellular components and processes. 2. The course provides extensive information about the cell morphology and processes with modes of genetic transfer which will enable the learner to identify the molecular mechanisms behind all the natural biological phenomena . 3. The learner will also get a wholesome idea about the process of genetic transfer of characters in animals and humans . 4. The course provides knowledge about the types of mutations and genetic disorders. 5. The student would also gain knowledge about the genetic dynamics of the population.					

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Detailed Syllabus
ZOO-63T-253-Cell Biology & Genetics

Unit-I

Introduction to cell: Cell theory, cell characteristics-morphology, size, shape, structure of prokaryotic and eukaryotic animal cells. **2 Lectures**

Cell membrane: Characteristics and composition of cell membrane, Fluid Mosaic model of Sanger and Nicholson. Cell membrane transport: Passive (diffusion and osmosis, facilitated, mediated) and active transport**.** **4 Lectures**

Cell organelles: Structure and biogenesis of mitochondria; electron transport chain and generation of ATP molecules, structure and functions of: endoplasmic reticulum, ribosome (prokaryotic and eukaryotic) and Golgi complex, lysosome, microbodies, and centrioles, cilia, flagella. **9 Lectures**

Unit-II

Nuclear organization: Structure and function of nuclear envelope, nuclear matrix and nucleolus; chromosomes: morphology, telomeres, primary and secondary constrictions, chromatids, prokaryotic chromosome; giant chromosome types: polytene and lampbrush; chromosomal organization: euchromatin, heterochromatin and nucleosome concept. Variations in chromosome numbers; haploidy, diploidy, polyploidy, aneuploidy, euploidy and polysomy. **6 Lectures**

Nucleic Acids: DNA structure, polymorphism (A, B and Z types) ; DNA replication (semi conservative mechanism) experiments of Meselson and Stahl(semi-conservative mode of DNA replication, elementary idea about polymerases, topoisomerases, single strand binding proteins, replication fork leading and lagging strands, RNA primers and Okazaki fragments; DNA repair mechanisms- excision repair; RNA structure and types (mRNA, rRNA and tRNA) ;Transcription in prokaryotes. **6 Lectures**

Genetic code and translation- Triplet code, characteristics of triplet code; Protein synthesis (translation) in Prokaryotes. **3 Lectures**

Unit-III

Cell in reproduction: Interphase nucleus and Cell Cycle: S, G_1, G_2 and M phase. Mitosis: Different stages, Structure and function of spindle apparatus; anaphasic movement. Meiosis: Different stages, synapsis, chiasmata and significance of crossing over. **5 Lectures**

Mendelism: Brief history of genetics and Mendel's work; Mendelian laws, their significance and current status. **3 Lectures**

Multiple gene inheritance: ABO blood groups and Rh factor and their significance. **2 Lectures**

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Genetic interaction: Supplementary genes, complementary genes, duplicate genes, epistasis, inhibitory and polymorphic genes. **5 Lectures**

Unit-IV

Mutation: definition, mutagens; Classification of mutation -based on cell types (somatic and germinal), based on origin (spontaneous and induced), based on size (gene and chromosomal); gene mutation (point mutation-substitution, insertion, deletion, frameshift mutation); chromosomal mutation- translocation, inversion, deletion and duplication. **4 Lectures**

Linkage and recombination- recombination frequency, chromosome mapping; Cytoplasmic inheritance.; Sex Linked inheritance. **3 Lectures**

Sex determination in Drosophila, and man **2 Lectures**

Pedigree analysis and genetic counselling; Eugenics and euthenics, genetic counselling **2 Lectures**

Genetic disorders: Down's, Turner's and Klinefelter's syndromes, colour blindness, Hemophilia, Phenylketonuria . **2 Lectures**

Population genetics: Hardy-Weinberg principle, factors affecting hardy-Weinberg equilibrium. **2 Lectures**

Suggested Books and References –

1. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter(2014),Garland Science, Taylor and Francis Group.
2. Molecular Biology of the Gene by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, and Richard Losick(2013),Pearson education.
3. The Cell: A Molecular Approach by Geoffrey M. Cooper and Robert E. Hausman
4. Principles of Molecular Biology by Burton E. Tropp,2009,ASM Press.
5. Concepts of Genetics, 10th Edition by William S. Klug, Michael R. Cummings, and Michael A. Palladino,2015,Pearson.
6. Genetics: Analysis and Principles, 6th Edition by Robert J. Brooker,2017,McGraw Hill
7. Human Heredity: Principles and Issues by Michael R. Cummings,2016,Cengage learning.
8. Principles of Genetics, 4th Edition by D. Peter Snustad and Michael J. Simmons (2005),Wiley.
9. Molecular Biology, 5th Edition by David Freifelder ,2012,Narosa Publishing House, India.
10. Molecular Cell Biology by Harvey Lodish et al. 2013,Freeman
11. Genomes by T.A. Brown,2018,CRC PRESS.
12. Human Molecular Genetics by Tom Strachan and Andrew P. Read,2018, Garland Science.
13. Modern Genetic Analysis by Anthony J.F. Griffiths et al. 2002.Freeman
14. Practical Methods in Molecular Biology by Robert F. Schleif and Perry C. Wensink ,2012.Springer Science & Business Media.
15. Basic Methods in Molecular Biology by Leonard Davis,2012. Elsevier.

Suggested E-Resources –

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1. Essentials of Cell Biology by C.M. O'Connor, J.U. Adams - NPG Education , 2010.
2. DNA Replication in Eukaryotic Cellsby Melvin L. Depamphilis (ed.) - Cold Spring Harbor Laboratory Press , 1996.
3. Cells: Molecules and MechanismsAxolotl Academic Publishing Co. , 2010.
4. A Guide to Genetic Counseling by Jane L. Schuette (Editor); Beverly M. Yashar (Editor); Wendy R. Uhlmann (Editor).ISBN: 9780470930533.Publication Date: 2010-08-03, - Axolotl Academic Publishing Co. , 2010.
5. Chromosome Abnormalities and Genetic Counseling by R. J. M McKinlay Gardner; Grant R. Sutherland; Lisa G. ShafferISBN: 0195375335 (2011).
6. Population Genetics(e-book)-2nd Edition- Matthew B. Hamilton –(2021) SBN: 978-1-118-43694-3.

