# Mohanlal Sukhadia University
# Udaipur, Rajasthan

## Department of Zoology

# B.Sc. Zoology Syllabus
# (as per NEP)

**Effective from**

**July 2023**

## B.Sc. Course structure

| Table 1: CBCS Course structure for B.A./B.Com./B.Sc. (Three Year Program) total credits 120 | | | | | | |
|---|---|---|---|---|---|---|
| | **SEM-1** | **SEM-II** | **SEM-III** | **SEM-IV** | **SEM-V** | **SEM-VI** |
| Core Courses | DCC-A1 (6 Cr)<br>DCC-B1 (6 Cr)<br>DCC-C1 (6 Cr) | DCC-A2 (6 Cr)<br>DCC-B2 (6 Cr)<br>DCC-C2 (6 Cr) | DCC-A3 (6 Cr)<br>DCC-B3 (6 Cr)<br>DCC-C3 (6 Cr) | DCC-A4 (6 Cr)<br>DCC-B4 (6 Cr)<br>DCC-C4 (6 Cr) | - | - |
| DSE / GEC | - | - | - | - | DSE-A1(6 Cr)<br>DSE-B1(6 Cr)<br>DSE-C1(6 Cr) | DSE-A1(6 Cr)<br>DSE-B1(6 Cr)<br>DSE-C1(6 Cr) |
| AECC | AECC-1 (2Cr) | AECC-2 (2 Cr) | - | - | | |
| SEC | | | SEC-1 (2 Cr) Communicative English | SEC-2 (2Cr) | SEC-3 (2 Cr) | SEC-4 (2Cr) |
| | **18+0+2+0=20** | **18+0+0+2=20** | **18+0+0+2=20** | **18+0+0+2=20** | **0+18+2+0=20** | **0+18+0+2=20** |
| **72(DCC)+36(DSE/GEC)+4(AECC)+8(SEC)=120** | | | | | | |

1. Discipline Centric Compulsory Course **(DCC):A, B, and C denote three different disciplines (subjects)**. A student will study 4 papers in each discipline.
2. **Discipline Specific Elective (DSE):**A student will choose DSE courses from the three chosen disciplines (A, B, and C) for semesters V and VI. Any such paper can be Generic Elective Course (GEC) for the students of other disciplines.
3. **Ability Enhancement Compulsory Courses (AECC)**: Modern Indian Languages (MIL), English, Hindi Communication (Odia/Hindi/Telugu/Bangla/……)
4. **Skill Enhancement Courses (SEC):**Communicative English in the 3rd semester and three more subjects from a common pool. Each discipline provide at least one SEC
5. Courses with Practical component: Theory (4 credits) + Practical (2 credits) = 6 credits
6. Non-practical Courses: Theory (5 credits) + Tutorial (1 credit) = 6 credits (Numbers shown in brackets indicate Credits). In some of the disciplines it can be (2L+2P+2T) or (2L+4P)

**Table 2: Proposed Zoology Courses for CBCS in 3-year B.Sc. Program: Semester wise types, codes, titles, Delivery type, Workload, Credits of the courses, Marks of Examination, and Remarks.**

| Level | Semester | Course Type | Course Code | Course Title | Delivery type per week | | | Total hours | Credits | Total Credits | Internal marks | EoSE Marks | Max. Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | | | | | | |
| 5 | I | DCC | ZOO5000T | Zoology-I: Life and Diversity of Animals-I (Invertebrates) | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO5000P | Zoology Lab-I:Practical exercises onLife and Diversity of Animals (Invertebrates) | - | - | P | 60 | 2 | | 20 | 80 | 100 |
| | | AECC | AEC5200T | | L | T | | 30 | 2 | 2 | 20 | 80 | 100 |
| | II | DCC | ZOO5001T | Zoology-II: Life and Diversity of Animals-II (Vertebrates) | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO5001P | Zoology Lab-II:Practical exercises on Life and Diversity of Animals (Vertebrates) | - | - | P | 60 | 2 | | 20 | 80 | 100 |
| | | AECC | AEC5201T | | L | T | | 30 | 2 | 2 | 20 | 80 | 100 |
| **Exit with Certificate in Science (After 2 more credits in SEC )** | | | | | | | | | | | | | |
| 6 | III | DCC | ZOO6002T | Zoology-III: Cell Biology and Genetics | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO6002P | Zoology Lab-III: Practical exercises on Cell Biology and Genetics | - | - | P | 60 | 2 | | 20 | 80 | 100 |
| | | SEC | SEC6300T | Communicative English | L | T | - | 30 | 2 | 2 | 20 | 80 | 100 |
| | IV | DCC | ZOO6003T | Zoology-IV: Animal Physiology, Biochemistry & Immunology | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO6003P | Zoology Lab-IV: Practical exercises on Animal Physiology, Biochemistry & Immunology | - | - | P | 60 | 2 | | 20 | 80 | 100 |
| | | SEC | SEC6390T | Public Health, Nutrition and Hygiene | L | T | - | 30 | 2 | 2 | 20 | 80 | 100 |
| **Exit with Diploma in Science** | | | | | | | | | | | | | |
| 7 | V | **Select anyone of the following Discipline Specific Elective (DSE) Courses in V and VI semester** | | | | | | | | | | | |
| | | DSE/ GEC | ZOO7004T | 1. Applied Zoology, Insect Vectors and Diseases | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO7004P | 1. Elective Zoology Lab: Applied | - | - | P | 60 | 2 | | 20 | 80 | 100 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Zoology, Insect Vectors and Diseases | | | | | | | | | |
| | | | ZOO7005T | 2. Developmental Biology | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO7005P | 2. Elective Zoology Lab: Developmental Biology | - | - | P | 60 | 2 | | 20 | 80 | 100 |
| | | SEC | SEC73091T | Wildlife Conservation and Management | L | T | - | 30 | 2 | 2 | 20 | 80 | 100 |
| | VI | DSE | ZOO7006T | 3. Ethology and Evolution | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO7006P | 3. Elective Zoology Lab: Ethology and Evolution | - | - | P | 60 | 2 | 6 | 20 | 80 | 100 |
| | | | ZOO7007T | 4. Ecology and Biostatistics | L | T | - | 60 | 4 | 6 | 20 | 80 | 100 |
| | | | ZOO7007P | 4. Elective Zoology Lab: Ecology and Biostatistics | - | - | P | 60 | 2 | 6 | 20 | 80 | 100 |
| | | SEC | SEC7392T | Use of Artificial intelligence (AI) in Biological Sciences | L | T | - | 30 | 2 | 2 | 20 | 80 | 100 |
| **Exit with Graduation Degree in Science (B.Sc.)** | | | | | | | | | | | | | |

**DCC**- Discipline Centric Compulsory Course (001 to 099); **DSE**- Discipline Specific Core Course (101 to 199)
**AECC**- Ability Enhancement Compulsory Course (English/Modern Indian Languages/Hindi) (201 to 299);**SEC**- Skill Enhancement Course (301 to 399)
The code has eight places. XYZ (subject name) Level (5/6/7)DCC/DSE/AEC/SEC (3 digits) T/P
If an SEC course is offered by commerce: SE**C**53XXT; Science: SE**S**63XXT; Arts/Humanities/: SE**A**53XXT; Management SE**M**73XXT

## Semester-wise syllabus
## Semester I

| | |
|---|---|
| Code of the course | ZOO5000T |
| Title of the course | **Zoology-I: Life and Diversity of Animals-I (Invertebrates)** |
| Level of the Course | NHEQF Level 4.5 |
| Credit of the Course | 4 |
| Type of the Course | DCC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60; The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

Develop a comprehensive understanding of the diversity, biology, and ecological importance of invertebrates, enabling students to identify and classify major invertebrate groups, understand their functional adaptations, and appreciate their ecological roles in various ecosystems.

**Learning outcomes**

1. Students will be able to identify and classify major groups of invertebrates, including but not limited to arthropods, mollusks, annelids, and cnidarians.
2. Students will gain knowledge of the functional adaptations of invertebrates, including locomotion, feeding, reproduction, and defense mechanisms.
3. Analyze invertebrate ecological roles: Students will learn about the ecological roles played by invertebrates in various ecosystems.
4. They will understand how these adaptations have evolved in response to ecological pressures and contribute to the success and survival of invertebrate species.
5. Analyze invertebrate ecological roles: Students will learn about the ecological roles played by invertebrates in various ecosystems.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

General characters and classification of Protozoa and Porifera (up to classes) with examples. Type study: Paramecium. Parasitic protozoans and their Pathogenesis. Type study-Sycon. Canal system in sponges.

**UNIT- 2 (Lecture hours: 12)**

General characters and classification of Coelenterata and Ctenophora. Type study - Obelia. Corals and coral reefs - their formation, kinds and importance. Polymorphism and metagenesis in Coelenterates.

**UNIT- 3(Lecture hours: 12)**

General characters and classification of Platyhelminthes (upto classes) and Aschelminthes (upto phyla). Type study – *Fasciola*, *Taenia*. General characters and classification of Nematoda (upto classes)
Type study – *Ascaris*. Endoparasites in relation to human diseases. Parasitic adaptations of trematodes, cestodes, and nematodes.

**UNIT- 4 (Lecture hours: 12)**

General characters and classification of Annelida and Arthropoda (up to classes) with examples. Concept of metamerism and coelom. Type study - *Pheretima*, *Periplaneta*.

**UNIT- 5(Lecture hours: 12)**

General characters and classification of and Mollusca and Echinodermata (up to classes) with examples. Type Study – *Pila* and *Asterias*. Concept of Torsion and its importance. Echinoderm larvae.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**


- Hickman C.P.Jr., F.M. Hickman and L.S. Roberts, Integrated Principles of Zoology, Mosby College Publication. St. Louis.
- Ayyar, E.K. and T.N.Ananthakrishnan, Manual of Zoology, Vol.1 (Invertebrate), Parts I and II. S, Viswanathan (Printers and Publishers) Pct. Ltd., Madras.
- Jordan, E.L. and P.S.Verma, Invertebrate Zoology, S. Chand & Co. Ltd., Ram Nagar, New Delhi. (English and Hindi Editions).
- Parker and Haswell, Text Book of Zoology, Vol.1, (Invertebrate), A.Z.T.B.S. Publishers and Distributors, New Delhi- 110051
- Ismail, S.A., Vermicology: The Biology of Earthworms, Orient Longman, India.
- Kotpal, RL. Agarwal and Khetrapal: Modern Text Book of Zoology: Invertebrates, Rastogi Publications, Meerut. (English and Hindi Editions)
- Storer, T.I. and Usinger, K.L.: General Zoology, Tata McGraw- Hill Publishing Co., New Delhi.
- Simpson, GG: Principles of Taxonomy, Oxford and IBH Publisher Co. New Delhi.


