**COURSE OUTCOME**

**DEPARTMENT OF ZOOLOGY**

**DINABANDHU MAHAVIDYALAYA, BONGAON**

**ACADEMIC SESSION 2023-2024**

**B.Sc. Program Outcome:**

After completion of the B.Sc. Degree program, the students will be able to

|  |  |  |
| --- | --- | --- |
| **PO No.** | **Program Outcome** | **Cognitive Level** |
| PO 1 | Recognize the scientific concepts and tempers that can be advantageous for society, as scientific advancements have the potential to foster rapid growth within nations or communities. | R |
| PO 2 | Understand scientific knowledge and engage in sharing dialogues with fellow stakeholders; raise awareness about the ethical and sustainable use of resources. | U |
| PO 3 | Comprehend and implement environmental considerations and sustainable development as fundamental interdisciplinary priorities. | U, Ap |
| PO 4 | Develop the capability to conduct experiments, analyze, and interpret precise outcomes, thereby acquiring problem-solving skills and engaging in critical, autonomous, and innovative thought processes. | An, E, |
| PO 5 | Acquire proficiency to apply and generate innovative ideas, granting a competitive edge for pursuing advanced studies either domestically or internationally, as well as for securing positions in academia, research, or industry. | Ap, E |
| PO 6 | Utilize the comprehensive understanding of applied subjects to cultivate professional and employable skills, enabling students to build careers and venture into entrepreneurship across various domains. | C |

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

**Zoology Programme Specific Outcome:**

After completion of the B.Sc. Zoology programme the students would be able to

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| **PSO No.** | **Program Specific Outcome** | **Cognitive Level** |
| PSO 1 | Recall fundamental concepts, terminology, and classifications related to zoology, including taxonomy, anatomy, physiology, and ecology of animals. Memorize key characteristics, behaviors, and adaptations of various animal species across different taxonomic groups. | R |
| PSO 2 | Demonstrate understanding of biological principles and processes underlying animal life, including metabolism, reproduction, and genetics. Explain the ecological relationships between organisms and their environments, including concepts such as symbiosis, predation, and competition genetics, molecular biology, biotechnology, biostatistics, bioinformatics, qualitative and quantitative microscopy, enzymology and analytical biochemistry. | U |
| PSO 3 | Apply scientific methodologies and laboratory techniques to conduct experiments, collect data, and analyze specimens in the field of zoology. Utilize knowledge of animal behavior, physiology, and ecology to address real-world problems related to conservation, wildlife management, and disease control in economic, ecological and medical significance of various animals in human life and thus apply in the entrepreneurship of their own on sericulture, apiculture, fisheries, poultry farming, environment monitoring and parasitic disease management.. | Ap |
| PSO 4 | Analyze anatomical structures, physiological functions, and ecological interactions of animals to identify patterns, trends, and relationships. Evaluate experimental data and scientific literature to draw conclusions and generate hypotheses about the behavior, evolution, and diversity of animal life. | An |
| PSO 5 | Critically evaluate scientific evidence, theories, and methodologies used in zoological research, considering factors such as reliability, validity, and ethical implications. Assess the effectiveness of conservation strategies, management practices, and policies aimed at protecting animal biodiversity and promoting sustainable use of natural resources. | E |
| PSO 6 | Synthesize information from diverse sources to develop comprehensive research projects, presentations, or publications on topics related to zoology. Create innovative approaches to studying and conserving animal populations, habitats, and ecosystems through interdisciplinary collaboration and problem-solving. | C |