Course Learning Outcome –

Upon completion of the course, students will be able to:

1. Understand about the structure and function of the basic unit of life i.e the cell.
2. The learner would know about the molecular mechanisms in cellular processes.
3. The learner would also know about the causes and types of injury to genetic component of cell under mutagenic stress.
4. The student would know about the symptoms and genetic conditions in common genetic disorders
5. The learner would also understand about the modes of gene transfer and various types of gene interactions.
6. The students would be able understand the concepts of genetic counselling for the improvement of genetic makeup of population.

UG0812-ZOO-63P-254-Practical based on Cell Biology & Genetics

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

Exercises based on Cell biology

1. Study of various cell types through slides or images: prokaryotic and eukaryotic cellular forms.
2. Janus green mitochondrial staining of in buccal epithelial cells
3. Isolation of genomic DNA from cheek cells.
4. Mitosis- Study of permanent slides.
5. Squash preparation and staining of onion root tips to identify the phases of mitosis.
6. Meiosis: Study of permanent slides.

Exercises based on Genetics

7. Problems based on genetics crosses (monohybrid and dihybrid)
8. Problems based on Hardy-Weinberg principle.
9. Study of Barr body in buccal epithelial cells
10. Study of Karyogram

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11. Ishihara test for colour blindness
12. Pedigree construction and analysis

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Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0802-ZOO-64T-255-Animal Physiology
IV-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
IV	UG0802-ZOO-64T-255 UG0802-ZOO-64P-256	Animal Physiology Practical based on Animal Physiology				6	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
6	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		III Semester					
Objectives of the Course:		The learning objectives of this course are as follows: 1. To achieve a thorough understanding of various aspects of physiological systems and their functioning in animals. 2. To expand their knowledge with respect to functioning of various organ systems such as muscular, nervous, digestive, circulatory, respiratory, excretory, reproductive and endocrine in animals. 3. To instill the concept of hormonal regulation of physiology, metabolism and reproduction in animals.					

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Detailed Syllabus
ZOO-64T-255-Animal Physiology

Unit – I

Physiology of digestion: Definition of digestion; various types of digestive enzymes and their digestive action in the alimentary canal, absorption and assimilation of the carbohydrates, proteins, and lipids, hormonal and neuronal control of digestion, disorders due to malnutrition, vitamins, and mineral deficiency. **9 Lectures**

Physiology of respiration: Definition of respiration; mechanism and control of breathing; exchange of gases: transportation of oxygen and carbon dioxide in blood; regulation of respiration, respiratory pigments. **6 Lectures**

Unit -II

Physiology of blood circulation: Composition and functions of blood; structure and function of haemoglobin; blood groups; mechanism of blood clotting; heartbeat; cardiac cycle; blood pressure; ECG: body temperature regulation. **8 Lectures**

Physiology of excretion: Kinds of nitrogenous excretory end products; Functional architecture of nephron, mechanism of urine formation, ornithine cycle; hormonal regulation of water and electrolyte balance (Homeostasis); osmoregulation in animals. **7 Lectures**

Unit -III

Physiology of nerve impulse: Functional architecture of a neuron, types of neurons; action potential; origin and propagation of nerve impulse, types of synapses; synaptic transmission, reflex arc, and central control of reflex action. **8 Lectures**

Physiology of muscle contraction: Type of muscles; functional architecture of skeletal muscles; neuromuscular junction; chemical and biophysical events during contraction and relaxation of muscle fibres. **7 Lectures**

Unit-IV

Physiology of reproduction: Functional architecture of testis and ovary; Control and regulations of testicular and ovarian functions; female reproductive cycles, implantation, parturition, and lactation in mammals. **9 Lectures**

Physiology of endocrine glands: type of endocrine glands and their secretions and functions: Pituitary, adrenal, thyroid, pancreas**,** mechanism of hormone action, feedback mechanism, hypothalamic control of pituitary function. **6 Lectures**

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Suggested Books and References –

1. A Text Book of Medical Physiology, Arthur C. Guyton MD, Eleventh ed., JohnE. Hall, Harcourt Asia Ltd.
2. Animal Physiology, Roger Eckert and Randal, 4th ed, Freeman Co, New York.
3. Text Book of Animal Physiology, Veer Bal Rastogi, Kedarnath Ramnath, Meerut.
4. Animal Physiology, Eckert R., Randall D. J., Burggen W., French K., 1997, Burggren WW & Co. Ltd.
5. Practical Zoology, Lal SS, 014, Rastogi Publications.
6. Lehninger Principles of Biochemistry, Nelson DL and Cox MM, 2013, 6th edition W. H. Freeman.
7. Animal Physiology and Biochemistry, Sastry KV. 2nd edition Rastogi Publications.
8. Animal Physiology, Verma PS, Tyagi BS, Agarwal VK, 2004, 6th edition S. Chand& Co.
9. Biochemistry, Voet D and Voet JG, 2011, 4th edition, John Wiley & Sons, Inc.
10. Concepts of Biochemistry, Gupta S.N., Rastogi Publications Meerut.
11. Zoology for Degree Students, Agarwal VK, S Chand and Company New Delhi.
12. Principles of Anatomy and Physiology, Tortora, G.J. and Derrickson, B.H., 2009, XII Edition, John Wiley & Sons, Inc.

Suggested E-resources –

1. National Institute of Science Communication & Information Resources (NISCAIR) http://nsdl.niscair.res.in/
2. National digital library of India (NDL. India) http://ndl.iitkgp.ac.in/
3. https://onlinecourses.swayam2.ac.in/cec19_bt02/preview
4. https://onlinecourses.nptel.ac.in/noc20_bt42/preview (Animal Physiology)
5. Virtual Labs (http//www.vlab.co.in)
6. http://www.ignouhelp.in/ignou-lse-05-study-material/ Animal Physiology (English Hindi)http://rastogipublications.com/Rastogi-Publications-SUCHIPATRA-2022-23-Mail.pdf
7. http://rastogipublications.com/Rastogi-Publications-SUCHIPATRA-2022-23-Mail.pdf
8. https://www.schandpublishing.com/books/higher-education/sciences /zoology-degree-students-semester-iv/9789352534104/
9. https://www.scribd.com/document/696830782/A-K-Jain-Physiology-Practical-Manual

Course Learning Outcomes –

By studying this course, students will be able to

- Have an enhanced knowledge and appreciation of animal physiology.
- Recognize and identify principal tissue structures and functions.
- Better understand the functions of important physiological systems including the nervous system, muscular system, endocrine and reproductive system
- Learn an integrative approach to understand how these separate systems interact to yield integrated physiological responses to maintain homeostasis in the body along with feedback mechanisms.
- Develop a strong foundation for research & employability skills.
- Improve the student's perspective of health biology through deep study of physiology.