**Suggested E-resources**

- https://www.askiitians.com/revision-notes/biology/
- https://www.onlinebiologynotes.com/
- https://www.notesonzoology.com/
- https://thesciencenotes.com/
- https://byjus.com/biology/
- https://en.wikipedia.org/

| | |
|---|---|
| Code of the course | ZOO5000P |
| Title of the course | **Zoology Lab-I: Practical exercises on Life and diversity of Animals-I (Invertebrates)** |
| Level of the Course | NHEQF Level 4.5 |
| Credit of the Course | 2 |
| Type of the Course | DCC |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

The primary objective is to impart practical knowledge about the morphological and anatomical aspects of the diverse range of invertebrate species. This involves exposure to various animal specimens/models, histological slides etc.

**Learning outcomes**

1. Identification Skills: Students will develop the ability to identify different types of invertebrates based on their physical characteristics, anatomy, and key features.
2. Taxonomic Classification: Students will learn about the taxonomy of invertebrates, including the major phyla and classes, and understand how invertebrates are classified based on their evolutionary relationships and shared characteristics.
3. Appreciation of Biodiversity: Through hands-on interactions with a variety of invertebrates, students will develop an appreciation for the vast diversity of invertebrate life forms and understand the importance of conserving and protecting these organisms and their habitats.

**Syllabus**

1 Study of museum specimens:
   a. Protozoa-*Entamoeba, Euglena, , Trypanosoma, Paramecium, Vorticella*
   b. Porifera-*Scypha, Hyalonema, Euplectella, Spongilla, Euspongia*
   c. Coelenterata- *Physalia, Aurelia, Alcyonium, Gorgonia, Pennatula, Metridium*
   d. Platyhelminthes and Aschelminthes- *Dugesia, Fasciola, Taenia, Schistosoma, Dracunculus, Ascaris*(male and female)*, Wucheraria, Enterobius*
   e. Annelida- *Nereis, Heteronereis, Aphrodite, Chaetopterus, Hirudinaria*
   f. Onychophora- *Peripatus.*
   g. Arthropoda- *Limulus, Aranea, Balanus, Sacculina, Eupagurus, Carcinus, Lepisma, Pediculus, Julus, Scolopendra, Ixodes*
   h. Mollusca- *Mytilus, Chiton, Teredo, Doris, Aplysia, Dentalium, Nautilus, Sepia, Octopus, Pecten*
   i. Echinodermata- *Asterias, Pentaceros, Antedon, Ophiothrix, Holothuria*
   j. Hemichordata- *Balanoglossus, Saccoglossus*

2. Study of permanent slides
    a. Protozoa-Blood smears showing malarial parasite. *Paramecium*: Binary fission, conjugation
    b. Porifera-T.S. and L.S. of Sycon., spicules, spongin fibres and gemmules.
    c. Coelenterata- Obelia (colony and medusa), Planula, Scyphistoma and Ephyra larvae of Aurelia
    d. Platyhelminthes-Miracidium, sporocyst, redia and cercaria larvae of *Fasciola,*scolex of *Taenia*, W.M. of mature and gravid proglottids of *Taenia*, hexacanth and cysticercus larvae of *Taenia*
    e. Aschelminthes- T.S. of *Ascaris* (male and female)
    f. Annelida- Parapodia of Nereis and Heteronereis, Trochophore larva
    g. Arthropoda- V.S. of compound eye, nauplius, zoea, megalopa larvae and Mysis
    h. Mollusca- T.S. of osphradium of *Pila*, glochidium larva.
    i. Echinodermata- T.S. of arm and bipinnaria larva of starfish, echinopluteus larva.
    j. Hemichordata- Torneria larva.
3. Virtual dissections/Diagrams of various systems of preserved animals
    a. *Pheretima*- General anatomy, digestive, nervous, excretory and reproductive systems.
    b. *Palaemon*- Appendages, general anatomy, digestive system and nervous system.
    c. *Pila*- Organs of pallial complex, nervous system
4. Mounting: Permanent preparation of the followings:
    a. Protozoa- *Euglena, Paramecium*, rectal ciliates, *Polystomella*.
    b. Porifera- Sponge spicules, spongin fibres and gemmules.
    c. Coelenterata- *Obelia*(colony and medusa)
    d. Platyhelminthes-Proglottid of *Taenia*.
    e. Annelida-Parapodia of *Nereis* and *Heteronereis*, ovary, septal nephridia and setae (*in situ*) of earthworm.
    f. Arthopoda- Statocyst and hastate plate of prawn, salivary glands and tracheae of cockroach, W.M. of *Cyclops, Daphnia*, mouth parts of any following insects: *Culex, Anopheles* male and female, housefly, cockroach and honey bee.
    g. Mollusca-Gill lamella, glochidium larva, osphradium and radula of *Pila.*

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**


- Verma, PS, A manual of practical Zoology S.Chand and Co. Ltd., Ram Nagar, New Delhi (English and Hindi Editions).
- Lal, SS: Practical Zoology, Invertebrates, Rastogi Publication, Meerut (English and Hindi Editions).


**Suggested E-resources**

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|---|
| • https://www.askiitians.com/revision-notes/biology/<br>• https://www.onlinebiologynotes.com/<br>• https://www.notesonzoology.com/<br>• https://thesciencenotes.com/<br>• https://byjus.com/biology/ |
| **Scheme for internal exam (Max. marks: 20)**<br>• Class interaction/Quiz – 5 marks<br>• Attendance – 5 marks<br>• Assignment/Seminar/Project/Model, etc. – 10 marks |
| **Scheme for external/main exam (Max. marks: 80)**<br>• Major exercise 1 – 15 marks<br>• Major exercise 2 – 15 marks<br>• Minor exercise – 10 marks<br>• Spots (10 in number) – 20 marks<br>• Viva-voce – 10 marks<br>• Record – 10 marks |

## Semester II

| | |
|---|---|
| Code of the course | ZOO5001T |
| Title of the course | **Zoology-II: Life and diversity of Animals-II (Vertebrates)** |
| Level of the Course | NHEQF Level 4.5 |
| Credit of the Course | 4 |
| Type of the Course | DCC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

The primary objective is to develop a comprehensive understanding of the diverse range of vertebrate species, including fishes, amphibians, reptiles, birds, and mammals. This involves learning their distinguishing characteristics, taxonomy, and type studies.

**Learning outcomes**

1. After completion of the course students will able to understand chordate diversity of animals and their taxonomic position.
2. Identification of morphological and anatomical features and basis of chordate classification
3. Know economic importance and present status that will develop positive attitude towards conservation of Biodiversity
4. The project, assignment will give them a flavor of research in studying biodiversity, taxonomy besides improving their writing skills and lay foundation of career in Zoology.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

Characteristics and classification of Protochordates and Agnathaupto orders with examples and their economic importance. Type study- *Herdmania*. Concept of Coelom: Acoelomate, Pseudocoelomate and Coelomate. Affinities of Amphioxus and importance of Ammocoete larva.

**UNIT- 2 (Lecture hours: 12)**

Characteristics and classification of Pisces (after Berg) upto orders with examples and their economic importance. Type study- *Scoliodon*. Characteristics and classification of Amphibiaupto orders with examples and their economic importance. Type study- *Rana*. Parental care in Amphibian. Neoteny and padeogenesis

**UNIT- 3(Lecture hours: 12)**

Characteristics and classification of Reptiles upto orders with examples and their

economic importance. Type study- *Calotes*. Identification of poisonous and non-poisonous snakes, venom, antivenom, medicinal significance of venom. *Sphenodon*: Characteristics and affinities.

**UNIT- 4 (Lecture hours: 12)**

Characteristics and classification of Aves upto orders with examples and their economic importance.

Type study - *Columba*, flight adaptations, perching mechanism, types of feathers. Bird migration.

**UNIT- 5(Lecture hours: 12)**

Characteristics and classification of Mammalia upto orders with examples and their economic importance. Type study – *Oryctolagus*. Dentition, hair and thermoregulation, and integumentary derivatives.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**


- Ayyar, E.K. and T.N. Ananthakrishnan, Manual of Zoology, Vol.II (Chordata), S.Viswanathan (Printers and Publishers) Pvt. Ltd. , Madras.
- Jordan, E.L. and P.S.Verma, Chordate Zoology and Elements of Animal Physiology, S. Chand & Co. Ltd., Ram Nagar, New Delhi (English and Hindi Editions).
- Parker and Haswell, Text Book of Zoology, Vol.II (Chordata), A.Z.T.B.S. Publishers and Distributors, New Delhi- 110051.
- Waterman, Allyn J. et.al., Chordate Structure and Function, Mac Millan and Co., New York.
- Kotpal, RL, Modern Text Book of Zoology- Vertebrates, Rastogi Publications, Meerut (English and Hindi Editions).
- Ganguly, BB, Sinha, AK and Adhikari, S : Biology of Animals, Vol.II, New Central Book Agency (P) Ltd. Kolkatta.
- Alexander, R.M.: The Chordates (Cambridge University Press).
- Monielth, A.R: The Chordates (Cambridge University Press).
- Young, J.Z : Life of Vertebrates (Oxford University PressL)
- Waterman, A.J: Chrodata - Structure and Function (Macmillan Co.).


