S. S. JAIN SUBODH PG COLLEGE, JAIPUR

DEPARTMENT OF ZOOLOGY
(Three-Year Undergraduate Programme)

SYLLABUS

B.Sc. Bio (Subject: Zoology)

(Semester Scheme)

Choice-Based Credit System (CBCS)

[As Per the National Education Policy (NEP) – 2020]

B. Sc. (Bio) Semester I & II

Subject: Zoology

B.Sc. Biology (Subject: Zoology)

Course Structure under C.B.C.S. And NEP-2020

Examination Scheme for EoSE for Semester I

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	**ZOO-T-101 – Diversity & Biology of Non-Chordates**	**CIA**	**1 Hrs**	**CIA**	**30 Marks**	**CIA**	**12 Marks**
		EoSE	**3 Hrs**	**EoSE**	**70 Marks**	**EoSE**	**28 Marks**
Practical	**ZOO-P-101–Practical I**	**CIA**	**1 Hrs**	**CIA**	**20 Marks**	**CIA**	**8 Marks**
		EoSE	3 Hrs	EoSE	30 Marks	EoSE	**12 Marks**
Theory	**ZOO-T-102**	**CIA**	**1 Hrs**	**CIA**	**30 Marks**	**CIA**	**12 Marks**
Practical	**ZOO-P-102**	**EoSE**	**3 Hrs**	**EoSE**	**70 Marks**	**EoSE**	**28 Marks**
Theory	**ZOO-T-201**	**CIA**	**1 Hrs**	**CIA**	**20 Marks**	**CIA**	**8 Marks**
Practical	**ZOO-P-201**	EoSE	3 Hrs	EoSE	30 Marks	EoSE	**12 Marks**
Theory	**ZOO-T-202**	**CIA**	**1 Hrs**	**CIA**	**20 Marks**	**CIA**	**8 Marks**
Practical	**ZOO-P-202**	EoSE	3 Hrs	EoSE	30 Marks	EoSE	**12 Marks**
Theory	**ZOO-T-301**	**CIA**	**1 Hrs**	**CIA**	**20 Marks**	**CIA**	**8 Marks**
Practical	**ZOO-P-301**	EoSE	3 Hrs	EoSE	30 Marks	EoSE	**12 Marks**
Theory	**ZOO-T-302**	**CIA**	**1 Hrs**	**CIA**	**20 Marks**	**CIA**	**8 Marks**
Practical	**ZOO-P-**302	**EoSE**	**3 Hrs**	**EoSE**	**30 Marks**	**EoSE**	**12 Marks**

B.Sc. Biology (S u b j e c t : Z o o l o g y)
Course Structure Under C.B.C.S. And NEP-2020
Examination Scheme for EoSE for Semester I &II

Semester	Course Code	Course Title	Credit	Marks	External	Internal
SEM- I	ZOO-101	Paper -I Diversity & Biology of Non-Chordates	4	100	EoSE 70	CIA 30
	ZOO-101 P	Practical	2	50	30	20
SEM- II	ZOT-102	Paper- II Diversity of Chordates & Developmental Biology of Vertebrates	4	100	EoSE 70	CIA 30
	ZOT-102 P	Practical	2	50	30	20
SEM- III	ZOO-201	Paper -I Economic Zoology & Ethology	4	100	EoSE 70	CIA 30
	ZOO-201 P	Practical	2	50	30	20
SEM- IV	ZOO-202	Paper -I Cell Bio, Genetics & Biotechnology	4	100	EoSE 70	CIA 30
	ZOO-202 P	Practical	2	50	30	20
SEM- V	ZOO-301	Paper -I Animal Physiology And Biochemistry	4	100	EoSE 70	CIA 30
	ZOO-301 P	Practical	2	50	30	20
SEM- VI	ZOO-302	Paper -I Microbiology, Immunology, and Biostatistics	4	100	EoSE 70	CIA 30
	ZOO-302 P	Practical	2	50	30	20

Examination Scheme

1. 1credit = 25marks for examination/ evaluation
2. For Regular Students, there will be a Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous assessment (30% weightage) and End of end-semester examination (EoSE) (70% weightage).
3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.
4. To appear in the EoSE examination of a course/ subject, a regular student must appear in the mid-semester examination.