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UG0802-ZOO-64P-256-Practical based on Animal Physiology

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

1. Counting of RBCs using Haemocytometer.
2. Counting of WBCs using Haemocytometer.
3. Estimation of hemoglobin by Sahli's method.
4. Estimation of haematocrit value (PCV).
5. Preparation of Blood smear using Wright's/Leishman stain to study different cell types.
6. Demonstration of enzyme activity (catalase) in the liver.
7. Study the effect of pH and temperature on salivary amylase activity.
8. Study of histological sections of various digestive organs: stomach, intestine, spleen, liver.
9. Study of histological sections of major endocrine glands: pituitary, parathyroid, thyroid, pancreas, adrenal gland, testis, and ovary.
10. Estimation of normal and exerted blood pressure.
11. Study of blood clotting time.
12. Glucose estimation in blood/ urine.

*Computer aided techniques should be adopted as per UGC guidelines.

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.

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4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0802-ZOO-64T-257-Environmental Biology & Wildlife
IV-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
IV	UG0802-ZOO-64T-257 UG0802-ZOO-64P-258	Environmental Biology & Wildlife Practical based on Environmental Biology & Wildlife	6	6

Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
6	Major	4	2	6	No	Lectures and Practical

List of Programme Codes in which Offered as Minor Discipline	NA
Prerequisites	III Semester
Objectives of the Course:	The learning objectives of this course are as follows: 1. To develop a comprehensive and advanced understanding of ecological principles and the intricate relationships between organisms and their environment. 2. To gain in-depth knowledge of the ecological processes and interactions that govern ecosystems. 3. To critically evaluate the impact of human activities on ecosystems and the environment. 4. To know both the local and global environmental issues. 5. To learn advanced techniques and methodologies for the study, conservation, and management of wildlife and natural habitats. 6. To introduce and analyze the concept of sustainable development and its critical role in environmental conservation. 7. To foster skills in scientific research, data analysis, and interpretation within the fields of ecology and wildlife studies.

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Detailed Syllabus
ZOO-64T-257-Environmental Biology & Wildlife

Unit -I

Basic Concepts in Ecology: Definitions and scope of Ecology; Historical development of ecological thoughts; Organization levels of ecological system; concept of limiting factors; habitat and niche; Biogeography: Major terrestrial and aquatic biomes; Biogeographical zones of India. **5 Lectures**

Ecosystems: Definition and concept of ecosystem; structure of ecosystem (Biotic and abiotic components); Function of ecosystem: physical (energy flow), biological (trophic level, food chain, food web) and biogeochemical (nutrient cycling); concept of productivity; ecological pyramids. **5 Lectures**

Population and Community Ecology: Concept of population, meta-population; life history models (r and K selection); Community structure and organization; species diversity (α, β and γ); species interaction (positive and negative); Ecological succession. **5 Lectures**

Unit -II

The Physical Environment and Global environmental problems: Lithosphere, Hydrosphere, Atmosphere; Environmental pollution and management; Global warming, Climate change, Impact of climate change on ecological systems, Ozone depletion. **5 Lectures**

Sustainable Development and International conventions: Consumerism, Carbon footprint; Sustainable development- principles and practices in relation to economics and ecology, Sustainable Development Goals; Convention on Biological Diversity; Convention to Combat Desertification (UNCCD); United Nations Framework Convention on Climate Change (UNFCCC). **5 Lectures**

Environmental Administration and Laws: MoEFCC, National Biodiversity Authority, Central Pollution Control Board, National Green Tribunal (NGT), Concept of Environmental Auditing (EA), Environmental Impact Assessment (EIA); The water (Prevention and Control of Pollution) Act 1974; The Environment Protection Act (1986). **5 Lectures**

Unit- III

Environmental hazards with special reference to Rajasthan: Silicosis, Fluoride toxicity, Uranium Poisoning, Lead Poisoning, Water scarcity, Droughts, Lightening, Heat stroke, Pesticide toxicity, Land degradation, Desertification. **5 Lectures**

Environmental Microbiology: Microbes in soil; Role of microbes in nitrogen fixation; Microbes in solid waste management; Microbial biogeochemical process of nutrient cycling;

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Use of bioindicators and biosensors in environmental monitoring; Biodegradation; Bioremediation; Bioleaching. **5 Lectures**

Environmental Biotechnology: Role of microbes in control of pollution; Waste water Treatment: Anaerobic and aerobic process, treatment scheme for waste water from dairy, tannery, and textile industries; Biodegradation of xenobiotics, hydrocarbons, Oil spills, pesticides; Biopesticides; Biofertilizers; Biomass and Biofuel. **5 Lectures**

Unit-IV

Introduction to wildlife: Current state of wildlife in India; Analysis of behaviour pattern of wild animals- taxis, kinesis and reflexes; Types of animal communications, Social behaviour in animals - Honey bees, Elephants. Human Wildlife Conflict. **5 Lectures**

Wildlife Techniques: Direct count (block count, transect methods, Point counts, visual encounter survey, waterhole survey); Indirect count (Call count, track and signs, pellet count, pugmark, camera trap); Capture-recapture techniques; Remote sensing in Wildlife management; Wildlife forensics. **5 Lectures**

Wildlife Conservation: *In-situ* and *ex-situ* conservation methods; Captive breeding: Aims, Principles, methods; Wildlife Projects (Tiger, Elephant, Lion and Hangul); Role of Government and Non-Governmental organizations in conservation: National Board for Wildlife, Wildlife Institute of India (WII), Forest Research Institute (FRI), Wildlife (Protection) Act, 1972. **5 Lectures**