**Suggested E-resources**

- SWAYAM: https:/www.swayamprabha.gov.in/index.php/program/eurrent
- www.prodissector.com
- https://opentextbc.ca/biology2eopenstax/chapter/chordates/
- http://www.ignouhelp.in/ignou-lse-10-study-material
- https://www.youtube.com/embed/M2uEOCW83NE
- http://www.youtube.com/embed/tFy9DSEo-dc
- www.youtube.com/embed/gqlKPQCINcQ

| | |
|---|---|
| Code of the course | ZOO5001P |
| Title of the course | **Zoology Lab-II: Practical exercises on Life and diversity of Animals-II (Vertebrates)** |
| Level of the Course | NHEQF Level 4.5 |
| Credit of the Course | 2 |
| Type of the Course | DCC |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

The primary objective is to impart practical knowledge about the morphological and anatomical aspects of the diverse range of vertebrate species, including fishes, amphibians, reptiles, birds, and mammals. This involves exposure to various animal specimens/models, histological slides etc.

**Learning outcomes**

1. This course involves the practical knowledge related to Life and Diversity of Vertebrates
2. It acquaints the students with various types of vertebrates by studying museum specimens and slides of their internal parts etc.
3. Students are imparted practical knowledge of preparing permanent slides of various materials available
4. Virtual dissection helps to have practical knowledge about the anatomy of different vertebrate animals.
5. Comparison of skeleton of pisces, amphibians, reptiles, aves and mammals gives an idea about the bones and their development.

**Syllabus**

1. Study of museum specimens:
    a. Urochordata-*Ciona, Pyrosoma, Doliolum, Salpa*
    b. Cephalochordata-*Amphioxus*
    c. Agnatha- *Petromyzon*, Ammocoete larva
    d. Pisces- *Echeneis, Sphyrna, Torpedo, Pristis, Anabas, Hippocampus, Chimaera, Anguilla, Protopterus*
    e. Amphibia- *Ichthyophis, Axolotl* larva, *Salamander, Bufo, Pipa, Amphiuma, Alytes*
    f. Reptilia- *Testudo, Trionyx, Calotes, Varanus, Phrynosoma, Heloderma, Vipera, Typhlops, Bungarus, Hydrophis, Eryx.*
    g. Aves- *Psittacula, Passer, Bubo,* model of *Archaeopteryx*
    h. Mammals- *Rhinopoma, Felis, Erinaceous, Hystrixcrocedura, Manis*
2. Study of permanent slides
    a. Urochordata-*Amphioxus*: T.S. through buccal region, T.S. through pharynx

showing gonads, T.S. through caudal region.

b. Pisces- Placoid, cycloid and Ctenoid scales, V.S. of skin
c. Amphibia- V.S. of skin, T.S. of testis, T.S. of kidney and T.S. of liver
d. Reptilia- V.S. of skin and T.S. of stomach.
e. Aves- T.S. of intestine, T.S. of liver, T.S. of ovary, filoplumeW.M .
f. Mammals-T.S. of pancreas, T.S. of thyroid gland, L.S. of pituitary gland, T.S. of intestine, L.S. of kidney, T.S. of testis and ovary and V.S. of skin, T.S. of lung

3. Virtual dissections/Diagrams of various systems of preserved animals
   a. *Herdmania*- Neural complex.
   b. *Scoliodon*- Alimentary canal, scroll valve *in situ*, afferent and efferent branchial arteries, eye muscles, internal ear.
   c. Digital dissection of animals (as available) - Arterial, venous and urino-genital system.
4. Mounting: Permanent preparation of the followings:
   a. Mounting of scales of fishes.
   b. Spicules of *Herdmania*
5. Appendicular skeleton (Limb bones and girdles) of *Rana*, *Varanus,Gallus* and *Oryctolagus*.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**

- Verma, PS, A manual of practical Zoology Vertebrates S.Chand and Co. Ltd., Ram Nagar, New Delhi (English and Hindi Editions).
- Lal, SS : Practical Zoology Vertebrates, Rastogi Publication, Meerut (English and Hindi Editions).

**Suggested E-resources**

- www.prodissector.com (Virtual Dissection)
- https://en.wikipedia.org/wiki/Chordate
- https://www.youtube.com/watch?v=BBfdzpdNh70
- https://www.youtube.com/watch?v=6GbJWJ3Swsc
- http://www.ignouhelp.in/ignou-lse-08-study-material-in-hindi/

**Scheme for internal exam (Max. marks: 20)**

- Class interaction/Quiz – 5 marks
- Attendance – 5 marks
- Assignment/Seminar/Project/Model, etc. – 10 marks

**Scheme for external/main exam (Max. marks: 80)**

- Major exercise 1 – 15 marks
- Major exercise 2 – 15 marks
- Minor exercise – 10 marks
- Spots (10 in number) – 20 marks
- Viva-voce – 10 marks
- Record – 10 marks

**Semester III**

| | |
|---|---|
| Code of the course | ZOO6002T |
| Title of the course | **Zoology-III: Cell Biology and Genetics** |
| Level of the Course | NHEQF Level 5.0 |
| Credit of the Course | 4 |
| Type of the Course | DCC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Foundation or introductory courses required. |

**Objectives of the Course**

The course aims to strengthen the conceptual knowledge of cell biology and genetics learn at School level and lay foundation for further learning of the subject through first course on cellular adaptation which is a prerequisite for higher courses in zoology.

**Learning outcomes**

1. Students will learn about the basic components and functions of a cell, including its organelles, cellular processes, and the structure and function of biomolecules.
2. Students will be able to understand the basic concepts of genetics in biological systems.
3. Students will be able to apply their understanding of cell biology to explain various cellular processes, such as cell division, metabolism, signal transduction, and cellular communication.
4. Students will develop the ability to analyze and interpret genetic patterns, such as Mendelian and non-Mendelian inheritance, linkage, and genetic mapping. They will be able to solve genetic problems.
5. Students will gain an understanding of the role of genetics in human health and disease.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

Cell theory and modern interpretation, types of cells and comparisons.

Cell organelles structure and functions: Plasma membrane, Cilia and flagella, Centriole and Basal bodies, Basic idea of cytoskeleton, Nucleus.

**UNIT- 2 (Lecture hours: 12)**

Cell organelles structure and functions: Endoplasmic reticulum, Golgi complex, Lysosome, Peroxisome, ribosome, Mitochondria. Brief idea of cell cycle including general description of mitosis and meiosis.

**UNIT- 3(Lecture hours: 12)**

Nucleic acids structure and functions: DNA and RNA. General process of replication, transcription and translation of nucleic acids. Structure of chromosome.

History of Genetics: Pre-Mendelian genetic concepts and Mendel's experiments and laws.

**UNIT- 4 (Lecture hours: 12)**

Linkage and crossing over: kinds of linkage – complete and incomplete linkage, linkage groups, significance of linkage. Genetic interaction: duplicate genes, epistasis, multiple-gene inheritance, ABO blood group, Rh factor. Extra-chromosomal inheritance. Chromosomal and hormonal theories of sex determination.

**UNIT- 5(Lecture hours: 12)**

Concept of gene, mucon, recon, cistron, gene expression, lac-operon, trip-operon. Mutations: Definition, gene mutation, chromosomal mutation, chromosomal aberrations, somatic and germ mutations, numerical alterations of chromosomes, molecular basis of mutation, mutagenic agents. Polytene and lamp-brush chromosomes.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**


- Koli VK, Joshi P, Koli, H. Cell Biology and Genetics. Himanshu Publication, Udaipur (India).
- S. Chand. Cell Biology (Cytology, Biomolecules and Molecular Biology). S. Chand Publication.
- P. K. Gupta. Cell biology and Genetics. Rastogi Publication, Meerut.
- B.D. Singh, P. Nallari, P.B.K. Kishor, P.H. Rao. Cell biology and Genetics. Kalyani Publishers.
- Alberts, Bray, Lewis, Raff, Roberts and Watson, Molecular Biology of the Cell (Garland).
- Balinsky, An Introduction to Embryology (CBS College Publishers)
- Grant: Biology of developing systems (Holt, Reihart and Winston).
- Alberts, B., et al., Molecular Biology of the Cell (Garland)
- Lodish, H., et al., Molecular Cell Biology (Freeman).


**Suggested E-resources**

- https://microbenotes.com/category/cell-biology/
- https://unacademy.com/content/neet-ug/study-material/biology/cell-biology/
- https://en.wikipedia.org/wiki/Cell_biology
- https://www.aakash.ac.in/
- https://www.careerlauncher.com/cbse-ncert/class-9/Biology/CBSE-TheFundamentalUnitofLife-Notes.html
- https://thebiologynotes.com/category/cell-biology/

| | |
|---|---|
| Code of the course | ZOO6002P |
| Title of the course | **Zoology Lab-III: Practical exercises on Cell Biology and Genetics** |
| Level of the Course | NHEQF Level 5.0 |
| Credit of the Course | 2 |
| Type of the Course | DCC |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Foundation or introductory courses required. |

**Objectives of the Course**

The course aims to strengthen the conceptual practical knowledge of cell biology and genetics and lay foundation for further learning of the subject through first course on cellular adaptation which is a prerequisite for higher courses in zoology as well as in genetics.

**Learning outcomes**

1. Students will develop proficiency to observe and analyze different types of cells, tissues, and cellular structures.
2. Students will gain a deeper understanding of cell anatomy and the organelles involved in various cellular processes.
3. Students will learn about the processes of mitosis and meiosis, including the different stages and their significance in growth, development, and reproduction. They will observe and analyze cells undergoing division, understanding the importance of accurate chromosome segregation and the generation of genetically diverse offspring.
4. Students will apply the principles of Mendelian inheritance to analyze and interpret genetic traits. They will conduct experiments involving traits such as eye color, flower color, or seed shape, and learn to predict and explain patterns of inheritance based on dominant and recessive alleles.

**Syllabus**

1. Spotting:
    a. Different cellular organelles-Nucleus, Nucleolus, Endoplasmic reticulum, Golgi Complex, Lysosome, Peroxisome, Centriole, Ribosome, Mitochondria, Chromosome, Plasma membrane
    b. Study of different stages of Mitosis and Meiosis
    c. Types of cells - Bacterial cell, Animal cells, Plant cells, Muscle cell, Stem cell, Sperm cell or Spermatozoon, Egg cell, Blood cells, and Fat cells
    d. Microscopes: Dissection microscope, compound microscope
2. Type study of the followings with suitable diagrams:
    a. Difference between prokaryotic cell and eukaryotic cells.

b. Difference between animal cell and plant cell.