Detailed Syllabus

Diversity & Biology of Non-Chordates
Practicals based on Diversity & Biology of Non- Chordates

I Semester -Zoology

<table>
<tr><td>Semester</td><td>Course Code</td><td colspan="4">Title of the Course/Paper</td><td>NHEQF Level</td><td>Credits</td></tr>
<tr><td>I</td><td></td><td colspan="4">Diversity & Biology of Non- Chordates
Practicals based on Diversity & Biology of Non-Chordates</td><td>5</td><td>6</td></tr>
<tr><td rowspan="2">Level of Course</td><td rowspan="2">Type of the Course</td><td colspan="3">Credit Distribution</td><td rowspan="2">Offered to NC Student</td><td colspan="2" rowspan="2">Course Delivery Method</td></tr>
<tr><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>5</td><td>Major</td><td>4</td><td>2</td><td>6</td><td>No</td><td colspan="2">60 lectures including diagnostic and informative assessments during lecture hours, and 30 Hours of Practical training/demonstration</td></tr>
<tr><td colspan="2">List of Programme Codes in which Offered as Minor Discipline</td><td colspan="6">Biotechnology
Botany
Chemistry
Microbiology
Psychology</td></tr>
</table>

Prerequisites	**XII Pass**
Objectives of the Course:	• The main purpose of introducing this course is to teach the students the Morpho-taxonomy, and evolutionary relationships among and between non-chordates and chordates along with creating awareness and concern towards the importance of animal diversity for human survival and its socioeconomic significance. • In addition to this, the course is aimed at nurturing skills of conducting scientific inquiry and experimentation in the field of animal diversity to acquire knowledge of fundamental concepts and theories of animal diversity.

Detailed Syllabus

25ZOO- 5101T: Diversity & Biology of Non -Chordates

UNIT-I

Principles of taxonomy: **6 Hrs**

- International code of nomenclature;
- Concept of the five-kingdom system;
- Basis of classification: symmetry, coelom, segmentation, embryogeny
- Levels of organization
- Invertebrate versus vertebrate (comparison)

Protozoa: **6 Hrs**

- General characteristics and classification up to classes
- Paramecium: Habit, Habitat, Morphology, locomotion, nutrition, and reproduction
- Economic importance of protozoa

Porifera: **4 Hrs**

- General characteristics and Classification up to classes;
- Canal system in Porifera

UNIT-II

Coelenterata (Cnidaria): **6 Hrs**

- General characteristics and Classification up to classes;
- Obelia: Habit, Habitat, Morphology, reproduction, and life cycle, Metagenesis

Platyhelminthes and Nemathelminthes: **8 Hrs**

- General characteristics and Classification up to classes
- Fasciola: Structure and life cycle
- Ascaris: Structure and life cycle

UNIT-III

Annelida: **7 Hrs**

- General characteristics and Classification up to classes;
- Neanthes (Nereis): Habit, Habitat, Morphology, organ systems: locomotion, digestive, excretory, nervous, reproductive and life cycle

Arthropoda: **7 Hrs**

- General characteristics and Classification up to classes;
- Prawn: Habit, Habitat, Morphology, organ systems: digestive, circulatory, excretory, nervous, and reproductive

UNIT-IV

Mollusca: **7 Hrs**

General characteristics and Classification up to classes;
Pila: Habit, Habitat, Morphology, organ systems: locomotion, digestive, circulatory, excretory, reproductive

Echinodermata: **7 Hrs**

- General characteristics and Classification up to classes;
- *Asterias:* Habit, Habitat, Morphology, organ system: water vascular system, digestive, Circulatory, reproductive, and life cycle

Hemichordata: **3 Hrs**

- Affinities with Chordata and Echinodermata
- Biology of Balanoglossus

Suggested Books and References:

1. Invertebrate Zoology. VII Edition, Barnes, R.D. (2006) Cengage Learning, India.
2. The Invertebrates: A New Synthesis. III Edition, Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002) Blackwell Science
3. Invertebrate Zoology. Jordan E.L., Verma P. S. (2022): S. Chand and Company Limited.
4. Invertebrate Structure and Functions. II Edition Barrington, E.J.W. (2012), EWP Publishers
5. Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003) Cengage Learning, India
6. Biology of the Invertebrates. VII Edition, Pechenik, J. A. (2015) Mraw-Hill Education
7. जैवविविधता Mali, P. C., Singh, M., Kumari, V. and Digarwal, G. L. (2023) (Animal Diversity-B.Sc I Semester). Neelkanth Publishers (P) Ltd.