Suggested Books and References –

1. Krebs, C.J. (2016). *Ecology: The Experimental Analysis of Distribution and Abundance*. Pearson Education Inc.
2. Odum, E.P., & Barrett, G.W. (1971). *Fundamentals of Ecology*. Saunders.
3. Smith, R.L. (1996). *Ecology and Field Biology*. Harper and Row Publishers.
4. Sutherland, W.J. (2000). *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences.
5. Odum, E.P., & Barrett, G.W. (2008). *Fundamentals of Ecology* (5th Indian Edition). Brooks/Cole.
6. Smith, T.M., & Smith, R.L. (2015). *Elements of Ecology* (9th International Edition). Benjamin Cummings.
7. Sharma, P.D. (2010). *Ecology and Environment* (8th edition). Rastogi Publications, Meerut, India.
8. Rana, S.V.S. (2005). *Essentials of Ecology and Environmental Sciences*. Prentice Hall of India, New Delhi.
9. Hawksworth, D. (2006). *Methods and Practice in Biodiversity Conservation*. Springer Publication.
10. Berwick, S.H., & Saharia, V.B. (1995). *Wildlife Research and Management*. OUP, New Delhi. 481pp.
11. Rajesh, G. (1989). *Fundamentals of Wildlife Management*. Justice Home, Allahabad.
12. Caughley, G., & Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.

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13. Bookhout, T.A. (1996). *Research and Management Techniques for Wildlife and Habitats* (5th edition). The Wildlife Society, Allen Press.
14. Hunter, M.L., Gibbs, J.B., & Sterling, E.J. (2008). *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
15. Li, R. (2015). *Forensic Biology* (2nd edition). CRC Press.
16. Rogers, W.A. (2006). *Techniques for Wildlife Census in India (A Field Manual)*. Wildlife Institute of India, Dehradun.
17. Majupuria, T.C. (2006). *Wildlife Wealth of India*. Tecpress Services, L.P., Bangkok, Thailand.
18. Saharia, V.B. (1982). *Wildlife in India*. Natraj Publishers, Dehradun.
19. Bahuguna, A., Sahajpal, V., Goyal, S.P., Mukherjee, S.K., & Thakur, V. (2010). *Species Identification from Guard Hair of Selected Indian Mammals: A Reference Guide*. Wildlife Institute of India.

Suggested E-Resources –

1. vlab.iitb.ac.in/vlab
2. https://cdsp.imdpune.gov.in/index.php#projects
3. https://cdsp.imdpune.gov.in/home_vivaranika_climateinfo.php

Course Learning Outcome –

- Demonstrate an advanced understanding of ecological principles and the functioning of ecosystems.
- Analyze and synthesize information on the interactions between organisms and their environment, considering both biotic and abiotic factors.
- Critically assess the impact of human activities on natural ecosystems and formulate evidence-based solutions for mitigation.
- Recognize and articulate the importance of biodiversity and wildlife in maintaining ecosystem stability and health.
- Apply the knowledge of local environmental issues and be able to contribute in policy issues.
- Develop and implement strategies for the effective conservation and management of wildlife and natural habitats.
- Critically evaluate and influence environmental policies and practices through informed scientific reasoning and advocacy.

UG0802-ZOO-64P-258-Practical based on Environmental Biology & Wildlife

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

Exercises in Ecology

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1. Study of Biomes of the world through map and online maps.
2. Study biogeographical zones of India using a map.
3. Geotagging of the site and creating a Google map of an ecological site.
4. Measurement of abiotic factors of any aquatic ecosystem: Temperature, Humidity, pH, DO.
5. Analysis of biotic factors of any aquatic ecosystem: Phytoplankton and zooplankton.

Exercises in Environmental Biology

6. Study of soil texture using micrometry, moisture content.
7. Study of population dynamics through numerical problems.
8. Study of environmental problems prevailing in the local area and pollution case studies (a report of the same can be prepared based on local survey. At least 1 case studies should be conducted).
9. Report on web-based climate and biodiversity tools of the Government of India:
   - RITU RANG (IMD): https://cdsp.imdpune.gov.in/index.php#projects
   - VIVARANIKA: https://cdsp.imdpune.gov.in/home_vivaranika_climateinfo.php

Exercises in Wildlife Studies

10. Demonstration of basic equipment needed in wildlife studies (use, care, and maintenance):
    i. Compass
    ii. Binoculars
    iii. Spotting scope
    iv. Range finders
    v. Global Positioning System
    vi. Various types of cameras and lenses.
11. Familiarization and study of animal evidence in the field; Identification of animals through pug marks, hoof marks, pellet groups, nest, antlers, etc.
12. Hair samples: Species identification of selected mammals (minimum five, slides to be submitted) and Morphometric studies.

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

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*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-75T-351-Evolution
V-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
V	UG0812-ZOO-75T-351 UG0812-ZOO-75P-352	Evolution Practical based on Evolution				7	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
7	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		IV Semester					
Objectives of the Course:		By the end of studying this course, students will be able to: 1. Gain a comprehensive understanding of life and the natural world through the study of evolutionary biology, the fundamental link connecting all living organisms from prokaryotes to advanced eukaryotes. 2. Analyze the processes and patterns of biological evolution, with a particular emphasis on the development and advancement of evolutionary theory. 3. Understand the various forces that lead to variations within populations of a species and drive the diversification into new species. 4. Develop skills to interpret diverse types of evidence, including fossil records and molecular data, and use this evidence to establish phylogenetic relationships among species.					

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Detailed Syllabus
ZOO-75T-351-Evolution

Unit - I

Concept of Evolution – Pre-Darwinian ideas, Lamarckism and Darwinism (Merits and demerits). Post-Darwinian era - Modern synthetic theory. **4 Lectures**

Origin of life on Earth – Chemogeny, cellular evolution, origin of photosynthesis, evolution of Eukaryotes from Prokaryotes. **4 Lectures**

Evidences in favour of evolution – Morphology, comparative anatomy, embryology, Palaeontology, Geographical distribution Taxonomy, connecting link, cytological, Biochemistry and physiology. **7 Lectures**

Unit -II

Mechanism of Evolution – Variations, mutations, recombination, polyploidy, isolation, Polymorphism.