3. Study of the followings tissues with suitable slides/diagrams: Epithelial tissue, Connective tissues, Muscular tissues, Vascular tissues, Adipose tissue
4. Cell biology exercises:
    a. Buccal smear preparation for localization of Mitochondria and Golgi complex using vital stains.
    b. Preparation of cell division stages (mitosis) using onion root tip.
    c. Squash preparation of polytene chromosomes.
5. Genetics exercise
    a. Life cycle and culture of *Drosophila*.
    b. Identification of wild and mutant *Drosophila*.
    c. Exercises based of Mendel's laws
    d. Exercises on linkage and chromosome mapping

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**

- Verma, PS, A manual of practical Zoology S.Chand and Co. Ltd., Ram Nagar, New Delhi (English and Hindi Editions).
- Lal, SS: Practical Zoology, Invertebrates, Rastogi Publication, Meerut (English and Hindi Editions).
- Prem Prakash sharma, AbhayDashora. Practical: Fundamentals of genetics. Himanshu Publication, Udaipur and New Delhi.

**Suggested E-resources**

- https://microbenotes.com/category/cell-biology/
- https://unacademy.com/content/neet-ug/study-material/biology/cell-biology/
- https://en.wikipedia.org/wiki/Cell_biology
- https://www.aakash.ac.in/
- https://www.careerlauncher.com/cbse-ncert/class-9/Biology/CBSE-TheFundamentalUnitofLife-Notes.html
- https://thebiologynotes.com/category/cell-biology/

**Scheme for internal exam (Max. marks: 20)**

- Class interaction/Quiz – 5 marks
- Attendance – 5 marks
- Assignment/Seminar/Project/Model, etc. – 10 marks

**Scheme for external/main exam (Max. marks: 80)**

- Major exercise 1 – 15 marks
- Major exercise 2 – 15 marks
- Minor exercise – 10 marks
- Spots (10 in number) – 20 marks
- Viva-voce – 10 marks
- Record – 10 marks

## Semester IV

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|---|---|
| Code of the course | ZOO6003T |
| Title of the course | **Zoology-IV: Animal physiology, Biochemistry & Immunology** |
| Level of the Course | NHEQF Level 5.0 |
| Credit of the Course | 4 |
| Type of the Course | DCC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Foundation or introductory courses required. |

**Objectives of the Course**

To develop a comprehensive understanding of the fundamental principles governing the functioning of animals at the physiological, biochemical, and immunological levels. By studying animal physiology, students aim to grasp the intricacies of the various physiological processes and gain insights into the mechanisms by which animals maintain homeostasis.

**Learning outcomes**

1. Understand how organs function at different levels i.e., from cellular to system levels.
2. Examine internal harmony of different body systems by learning inherent disorders and deficiencies, which is needed to maintain good health.
3. Understand functions of biomolecules & their role in metabolism by studying biochemistry.
4. Develop a strong foundation for research & employability skills.
5. Improve the student's perspective of health biology through deep study of physiology.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

Carbohydrates: Types, structure and function. Proteins: Structure, Nomenclature, Basic concept of Protein Folding (α- Helix and β Sheet). Classification, Biological Importance and diseases related to proteins. Enzymes: General Characteristics, Nomenclature,

Mechanism and regulation of Enzyme Action, Co-Enzyme. Lipids and Fats: Types structure and function. Vitamins and Minerals: Types and Sources, Biological importance, Diseases and Disorders.

**UNIT- 2 (Lecture hours: 12)**

**Metabolism of carbohydrates**: Glycolysis, decarboxylation of pyruvic acid, Krebs cycle, electron transport system and oxidative phosphorylation; glycogenesis and glycogenolysis. **Metabolism of proteins**: Essential and non-essential amino acids, metabolism of amino acids, biosynthesis of glutamic acid. **Metabolism of lipids**: Biosynthesis of saturated fatty acids and B-oxidative pathways of fatty acid, formation of ketone bodies.

**UNIT- 3(Lecture hours: 12)**

Physiology and mechanism of Digestion. Respiration: Mechanism of respiration, vital capacity of lungs, transport of gases, dissociation curve of oxyhemoglobin and control of respiration, chloride shift. Blood: structure and functions of blood cells, ABO blood groups and Rh factor, mechanism of blood clotting. Structure and type of Muscles, Physiology and biochemistry of muscle contraction.

**UNIT- 4 (Lecture hours: 12)**

Excretion: Structure and function of nephron, urine formation and counter current Mechanism. Nerve physiology: Ultrastructure of neuron, synapse, conduction of nerve impulse and neuromuscular junctions. Reproductive physiology: Hormonal control of testicular and ovarian functions with reference to estrous and menstrual cycles. Endocrine System: Structure, function and disorders of Pituitary Gland, Thyroid Gland, Parathyroid Gland, Adrenal Gland, Thymus Gland, Pineal Gland and Pancreas.

**UNIT- 5(Lecture hours: 12)**

Immunology: Definition, types of immunity: innate and acquired immunity, and humoral and cell-mediated immunity. Cells of immunity. Antibody: definition structure and functions. Antigen: antigenecity of molecules, haptens. Antigen – antibody reactions (Precipitation reaction, Agglutination reaction, Neutralizing reaction), Complement system and its functions.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination.

**Suggested Books and References:**

ANIMAL PHYSIOLOGY :

- William S. Hoar, General and Comparative Physiology, Prentice Hall of India Pvt. Ltd.
- Wood, D.W., Principles of Animal Physiology.
- Prosser CL., Comparative Animal Physiology, Satish Book Enterprise.
- Eckert, Animal Physiology. (W.H. Freeman).
- Ganong : Review of Medical Physiology (Lange).

BIOCHEMISTRY :

- Stryer, L : Biochemistry (Freeman)
- Conn et al : Outlines of Biochemistry (Wiley)

- R.K.Murray et al, Harpers Biochemistry, Lang Medical Book.

IMMUNOLOGY

- Roitt I : Essential Immunology (ELBS)
- Kuby : Immunology (W.H. Freeman).

**Suggested E-resources**

- National Institute of Science Communication & Information Resources (NISCAIR) http://nsdl.niscair.res.in/
- National digital library of India (NDL. India) http://ndl.iitkgp.ac.in/
- https://onlinecourses.swayam2.ac.in/cec19_bt02/preview
- http://epgp.inflibnet.ac.in
- https://en.wikipedia.org/wiki/Physiology
- CEG Gurukul: http://www.cec.nic.in/cec/
- https://onlinecourses.nptel.ac.in/noc20_bt42/preview ( Animal Physiology)

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|---|---|
| Code of the course | ZOO6003P |
| Title of the course | **Zoology Lab-IV: Practical exercises on Animal physiology, Biochemistry & Immunology** |
| Level of the Course | NHEQF Level 5.0 |
| Credit of the Course | 2 |
| Type of the Course | DCC |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Foundation or introductory courses required. |

**Objectives of the Course**

To impart practical knowledge about various physiological aspects related to human body and about various organs. To perform experiments related to physiology and biochemical tests.

**Learning outcomes**

1. Students will be able to perform, analyze and detect various biochemical tests of proteins, lipids etc.
2. Students will be able to learn to detect the blood group and identify different blood cells.
3. Students will be able to perform various experiments related to blood like RBC, WBC counting, estimation of hemoglobin measurement of blood pressure etc.
4. Students will learn the detailed anatomy of various endocrine structures and other organs.

**Syllabus**

1. Study of different instruments and permanent slides (Spotting):
    a. Principles and uses of instruments: Sphygmomanometer, Stethoscope.
    b. Histological studies through permanent slides: Pituitary Gland, Adrenal Gland, Thyroid Gland, Pancreas, Testis, Ovary, Spleen, Thymus, Esophagus, Duodenum, Ileum, Rectum, Liver, Trachea, Lung, Kidney, and Cells of immunity.
2. Biochemical exercises:
    a. Various biochemical tests for detection of the following: Proteins, Carbohydrates, Lipids
    b. Effect of temperature and pH on action of salivary amylase enzyme.
3. Physiological exercises:
    a. To determine RBC and WBC counts.
    b. Estimation of hemoglobin.
    c. Identification of blood groups (ABO and Rh factor).
    d. Measurement of blood-pressure.
    e. Abnormal and normal values of constituents of urine.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**

- Koli VK. Practical Zoology (B. Sc. III year). Himanshu Publication. Udaipur
- Verma, PS, A manual of practical Zoology Vertebrates S.Chand and Co. Ltd., Ram Nagar, New Delhi(English and Hindi Editions).
- Lal, SS : Practical Zoology Vertebrates, Rastogi Publication, Meerut(English and Hindi Editions).
- Verma PS & Srivastava PC, Advanced Practical Zoology, S.Chand& Co.

**Suggested E-resources**

- Virtual Labs (http//www.vlab.co.in)
- http://www.ignouhelp.in/ignou-lse-05-study-material/ Animal Physiology (English-Hindi)

**Scheme for internal exam (Max. marks: 20)**

- Class interaction/Quiz – 5 marks
- Attendance – 5 marks
- Assignment/Seminar/Project/Model, etc. – 10 marks

**Scheme for external/main exam (Max. marks: 80)**

- Major exercise 1 – 15 marks
- Major exercise 2 – 15 marks
- Minor exercise – 10 marks
- Spots (10 in number) – 20 marks
- Viva-voce – 10 marks
- Record – 10 marks

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|---|---|
| Code of the course | SEC6390T |
| Title of the course | **Public Health, Nutrition and Hygiene** |
| Level of the Course | NHEQF Level 4.5 |
| Credit of the Course | 2 |
| Type of the Course | SEC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

The main objective of this course is to make the student aware of the essentials of public health and sanitation thereby warding off diseases and uplifting the living standards of the community and to learn the principles of nutrition and dietetics, understand the ill effects of modern lifestyle, to study the advantages of being hygienic.