Suggested E-roesources:

1. Kachhwaha, N and Kaushik, P (2019): Freely online available gaming websiteinnovativezoology.com to study vertebrate and invertebrate classification.

Course Learning Outcome:

Upon completion of the course, students will have knowledge of:

- **Morpho-taxonomy and structural organization of non-chordata and chordata groups.**
- **Diversity of non-chordata and chordata groups.**
- **Evolutionary relationships and phylogeny of non-chordates and chordates through functional and structural similarities.**
- **Economic importance of non-chordates and chordates and their significance in the ecosystem.**

25ZOO-5101P- Practical Syllabus

Based on Diversity & Biology of Non- Chordates

1. **Microscopy**
   i. Organization and working of Optical Microscope: Dissecting and compound microscopes.
   ii. General methods of microscopic slide preparations: Narcotization; fixing and preservation; washing; staining; destaining; dehydration; clearing and mounting.

2. **General idea of composition, preparation, and use of:**
   i. Fixatives: Formalin, Bouin's fluid.
   ii. Stains: Aceto-carmine, Aceto-orcein, Haematoxylin, Eosin.
   iii. Common reagents: Normal saline, Acid water, Acid alcohol and Mayer's albumin.

3. **Study of Microscopic Slides and Museum Specimens:**
   i. Protozoa: *Euglena, Amoeba, Plasmodium, Paramecium* (W.M.), binary fission, conjugation)
   ii. Porifera: *Leucosolenia, Euplectella, Spongilla, sycon*
   iii. Coelenterata: Millipora, *Physalia, Aurelia, Velella,* Sea anemone, *Gorgonia*, Stone corals.
   iv. Platyhelminthes: *Taenia* (WM), Cysticercus larva, *Fasciola* (WM), Miracidium, Sporocyst, Redia, Cercaria and Metacercaria Larvae of *Fasciola.*
   v. Aschelminthes: *Ascaris, Dracunculus, Wuchereria*
   vi. Annelida: Neanthes*(Nereis), Aphrodite, Pontobdella, Arenicola, Glossiphonia, Hirudinaria.*
   vii. Onychophora: *Peripatus*
   viii. Arthropoda: *Limulus,* Scorpion, Centipede, Millipede, *Lepas,* Crab**,** *Mantis, Pediculus,* Termite, *Cyclops, Daphnia,* crustacean larvae (Nauplius, Zoea, Mysis, Megalopa)
   ix. Mollusca: *Chiton, Aplysia, Dentalium, Cypraea, Mytilus, Loligo, Octopus, Nautilus.* Glochidium larva
   x. Echinodermata: *Asterias, Antedon, Ophiothrix, Echinus, Holothuria*

4. **Anatomy:**
   i. Pila: External features and nervous system.
   ii. Prawn: External features, appendages, alimentary canal, and nervous system.

5. **Study of the following through Permanent Slide Preparation:**
   i. *Euglena*, *Paramecium*,
   ii. Sponge spicules, Gemmule,
   iii. *Obelia* colony,
   iv. Statocyst and hastate plate of prawn,
   v. Osphradium and gill lamella of *Pila*

6. Education tour and report preparation on the study of local invertebrate fauna

Scheme of Practical Examination and Distribution of Marks

S.No.	Practical Exercise	Regular Students	Ex. Students
1.	Major exercise	**3**	**3**
2.	Minor exercise	**2**	**2**
3.	Permanent slide preparation	**3**	**3**
3.	Identification and comments on Spots (1 to 6)	**12**	**12**
4.	Viva Voce	**5**	**10**
5.	Class Record	**5**	
	Total	**30**	**30**

Note:

***Internal marks for regular students only.**

1. Anatomy: Study of systems of the prescribed types with the help of dissection. Detailed charts/Dissection softwares/virtual tools/models can also be utilized to study anatomy.
2. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
3. 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.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.
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.