4 Lectures

Natural Selection – Concept, prerequisites, types and levels (k-selection, r-selection) of natural selection. **3 Lectures**

Concepts of species and speciation – Allopatric, sympatric, parapatric speciation. Subspecies categories, Clines, demes and clades. **3 Lectures**

Molecular phylogeny – Concept of molecular Phylogeny, phylogeny of horse and molecular drive. **5 Lectures**

Unit -III

Adaptation – Kind of adaptation, Divergent, parallel and causes of Adaptation, Mimicry and Protective coloration. **3 Lectures**

Population Genetics, Gene Frequency, Genetic Equilibrium: Population genetics, Genetic drift (Bottleneck and Founder effects), Hardy-Weinberg Law of equilibrium, Hardy-Weinberg principal and evolution. **4 Lectures**

Micro and Macro evolution: Microevolution- Micro evolutionary forces, mechanism of micro evolution, sequential evolution, examples of micro evolution; Macro evolution- Mechanism of macro evolution, essential features of macro evolution and examples of macro evolution. **4 Lectures**

Evolution of humans: Introduction, history of human evolution, major sites of human fossils, places and time of origin of man, primate heritage, pre-human ancestors, future of human. **4 Lectures**

Unit-IV

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Animal Distribution: Aspects of animal distribution, pattern of animal distribution, theories of animal distribution, factors influencing animal distribution, barriers and means of dispersal. **5 Lectures**

Zoogeographical Distribution– Principles and concept, Zoogeographical realms, i) Arctogean realm, ii) Neogean realm, iii) Notogean realm. Wallace's Line and Weber's Line. **7 Lectures**

Continental drift: Concept of continental drift, Evidences to support continental drift, Mechanism of continental drift, Biological effects of continental drift; Theory of Plate Tectonics, Result of plate tectonics. **3 Lectures**

Suggested Books and References –

1. Evolution, Ridley, M., 2004, Blackwell Publishing.
2. Evolution. V Edition, Hall, B.K. and Hallgrimson, B., 2013, Jones and Barlett Publishers.
3. Evolutionary Biology, Futuyma, D. J., 1997, Sinauer Associates.
4. Bioinformatics and Functional Genomics. II Edition, Pevsner, J., 2009, Wiley-Blackwell
5. Biology. IX Edition, Campbell, N.A. and Reece J.B., 2011, Pearson, Benjamin, Cummings.

Suggested E-resources –

1. https://swayam.gov.in/courses/4062-environmental-biology-genetics-and-evolution
2. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202003291608409972geetanjali_Process_of_evolution.pdf
3. https://egyankosh.ac.in/bitstream/123456789/65792/1/Unit6.pdf

Course Learning Outcomes –

1. Learn how to solve difficulties and apply higher level analytical abilities by taking on numerical challenges of different evolutionary processes.
2. Use newly acquired information to analyse behaviour, speciation, and disease susceptibility in populations in real time.
3. Learn how different species' evolutionary histories and the environments in which they inhabit interact.
4. Become inspired to work towards climate change mitigation in order to prevent the extinction of well-adapted species due to abrupt, severe changes in the environment.
5. To make sure that conservation efforts for tiny, vulnerable populations are directed in the proper direction, use the knowledge obtained from the study of variations and genetic drift.
6. Forecast the real-world effects of different evolutionary processes on the human population in the area of health.

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UG0812-ZOO-75P-352-Practical based on Evolution

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

1. Study of evolution of man with help of models
2. Study and verification of Hardy-Weinberg Law by chi square analysis.
3. Numerical problems based on population genetics
4. Study of fossils from models/pictures.
5. Study of homology and analogy from suitable specimens.
6. Construction of cladograms based on morphological characters.
7. Study of variations in a sample human population, Continuous variation: Height/Weight in relation to age and sex.
8. Study of variations in a sample human population, Discontinuous variation: Ability/Inability to taste Phenyl thiocarbamide (PTC).
9. Study any two tectonic plates, their locations and importance using maps.
10. Find out from newspapers and popular science articles any new fossil discoveries or controversies about evolution.
11. Study and role of connecting links in evolution.

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.

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3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-75T-353-Nanobiotechnology
V-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
V	UG0812-ZOO-75T-353 UG0812-ZOO-75P-354	Nanobiotechnology Practical based on Nanobiotechnology				7	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
7	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		IV Semester					
Objectives of the Course:		By the end of studying this course, students will be able to: 1. Understand and apply basic concepts of nanotechnology. 2. Understand the science of nanomaterials. 3. Learn about properties of bulk and nanomaterials. 4. Know about the different methods of synthesis of nonmaterial. 5. Understand the instrumental techniques for characterization of nanomaterials					

Detailed Syllabus
ZOO-75T-353-Nanobiotechnology

Unit - I

Introduction to Nanobiotechnology: Define nanotechnology, its multidisciplinary nature, and its relevance to biology and medicine. Historical development of nanotechnology.

6 Lectures

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The Nanoscale: Unique properties of materials at the nanoscale: quantum effects, surface-area-to-volume ratio, surface functionalization. **3 Lectures**

Types of Nanomaterials and their unique properties: Zero-dimensional (0D): Nanoparticles, quantum dots. One-dimensional (1D): Nanotubes, nanowires. Two-dimensional (2D): Nanosheets, graphene. Three-dimensional (3D): Nanocomposites, bulk nanostructured materials **6 Lectures**

Unit -II

Basic Concepts of Nano Fabrication: Top-down and Bottom-up approaches; Physical Techniques; Chemical Methods; Self-Assembly; Green synthesis. **7 Lectures**

Characterization of materials: Basic principles and applications of UV-Vis-NIR, FTIR, XRD, SEM, TEM, AFM. **8 Lectures**

Unit -III

Applications of Nanotechnology in medicine: Nano-medicine, Bio-Pharmaceuticals **3 Lectures**

Applications of Nanotechnology in diagnostics: Implantable Materials Implantable Devices, Surgical Aids, Diagnostic Tools, Genetic Testing, Imaging, Nanoparticles Probe. **6 Lectures**

Applications of Nanotechnology in delivery: Nanocarriers for Drug Delivery; Protein delivery; Liposomes for Genetic Vaccines and cancer therapy; Nanobiosensors. **6 Lectures**

Unit-IV

Environmental Applications of Nanotechnology: Water treatment: Nanofiltration, photocatalysis.; Air purification: Nanocatalyst, air filters.; Soil remediation: Nanoparticles for pollutant degradation. **7 Lectures**

Nanotechnology for Sustainable Development and Safety concerns: Renewable energy: Nanomaterials in solar cells, fuel cells. **5 Lectures**

Environmental impact of Nanomaterials: Toxicity, persistence, and bioaccumulation; Human health impact: Exposure routes, safety protocols. **3 Lectures**

Suggested Books and References –

1. Nanotechnology: Basic Science & Emerging Technologies," Mick Wilson, Kamali Kannangara & Geoff Smith, 2005, Overseas Press India Private Limited.
2. Introduction to Nanotechnology," Frank J. Owens & Charles P. Poole, 2003, Wiley-IEEE.