**Learning outcomes**

1. Student will be able to understand the linkage between water, sanitation, and health, and the current and future challenges in this area.
2. Participants will learn about the enabling environment for improved water and sanitation for all, tools and approaches for better water and sanitation planning and progress.
3. The course will teach students to use a risk-based approach to protect public health specially vector borne diseases.
4. Upon completion of the course, students will be able to identify the methods and tools of public health data collection, use, and analysis, and why evidence-based approaches are an essential part of public health practice.
5. They will also be able to explain the history and philosophy of public health as well as its core values, concepts, and functions across the globe and in society.

**Syllabus**

**UNIT-1 (Lecture hours: 6)**

Basics of Nutrition-I: Nutrition – definition, importance, Good nutrition and mal nutrition. Balanced Diet: Basics of Meal Planning. **Carbohydrates** –functions, dietary sources, effects of deficiency. **Lipids** –functions, dietary sources, effects of deficiency. **Proteins** –functions, dietary sources, effects of deficiency.

**UNIT- 2 (Lecture hours: 6)**

Basics of Nutrition-II: Brief account of Vitamins- functions, food sources, effects of deficiency. Macro and micro minerals –functions, effects of deficiency. Food sources of Calcium, Potassium and Sodium

Food sources of Iron, Iodine and Zinc. Importance of water– functions, sources, requirement and effects of deficiency.

**UNIT- 3(Lecture hours: 6)**

Common food borne and water borne diseases (gastroenteritis, jaundice, cholera, salmonellosis, travellers'diarrhoea and Escherichia coli infection, typhoid) – mode of transmission, causative agents, symptoms, prevention and control.

**UNIT- 4 (Lecture hours: 6)**

Common Vector Borne Diseases (Malaria, Dengue, Chickungunya, Filariasis, Japanese encephalitis and Scrub typhus) – mode of transmission, causative agents, symptoms, prevention and control; Mosquito identification and their control.

**UNIT- 5(Lecture hours: 6)**

Hygiene: Definition, personal hygiene- body odour, oral hygiene, hand washing, toiletry, occupational hygiene, food and cooking hygiene, medical hygiene. Adulteration of food: food hygiene – hygiene of milk, meat, fish, eggs, fruits and vegetables, common food adulterants – harmful effects and their detection, food additives, fortification of food.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**


- Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation
- Murray, C. J. L. and A.D. Lopez. (1996). The Global Burden Of Disease. Part I- IV,
- World Health Organization. Park, J.E. and Park, K. Textbook of Community Health for Nurses.
- Swaminathan S. Principles of Nutrition and Dietetics.
- Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers
- Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors.
- Kumar and Corton. Pathological Basis of Diseases.
- Arthropod Vectors of Human Infections by M.W. Service
- Biology of Disease Vectors edited by William H. Marquardt
- Insect, Vectors & Diseases by S. K. Das


**Suggested E-resources**

## Semester V

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|---|---|
| Code of the course | ZOO7004T |

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|---|---|
| Title of the course | **1. Applied Zoology, Insect Vectors and Diseases** |
| Level of the Course | NHEQF Level 6.0 |
| Credit of the Course | 4 |
| Type of the Course | DSE |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Core courses of Zoology at graduation level<br>(2) Knowledge of intermediate level courses |

**Objectives of the Course**

The objective of this course includes scientific training in applied zoology, organism biology, and to define the concepts of applied subjects and also to understand the fundamentals of parasitic life, with special emphasis on host-parasite interaction. The course also aims to provide training on clinical management, diagnosis, and vector control, and to support the development and evaluation of new tools, technologies, and approaches for vector-borne diseases, and also to understand the importance of targeting vectors to combat vector-borne diseases.

**Learning outcomes**

1. Students will be able to explain and apply fundamental concepts of zoological sciences, as well as the ability to apply the process of scientific inquiry to the study of animals.
2. Students will also be able to define the concepts of applied subjects like Lac culture and Sericulture, and understand the mechanisms and principles of animal behavior and ecology.
3. Students will learn the principles of transmission of human and animal pathogens by insects, mites, and ticks.
4. At the end of the course, students will be able to describe the pathogenesis of arthropod-borne diseases, understand the behavioral and ecological factors that influence vector-borne disease transmission, and identify the most important vector-borne diseases and their causative agents.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

Sericulture: History, general account and scope of sericulture. Types of silkworm. Life cycle of *Bombyxmori*. Rearing of silk worm, and reeling of silk yarn. Brief idea of diseases of silk worm.

Lac culture: History and types of lac, life cycle and culture technique of lac insect, economic importance of lac culture.

**UNIT- 2 (Lecture hours: 12)**

Pearl culture: History and scope of pearl culture, Rearing of pearl oyster, Economic Importance of pearl culture, Brief idea of diseases and enemies of pearl culture. Culture of fresh water fishes of India, Inland, marine and estuarine fisheries, Preservation of fishes, Economic importance of fishing industry.

**UNIT- 3(Lecture hours: 12)**

Introduction to host-parasite relationship: Host, definitive host, intermediate host, parasitism, symbiosis, commensalism, zoonosis. Parasitic protozoa: Life history and pathogenicity of *Plasmodium vivax*. Parasitic helminthes: Life history and pathogenicity of *Wuchereriabancrofti*.

**UNIT- 4 (Lecture hours: 12)**

Introduction to Insects: General classification of insects up to orders. General Morphological features of insects head – Eyes, antennae, Types of mouth parts. Concept of Vectors: Brief introduction of carrier and vectors (mechanical and biological vector), Host-vector relationship, Adaptations as vectors.

**UNIT- 5(Lecture hours: 12)**

Insects of medical importance: Medical importance and control of Mosquitoes (*Anopheles, culex* and *Aedes*), Sand fly (*Phlebotomus*), Housefly (*Muscadomestica*), flea (*Xenopsylla sp*.) and lice (*Pediculus sp*.). Morphology and Life cycle of mosquitoes, and their control. Brief knowledge of Mosquito-borne diseases – Malaria, Dengue, Chikungunya, Filariasis and Japanese encephalitis

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**


- Jhingran, VG, Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
- Kovaleve, PA, Silkworm Breeding Stocks, Central Silk Board, Merine Drive, Bombay.
- Metcalf CL and WP Flint, Destructive and Useful Insects, Tata McGraw Hill publishing Co. Ltd., New Delhi- 110051
- Sharma PD, Microbiology, Rastogi Publications Meerut.
- Shukla and Upadhyaya : Economic Zoology ( Rastogi Publishers)
- Venkitaraman : Economic Zoology (Sudarshana Publishers)
- Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers
- Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors.
- Kumar and Corton. Pathological Basis of Diseases.
- Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.
- Text Book Of Applied Zoology by P.V. Jabde
- "Arthropod Vectors of Human Infections" by M.W. Service
- "Biology of Disease Vectors" edited by William H. Marquardt
- "Insect, Vectors & Diseases" by S. K. Das


**Suggested E-resources**

- Microsoft PowerPoint - 6.71.pptx (sscasc.in)
- https://byjus.com/biology/
- https://www.onlinebiologynotes.com/
- Studocu - Free summaries, lecture notes & exam prep
- Vector-borne diseases (who.int)

- https://en.wikipedia.org/
- Medical and Veterinary Entomology - Wiley Online Library

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|---|---|
| Code of the course | ZOO7004P |
| Title of the course | **1. Elective Zoology Lab: Applied Zoology, Insect Vectors and Diseases** |
| Level of the Course | NHEQF Level 5.0 |
| Credit of the Course | 2 |
| Type of the Course | DSE |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Knowledge of intermediate level courses |

**Objectives of the Course**

The objective of this course includes practical training in the applied zoology, organism biology, and to define the concepts of applied subjects and also to understand the fundamentals of parasitic life, with special emphasis on host-parasite interaction.

**Learning outcomes**

1. Identification of Insect Vectors: Students will develop the ability to identify and classify different insect vectors, such as mosquitoes, ticks, flies, and fleas, based on their morphological characteristics, life cycle stages, and host preferences.
2. Understanding Disease Transmission: Students will gain knowledge about the mechanisms of disease transmission by insect vectors. They will learn about vector-borne diseases, their causative agents, and the role of insects in spreading diseases among humans, animals, and plants.
3. Vector Control Strategies: Students will explore various strategies for controlling insect vectors and mitigating the spread of vector-borne diseases. They will learn about preventive measures, such as habitat modification, insecticide application, and the use of protective barriers, and understand the importance of integrated vector management.

**Syllabus**

1. Identification of different stages (from egg to adult) of silkworm.
2. Tools used in silk worm rearing.
3. Study of different stages lac insects
4. Identification of cultivable varieties of shell fish and fin fish.
5. Study of different kinds of mouth parts of insects
6. Study of different diseases transmitted by above insect vectors
7. Rearing/ life cycle of medically important insects
8. Study of following insect vectors and causative agents through permanent slides/ photographs: *Anopheles, Aedes, Culex, Xenopsyllacheopis, Pediculus, Phlebotomusargentipes, Muscadomestica*, different stages of Plasmodium parasite in blood smear (i.e. schizont/ merozoite), filarial worm.
9. Identification of different stages of mosquito

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| **Scheme of Examination**<br>Internal and EoSE as per NEP scheme of examination |
| **Suggested Books and References:**<br>• Koli VK. Practical Zoology (B. Sc. III year). Himanshu Publication. Udaipur<br>• Verma, PS, A manual of practical Zoology S.Chand and Co. Ltd., Ram Nagar, New Delhi (English and Hindi Editions).<br>• Lal, SS: Practical Zoology, Invertebrates, Rastogi Publication, Meerut (English and Hindi Editions). |
| **Suggested E-resources**<br>• https://byjus.com/biology/<br>• https://www.onlinebiologynotes.com/<br>• Vector-borne diseases (who.int)<br>• https://en.wikipedia.org/<br>• Division of Vector-Borne Diseases (DVBD) \| Division of Vector-Borne Diseases \| NCEZID \| CDC<br>• Medical and Veterinary Entomology - Wiley Online Library |
| **Scheme for internal exam (Max. marks: 20)**<br>• Class interaction/Quiz – 5 marks<br>• Attendance – 5 marks<br>• Assignment/Seminar/Project/Model, etc. – 10 marks |
| **Scheme for external/main exam (Max. marks: 80)**<br>• Major exercise 1 – 15 marks<br>• Major exercise 2 – 15 marks<br>• Minor exercise – 10 marks<br>• Spots (10 in number) – 20 marks<br>• Viva-voce – 10 marks<br>• Record – 10 marks |

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|---|---|
| Code of the course | ZOO7005T |

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|---|---|
| Title of the course | **2. Developmental Biology** |
| Level of the Course | NHEQF Level 6.0 |
| Credit of the Course | 4 |
| Type of the Course | DSE |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | 1. Core courses of Zoology at graduation level<br>2. Knowledge of intermediate level courses |

**Objectives of the Course**

The objectives of a developmental biology course are to teach students about the molecular and cellular principles behind how a single cell becomes an organism and to understand the processes that lead from the fertilization of an egg cell to the formation of a well-structured and functional multi cellular organism.