Syllabus

Diversity of Chordates & Developmental Biology of Vertebrates

II-Semester -Zoology

<table>
<tr><th>Semester</th><th>Course Code</th><th colspan="4">Title of the Course/Paper</th><th>NHEQF Level</th><th>Credits</th></tr>
<tr><td>II</td><td>25ZOO-5102T
25ZOO-5102P</td><td colspan="4">Diversity of Chordates & Developmental Biology of Vertebrates
Practical based on Diversity of Chordates & Developmental Biology of Vertebrates</td><td>5</td><td>6</td></tr>
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<tr><td colspan="2">List of Program Codes in which Offered as Minor Discipline</td><td colspan="6">B.Sc. Chemistry: B.Sc. Bo</td></tr>
<tr><td colspan="2">Prerequisites</td><td colspan="6">B.Sc. I Semester (Bio Group)</td></tr>
<tr><td colspan="2">Objectives of the Course:</td><td colspan="6">• The course offers a complete understanding about diversity and classification of Chordate animals.
• It educates the students regarding general and specific characteristics of chordates. Thorough understanding of their affinities and evolutionary aspects of chordates will be developed in students.
• The course will also provide a glimpse of the scope and historical background of developmental biology to the students.
• It will impart knowledge regarding basic concepts of differentiation, morphogenesis, and pattern formation, and insight into stem cells and cloning.</td></tr>
</table>

	• Understanding of essential events of developmental biology will be imparted through proper explanation of gametogenesis, stages of embryonic development, and foetal formation.

Detailed Syllabus

25ZOO-5102T- Diversity of Chordates & Developmental Biology of Vertebrates

Unit-I

Lower Chordates and Vertebrates:

- General characteristics and classification of Chordata up to classes **2 Hrs**
- **Urochordata:**-General characteristics and classification up to sub-classes
  Study of Biology of Herdmania and its affinities **6 Hrs**
- **Cephalochordata**: General characteristics and classification up to sub-classes
  Study of Biology of *Branchiostoma* (Amphioxus) **4 Hrs**
- **Cyclostomata (Agnatha)**: General characteristics and classification up to sub-classes
  Study of *Petromyzon* and Ammocoete Larva **3 Hrs**
- **Pisces**: General characteristics and classification up to sub-classes
  Types of fins and scales, swim bladder, Weberian ossicles, parental care and migration in fishes **4 Hrs**

Unit-II

Amphibia:

- General characteristics and classification up to sub-classes;
- Neoteny
- Parental care in Amphibians **4 Hrs**

Reptilia:

- General characteristics and classification up to sub-classes
- Identification of poisonous and non-poisonous snakes

Aves: **5 Hrs**

- General characteristics and classification up to sub-classes
- Flight adaptations and Migration in birds **4 Hrs**

Mammals:

- General characteristics and classification up to sub-classes
- Dentition in Mammals
- Adaptive radiation in mammals **4 Hrs**

Unit-III

Introduction to Developmental Biology:

- Scope and History of Developmental Biology **1 Hrs**

Gametogenesis:

- Spermatogenesis
- Oogenesis;

Fertilization: Mechanism of fertilization, parthenogenesis **3 Hrs**

Early Embryonic Development **10 Hrs**

- Cleavage: planes and patterns of cleavage.
- Blastulation and Morulation.

- Gastrulation: Types of morphogenetic movements; embryonic induction, Fate of germ layers, fate maps
- Early embryonic development of frog (up to neurulation) and chick (up to 96 hrs).

Unit-IV

- Metamorphosis and its hormonal regulation in frogs; Regeneration of limb in frog 4 **Hrs**
- Types and functions of extra embryonic membranes in chick development **2 Hrs**
- Types, formation, and functions of placenta in mammals, Implantation, pregnancy and Parturition 3 **Hrs**
- Teratology and Developmental Disorders. 2 **Hrs**

Suggested Books and References:

1. Biology. Campbell & Reece (2005)., Pearson Education, (Singapore) Pvt. Ltd.
2. Chordate Zoology. Jordan E.L., Verma P. S. (2022) S. Chand and Company Limited.
3. Biology, 6th edition. Raven, P. H. and Johnson, G. B. (2004) Tata McGraw Hill Publications. New Delhi.
4. Analysis of Vertebrate Structure. Hilderbrand, M and Gaslow G.E.. John Wiley and Sons
5. Principles of Developmental Biology (4th edition). Wolpert, L & Tickle, C (2011). Oxford University Press, ISBN: 9780198792918
6. Patten's Foundations of Embryology. Carlson, Bruce M (1996). McGraw Hill, Inc. ISBN: 9780070634275
7. The Life of Vertebrates. III Edition. Young, J. Z. (2004) Oxford university press.
8. Comparative Anatomy and Development Biology of Vertebrates (2024) Dr Jyotsna Jain, Dr Dev D. Patel, Dr Pallavi Kaushik and Dr Dau Lal Bohra.Text book for B.Sc. II Semester, Neelkanth Publishers (P) Ltd, Jaipur, India 2024 ISBN: 978-93-5736-733-2.
9. Developmental Biology. X Edition. Gilbert, SF (2014) Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. ISBN : 9780878939787
10. An Introduction to Embryology. Balinsky, B.I. (2008). International Thomson Computer Press.