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

**West Bengal State University**

**NEP curricula and syllabi for UG 2023**

**Zoology Honours (Credit values given within brackets)**

# Draft UG syllabus for

Zoology as Major

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Semester | Paper code | Course structure | Name of paper | Credits |
| Semester I | ZOODSC101T  ZOODSC101P | DS-1 (5) | Animal Diversity I  Animal Diversity I Lab | 3  2 |
| Semester II | ZOODSC202T  ZOODSC202P | DS-2 (5) | Animal Diversity II  Animal Diversity II Lab | 3  2 |
| Semester III | ZOODSC303T  ZOODSC303P | DS-3 (5) | Advanced Non-chordates and Chordates  Advanced Non-chordates and Chordates Lab | 3  2 |
| Semester IV | ZOODSC404T  ZOODSC404P | DS-4 (5) | Comparative Anatomy and Physiology  Comparative Anatomy and Physiology Lab | 3  2 |
| ZOODSC405T  ZOODSC405P | DS-5 (5) | Ecology  Ecology Lab/Field | 3  2 |
| ZOODSC406T  ZOODSC406P | DS-6 (5) | Cell Biology  Cell Biology Lab | 3  2 |
| ZOODSC407T  ZOODSC407P | DS-7 (5) | Biochemistry  Biochemistry Lab | 3  2 |
| Semester V | ZOODSC508T  ZOODSC508P | DS-8 (5) | Molecular Biology  Molecular Biology Lab | 3  2 |
| ZOODSC509T  ZOODSC509P | DS-9 (5) | Genetics  Genetics Lab | 3  2 |
| ZOODSC510T  ZOODSC510P | DS-10 (5) | Animal Behaviour and Chronobiology  Animal Behaviour and Chronobiology Lab | 3  2 |
| ZOODSC511T  ZOODSC511P | DS-11 (5) | Endocrinology, Histology and Histochemistry  Endocrinology, Histology and Histochemistry Lab | 3  2 |
| Semester VI | ZOODSC612T  ZOODSC612P | DS-12 (5) | Biostatistics and Taxonomy  Biostatistics and Taxonomy Lab | 3  2 |
| ZOODSC613T  ZOODSC613P | DS-13 (5) | Developmental Biology  Developmental Biology Lab | 3  2 |
| ZOODSC614T  ZOODSC614P | DS-14 (5) | Evolutionary Biology  Evolutionary Biology Lab | 3  2 |
| ZOODSC615T  ZOODSC615P | DS-15 (5) | Immunology  Immunology Lab | 3  2 |
| Semester VII | ZOODSC716T  ZOODSC716P | DS-16 (5) | Entomology and vector biology  Entomology and vector biology Lab | 3  2 |
| ZOODSC717T  ZOODSC717P | DS-17 (5) | Biodiversity and Conservation  Biodiversity and Conservation Field | 3  2 |
| Semester VIII | ZOODSC818T  ZOODSC818P | DS-18(5) | Research Methodology and Scientific writing  Research Methodology and Scientific writing Lab | 3  2 |
| ZOODSC819T  ZOODSC819P | DS-19(5) | Toxicology & Cancer Biology  Toxicology & Cancer Biology Lab | 3  2 |
| ZOODSC820T  ZOODSC820P | DS-20(5) | Fisheries sciences  Fisheries sciences Lab/Field | 3  2 |
| ZOODSC821T  ZOODSC821P | DS-21(5) | Parasitology  Parasitology Lab | 3  2 |
| ZOORES801M | R-1(15) | Dissertation | 15 |

**West Bengal State University**

**NEP curricula and syllabi for UG 2023**

**Draft UG syllabus for Zoology as Minor (Credit values given within brackets)**

**(With effect from the session 2023-2024)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Semester | Course code Multidisciplinary Program | Course code  Honours /with Research | Name of paper | Credits | Classes |
| Semester I | ZOOCOR101T  ZOOCOR101P | ZOOMIN101T  ZOOMIN101P | Animal Diversity  Animal Diversity Lab | 3  2 | 45  60 |
| Semester II | ZOOCOR202T  ZOOCOR202P | ZOOMIN202T  ZOOMIN202P | Physiology and Biochemistry Physiology and Biochemistry Lab | 3  2 | 45  60 |
| Semester III | ZOOCOR303T  ZOOCOR303P | ZOOMIN303T  ZOOMIN303P | Insect, Vectors and Diseases Insect, Vectors and Diseases Lab | 3  2 | 45  60 |
| Semester IV | ZOOCOR404T  ZOOCOR404P | Not Applicable  Not Applicable | Applied Zoology  Applied Zoology Lab | 3  2 | 45  60 |
| Semester V | ZOOCOR505T  ZOOCOR505P | Not Applicable  Not Applicable | Aquatic Biology  Aquatic Biology Lab | 3  2 | 45  60 |
| Semester VI | ZOOCOR606T  ZOOCOR606P | Not Applicable  Not Applicable | Environment and Public Health  Environment and Public Health Lab | 3  2 | 45  60 |
| Semester VII  (for 4year Honours/ Honours with Research) | Not Applicable  Not Applicable | ZOOSMC701T  ZOOSMC701P | Ecology and evolution  Ecology and evolution Lab | 3  2 | 45  60 |