**Learning outcomes**

1. Describe the developmental stages that occur in a variety of animals, compare these stages, and identify the characteristics and basic needs of living organisms and ecosystems. Describe the main anatomical changes that occur during development.
2. Identify the cellular behaviors that lead to morphological change during development.
3. Students should be able to apply problem-solving skills to biological problems and issues, write up the results of an experimental study in a lab report, and demonstrate their ability to reason both inductively and deductively with experimental information and data.
4. Understanding the basic principles of embryonic development, lifelong tissue renewal, and the molecular mechanisms that regulate these processes.
5. Learning key principles of embryonic development and lifelong tissue renewal, with an emphasis on model invertebrates and vertebrates.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

History and basic concepts of Embryology. Gametogenesis: Spermatogenesis and oogenesis. Structure and types: eggs and sperms. Neuroendocrine regulation of reproductive organs in brief. Elementary idea of menstrual and estrous cycle.

**UNIT- 2 (Lecture hours: 12)**

Fertilization: Main events of fertilization, acrosome reaction, polyspermy preventing mechanisms. Cleavage: planes, patterns & types of cleavage. Blastulation: Types of blastulae.

**UNIT- 3(Lecture hours: 12)**

Gastrulation: fate maps, morphogenetic movements and their significance in gastrulation. Mechanism and main characteristic of gastrulation. Parthenogenesis. Regeneration

**UNIT- 4 (Lecture hours: 12)**

Elementary knowledge of fate of three germ layers. Primary organizer and embryonic induction, concept of competence. Determination and differentiation.

**UNIT- 5(Lecture hours: 12)**

Extra embryonic membranes: Development and functions. Placentation: Definition, types, classification on the basis of morphology and histology. Functions of placenta. Post embryonic development: Insects and amphibians.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**

- "Organ Development" by DeneenWellik.
- "Vertebrate Skeletal Development" by Bjorn R.
- "Sex Determination in Vertebrates" by Blanche Capel.
- "Developmental Biology" by Scott F Gilbert.
- "The Invertebrate Tree of Life" by Ward C. Wheeler.
- "Principles of Development" by Lewis Wolpert
- Balinsky, An Introduction to Embryology (CBS College Publishers)
- Grant: Biology of developing systems (Holt, Reihart and Winston).

**Suggested E-resources**

- https://www.onlinebiologynotes.com/
- https://byjus.com/biology/
- Virtual Library-Developmental Biology (sdbonline.org)
- Developmental Biology 12e Student Resources - Learning Link (oup.com)
- Find Articles - Genetics, Developmental Biology, and Evolutionary Biology - Library Guides at Penn State University (psu.edu)
- https://en.wikipedia.org/

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|---|---|
| Code of the course | ZOO7005P |
| Title of the course | **2. Elective Zoology Lab: Developmental Biology** |
| Level of the Course | NHEQF Level 5.0 |
| Credit of the Course | 2 |
| Type of the Course | DSE |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Knowledge of intermediate level courses |

**Objectives of the Course**

This practical paper aims to familiarize students with developmental biology by investigating how aniamls and organ developed. Students will gain practical skills in experimental techniques, and data analysis.

**Learning outcomes**

1 Observation and Documentation: Students will develop skills in observing and documenting various stages of embryonic and post-embryonic development in different organisms. They will learn to record and describe developmental changes, including morphological, cellular, and molecular events.

2 Understanding Developmental Processes: Students will acquire a comprehensive understanding of the principles and mechanisms underlying embryonic development. They will learn about processes such as fertilization, cleavage, gastrulation, organogenesis, and tissue differentiation, and understand the molecular and cellular basis of these events.

3 Students will study developmental stages/Metamorphosis of followings: Mosquitoes, Cockroach, Butterfly/ Moth, Drosophila.

**Syllabus**

1 Spotting
   a. W.M of eggs, early cleavage stage, T.S. of blastula and gastrula of frog
   b. Study of chick embryo: 18 hours, 24 hours, 36 hours, 48 hours and 72 hours.
   c. T.S. of ovary and testis of mammals.
   d. Study of different types of sperm.
   e. Study of different types of eggs
2 Study of fetus with placenta.
3 Study of developmental stages and metamorphosis of insects: Mosquitoes, Cockroach, Butterfly/ Moth, Drosophila
4 Study of living tadpole larvae and its metamorphosis
5 Mountings: Permanent preparation of the different developmental stages: Fish eggs, Amphioxus eggs, Different developmental stages of mosquito eggs/larvae/Pupae/ Adult

**Scheme of Examination**

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| Internal and EoSE as per NEP scheme of examination |
| **Suggested Books and References:**<br>• Verma, PS, A manual of practical Zoology S.Chand and Co. Ltd., Ram Nagar, New Delhi (English and Hindi Editions).<br>• Lal, SS: Practical Zoology, Invertebrates, Rastogi Publication, Meerut (English and Hindi Editions). |
| **Suggested E-resources**<br>• https://www.onlinebiologynotes.com/<br>• https://byjus.com/biology/<br>• Virtual Library-Developmental Biology (sdbonline.org)<br>• Developmental Biology 12e Student Resources - Learning Link (oup.com)<br>• Find Articles - Genetics, Developmental Biology, and Evolutionary Biology - Library Guides at Penn State University (psu.edu)<br>• https://en.wikipedia.org/ |
| **Scheme for internal exam (Max. marks: 20)**<br>• Class interaction/Quiz – 5 marks<br>• Attendance – 5 marks<br>• Assignment/Seminar/Project/Model, etc. – 10 marks |
| **Scheme for external/main exam (Max. marks: 80)**<br>• Major exercise 1 – 15 marks<br>• Major exercise 2 – 15 marks<br>• Minor exercise – 10 marks<br>• Spots (10 in number) – 20 marks<br>• Viva-voce – 10 marks<br>• Record – 10 marks |

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|---|---|
| Code of the course | SEC7391T |

| | |
|---|---|
| Title of the course | Wildlife conservation and management |
| Level of the Course | NHEQF Level 6.0 |
| Credit of the Course | 2 |
| Type of the Course | SEC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

Develop the knowledge and skills necessary to understand the principles and practices of wildlife conservation and management, enabling students to contribute to the protection, sustainable use, and effective management of wildlife populations and their habitats.

**Learning outcomes**

1. Students will develop a comprehensive understanding of the principles and objectives of wildlife conservation. They will learn about the importance of maintaining biodiversity, the threats facing wildlife populations, and the ethical considerations involved in wildlife conservation efforts.
2. Students will learn to assess and manage wildlife habitats. They will understand the ecological requirements of different wildlife species, including their food, water, shelter, and breeding needs.
3. They will gain knowledge of habitat management techniques, including habitat restoration, conservation planning, and the establishment of protected areas.
4. Students will develop the ability to analyze human-wildlife interactions, including conflicts and coexistence. They will learn about the impacts of human activities on wildlife populations and habitats, and explore strategies for mitigating conflicts, promoting sustainable land use, and fostering positive relationships between humans and wildlife.
5. Students will acquire the skills to design and implement effective wildlife conservation projects. They will learn how to develop conservation plans, set conservation goals, and implement monitoring and evaluation frameworks to assess the effectiveness of conservation interventions.
6. Students will enhance their communication and advocacy skills to raise awareness about wildlife conservation issues. They will learn how to effectively communicate scientific information to diverse audiences, engage in public outreach and education initiatives, and advocate for the importance of wildlife conservation at local, national, and global levels.

**Syllabus**

**UNIT-1 (Lecture hours: 6)**

Basic concept of biodiversity and wildlife. Types of biodiversity. Factor causing biodiversity degradation.

**UNIT- 2 (Lecture hours: 6)**

Species conservation techniques: In situ conservation (Biosphere Reserves, National

Parks, Wildlife Sanctuaries, Conservation Reserves, Community reserves, Sacred Habitats), Ex-situ conservation (Botanical & Zoological Gardens, Gene Banks, Seed And Seedling Banks, Pollen Culture, Tissue Culture and DNA banks, Butterfly Gardening); Concept of biodiversity hotspots and mega-diversity Country. Role of captivity in wildlife management.

**UNIT- 3(Lecturehours: 6)**

Biodiversity of Indian subcontinent. Bio-geographical region in India, Biodiversity hotspot in India, Species conservation projects in India (Tiger, Rhino, Lion, Turtles, Crocodiles, Birds, Coral reefs).

**UNIT- 4 (Lecture hours: 6)**

Concept of habitat and habitat management, Habitat edge improvement, Role of corridor in wildlife management, Basic knowledge about agencies working in wildlife conservation: WII, ZSI, WWF, SACON, IUCN.

**UNIT- 5(Lecture hours: 6)**

Field techniques for identification of butterflies, snakes, birds and mammals. Elementary knowledge about ecology and behaviour of important threatened animals and birds of India: Tiger, Leopard, Sloth bear, Four-horned antelope, Elephant, Great Indian Bustard, Sarus crane.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination.