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3. Nano biotechnology: Concepts, Applications and Perspectives, Christ of M.
4. Niemeyer, 2004, Wiley.
5. Handbook of Nanostructured Materials and Nanotechnology," vols. 1-5, H. S. Nalwa (Ed.), 2000, Academic Press.
6. Encyclopaedia of Nanoscience & Nanotechnology," H. S. Nalwa, 2004, American Scientific Publishers.
7. Vladimir P.T., "Nanoparticulates as Drug Carriers", 2006, Imperial College Press.
8. Nanobiotechnology, Ninmeyer C.M, Mirkin, 2005, C.A (Eds).
9. K.K.Jain, Nano Biotechnology, 2006, Horizions Biosciences.

Suggested E-resources –

1. https://www.nsf.gov/news/classroom/nano.jsp
2. https://www.nano.gov/about-nanotechnology
3. https://archive.nptel.ac.in/courses/118/107/118107015/

Course Learning Outcomes –

Upon completing the course:

1. Students will have the basic knowledge of nanoscience and nanotechnology and will understand different types of nanomaterials, such as nanoparticles, nanotubes, and nanolayers.
2. They will be able to recognize various characterization techniques available for the studying different nanomaterials.
3. Introduce the concept of nanomaterial green synthesis and their potential applications in the field of medicine, drug delivery and diagnostics.
4. Develop the concept of interaction of nanomaterials with environment and living systems.

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UG0812-ZOO-75P-354-Practical based on Nanobiotechnology

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

1. Synthesis of nanoparticles by Chemical method.
2. Synthesis of nanoparticles by hydrothermal method.
3. Green synthesis of nanoparticles.
4. UV/VIS Spectrophotometric Analysis of nanomaterials.
5. XRD result analysis of nanomaterials.
6. SEM/TEM result analysis of nanomaterials.
7. Comparative study of nanoparticles types through chart.
8. Imaging of fluorescent nanoparticles in cells (Bacteria/Drosophila/Protozoans).
9. Study the effect of nanoparticles on Zooplanktons/Phytoplanktons.

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-76T-355-Immunology & Microbiology
VI-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
VI	UG0812-ZOO-76T-355 UG0812-ZOO-76P-356	Immunology & Microbiology Practical based on Immunology & Microbiology				7	6
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Student**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
7	Major	4	2	6	No	Lectures and Practical	
List of Programme Codes in which Offered as Minor Discipline		NA					
Prerequisites		V Semester					
Objectives of the Course:		1. This course is designed to provide students with a solid foundation in immunology and microbiology. 2. By delving into the intricacies of immune responses and their pivotal role in disease prevention and control, students will gain a comprehensive understanding of the human immune system. 3. Furthermore, the course will explore the vast diversity of microorganisms, their significance in causing diseases, and their potential contributions to various industries. 4. Through hands-on laboratory experiences, students will develop proficiency in essential immunological and microbiological techniques, fostering critical thinking and problem-solving skills					

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Detailed Syllabus
ZOO-76T-355-Immunology & Microbiology

Unit-I

Immunity: Types: Active and passive immunity, innate and acquired, specific and non-specific immunity. **4 Lectures**

Introduction to components of immune system- primary and secondary lymphoid organs,Cells of immune system. **3 Lectures**

Antigens: Essential features of Antigen, haptens, Carrier molecule, Immunological valence, Antigenic determinants. **3 Lectures**

Antibodies: Primary structure of immunoglobulins, light chain, heavy chain, variable region, constant region. Types –IgG, IgM, IgA, IgD and IgE (structure and functions). Monoclonal antibodies and their production. **5 Lectures**

Unit-II

Cell mediated immunity, humoral immunity **2 Lectures**

Interferons, Null cells, Natural Killer cells. Complement system **3 Lectures**

T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors **3 Lectures**

Major Histocompatibility complexes – Class I & Class II MHC antigen processing. **2 Lectures**

Auto-immune diseases; organ specific (Myasthenia gravis, Addison disease), systemic (systemic lupus erythematosus) **3 Lectures**

Brief idea about hypersensitivity **2 Lectures**

Unit-III

History of microbiology- Contribution of Anton van Leeuwenhoek, Louis Pasteur, Edward Jenner, Robert Koch to the field of microbiology, Theory of spontaneous generation, Germ theory of disease **4 Lectures**

Basic characteristics of bacteria, Fungi,virus, rickettsiae, mycoplasmas **3 Lectures**

Ultrastructure of Bacteria- flagella, capsule, cell wall, cell membrane, cytoplasm, chromosome, plasmids, bacterial growth cycle **4 Lectures**

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Bacterial reproduction- Sexual reproduction (transformation, conjugation, transduction), asexual reproduction (binary fission, budding, fragmentation) **4 Lectures**

Techniques in microbiology: Gram's staining, pure culture techniques, growth conditions (temperature, pH , nutrients) **4 Lectures**

Unit-IV

Bacterial borne diseases (causative agent, pathology, treatment, prevention)-Diphtheria, meningitis, tuberculosis, botulism, tetanus **5 Lectures**

Virus borne diseases (causative agent, brief pathology, treatment, prevention) - herpes, influenza, polio, AIDS, COVID-19 **5 Lectures**

Application of microbes in dairy, beverages, fermented food industry, petroleum and metal refinery, decomposition of xenobiotics **3 Lectures**