**B.Sc. in Zoology 1st year Semester – I (Hons)**

|  |  |
| --- | --- |
| Course Title | Animal Diversity I |
| Code | ZOODSC101T: DS-1 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

* Understand the classification, characteristics and analyze the structural organization, life cycle, and physiological phenomenon of Protista, Parazoa and Metazoa.
* Understand the classification, characteristics and analyze the structural organization, and canal system of Porifera
* Understand the classification, characteristics and analyze the structural organization, metagenesis, polymorphism of Cnidaria, interpret the fate of Indian Coral Reefs in near future.
* Understand the classification, characteristics of Ctenophora.
* Understand the classification, characteristics and analyze the structural organization, life cycle of Platyhelminthes.
* Understand the classification, characteristics and analyze the structural organization, life cycle of Aschelminthes and their host specific evolution of parasitism and adaptation
* Understand the classification, characteristics and analyze the structural organization of Annelida
* Understand the classification, characteristics and analyze the structural organization Arthropoda
* Understand the classification, characteristics and analyze the structural organization of Mollusca

**Unit 1: General introduction to Protista and Metazoa 8 classes TA**

General characteristics and Classification of Protozoa up to phylum (Levine, 1980)

General characteristics Amoeba, Paramoecium and Euglena

Evolution of symmetry and segmentation of Metazoa

**Unit 2: Porifera 4 classes**

General organization and Classification up to classes

Canal system and spicules in sponges

**Unit 3: Cnidaria 4 classes**

General organization and Classification up to classes

Metagenesis in Obelia

Polymorphism in Cnidaria

**Unit 4: Ctenophora 2 classes**

General organization and evolutionary significance

**Unit 5: Platyhelminthes 2 classes**

General organization and Classification up to classes

**Unit 6: Nematoda 3 classes**

General organization and Classification up to classes

Origin and evolution of parasitic helminths

**Unit 7: Introduction to Coelomates 2 classes**

Evolution of coelom and metamerism

**Unit 8: Annelida 3 classes**

General organization and classification up to classes

**Unit 9: Arthropoda 8 classes**

General characteristics and classification up to classes

General organization and evolutionary significance: King Crab and Crustacean Larvae

**Unit 10: Onychophora 2 classes**

General organization and evolutionary significance

**Unit 11: Mollusca 7 classes**

General characteristics and classification up to classes

Evolutionary significance of trochophore larva

**B.Sc. in Zoology 1st Year Semester – I (Hons)**

|  |  |
| --- | --- |
| Course Title | Animal Diversity I Lab |
| Code | ZOODSC101P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of whole mount of *Amoeba, Paramecium* and *Euglena*, Binary fission and Conjugation in *Paramecium*.

2. To submit a Project Report on examination of pond water for studyingprotistan diversity.

3. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella, Spongilla*.

4. Sudy of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia,*

*Metridium, Pennatula, Fungia, Meandrina, Madrepora*.

5. One specimen/slide of any Ctenophore

6. Study of adult *Fasciola hepatica*, *Taenia solium*

7. Study of adult male and female *Ascaris lumbricoides*

8. Study of following specimens:

Annelids - *Aphrodita, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria*

Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus,Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees

Onychophora – *Peripatus*

Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the general characteristics and classifications of Euglena, Amoeba, Paramoecium, Porifera, Cnidaria, Ctenophora, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Onycophora and Mollusca. Memorize the life cycles and pathogenicity of different helminths. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the locomotion and reproduction mechanisms in Protista. Explain the evolution of symmetry and segmentation in Metazoa. Interpret the canal system and spicules in sponges. Comprehend metagenesis, polymorphism, and coral reef formation in Cnidaria. Discuss the structural and functional roles of unique features like spicules in Porifera and trochophore larvae in Mollusca. | PO 2,4 | PSO 2,4 | Un |
| **CO – 3** | Apply knowledge of Protista locomotion and reproduction to analyze Euglena, Amoeba, and Paramoecium. Utilize understanding of sponge characteristics to identify specimens and analyze their adaptations. Apply knowledge of Cnidaria metagenesis and polymorphism to understand life cycles and adaptations. | PO 3,4 | PSO 3,4 | Ap |
| **CO – 4** | Analyze the canal system and spicules in sponges to understand their roles and evolutionary significance. Compare and contrast the life cycles and pathogenicity of different parasitic organisms. Analyze adaptations of parasitic helminths and their evolutionary origins. Analyze the role of specific organisms, such as King Crabs and Crustacean larvae, in demonstrating arthropod diversity and evolutionary trends. | PO 4,5 | PSO 4,5 | An |
| **CO – 5** | Evaluate the effectiveness of different classification systems for organizing organisms within specified taxa. Assess the impact of parasitic infections on human health and society. Evaluate the conservation significance of coral reefs and propose management strategies. Assess the ecological and evolutionary roles of transitional forms like Onychophora in bridging phyla | PO 5 | PSO 5 | An |
| **CO – 6** | Develop hypotheses about the evolutionary relationships between taxa based on morphological and ecological characteristics. Synthesize information about coral reefs to evaluate conservation significance. Create educational materials illustrating life cycles and pathogenicity of parasitic organisms. Design a conceptual framework linking major transitions, such as the evolution of coeloms and segmentation, to the success of complex multicellular organisms | PO 6 | PSO 6 | E |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Biology of the Invertebrates by Jan A Pechenik

2. Invertebrates by Brusca and Brusca 2nd Ed

**References:**

1. An introduction to Invertebrates by Janet Moore 2nd ed.

2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science

3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

4. Bose, Mala. Parasitoses and Zoonoses, New Central Book Agency , 2017.

5. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

6. Invertebrate Zoology : Third Edition; Paul A Meglitsch , Frederick R Schram January 2020 , OXFORD UNIVERSITY PRESS

**B.Sc. in Zoology 1st Year Semester – I (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Animal Diversity |
| Code | ZOOCOR101T / ZOOMIN101T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
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|  | * Understand the classification, characteristics and analyze the structural organization, life cycle, and physiological phenomenon of Protista. |
|  | * Understand the classification, characteristics and analyze the structural organization, and canal system of Porifera |
|  | * Understand the classification, characteristics and analyze the structural organization, metagenesis, polymorphism of Cnidaria. |
|  | * Understand the classification, characteristics and analyze the structural organization, life cycle of specific Platyhelminthes. |
|  | * Understand the classification, characteristics and analyze the structural organization, life cycle of specific Aschelminthes. |
|  | * Understand the classification, characteristics and analyze the structural organization of Annelida |
|  | * Understand the classification, characteristics and analyze the structural organization Arthropoda |
|  | * Understand the classification, characteristics and analyze the structural organization of Mollusca |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Echinodermata |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Protochordata. |
|  | * Understand the classification, characteristics and analyze the structural organization of Agnatha |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Pices |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Amphibia. |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Reptilia |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Aves |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Mammalia |

**Unit-1 Kingdom Protista**

General characters and classification of Subkingdom Protozoa up to Phylum (Levine et al., 1980); Locomotory Organelles and locomotion in Protozoa

**Unit-2 Phylum Porifera**

General characters and classification up to classes; Canal System in Sycon

**Unit-3 Phylum Cnidaria**

General characters and classification up to classes; Polymorphism in Hydrozoa

**Unit-4 Phylum Platyhelminthes**

General characters and classification up to classes; Life history of Taenia solium

**Unit-5 Phylum Nematoda**

General characters and classification up to classes; Life history of Ascaris lumbricoides and its parasitic adaptations

**Unit-6 Phylum Annelida**

General characters and classification up to classes; Nephridia in Annelida

**Unit 7 Phylum Arthropoda**

General characters and classification up to classes; Vision in insect, Metamorphosis in Insects

**Unit-8 Phylum Mollusca**

General characters and classification up to classes; Respiration in Pila

**Unit-9 Phylum Echinodermata**

General characters and classification up to classes; Water-vascular system in Asterias

**Unit-10 Protochordates**

General features; Feeding in Branchiostoma

**Unit-11 Agnatha**

General features and classification up to classes (Young, 1981)

**Unit-12 Pisces**

General features and Classification up to Subclasses (Romer, 1959); Osmoregulation in Fishes.