**Suggested Books and References:**


- Mathur R. (2018). Wildlife Conservation and Management. First edition. Rastogi Publications.
- Singh S K. (2020). Taxtbook of wildlife management. Third edition. CBS Publisher and distributor
- Saha GK and Mazumdar S. (2017). Wildlife Biology: an Indian perspective. PHI publisher.
- Gupta T. (2017). Ecology, wildlife conservation and management. EBH Publishers (India).
- Santra AK (2018). Handbook on wild and zoo animals: a treatise for students of veterinary, zoology, forestry and environmental science. CBS Publishers and Distributors Pvt. Ltd.


**Suggested E-resources**

- https://www.bbau.ac.in/dept/dz/TM/AS-302%20Wildlife%20and%20Conservation%20Biology.pdf
- https://www.wii.gov.in/
- https://en.wikipedia.org/

**Semester – VI**

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|---|---|
| Code of the course | ZOO7006T |
| Title of the course | **3. Ethology and Evolution** |
| Level of the Course | NHEQF Level 6.0 |
| Credit of the Course | 4 |
| Type of the Course | DSE |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Core courses of Zoology at graduation level<br>(2) Knowledge of intermediate level courses |

**Objectives of the Course**

Develop a comprehensive understanding of ethology (animal behavior) and the mechanisms and processes of evolution, enabling students to analyze and interpret behavioral patterns, evolutionary adaptations, and their underlying genetic and ecological factors.

**Learning outcomes**

1. Students will be able to demonstrate a comprehensive understanding of the foundational principles and theories of ethology, including the study of animal behavior, its proximate and ultimate causes, and the evolutionary basis of behavior.
2. Students will develop the ability to observe and analyze animal behavior in various contexts. They will be able to identify and interpret behavioral patterns, including communication, mating, foraging, and social behaviors, and understand their adaptive significance.
3. Students will develop an understanding of the relationship between behavior and evolution. They will be able to explain how natural selection acts on behavior, the role of behavior in mate choice and sexual selection, and the influence of behavior on the formation and maintenance of social structures.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

Introduction and history of Ethology. Methods of studying behaviour. Neuroanatomical, neurophysiological, neurochemical, focal and scan sampling techniques. Evolutionary approach to behaviour, levels of natural selection. Orientation, taxes and kinesis. Brief idea of learning.

**UNIT- 2 (Lecture hours: 12)**

Social organization with reference to dominance, hierarchy, social competition and territoriality. Reproductive behaviour with reference to courtship, mating, parental investment and stickle back fish (sexual dimorphism). Elementary idea of role of pheromones and hormones in insects and vertebrates in relation to behaviour. Adaptation and behaviour of Tiger.

**UNIT- 3(Lecture hours: 12)**

Origin of life. History of evolutionary thought lamarckism and neo-lamarckism. Darwinism and Neo-Darwinism. Evidences of organic evolution. Concept of micro and

mega–evolution.

**UNIT- 4 (Lecture hours: 12)**

Variation: Kinds and sources, role in evolution. Isolation and speciation, definition, isolating mechanism, origin of species and processes of speciation. Adaptation: Definition, kinds of adaptations, adaptive radiation, convergence and divergence.

**UNIT- 5(Lecture hours: 12)**

Geological time scale. Brief account of zoogeographical regions of world. Fossils and their evolutionary significance. Phylogeny of horse. Evolution of man.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**

ETHOLOGY

- Drickamer&Vessey: Animal Behaviour, Concepts, Processes and Methods (Wadsworth).
- Grier : Biology of Animal Behaviour (Mosby College)
- Immelmann : Introduction to Ethology (Plenum Press)
- Lorenz : The Foundation of Ethology (Springer-Verlag)
- Manning : An Introduction to Animal Behaviour (Addison-Wesley)
- ReenaMathur : Animal Behaviour, Rastogi Publications, Merrut.

EVOLUTION :

- Dobzhansky, Ayala, Stebbins & Valentine : Evolution (WH Freeman)
- Dobzhansky : Genetics and Origin of species (Columbia University Press)
- Major : Population, Species and Evolution
- White : Animal Cytology and Evolution.
- Moody : Introduction to Evolution
- Savage : Evolution (Holt, Reinhart and Winston).

**Suggested E-resources**

- https://www.notesonzoology.com/ethology
- https://www.vedantu.com/biology/ethology
- https://www.bbau.ac.in/dept/dz/TM/ZL%20202%20Animal%20Behaviour.pdf
- https://www.iaszoology.com/animal-behavior/
- http://assets.vmou.ac.in/MZO07.pdf
- https://www.khanacademy.org/science/ap-biology/ecology-ap/responses-to-the-environment/a/intro-to-animal-behavior
- https://www.learncbse.in/evolution-cbse-notes-class-12-biology/
- https://unacademy.com/content/cbse-class-12/study-material/biology/evolution/

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|---|---|
| Code of the course | ZOO7006P |
| Title of the course | **3. Elective Zoology Lab: Ethology and Evolution** |
| Level of the Course | NHEQF Level 6.0 |
| Credit of the Course | 2 |
| Type of the Course | DSE |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level<br>(3) Knowledge of intermediate level courses. |

**Objectives of the Course**

This practical paper aims to engage students in the study of ethology and evolution by observing and analyzing behavioral patterns in provided exercises. Through hands-on experience, students will explore how behaviors have evolved over time, gaining insights into the adaptive significance and underlying evolutionary processes shaping animal behavior.

**Learning outcomes**

1 Students will develop skills in observing and documenting animal behaviors in their natural habitats or controlled settings. They will learn to record behavioral patterns, including social interactions, mating behaviors, feeding strategies, and communication signals.

2 Comparative Analysis: Students will compare and analyze behavioral traits and patterns across different species, considering factors such as ecological niche, evolutionary history, and environmental adaptations. They will develop insights into the diversity of behavioral strategies and the relationship between behavior and evolutionary processes.

3 Understanding Behavioral Adaptations: Students will study how animal behaviors have evolved as adaptations to different ecological challenges and environmental conditions. They will explore concepts such as foraging strategies, reproductive behaviors, predator-prey interactions, and social organization, and understand how these behaviors enhance survival and reproductive success.

**Syllabus**

1 Spotting
   a. Adaptive modifications in the feet of birds.
   b. Adaptive modification in the beak of birds.
   c. Adaptive modification in the mouth parts of insects.
   d. Museum specimens/ slides showing adaptations:
      i. Cursorial - *Acinonyxjubatus*, *Equuscaballus*, *Moschusmoschiferous*
      ii. Flight - *Columba livia,Pteropus*, *Draco*, *Exocoetus*, *Papilio.*
      iii. Arboreal - *Chamaeleon, Hyla, Preshytis*
      iv. Aquatic - *Physalia, Chiton, Hydrophis, Labeo Anguilla, Notopterus*

v. Fossorial - *Pheretima, Teredo, Chaetopterus, Talpa, Lepus, Ichthyophis, Naja*
vi. Parasitic - *Taenia, Fasciola, Enterobius, Ascaris, Schistosoma, Hirudinaria*,*Pediculus*, *Ixodes*

2 Ethology and evolution based exercise:

a. Habituation in earthworm/mosquito larvae/snail.
b. Feeding behaviour of housefly/stored product pest.
c. Antennal grooming behaviour of cockroach.
d. Trial and error and latent learning in rat /mice.
e. Phototaxis and chemotactic behaviour in *Paramecium*.
f. Visit to a zoo/natural habitat of wild animals.
g. Demonstration of social behaviour by honey bee colony.
h. Different types of nest and nesting behaviour of birds.
i. Exercise based on Hardy-Weinberg law.
j. Study of fossil evidences from plaster cast models and pictures.
k. Study of homology and analogy from suitable specimens/pictures.
l. Study of picture/charts with reference to: a) Phylogeny of horse with diagrams/cut outs of limb, b) and teeth of horse ancestors.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination.

**Suggested Books and References:**

- Koli VK. Practical Zoology (B. Sc. III year). Himanshu Publication. Udaipur
- Verma, PS, A manual of practical Zoology Vertebrates S.Chand and Co. Ltd., Ram Nagar, New Delhi(English and Hindi Editions).
- Lal, SS : Practical Zoology Vertebrates, Rastogi Publication, Meerut(English and Hindi Editions).
- Verma PS & Srivastava PC, Advanced Practical Zoology, S.Chand& Co.

**Suggested E-resources**

- https://www.notesonzoology.com/ethology
- https://www.vedantu.com/biology/ethology
- https://www.bbau.ac.in/dept/dz/TM/ZL%20202%20Animal%20Behaviour.pdf
- https://www.iaszoology.com/animal-behavior/
- http://assets.vmou.ac.in/MZO07.pdf
- https://www.khanacademy.org/science/ap-biology/ecology-ap/responses-to-the-environment/a/intro-to-animal-behavior
- https://www.learncbse.in/evolution-cbse-notes-class-12-biology/
- https://unacademy.com/content/cbse-class-12/study-material/biology/evolution/

**Scheme for internal exam (Max. marks: 20)**

- Class interaction/Quiz – 5 marks
- Attendance – 5 marks
- Assignment/Seminar/Project/Model, etc. – 10 marks

**Scheme for external/main exam (Max. marks: 80)**

- Major exercise 1 – 15 marks
- Major exercise 2 – 15 marks
- Minor exercise – 10 marks
- Spots (10 in number) – 20 marks
- Viva-voce – 10 marks
- Record – 10 marks

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|---|---|
| Code of the course | ZOO7007T |

| | |
|---|---|
| Title of the course | **4. Ecology and Biostatistics** |
| Level of the Course | NHEQF Level 6.0 |
| Credit of the Course | 4 |
| Type of the Course | DSE |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Core courses of Zoology at graduation level<br>(2) Knowledge of intermediate level courses |

**Objectives of the Course**

The course aims to develop a comprehensive understanding of ecological principles and biostatistical techniques to analyse and interpret ecological data, enabling students to apply this knowledge to address ecological challenges and contribute to the field of ecology.