Physical and chemical means to control microorganisms- heating, drying, UV light, filtration, use of disinfectants, antiseptics **2 Lectures**

Suggested Books and References –

1. Essential immunology- Ivan M. Roitt.
2. Introduction to Immunology – John W.Kinball.
3. Immunology – D.M. Weir.
4. Fundamentals of microbiology by Edward Alcamo.benjamin/cummings publishing company,Inc.
5. Prescott's Microbiology by Joanne.M.Willey,LindaSherwood,Christoppher J. Woolverton,2017. McGraw-Hill Education
6. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2007). Kuby Immunology (6th ed.). New York: W.H. Freeman and Company.
7. Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2019). Kuby Immunology (8th ed.). New York: W.H. Freeman and Company.
8. Abbas, A.K. & Lichtman, A.H. (2001). Basic Immunology: Functions and Disorders of Immune System. US: W.B. Saunders.
9. Microbiology -concepts and applications: Micheal Joseph Pelczar,Eddie Chin Sun Chan,Noel R. Krieg. McGraw-Hill Education
10. Microbiology: A Laboratory Manual Spiral-bound – 2020:by James G. Cappuccino (Author), Natalie Sherman (Author).
11. Delves, P.J., Martin, S.J., Burton, D.R., &Roitt, I.M (2011). Roitt's Essential Immunology (12thed.). New Jersey, USA: John Wiley & Sons Ltd.
12. Textbook of Applied Microbiology and Infection Control: Including Safety Paperback – 4 January 2024 by I Clement (Author).Jaypee publishers.
13. Vaccines A Clinical Overview And Practical Guide 2021 By Domachowske J.Springer

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Suggested E-resources –

1. Bacterial structure: https://www.bellarmine.edu/faculty/dobbins/Secret%20Readings/Lecture%20Notes%20313/Ch03_.pdf Presscott.Wiley chapter 3.
2. Bacterial growth curve and growth rate: https://www.iitg.ac.in/biotech/MTechLabProtocols/Expt-2%20(Specific%20Growth%20Rate).pdf
3. Hybridoma technology https://www.ndvsu.org/images/StudyMaterials/Micro/Hybridoma-Technology-and-mAbs.pdf
4. Vaccines: https://www.bu.edu/ceid/files/2021/07/Types-of-nes.pdf

Course Learning Outcome –

- The student shall learn about the basic immunological processing which can prevent the body from diseases
- The student would be able to understand the importance of healthy body with specific and non-specific immune system.
- Students shall also be able to apply the fundamental knowledge of immune function and how the immune response can cause immunopathology such as allergy, autoimmunity as well as the consequences of a lack of effective immune function as in immunodeficiency.
- The syllabus of microbiology provides brief but comprehensive information about microbial diversity, growth and threats associated with microbial infections. The students will also know about the treatment, prevention and control of diseases caused due to microbes.
- The student shall also learn the importance of microbes in various industries and environmental bioremediation.

UG0812-ZOO-76P-356-Practical based on Immunology & Microbiology

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

I. Exercises based on Immunology

1. Antigen-Antibody reactions – Agglutination (Blood grouping testing).
2. Differential staining of blood cells
3. Slide study- spleen, thymus, lymph nodes
4. Antibody titration (Ouchterlony Double Diffusion).

II. Exercises based on Microbiology

5. Use and working of laminar air flow and autoclave

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6. Basic instruments used in microbiology-hot plate, incubator, colony counter, oven, microscope.
7. Culture media preparation for bacteria.
8. Bacterial culture technique -spread plate, pour plate and streaking
9. Slide preparation and identification of any two fungi.
10. Gram's staining to identify gram positive and gram negative bacteria.
11. Methylene blue staining of bacteria
12. Effect of temperature on bacterial growth

Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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UG0812-ZOO-76T-357-Biochemistry & Biostatistics
VI-Semester - Zoology

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
VI	UG0812-ZOO-76T-357 UG0812-ZOO-76P-358	Biochemistry & Biostatistics Practical based on Biochemistry & Biostatistics	7	6

Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
7	Major	4	2	6	No	Lectures and Practical

List of Programme Codes in which Offered as Minor Discipline	NA
Prerequisites	V Semester
Objectives of the Course:	The learning objectives of this course are as follows: 1. To provide students with an understanding of the four major biomolecules, the basic building blocks of living organisms, focusing on their structure, unique properties, biological roles, and functions. 2. To obtain clarity on the interrelations of biomolecules in the system. The course will outline the importance of protein, carbohydrates, lipids, nucleic acid, vitamins, and enzymes as vital ingredients of life. 3. To provide students with an understanding of mean, mode, median, standard error and deviation. 4. The objective of biostatistics is to advance statistical science and its application to problems of human health and disease.

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Detailed Syllabus
ZOO-76T-357-Biochemistry & Biostatistics

UNIT -I

Carbohydrates: Classification & biological importance of carbohydrates, Structure of Monosaccharides, Stereochemistry of Monosaccharides & diastereomers. Reactions of fructose and glucose, Elucidation of open chain structure of glucose. Mutarotation. Disaccharide: Establishment of glycosidic linkage in sucrose, maltose, and lactose. Deoxyribose & ribose sugar. Polysaccharides: Types, Partial structure, starch, glycogen, inulin, cellulose, chitin, pectin. Metabolism of Carbohydrates: Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogen Metabolism. **7 Lectures**

Lipids: Classification and biological role of lipids. Fatty acids nomenclature, structure & properties of saturated, unsaturated, essential fatty acids. Triacylglycerol nomenclature, physical properties, Chemical properties (hydrolysis, esterification, Rancidity of fats, saponification value, iodine value, Acid value) and significance. Biological significance of fats. Phospholipids: Glycerophospholipids and Sphingophospholipids. Glycolipids, Lipoprotein, Steroids. Metabolism of Lipids: Fatty acid oxidation, Ketone bodies, Biosynthesis of fatty acids, Synthesis of Triacylglycerols. **8 Lectures**

