

Program Name	B.Sc.	SEMESTER	V
Course Title	NON-CHORDATES AND ECONOMIC ZOOLOGY (Theory)		
Course Code:	BSCZOCN501	No. of Credits	4
Contact hours	60 Hrs.	Duration of SEA/Exam	2 Hrs.
Formative assessment marks	40	Summative assessment marks	60

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

- Group the animals on the basis of their morphological characteristics/ structures.
- Demonstrate comprehensive identification abilities of Non-Chordate diversity.
- Explain structural and functional diversity of Non-Chordates.
- Develop understanding on the diversity of life with regard to protists, nonchordates and chordates.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.

UNIT – I:

15 Hrs.

An overview of Invertebrate classifications up to the phylum; Protozoa: *Paramecium* -Morphology and Reproduction: Asexual- binary fission, Sexual-conjugation (endomixis, autogamy, cytogamy); Porifera: *Sycon* – Morphology and *Canal* System; Coelenterata: *Obelia* - Morphology and life cycle; Ctenophora: Salient features with an example.

UNIT – II:

15 Hrs.

Platyhelminthes: *Taenia solium* - Morphology and Life cycle; Nematelminthes: *Ascaris lumbricoides* - Morphology and life cycle; Annelida: Characteristics and classification: *Hirudinaria* (Leech) - Morphology and Reproduction.

UNIT – III:

15 Hrs.

Arthropoda: Characteristics and classification: *Palaemon* (Prawn) - Morphology, Appendages, Nervous System and Reproduction; Mollusca: Characteristics and classification: *Pila* - Morphology, Shell, Respiratory system, Nervous System and Reproduction; Echinodermata: Characteristics and classification: *Asterias* - Morphology and Water vascular system.

UNIT – IV:

15 Hrs.

Economic Zoology: Life cycle and control of pests - Gundhi bug, Sugarcane leafhopper, Termites, Rodents; Mosquito life cycle and control; Bio-culture: Lac-culture - techniques and applications; Vermi-culture - techniques and its applications; Apiculture -Types and applications; Aquaculture –techniques and applications; Poultry-housing management and applications; Dairy farming- cattle breeds and Management of dairy.

References:

1. Adam, S. 1990. A Students Text Book of Zoology, Vol. I, II & Vol. III. Low Price Publications, New Delhi.
 2. Agarwal, V.K. 2017. Zoology for Degree Students: Non-Chordata, S. Chand & Company, New Delhi.
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 5. Dhami, P.S. & Dhami, J.K. 2021. Invertebrate Zoology, 5th Edition, R. Chand & Co. New Delhi.
 6. Hickman, C., Roberts, L.S., Keen, S.L., Larson, A. and Eisenhour, D. 2018. Animal Diversity, McGraw-Hill.
 7. Holland, P. 2011. The Animal Kingdom: A Very Short Introduction, Oxford University Press.
 8. Jordan, E.L. & Verma, P.S. 2022. Invertebrate Zoology, S. Chand & Company, New Delhi.
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 10. Kotpal, R.L. 2017. Modern Text Book of Invertebrates, Rastogi Publications, Meerut.
 11. Kotpal, R.L. 2017. Protozoa to Echinodermata (Phylum Series), Rastogi Publications, Meerut.
 12. Lal, S.S. 2016. A Text book of Practical Zoology – Invertebrates, Rastogi Publications.
 13. Prakash, M. & Arora, C. K. 1998. Laboratory Animals, Anmol Publications, New Delhi.
 14. Shukla & Upadhyaya, V. B. 2008. Economic Zoology, Rastogi Publications.
 15. Srivastava. 1985. A Text Book of Fishery Science and Indian fishery, Kitabmahal.
 16. Theobald, F. 1997. Economic Zoology, Printwell, Jaipur.
 17. Uday, S. B. 1995. Vermiculture Ecotechnology, Bhawalkar Earthworm Research Institute, Pune.
 18. Verma, P.S. 2013. A Manual of Practical Zoology – Invertebrates, S. Chand & Co. New Delhi.
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SCHEME OF THEORY EXAMINATION

B.Sc. Zoology V Semester

Course Title/Code: BSCZOCN501: NON-CHORDATES AND ECONOMIC ZOOLOGY

Duration: 2 Hours

Max. Marks: 60

PART - A

Q-I. Answer any SIX questions out of EIGHT questions (2 questions from each Unit) (6 x2) = 12

PART - B

Q-II. Answer any TWO questions out of THREE questions (From Unit-I) (2 x 3) = 06

Q-III. Answer any ONE question out of TWO questions (From Unit-I) (1 x 6) = 06

Q-IV. Answer any TWO questions out of THREE questions (From Unit-II) (2 x 3) = 06