**Unit-13 Amphibia**

General features and Classification up to living orders (Duellman & Trueb, 1986); Metamorphosis in Toad

**Unit-14 Reptiles**

General features and Classification up to living Subclass (Young, 1981); Poisonous and nonpoisonous snakes, Biting mechanism in snakes

**Unit-15 Aves**

General features and Classification up to orders (Young, 1981); Flight adaptations in birds

**Unit-16 Mammals**

Classification up to Subclasses (Young, 1981); Origin & distribution of Cranial nerves in Cavia

**B.Sc. in Zoology 1st Year Semester – I (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Animal Diversity Lab |
| Code | ZOOCOR101P/ ZOOMIN101P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1.Spot identification of the following specimens: Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Euspongia,, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Julus, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio, Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Passer, Psittacula, Alcedo, Sorex, Pteropus, Funambulus, Suncus.

2. Study of the following permanent slides: Transverse section of male and female Ascaris

3. Identification of poisonous and non-poisonous snakes

4. An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSO Addressed** | **Cognitive level** |
| **CO – 1** | Recall the general characteristics and classifications of Kingdom Protista, Phyla Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata, Protochordates, Agnatha, Pisces, Amphibia, Reptiles, Aves, and Mammals. Memorize specific details such as locomotory organelles and locomotion in Protozoa, canal system in Sycon, and polymorphism in Hydrozoa. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the characteristics and classifications of different phyla up to classes within Kingdom Protista, Phyla of Non-Chordates and Chordates. Comprehend specific topics such as the life history of *Taenia solium*, life history of *Ascaris lumbricoides*, nephridia in Annelida, water-vascular system in Asterias, and feeding in Branchiostoma. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of classification systems to identify and classify organisms within different phyla.  Apply understanding of specific features such as vision in insects, respiration in Pila, osmoregulation in fishes, metamorphosis in toads, and flight adaptations in birds. | PO 2,3 | PSO 2,3 | Ap, Un |
| **CO – 4** | Analyze the structure and function of locomotory organelles in Protozoa and nephridia in Annelida.  Analyze the life history and parasitic adaptations of Taenia solium and Ascaris lumbricoides. | PO 4 | PSO 4 | An |
| **CO – 5** | Evaluate the significance of polymorphism in Hydrozoa and metamorphosis in toads in terms of ecological and evolutionary adaptations and role of specific adaptations such as flight adaptations in birds and biting mechanisms in snakes for survival and reproduction. | PO 5,4 | PSO 5,4 | E,An |
| **CO – 6** | Synthesize information from different phyla and subphyla to create comprehensive classifications and understand evolutionary relationships from the photographs, cut-outs, and text to create a cohesive and well-organized "animal album" project. | PO 6 | PSO 6 | An |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Suggested Readings [Consult Latest Editions]**

1. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.

2. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates.

3. Kardong, K.V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.

4. Kent, G.C. & Carr, R.K. (2001). Comparative anatomy of theVertebrates. 9thEd. McGraw Hill.

5. Romer, A.S. & Parsons,T.S.(1986).The vertebrate body. 6thEd. Saunders College Pub.

6. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.

7. Young,J. Z.(2004).The Life of Vertebrates. III Edition. Oxford university press.

**B.Sc. in Zoology 1st year Semester – II (Hons)**

|  |  |
| --- | --- |
| Course Title | Animal Diversity II |
| Code | ZOODSC202T: DS-2 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**General Objectives**

The students can gain a lot of knowledge about the classification of invertebrates upto classs, will be able to describe their organization with examples, evaluate their biological importance and apply knowledge to analyze their present global and national status.

**Course Objectives**

The student will be able to

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| * Understand the classification, characteristics and analyze the structural organization with some special features of Echinodermata |
| * Understand the classification, characteristics and analyze the structural organization with some special features of Protochordata. |
| * Understand the classification, characteristics and analyze the structural organization of Agnatha |
| * Understand the classification, characteristics and analyze the structural organization with some special features of Pices |
| * Understand the classification, characteristics and analyze the structural organization with some special features of Amphibia. |
| * Understand the classification, characteristics and analyze the structural organization with some special features of Reptilia |
| * Understand the classification, characteristics and analyze the structural organization with some special features of Aves |
| * Understand the classification, characteristics and analyze the structural organization with some special features of Mammalia |

**Unit 1: Echinodermata 4 classes**

General characteristics and Classification up to classes

Larval forms in Echinodermata

**Unit 2: Hemichordata 3 classes**

General organization of phylum Hemichordata.