UNIT-II

Proteins: Classification based on solubility, nutrition & functions. Protein structure: Primary, secondary (helix and pleated sheet), tertiary and quaternary. Amino acids: common structural features, stereoisomerism, R & S notations. Structure & classification of standard amino acids. Essential and non-essential amino acids. pH titration curve, isoelectric pH of amino acids & pKa value. Peptides: structure of peptide bond. Forces stabilizing the secondary, tertiary and quaternary structures of proteins. Denaturation and renaturation of proteins. **9 Lectures**

Nucleic acids: Introduction, nitrogenous bases: purines and pyrimidines. Nucleosides and nucleotides: structure and properties, phosphodiester bonds. Types and functions of DNA and RNA. Biological importance of DNA and RNA. Nucleic acid chemistry: UV absorption, effect of acid and alkali on DNA. **6 Lectures**

UNIT-III

Vitamins: Fat-soluble - A, D, E, & K: structural formula, dietary sources, requirements, deficiency symptoms and biological role. Water soluble vitamins –B complex (B1, B2, B6, Niacin, Folic Acid, Biotin, Pantothenic acid, Vitamin B12) and Vitamin C: Structural formula, coenzyme forms, biological role, deficiency symptoms and dietary sources. **9 Lectures**

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Enzymes: History, general characteristics, nomenclature, IUB enzyme classification with the suitable example, Definitions with examples: Holoenzyme, apoenzyme, coenzyme, cofactors, prosthetic groups, activators, inhibitors, metalloenzymes. Active site characteristics, Isoenzymes, monomeric enzymes, oligomeric enzymes, multienzyme complexes. Enzyme specificity, different types with suitable examples. **6 Lectures**

UNIT-IV

Introduction: Application and uses of Biostatistics as a Science, as figures, Scope, Common Statistical Terms, and Notations. **2 Lectures**

Sources and Presentation of Data: Qualitative (or discrete) data, Quantitative (or continuous data), Methods of presentation, and Frequency distribution drawings. **3 Lectures**

Measures of Central Tendency: Averages, Definition, Objectives of an Average, Types of Averages-Mean, Median, Mode with merits and demerits. **5 Lectures**

Variability and its Measures: Need and Definition, Measures of Dispersion, Biological, Real, Experimental, Measures of Variability, Range, Mean deviation, Standard Deviation (SD), Coefficient of Variation (CV), Standard error of Mean. **5 Lectures**

Suggested Books and References –

1. Fundamentals of Biochemistry by J.L Jain,(2005) 6th Ed, S. Chand & Co Ltd.
2. Principles of Biochemistry:Lehninger (2013) 6th ed., Nelson, D.L. and Cox, M.M.
3. Biochemistry of Biomolecules: Ritu kamal (2006) Paragon Int. Publisher.
4. Biochemistry: Donald, V. and Judith G.V.,(2011) 4th ed.John Wiley & Sons Asia Pvt. Ltd.(New Jersey), ISBN:978-1180-25024.
5. Biochemistry : Garret, R. H. and Grisham, C.M., (2010) 4th ed.,Cengage Learning (Boston), ISBN-13:978-0-495-11464-2
6. Biochemistry : by U. Satyanarayana and U. Chakrapani (2011) 4th edition, Elsevier.
7. Harper's Biochemistry: Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W.,(2012) 29th ed. Lange Medical Books/McGraw Hill. ISBN: 978-0-07-176-576
8. Fundamentals of Statistics :Goon, A.M., Gupta, M.K. and Dasgupta, B. (2002). Vol. I, 8th Ed. The World Press, Kolkata.
9. Mathematical Statistics with Applications, Miller, I. and Miller, M. (2006).7th Ed., Pearson Education, Asia.
10. Introduction to the Theory of Statistics Mood, A.M., Graybill, F.A. and Boes, D.C. (2007). 3rd Ed., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
11. Introduction to Biostatistics and Research Methods. Sunder Rao PSS and Richard J(2012):PHI Publishers.
12. A first course in Probability, Ross, S.M. (2002). 6th Ed., Pearson.
13. Introductory statistics,Ross, S. M. (2010). 3rd Ed., Academic Press.

Suggested E – Resources –

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1. https://www.bing.com
2. https://www.ocw.mit.edu/cources
3. https://wwwbio.libretexts.org/bookshelves
4. http://www cengageasia.com/title.
5. https://coursera.org.

Course Learning Outcome –

- Appreciate the role of biomolecules as building blocks of biological systems ,thorough with chemical and molecular foundations of life.
- Able to write the structure, function and properties of carbohydrates, lipids, proteins and nucleic acids.
- Learn the types, nature and biological importance of enzymes in living systems, and gain insight into the classification of vitamins.
- Develop clear, concise, and accurate mathematical proofs, represent relevant structures and relationships .

UG0812-ZOO-76P-358-Practical based on Biochemistry & Biostatistics

Duration: 4 Hrs

Max. Marks: 10+40 Marks **Min. Marks: 4+16 Marks**

Exercises based on Biochemistry and Biostatistics.

1. Detection of proteins, carbohydrates and lipids.
2. Identification of different kinds of carbohydrates: mono-, di- and polysaccharides in the given samples.
3. Quantitative estimation of protein using Bradford assay .
4. Preparation of buffer solution of specific pH.
5. Separation of dyes by paper chromatography .
6. Separation of amino acids by using TLC.
7. Determination of amylase enzyme activity .
8. Preparation of frequency tables ,bar diagrams .
9. Preparation of histograms ,Polygons and pi chart .
10. Numericals based on means.
11. Numericals based on mode and median .
12. Numericals based on Standard deviation, standard error and coefficient of variation
13. Preparation of frequency tables, bar diagrams, histograms, frequency, polygons, and pi-charts.

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14. Calculation of mean, mode and median, standard deviation and coefficient of variation.

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Scheme of Practical Examination and Distribution of Marks

S.N.	Exercise/Practical	Regular	Ex. Students
1.	Major Exercise	**6**	**12**
2.	Minor Exercise	**4**	**6**
3.	Minor Exercise	**4**	**6**
4.	Identification and comments on Spots (1 to 8)	**16**	**16**
5.	Viva Voce	**5**	**10**
6.	Class Record	**5**	
	Total	**10*+40=50**	**50**

*Internal marks for regular students only

Note:

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. The candidates may be asked to write detailed methodology wherever necessary and separate marks may be allocated for the same.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

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