Q-V. Answer any ONE question out of TWO questions (From Unit-II) (1 x 6) = 06

Q-VI. Answer any TWO questions out of THREE questions (From Unit-III) (2 x 3) = 06

Q-VII. Answer any **ONE** question out of **TWO** questions (**From Unit-III**) **(1 x 6) = 06**

Q-VIII. Answer any **TWO** questions out of **THREE** questions (**From Unit-IV**) **(2 x 3) = 06**

Q-IX. Answer any **ONE** question out of **TWO** questions (**From Unit-IV**) **(1 x 6) = 06**

Pedagogy: Written Assignment/Presentation/Project/Term Papers/Seminar

Formative Assessment for Theory	
Assessment Occasion/ type	Marks
House Examination/Test	20
Written Assessment/ Presentation/Project/Term papers/Seminars	15
Class room Performance/Participation	05
TOTAL	40
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Course Title	NON-CHORDATES AND ECONOMIC ZOOLOGY (Practical)		
Course Code:	BSCZOPN501	Practical Credits	2
Contact hours	4 Hours/Week	Duration of Practical Exam.	3 Hrs.
Formative Assessment Marks	25	Summative Assessment Marks	25

Course Outcomes (COs): At the end of the course the student should be able to:

- Understand the basics of classification of non-chordates.
- Learn the diversity of habit and habitat of these species.
- Develop the skills to identify different classes and species of animals.
- Know uniqueness of a particular animal and its importance.
- Enhancement of basic laboratory skill like keen observation and drawing.

PRACTICALS	15x4=60 (4Hrs/week)
<ol style="list-style-type: none"> 1. Preparation and observation of protozoan culture. 2. Protozoa: Systematics of <i>Amoeba</i>, <i>Euglena</i>, <i>Noctiluca</i>, <i>Paramecium</i> and <i>Vorticella</i> (Permanent slides). 3. Porifera: Systematics of <i>Sycon</i>, <i>Euplectella</i>, <i>Hyalonema</i>, <i>Spongilla</i> and <i>Euspongia</i> (Specimens). Study of permanent slides of T.S of <i>Sycon</i>, spicules and gemmules. 4. Cnidaria: Systematics of <i>Aurelia</i> and <i>Metridium</i> (Specimens). Slides of <i>Hydra</i>, <i>Obelia</i>-polyp and medusa, and <i>Ephyra</i> larva, T.S. of <i>Metridium</i> passing through mesenteries. 5. Study of Corals- <i>Astraea</i>, <i>Fungia</i>, <i>Meandrina</i>, <i>Corallium</i>, <i>Gorgonia</i>, <i>Millepora</i> and <i>Pennatula</i>. 6. Helminthes: Systematics of <i>Planaria</i>, <i>Fasciola hepatica</i> and <i>Taenia solium</i>, <i>Ascaris</i>- Male and female (Specimens). Slides of T.S. of <i>Planaria</i>, T.S of male and female <i>Ascaris</i>. 7. Annelida: Systematics of <i>Nereis</i>, <i>Heteronereis</i>, <i>Sabella</i>, <i>Aphrodite</i> (Specimens). Slide of T.S. of Earth worm through typhlosole. 8. Arthropoda: Systematics of <i>Penaeus</i>, <i>Palaemon</i>, <i>Astracus</i>, Scorpion, Spider, <i>Limulus</i>, <i>Peripatus</i>, <i>Millipede</i>, <i>Centipede</i>, Praying mantis, Termite Queen, Moth, Butterfly, Dung beetle/Rhinoceros beetle (Any six specimens). Slide of Larvae- Nauplius, Zoea, Mysis. 9. Mollusca: Systematics of <i>Chiton</i>, <i>Mytilus</i>, <i>Aplysia</i>, <i>Pila</i>, <i>Octopus</i>, <i>Sepia</i> (Specimens) and Glochidium larva (Slide). Shell Pattern- <i>Unio</i>, <i>Ostrea</i>, <i>Cypria</i>, <i>Murex</i>, <i>Nautilus</i>, <i>Patella</i>, <i>Dentalium</i>, Cuttle bone. 10. Echinodermata: Systematics of Sea star, Brittle star, Sea Urchin, Sea cucumber, Sea lilly (Specimens). Slides of Bipinnaria larva, Echinopluteus larva and Pedicellaria. 	

11. Harmful Non chordates: Soil Nematodes. Agricultural, veterinary and human pests / vectors of Arachnida and Arthropoda – Mosquito, Lice, Mites.
12. Beneficial Non chordates: *Bombyx mori*: Life cycle - Cocoon, Raw silk. Uzi fly; Study on honey bee (any twospecies) and bee wax; Pearl Oyster and Natural Pearls.
13. Indian Poultry breeds and Cattle breeds (Any three).
14. Virtual Dissection/Cultured specimens: Earthworm – Nervous system, Leech- Digestive system.
15. Virtual Dissection/Cultured specimens: Prawn - Nervous system; Cockroach- Salivary apparatus and Digestive system

SCHEME OF PRACTICAL EXAMINATION

B.Sc. Zoology: V Semester

Course Title/Code: BSCZOPN501: NON-CHORDATES AND ECONOMIC ZOOLOGY

Duration: 3 hours

Max. Marks: 25

Q I. Dissect and display the organ system of available cultured specimens provided and comment.