**Learning outcomes**

1. Students will be able to demonstrate a deep understanding of the key ecological concepts, including species interactions, population dynamics, community structure, and ecosystem functioning.
2. Students will gain proficiency in the use of statistical methods to analyze ecological data. They will be able to select and apply appropriate statistical tests, interpret the results, and effectively communicate findings in a scientific manner.
3. Students will develop the skills to collect, analyze, and interpret ecological data sets. They will be able to effectively summarize and visualize data, identify patterns and trends, and draw meaningful conclusions based on statistical analyses.
4. Students will understand the influence of environmental factors, such as climate change, habitat fragmentation, and pollution, on ecosystems. They will be able to critically evaluate the consequences of these factors on biodiversity, species distributions, and ecosystem health.
5. Students will be able to apply ecological knowledge to propose effective conservation strategies and management plans. They will analyze the impact of human activities on biodiversity and ecosystems, and develop solutions to mitigate environmental degradation and promote sustainability.

**Syllabus**

**UNIT-1 (Lecture hours: 12)**

Terminology and scope of Ecology. Habitat and niche. Ecosystem: Components of ecosystem, energy flow and nutrient cycles, food chain, food web and ecological pyramids. General idea of population and community ecology.

**UNIT- 2 (Lecture hours: 12)**

Freshwater environment: Physico-chemical features and biotic communities, productivity and eutrophication. Marine environment: Characteristics, zonation, fauna and their adaptation, deep sea and estuarine fauna. Terrestrial environment: General characteristics of desert, grass land and forest ecosystems

**UNIT- 3(Lecture hours: 12)**

Environmental pollution: Biodegradable and non-biodegradable pollutants. Air pollution: Source, nature, prevention and control, greenhouse effect, ozone depletion and global warming. Water pollution: Source, nature and abatement. General account of noise pollution and radioactive pollution.

**UNIT- 4 (Lecture hours: 12)**

Conservation of natural resources: Wild life management, brief idea of national parks and wild life sanctuaries of India. Threatened and endangered species of India. Environmental planning and environmental impact assessment. Brief account of environmental Acts and Legislations (enacted after 1970).

**UNIT- 5(Lecture hours: 12)**

Concepts and applications of Biostatistics. Frequency distribution, graphical presentation, mean, mode, median, standard deviation and standard error. Correlation, T-test, Chi-square test. Shanon and Weinner diversity index.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination

**Suggested Books and References:**

ECOLOGY


- Mahur, Koli &Sankhla. Ecology and Biostatistics. Himanshu Publication, Udaipur & New Dehli. (In Hindi)
- Odum : Ecology (Amerind).
- Odum : Fundamentals of Ecology (Saunders).
- Ricklefy : Ecology (W.H.Freeman).


BIOSTATISTICS :


- Green, R.H.Sampling design and statistical methods for environmental biologists. John Wiley and Sons New York.
- Snedecor, G.W. and W.G. Cochran. Statistical methods. Affilited East-West Press, New Delhi (Indian Ed.)
- P.N. Arora and P.K. Malhan, Biostastics, Himalaya Publishing House, Bombay.


**Suggested E-resources**

- https://www.uou.ac.in/sites/default/files/slm/BSCBO-203.pdf
- https://www.easybiologyclass.com/topic-ecology/
- https://byjus.com/biology/ecology/
- https://www.biologydiscussion.com/ecology/ecology-useful-notes-on-ecology/6610
- http://assets.vmou.ac.in/MBO07.pdf
- https://www.easybiologyclass.com/biostatistics-free-lecture-notes-online-tutorials-ppts-and-mcqs/
- https://www.easybiologyclass.com/biostatistics-introduction-significance-applications-and-limitations-of-statistics/

| | |
|---|---|
| Code of the course | ZOO7007P |
| Title of the course | **4. Elective Zoology Lab: Ecology and Biostatistics** |
| Level of the Course | NHEQF Level 6.0 |

| | |
|---|---|
| Credit of the Course | 2 |
| Type of the Course | DSE |
| Delivery Type of the Course | Practical (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

The course aims to develop practical skills in ecological and biostatistical techniques to analyse and interpret ecological data, enabling students to apply this knowledge to address ecological challenges and contribute to the field of ecology.

**Learning outcomes**

1 Students will acquire practical skills in field sampling methods used in ecological studies. They will learn to design and execute field surveys, collect data on species abundance, diversity, and habitat characteristics, and apply appropriate sampling techniques such as quadrat sampling, transects, and mark-recapture methods.

2 Data Visualization: Students will learn to visually represent ecological data using graphs, charts, and maps. They will understand how to choose appropriate visualization techniques to effectively communicate ecological patterns, trends, and relationships to scientific audiences.

3 Statistical Analysis: Students will learn and apply statistical techniques commonly used in ecological research.

4 Community Ecology: Students will understand the principles of community ecology and the factors influencing species interactions and community structure. They will explore concepts such as niche partitioning, trophic interactions, competition, and species diversity, and apply these concepts to analyze and interpret community data.

**Syllabus**

1 Spotting

a. Zooplankton: Jelly fish, Daphnia, Rotifers, Radiolarians, Crustaceans
b. Larval forms of echinoderms
c. Phytoplankton: Diatoms, green algae, dinoflagellate, cyanobacteria, volvex, nostoc.
d. Ecological equipments: Secchi disc, thermometer, pH meter, hygrometer, Sound level meter, Lux meter

2. Ecological exercises

a. Water analysis: pH, alkalinity, dissolved oxygen, chloride and transparency.
b. Soil analysis: texture, moisture, organic and inorganic contents.
c. Noise measurement using sound level meter.
d. Light intensity measurement using lux meter.
e. Mapping of major deserts, grasslands and forest ecosystem on the world map

3. Biostatistics exercises

a. Measurement of mean, mode and median

b. Graphical representation of data with suitable example:
   i. Bar plot
   ii. Line graph
   iii. Pie chart
   iv. Scattered plot
   v. Histogram
c. Estimation of biodiversity using Shanon and Weinner diversity index.

4. A students' visit to nearby green house and wetlands.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination.

**Suggested Books and References:**

- Koli VK. Practical Zoology (B. Sc. III year). Himanshu Publication. Udaipur

**Suggested E-resources**

- https://www.uou.ac.in/sites/default/files/slm/BSCBO-203.pdf
- https://www.easybiologyclass.com/topic-ecology/
- https://byjus.com/biology/ecology/
- https://www.biologydiscussion.com/ecology/ecology-useful-notes-on-ecology/6610
- http://assets.vmou.ac.in/MBO07.pdf
- https://www.easybiologyclass.com/biostatistics-free-lecture-notes-online-tutorials-ppts-and-mcqs/
- https://www.easybiologyclass.com/biostatistics-introduction-significance-applications-and-limitations-of-statistics/

**Scheme for internal exam (Max. marks: 20)**

- Class interaction/Quiz – 5 marks
- Attendance – 5 marks
- Assignment/Seminar/Project/Model, etc. – 10 marks

**Scheme for external/main exam (Max. marks: 80)**

- Major exercise 1 – 15 marks
- Major exercise 2 – 15 marks
- Minor exercise – 10 marks
- Spots (10 in number) – 20 marks
- Viva-voce – 10 marks
- Record – 10 marks

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|---|---|
| Code of the course | SEC7392T |
| Title of the course | **Use of Artificial intelligence (AI) in Biological Sciences** |
| Level of the Course | NHEQF Level 6.0 |

| | |
|---|---|
| Credit of the Course | 2 |
| Type of the Course | SEC |
| Delivery Type of the Course | Lecture and tutorial (40+20=60. The 40 lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving) |
| Prerequisites | (1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level<br>(2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level |

**Objectives of the Course**

This course will provide a fundamental understanding of AI, machine learning, and deep learning, focusing on their relevance and applications in biological sciences. Demonstrate to students that how AI is transforming various biological fields.

**Learning outcomes**

- Demonstrate a solid understanding of key AI concepts, including machine learning and deep learning, and their relevance to biological sciences.
- Gain proficiency in using popular AI tools and frameworks for biological data analysis.
- Recognize and address ethical issues related to the use of AI in biological sciences, including data privacy, bias, and the responsible dissemination of AI findings.
- Keep abreast of the latest advancements in AI technologies and their applications in biological sciences, ensuring ongoing professional development and innovation.

**Syllabus**

**UNIT-1 (Lecture hours: 6)**

- AI development along time scale.
- Major components of artificial intelligence.
- Cutting-edge developments and trends in AI.

**UNIT- 2 (Lecture hours: 6)**

- Role of computers and data science in AI.
- AI related computational techniques.
- Popular AI tools.
- Basic introduction and types of machine learning.
- Basic understanding of computer programming used in AI programs.

**UNIT- 3(Lecture hours: 6)**

- Future Prospects of AI in research.
- Role of AI in biomedical sciences.
- AI in health diagnosis.
- Role of AI in Agriculture biotechnology.

**UNIT- 4 (Lecture hours: 6)**

- Role of AI in Industrial biotechnology.
- Applications of AI in ecology and wildlife sciences.

**UNIT- 5(Lecture hours: 6)**

- Risks involved and ethical concerns to AI.
- Challenges and limitation of Artificial Intelligence.
- Job opportunities in AI related fields.

**Scheme of Examination**

Internal and EoSE as per NEP scheme of examination.

**Suggested Books and References:**

- Hunter L. 1993. Artificial Intelligence and molecular biology. MIT Press.
- Hamadani A, Ganai NA, Hamadani H., Bashir J. (Editor) 2024. A Biologist's Guide to Artificial Intelligence. Academic press.
- Rout, R. K., Umer, S., Sheikh, S., &Sangal, A. L. (Eds.). (2022). Artificial Intelligence Technologies for Computational Biology. CRC Press.
- Dubitzky, W., &Azuaje, F. (Eds.). (2004). Artificial intelligence methods and tools for systems biology. Heidelberg: Springer.
- Cartwright, H. (2008). Using artificial intelligence in chemistry and biology: a practical guide. CRC Press.


**Suggested E-resources**

- https://crsreports.congress.gov/product/pdf/R/R47849#:~:text=For%20example%2C%20AI%20can%20be,markers%20linked%20with%20those%20traits.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9505413/
- https://encyclopedia.pub/entry/28917#:~:text=Artificial%20intelligence%20(AI)%2C%20currently,organisms%20are%20constantly%20being%20refined.
- https://academic.oup.com/icb/article/61/6/2267/6358530
- https://byjus.com/free-ias-prep/artificial-intelligence-upsc-notes/