Suggested E-resources:

1. Meena G, 2020. Developmental Biology, Glossary, Ideal International Publication Pvt. Ltd. https://drive.google.com/file/d/1ebK1B6QHc6fJG6CXaGicmXTZlY6VkOxi/view ?usp=drivesdk

Course Learning Outcome:

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

- Know about the levels of organization among different groups of vertebrates.
- Understand how chordates evolved during the course of evolution through succession.
- Know the evolution of different concepts in developmental biology.
  Understand the process of gamete formation from stem cell population to mature ova and sperm.
- Comprehend the sequence of steps leading to the formation of gametes and development of embryo.
- Know the mechanisms underpinning cellular diversity and specificity in animals.
- Have the knowledge about the methods and tools related to developmental biology which help to understand different processes of embryogenesis.

Practical Syllabus

25ZOO-5102P Practical based on Diversity of Chordates & Developmental Biology of Vertebrates

1. **Anatomy**: Study of swim bladder and Cranial nerves in any edible fish
2. **Study of microscopic slides and museum specimens**:
   i. **Protochordates:** *Herdmania*, *Ciona*, *Botryllus*, *Amphioxus*, *Doliolum*, *Oikopleura*, *Pyrosoma*, Tadepole larva of Ascidia
   ii. **Agnatha:** *Petromyzon*, *Myxine*, Ammocoete larva.
   iii. **Pisces:** *Zygaena* (*Sphyrna*), *Torpedo*, *Pristis*, *Chimaera*; *Acipenser*, *Amia* or *Lepidosteus*, *Labeo*, *Clarias*, *Anguilla*, *Hippocampus*, *Exocoetus*, *Echenies*, *Syngnathus*, *Protopterus*, *Lepidosiren*, *Neoceratodus*, *Notopterus*.
   iv. **Amphibia:** *Icthyophis*, *Necturus*, *Proteus*, *Ambystoma*, *Salamander*, Axolotl, *Siren*, *Alytes*, *Hyla*, *Pipa*, *Rachophorus, Rana*
   v. **Reptilia:** *Testudo*, *Chelone* and freshwater tortoise, *Sphenodon*, *Hemidactylus*, *Phrynosoma*, *Draco*, *Calotes*, *Chameleon*; *Eryx*, *Hydrophis*, *Krait*, *Naja*, *Viper*, *Bungarus*, *Crocodilus*, Alligator**.**
   vi. **Aves:** *Pavo cristatus* (peacock), *Choriotis* (Great Indian Bustard), *Columba*
   vii. **Mammalia:** *Ornithorhynchus*, *Echidna*, *Tachyglossus*, *Didelphis*, Kangaroo, Bat, *Loris*, *Manis*, Mongoose, Otter
3. **Study of the following through Permanent Slide preparations:** Oral hood of amphioxus, scales of fishes, hair of mammals
4. **Developmental Biology**
   i. Study of Developmental stages of Frog - Permanent slides (whole mounts and sections) — cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
   ii. Study of Chick Embryo: 18 hrs, 21 hrs, 24 hrs, 33 hrs, 48 hrs, 72 hrs and 96 hrs of incubation.
   iii. Window making in chick eggs to study the various incubation stages of the developing chick embryo
   iv. Study of extra-embryonic membranes in chick development.
   v. Educational tour: Visit to Zoo/National Park/Sanctuary and submission of report.

Scheme of Practical Examination and Distribution of Marks

S.No.	Practical Exercise	Regular Students	Ex. /N.C. Students
1.	Major exercise	**3**	**3**
2.	Permanent slide preparation	**2**	**2**
3.	Developmental Biology	**3**	**3**
3.	Identification and comments on Spots (1 to 6)	**12**	**12**
4.	Viva Voce	**5**	**10**
5.	Class Record	**5**	
		30 + 20 * = 50	**30**

Note:

***Internal marks for regular students only.**

1. Anatomy: Study of systems of the prescribed types with the help of dissection. Detailed charts/Dissection softwares/virtual tools/models can also be utilized to study anatomy.
2. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
3. 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.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.
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.