(Dissection and display-4 marks, comments-2 marks)

(4+2) = 06

OR

Virtual dissection (Two specimens) - Identify, draw labelled diagram and comment on the flagged systems (Identification of the system - ½ mark; Identification of the flagged part - ½ mark; Labelled diagram of the entire system - 1 marks; Description of flagged part -1 mark)

(3+3) = 06

Q II. Identify with systematics, draw labelled diagram and comment (**A- C**). (1 slide, 2 specimens).

(Identification -½ mark; Systematics -½ mark; Labelled diagram -1 mark; Comments -1 mark) **(3x3) = 09**

Q III. Identify and comment on the economic importance (**D and E**). (D- Harmful Non chordates;

E-Beneficial non chordates/ Breeds) (Identification-1, Economic importance-1.5 marks) **(2.5x2) = 05**

Q IV. Record and Viva voce

05

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/ type	Marks
House Examination/Test	10
Project/Model submission	05
Class room Performance/Participation	05
Record writing & timely submission	05
Total	25
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Program Name	B.Sc.	SEMESTER	V
Course Title	CHORDATES AND COMPARATIVE ANATOMY (Theory)		
Course Code	BSCZOCN502	No. of Credits	4
Contact hours	60 Hrs.	Duration of SEA/Exam	2 Hrs.
Formative assessment marks	40	Summative assessment marks	60

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

- Demonstrate comprehensive identification abilities of chordate diversity
- Explain structural and functional diversity of chordate diversity
- Understand evolutionary relationship amongst chordates
- Take up research in biological sciences.
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Get a flavour of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.

UNIT – I:

15 Hrs.

Hemichordata: *Balanoglossus* –Habitat and Habit; morphology; Coelom; Tornaria larva and its affinities; Affinities and systematic position of Hemichordata; Chordata: Origin of Chordates; Basic characters of chordates and classification up to classes; Urochordata: *Herdmania*- Habitat and Habit; Morphology; Ascidian tadpole- structure and retrogressive metamorphosis. Cephalochordata: *Branchiostoma (Amphioxus)*-Habitat and Habit; Morphology; Digestive system; Feeding mechanism; Excretory and Circulatory system; Agnatha: General characters of *Agnatha* and classification up to classes; Salient features of *Cyclostomata* and *Ostracodermi* with examples. *Ammocoete* larva and its significance.

UNIT – II:

15 Hrs.

Vertebrates: General characters and Classification of different classes of Vertebrates (*Pisces*-up to classes, *Amphibia*-up to orders, *Reptilia* up to orders (living orders only), *Aves*-up to super orders, *Mammalia* up to subclass) citing examples; General characters and comparison of *Chondrichthyes* and *Osteichthyes*; Interesting features and evolutionary significance of *Dipnoi*; Salient features of *Placodermi* with examples; Interesting features of *Sphenodon*, crocodile and *Archaeopteryx*; Salient features of *Ratitae* and *Carinatae* with examples. Interesting features of mammalian orders (*Insectivora*, *Carnivora*, *Chiroptera*, *Cetacea*, *Proboscidea*, *Ungulata* – *Perissodactyla* and *Artiodactyla* and *Primates* –*Platyrrhini* and *Catarrhini*) with examples.

UNIT – III:**15 Hrs.**

General account of Chordates: Types of caudal fins, scales and swim bladder in fishes; Origin of Amphibia; Neoteny and Paedogenesis in Amphibians; Parental care in Pisces and Amphibians; Adaptive radiation in extinct reptiles with suitable examples; Temporal fossae in reptiles; Distinguishing poisonous snakes from non-poisonous snakes; Poison apparatus and biting mechanism in snakes; Flight adaptations in birds; Dentition in mammals; Evolution of molar tooth; Migration in fishes -catadromous and anadromous with suitable example; Bird migration-types with example; Echolocation in mammal.

UNIT – IV:**15 Hrs.**

Integumentary System: Structure of skin and its derivatives; Skeletal System: Comparative account of Axial Skeletal system in vertebrates- Skull- Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man); Comparative account of Appendicular skeletal system in vertebrates-Pectoral and Pelvic girdles of Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man); Respiratory system: Comparative account of respiratory system in vertebrates: Pisces (Scoliodon), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man); Circulatory System: Comparative account of heart and aortic arches in vertebrates: Pisces (Scoliodon), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man); Excretory System: Succession of kidney in vertebrates; Nervous system: Comparative account of brain in vertebrates: Pisces (Scoliodon), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man).

References

1. Adam, S. 1990. A Students Text Book of Zoology, Low Price Publications, Delhi, Vol. I, II & Vol.III.
2. Ayyar, E. 1982. A Manual of Zoology Vo1. II, S. Vishwanathan Pvt. Ltd.
3. Colbert, E.H. 2011. Evolution of the Vertebrates, Wiley Student Edition.
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5. Edwin, H. C. , Michael M. and Eli, C. M.. 2002. Colbert's Evolution of the Vertebrates: A history of the backboned animals through time. 5th edition.
6. Ghose, K.C. and Manna, B.2004. Fundamentals of Zoology, Books and Allied (P), Kolkata.
7. Hussain, S. A. & Achar, K.P. 1999. Biodiversity of the Western Ghats Complex of Karnataka, Biodiversity Initiative Trust, Mangalore.
8. John, W. 1995. Hildebrand: Analysis of vertebrate Structure, 4thedition.
9. Jordan, E.L. & Verma. P.S. 2013. Chordate Zoology, S. Chand & Company, New Delhi.
10. Kenneth, V. K.. 2005. Vertebrates: Comparative Anatomy, Function, Evolution. McGrawHill.
11. Kingsley, J.S. 1969. Outline of comparative anatomy of vertebrates, 2nd edition, Central books Depot, Allahabad.

12. Kotpal, R.L. 2016. Modern Text Book of Zoology – Vertebrates, Rastogi Publications, Meerut.
13. Lal, S.S. Practical Zoology Vertebrate 12/Ed, Rastogi Publications, Meerut.
14. Parker, T. J. & William A. H.. 1990. A Text Book of Zoology, Low Price Publications, Delhi, Vol. I & II.
15. Prakash, M & Arora, C. K. 1998. Laboratory Animals, Anmol Publication, Ansari Road, New Delhi.
16. Prasad, S.N. and Kashyap, V., 2015. A text book of Vertebrate Zoology, New Age International Ltd, New Delhi.
17. Romer and Parsons. 1986. The Vertebrate Body, 6th edition, CBS Publishing, Japan.
18. Saxena, R .K. & Sumitra, S. 2020. Comparative Anatomy of Vertebrates. 2nd edition, Viva Books Originals, New Delhi.
19. Young. 2006. The Life of vertebrates, 3rd edition, ELBS/Oxford University Press, London.

SCHEME OF THEORY EXAMINATION
B.Sc. Zoology V Semester

Course Title/Code: BSCZOCN502: CHORDATES AND COMPARATIVE ANATOMY

Duration: 2 Hours

Max. Marks: 60

PART - A

Q-I. Answer any **SIX** questions out of **EIGHT** questions (**2 questions from each Unit**) (6 x 2) = 12

PART - B

Q-II. Answer any **TWO** questions out of **THREE** questions (**From Unit-I**) (2 x 3) = 06

Q-III. Answer any **ONE** question out of **TWO** questions (**From Unit-I**) (1 x 6) = 06

Q-IV. Answer any **TWO** questions out of **THREE** questions (**From Unit-II**) (2 x 3) = 06

Q-V. Answer any **ONE** question out of **TWO** questions (**From Unit-II**) (1 x 6) = 06

Q-VI. Answer any **TWO** questions out of **THREE** questions (**From Unit-III**) (2 x 3) = 06

Q-VII. Answer any **ONE** question out of **TWO** questions (**From Unit-III**) (1 x 6) = 06

Q-VIII. Answer any **TWO** questions out of **THREE** questions (**From Unit-IV**) (2 x 3) = 06

Q-IX. Answer any **ONE** question out of **TWO** questions (**From Unit-IV**) (1 x 6) = 06

Pedagogy: Written Assignment/Presentation/Project/Term Papers/Seminar

Formative Assessment for Theory	
Assessment Occasion/ type	Marks
House Examination/Test	20
Written Assessment/ Presentation/Project/Term papers/Seminars	15
Class room Performance/Participation	05
TOTAL	40
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Course Title	CHORDATES AND COMPARATIVE ANATOMY (Practical)		
Course Code:	BSCZOPN502	Practical Credits	2
Contact hours	4 Hours/Week	Duration of Practical Exam.	3 Hrs.
Formative Assessment Marks	25	Summative Assessment Marks	25

Course Outcomes (COs): At the end of the course the student should be able to:

- Understand the basics of classification of chordates.
 - Learn the diversity of habit and habitat of types species of each groups.
 - Know uniqueness of a particular animal and their evolutionary modifications and its importance.
 - Handling of few animals as a laboratory skill to understand their anatomy and to identify different classes and species of animals.
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PRACTICALS

(15x4) = 60 (4Hrs/ Week)

1. Protochordata: *Balanoglossus* and its T. S through proboscis; Ascidian/*Herdmania* and *Amphioxus*; T.S. of *Amphioxus* through pharynx and intestine.
 2. Cyclostomata: *Petromyzon*; Ammocoete larva and *Myxine*.
 3. Pisces: Cartilaginous Fishes – *Narcine*, *Trygon*, *Pristis*, *Mylobaties*; Bony Fishes –*Zebra fish*, *Hippocampus*, *Muraena*, *Ostracion*, *Tetradon*, *Pleuronectus*, *Diodon*, *Echeneis*. (Any six). Ornamental fishes: *Siamese*, *Koi*, *Oscar*, *Betta* sp., *Neon tetra*, *Guppies*, *Gold fish*, *Angle fish*, *Rainbow fish*, *Mollies* (Any four).
 4. Accessory respiratory organs: *Saccobranthus*, *Clarias* and *Anabas*.
 5. Amphibia: *Haplobatrachus*, *Bufo*, *Ambystoma*, *Axolotl* larva, *Necturus* and *Ichthyophis*.
 6. Reptilia: *Turtle*, *Tortoise*, *Mabuya*, *Calotes*, *Chameleon*, *Varanus*. snakes –*Dryophis*, *Rat snake*, *Brahmini*, *Cobra*, *Krait*, *Russell 's viper* and *Hydrophis*.
 7. Aves: Beak and feet modifications in the following examples: *Duck*, *Crow*, *Sparrow*, *Parrot*, *King fisher*, *Eagle* or *Hawk*.
 8. Mammalia: *Mongoose*, *Squirrel*, *Pangolin*, *Hedge Hog*, *Rat*, *Loris* and *Bats*.
 9. Virtual Dissection/Cultured specimens: Shark/Bony fish: Afferent and efferent branchial systems; glossopharyngeal and vagus nerves.
 10. Virtual Dissection/Cultured specimens: Rat: Dissection (only demonstration) – Circulatory system (arterial and venous); Urinogenital system.
 11. Skeletal System in man: Skull, Vertebrae, Girdles and Limb bones (Except hands and feet).
 12. Comparative account of skin in *shark*, *frog*, *calotes*, *pigeon* and *Man*.
 13. Comparative account of heart in *shark*, *frog*, *calotes*, *pigeon* and *Man*.
 14. Comparative account of brain in *shark*, *frog*, *calotes*, *pigeon* and *Man*.
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SCHEME OF PRACTICAL EXAMINATION
B.Sc. Zoology: V Semester

Course Title/Code: BSCZOPN502:CHORDATES AND COMPARATIVE ANATOMY

Duration: 3 hours

Max. Marks: 25

Q I. Dissect and display the organ system of available cultured specimens provided and comment.
(Dissection and display-4 marks, comments-2 marks) **(4+2) = 06**

OR

Virtual Dissection (Two Specimen) - Identify, draw labelled diagram and comment on the flagged Systems (Identification of the system - ½ mark; Identification of the flagged part - ½ mark; Labelled diagram of the entire system - 1 marks; Description of flagged part -1mark) **(3+3) = 06**

Q II. Identify with systematics, draw labelled diagram and comment (**A&B**). (1 slide/ 1 specimen).
(Identification - ½ mark; Systematics -½ mark; Labelled diagram -1 mark; Comments -1 mark) **(3x2) = 06**

Q III. Identify the human endoskeleton 'C' with neat labelled diagram and comment. **03**
(Identification -1 mark, diagram -1 mark, comment-1 marks)

Q IV. Identify and give the comparative account of skin / heart / brain of two vertebrates (**D**) **05**
(Identification -1 mark, diagram -2 mark, comment-2 marks)

Q IV. Record and Viva voce **05**

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/ type	Marks
House Examination/Test	10
Project/Model submission	05
Class room Performance/Participation	05
Record writing & timely submission	05
Total	25
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark -X in the intersection cell if a course outcome addresses a particular program outcome.

Course Outcomes (COs) / Program Outcomes (POs)	BSCZOCN501	BSCZOPN501	BSCZOCN502	BSCZOPN502
Core competency				
Critical thinking				
Analytical reasoning				
Research skills				
Team work				

Program Name	B.Sc.	SEMESTER	VI
Course Title	EVOLUTIONARY & DEVELOPMENTAL BIOLOGY (Theory)		
Course Code	BSCZOCN601	No. of Credits	4
Contact hours	60 Hours	Duration of SEA/Exam	2 hours
Formative assessment marks	40	Summative assessment marks	60

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

- Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past.
- Understand that natural selection is one of several processes that can bring about evolution although it can also promote stability rather than change.
- Understand how the single cell formed at fertilization forms an embryo and then a full adult organism.
- Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
- Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features.
- Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental Life sciences.

UNIT – I:

15 Hrs.

Theories of Evolution: Origin of Life; Historical review of evolutionary concept- Lamarckism, Darwinism (Natural, Sexual and Artificial selection); Modern synthetic theory of evolution; Adaptive radiations- Patterns of evolution (Divergence, Convergence, Parallel, Co-evolution). Population Genetics: Microevolution and Macroevolution; allele frequencies; genotype frequencies; Hardy- Weinberg equilibrium and conditions for its maintenance; Forces of evolution- mutation, selection, migration, genetic drift.

UNIT – II:

15 Hrs.

Direct evidences of evolution: Types of fossils; Incompleteness of fossil record; Dating of fossils; Evolution of horse- *Eohippus*, *Mesohippus*, *Merychippus* and *Equus*; Species concept - Biological species concept; Advantages and Limitations; Modes of speciation –Allopatric and Sympatric; Speciesextinction: Mass extinction - Causes and names of five major extinctions.

UNIT – III:**15 Hrs.**

Gamete Fertilization and Early Development: Gametogenesis; Fertilization; Cleavage pattern; Gastrulation; Fate maps and Morphogenesis; Developmental Genes: General concepts of organogenesis; Introduction to the genetic basis of embryonic development and Developmental control genes in *Drosophila* (*Homeo- box* genes).

UNIT – IV:**15 Hrs.**

Vertebrate Development: Early developmental process: Metamorphosis in amphibians; Placentation in mammals; Environmental regulation of development. Late developmental processes: Development of eye, kidney, limb in amphibians; Mammalian female reproductive cycles - estrous and menstrual cycle; Regeneration in mammals; Aging- Biology of senescence.

References:

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2. Arora, M.P. and Chaudar, K. 2000. Evolution, 2nd edition, Himalaya Publishing House, New Delhi.
3. Balinsky, B.I. 2012. An Introduction to Embryology, Cengage Learning.
4. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. 2007. Evolution. Cold Spring, Harbour Laboratory Press.
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B.Sc. Zoology VI Semester

Course Title/Code: BSCZOCN601: EVOLUTIONARY & DEVELOPMENTAL BIOLOGY

Duration: 2 Hours

Max. Marks: 60

PART - A

Q-I. Answer any SIX questions out of EIGHT questions (2 questions from each Unit) (6 x2) = 12

PART - B

Q-II. Answer any **TWO** questions out of **THREE** questions (**From Unit-I**) **(2 x 3) = 06**

Q-III. Answer any ONE question out of TWO questions (From Unit-I) (1 x 6) = 06

Q-IV. Answer any TWO questions out of THREE questions (From Unit-II) (2 x 3) = 06

Q-V. Answer any ONE question out of TWO questions (From Unit-II) (1 x 6) = 06

Q-VI. Answer any TWO questions out of THREE questions (From Unit-III) (2 x 3) = 06

Q-VII. Answer any **ONE** question out of **TWO** questions (**From Unit-III**) **(1 x 6) = 06**

Q-VIII. Answer any **TWO** questions out of **THREE** questions (**From Unit-IV**) **(2 x 3) = 06**

Q-IX. Answer any **ONE** question out of **TWO** questions (**From Unit-IV**) **(1 x 6) = 06**

Pedagogy: Written Assignment/Presentation/Project/Term Papers/Seminar

Formative Assessment for Theory	
Assessment Occasion/ type	Marks
House Examination/Test	20
Written Assessment/ Presentation/Project/Term papers/Seminars	15
Class room Performance/Participation	05
TOTAL	40
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Course Title	EVOLUTIONARY & DEVELOPMENTAL BIOLOGY (Practical)		
Course Code:	BSCZOPN601	Practical Credits	2
Contact hours	4 Hours/Week	Duration of Practical Exam.	3 Hrs.
Formative Assessment Marks	25	Summative Assessment Marks	25

Course Outcomes (Cos) :

- The foundation in other courses further makes the student to understand the basis of classification of different taxa.
- Species characteristics and their evolutionary modifications are studied by closely observing unique characteristics.
- Adaptive modifications for varied eco-regions and climatic conditions in certain important groups will be understood.
- Developmental process through egg to adult stages are studied in the selected invertebrates and vertebrates
- Few statistical tools will also be applied to understand the evolutionary divergences of adaptive characters.

PRACTICALS

15x4=60 (4Hrs/week)

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1. Study of fossils from models/pictures. - *Archaeopteryx, Dinosaurs, Horse and Human.*
 2. Study of homology and analogy from suitable specimens- Forelimbs of vertebrates; wings in animals; Prawn appendages - serial homology.
 3. Study and verification of Hardy-Weinberg equilibrium by Chi-square analysis.
 4. Graphical representation and interpretation of data of height/ weight of sample of 100 humans in relation to their age and sex.
 5. Study the types of eggs based on quantity and distribution of yolk: *Sea urchin, insect, frog and Chick.*
 6. Study the early developmental stages in frog - cleavage, blastula, gastrula, neurula.
 7. Study the metamorphosis in frog (tadpole to adult).
 8. Study the development of chick embryo using the incubated chick eggs (up to 96h).
 9. Study of adaptive radiations in feet of birds and mouth parts of insects.
 10. Study the placental structure and classification.
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SCHEME OF PRACTICAL EXAMINATION
B.Sc. Zoology VI Semester

Course Title/Code: BSCZOPN601: EVOLUTIONARY & DEVELOPMENTAL BIOLOGY

Duration: 3 hours

Max. Marks: 25

Q I. Identify and comment on the given model A and comment (Expt.- 1) (Identification - 1 mark; comments - 2 marks)	03
Q II. Identify and comment on the spotter B (Expt.- 2) (Identification- 1 mark; comments- 2 marks)	03
Q III. Problem / Graphical representation of data (Expt.-3/4)	04
Q IV. Identify and comment on the given chart / specimen with a labeled diagram- C (Expt.-5/6) (Identification-1 mark; diagram –1 mark; comments-1 mark)	03
Q V. Identify and comment on the given specimen/slide with a labeled diagram - D (Expt.-7/8) (Identification-1 mark; diagram – 1 mark; comments-1 mark)	03
Q VI. Identify and comment on the given spotter- E (Expt.-9/10) (Identification- 1 mark; diagram- 1 mark; comments - 2 marks)	04
Q VII. Record and Viva-voce	05

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/ type	Marks
House Examination/Test	10
Project/Model submission	05
Class room Performance/Participation	05
Record writing & timely submission	05
Total	25
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Program Name	B.Sc.	SEMESTER	VI
Course Title	ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT & CONSERVATIONS (Theory)		
Course Code:	BSCZOCN602	No. of Credits	4
Contact hours	60 Hrs.	Duration of Exam.	2 Hrs.
Formative assessment marks	40	Summative assessment marks	60

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

- Develop an understanding of how animals interact with each other and their natural environment.
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
- Develop the ability to work collaborative team-based projects.
- Gain an appreciation for the modern scope of scientific inquiry in the field of Wildlife conservation and management
- Develop an ability to analyze, present and interpret Wildlife conservation and management practices.

UNIT – I

15 Hrs.

Ecology: Introduction to ecology; food chain and food web, trophic levels-ecological pyramids; Ecological succession –Ecotone and edge effect; Ecosystem: types of ecosystem- terrestrial; aquatic; desert; grassland; cave; mangrove; Man-made ecosystems- cropland; garden; aquarium. Ecological factors- weather, climate, ozone layer. Adaptive features of plants and animals to different environmental conditions (Light, Temperature).

UNIT – II

15 Hrs.

Pollution: Types of pollutions - air, soil, water and thermal pollution- causes, effect and control measures; ozone layer depletion; bio-accumulation, bio-magnifications, and bio-remediation; Effects of pollution on plants and animals; Pollution monitoring; Waste management – Types and sources of wastes; Degradable and non-degradable wastes management.

UNIT – III

15 Hrs.

Wildlife Management: Taxonomy in biodiversity assessment; Biodiversity – levels of biodiversity- Ecosystem, Genetic and Species (Alpha, Beta, Gamma); Zoological realms; Unique Indian animals- Endemic species; Niche, Home range and Territory; Biodiversity hot spots –Western Ghats biodiversity; Biodiversity assessment - monitoring biodiversity –WCMC, IGCMC, Animal census; Remote sensing and GIS techniques in Wildlife studies; Threats to wildlife; IUCN Red list categories with examples in Indian context.

UNIT – IV

15 Hrs.

Wildlife Conservation: *In-situ* conservation: Wildlife National Parks, sanctuaries & biosphere reserves; *ex-situ* conservation: Zoological gardens and Captive breeding program; Legal aspects- Wildlife (Protection) Act, 1972; Biodiversity Act (2002); Ramsar convention; Special projects: Project Tiger; Project Elephant; Project Lion; Crocodile breeding project; Project Rhino. Organizations working on wildlife conservation.

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6. Darlington, P.J. 1996. Zoogeography- The Geographic distribution of animals, John Wiley & Sons, New York.
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 17. Saharia. V.B. 1982. Wildlife in India, Natraj publications, Dehradun.
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SCHEME OF THEORY EXAMINATION
B.Sc. Zoology VI Semester

Course Title/Code: BSCZOCN602: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT & CONSERVATIONS

Duration: 2 Hours

Max. Marks: 60

PART - A

Q-I. Answer any **SIX** questions out of **EIGHT** questions (**2 questions from each Unit**) (6 x 2) = 12

PART - B

Q-II. Answer any **TWO** questions out of **THREE** questions (**From Unit-I**) (2 x 3) = 06

Q-III. Answer any **ONE** question out of **TWO** questions (**From Unit-I**) (1 x 6) = 06

Q-IV. Answer any **TWO** questions out of **THREE** questions (**From Unit-II**) (2 x 3) = 06

Q-V. Answer any **ONE** question out of **TWO** questions (**From Unit-II**) (1 x 6) = 06

Q-VI. Answer any **TWO** questions out of **THREE** questions (**From Unit-III**) (2 x 3) = 06

Q-VII. Answer any **ONE** question out of **TWO** questions (**From Unit-III**) (1 x 6) = 06

Q-VIII. Answer any **TWO** questions out of **THREE** questions (**From Unit-IV**) (2 x 3) = 06

Q-IX. Answer any **ONE** question out of **TWO** questions (**From Unit-IV**) (1 x 6) = 06

Pedagogy: Written Assignment/Presentation/Project/Term Papers/Seminar

Formative Assessment for Theory	
Assessment Occasion/ type	Marks
House Examination/Test	20
Written Assessment/ Presentation/Project/Term papers/Seminars	15
Class room Performance/Participation	05
TOTAL	40
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Course Title	ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT & CONSERVATION (Practical)		
Course Code:	BSCZOPN602	Practical Credits	2
Contact hours	4 Hours/Week	Duration of Practical Exam.	3 Hrs.
Formative assessment marks	25	Summative assessment marks	25

Course Outcomes (COs):

The students will be trained on various methods of assessment animals in the field and laboratory by ;

- The estimation of various pollutions in the habitats
- The impact of various pollutions on biotic community will be assessed through biological samples collected from polluted and unpolluted habitats
- The collection, preservation and identification of important groups of regional fauna.
- The identification of wild vertebrate animals by indirect methods without collecting the animals .
- The handling of various equipments used in wildlife studies.
- The assessment of animal population using field based techniques .
- The students also will be trained in degradable Solid waste management techniques
- Different ecosystems will be visited by the students to record the faunal diversity in the form of a report.

PRACTICALS

15x4=60 (4Hrs/ Week)

1. Water quality parameters assessment:
 - Estimation of Dissolved Oxygen (O₂);
 - Estimation of Carbon dioxide (CO₂);
 - Estimation of Biological Oxygen Demand (BOD);
 - Estimation of Chemical Oxygen Demand (COD);
 - Estimation of Chlorides, hardness and salinity of water.
2. Analysis of physico-chemical parameters of soil: pH, moisture, temperature, organic matter.
3. Analysis of air pollution: Air monitoring for particulate matter.
4. Collection, preservation and estimation of zooplanktons (Ponds & Lakes).
5. Identification of wild animals: Pugmarks & hoof marks; scats & pellet counts; nest; antlers. Feathers.

6. Studies on field equipments and their applications in wildlife census- Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System(GPS), Photography & Videography.
 7. Demonstration of field techniques for assessment of animals (Line transect, quadrature methods)
 8. Demonstration of waste management techniques: Vermitechnology / Hermitechnology
 9. Collection, identification and recordings of fauna of selected ecosystems & submission of report.
 10. Visit to protected areas/ ex-situ conservation facilities/ industries and submission of report.
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SCHEME OF PRACTICAL EXAMINATION
B.Sc. Zoology VI Semester

Course Title/Code: BSCZOPN602: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT & CONSERVATION

Duration: 3 hours

Max. Marks: 25

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- Q I. Analyses of the quality of the given water sample (O₂/ CO₂/Chloride/ Hardness/Salinity). **05**
(Procedure- 2 marks; readings- 2 marks; results – 1 mark)
- Q II. Analysis of physico-chemical parameters of soil sample (pH,Temp, Moisture,Organic matter). **04**
(Procedure- 2 marks; results- 2 marks)
- Q III. Identify and comment on the given spotters- **A and B (Expt.-5 & 6)** **(2x3)= 06**
(Identification- 1 mark; comments - 2 marks)
- Q IV. Submission of report (**Expt.-9 / 10**) **05**
- Q V. Record and Viva-voce **05**
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Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/ type	Marks
House Examination/Test	10
Project/Model submission	05
Class room Performance/Participation	05
Record writing & timely submission	05
Total	25
<i>Formative Assessment as per NEP guidelines are compulsory</i>	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark -X in the intersection cell if a course outcome addresses a particular program outcome.

Course Outcomes (COs) / Program Outcomes (POs)	BSCZOCN601	BSCZOPN601	BSCZOCN602	BSCZOPN602
Core competency				
Critical thinking				
Analytical reasoning				
Research skills				
Team work				