Phylogenetic relationship with non-chordates and chordates (only recent concepts) \*.

**Unit 3: Introduction to Chordates 2 classes**

General characteristics and Outline Classification of Phylum Chordata up to Classes.

**Unit 4: Non vertebrate lower chordates 3 classes**

General characteristic s and Classification of sub-phylum Urochordata and Cephalochordata up to Classes. Metamorphosis in *Ascidia*

**Unit 5: Origin of Chordata 4 classes**

Dipleurula concept and the echinoderm theory of origin of chordates

Advanced features of vertebrates over Protochordata

**Unit 6: Agnatha 2 classes**

General characteristics and Classification of cyclostomes up to Order

**Unit 7: Pisces 3 classes**

General characteristics and Classification of Chondrichthyes and Osteichthyes up to Sub-classes (Romer 1959).

**Unit 8: Amphibia 4 classes**

General characteristics and Classification up to living Orders

Metamorphosis in Amphibia

**Unit 9: Reptilia 3 classes**

General characteristics and Classification up to living Orders

**Unit 10: Aves 4 classes**

General characteristics and Classification up to Sub-Classes

Principles and aerodynamics of flight

**Unit 11: Mammals 8 classes**

General characters and Classification up to living orders

Phylogenetic significance of Prototheria

Adaptive radiation in mammals with reference to locomotory appendages

**Unit 12: Zoogeography 4 classes**

Zoogeographical realms

Plate tectonic and Continental drift theory

Distribution of birds and mammals in different realms

**B.Sc. in Zoology 1st year Semester – II (Hons)**

|  |  |
| --- | --- |
| Course Title | Animal Diversity II Lab |
| Code | ZOODSC202P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of the following specimens:

Echinoderms - *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*

Hemichordates- *Saccoglossus*

2. Lab/field study of:

Protochordata: *Herdmania, Branchiostoma*, colonial Urochordates

Agnatha: *Petromyzon, Myxine*

Fishes: *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus,Echeneis, Anguilla, Hippocampus, Tetraodon, Anabas,* Flat fish

Amphibia: *Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra*

Reptilia: *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*

Aves: Study of six common birds from different orders (Stork, Owl/Falcon, Sun Bird, Jacana, Duck)- typesof beaks and claws.

Mammalia: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus,* Loris, *Herpestes, Erinaceous*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO addressed** | **PSO**  **Addressed** | **Cognitive level** |
| **CO – 1** | Identify and recall the general characteristics and classification of major chordate and non-chordate groups, including Echinodermata, Hemichordata, Urochordata, Cephalochordata, and vertebrates.  Describe specific features such as larval forms in echinoderms, metamorphosis in *Ascidia* and amphibians, and the aerodynamics of bird flight. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the phylogenetic relationships between non-chordates and chordates using modern concepts such as the Dipleurula hypothesis and echinoderm theory. Summarize the evolutionary trends and adaptations in major groups such as cyclostomes, amphibians, reptiles, birds, and mammals. Discuss zoogeographical realms and the effects of plate tectonics and continental drift on species distribution. | PO 2 | PSO 2 | Un |
| **CO – 3** | Demonstrate the significance of larval forms in echinoderms and their evolutionary relevance to chordates. Comprehend and relate the adaptations in locomotory appendages to the concept of adaptive radiation in mammals. Apply principles of aerodynamics to understand bird flight. | PO 2,3 | PSO 2,3 | Ap,Un |
| **CO – 4** | Compare and contrast the structural and functional features of chordate subphyla (Urochordata, Cephalochordata, Vertebrata) and their evolutionary advantages. Analyze the advanced features of vertebrates over protochordates, highlighting their ecological and evolutionary significance. Examine the role of plate tectonics and continental drift in shaping zoogeographical patterns. | PO 4 | PSO 4 | An |
| **CO – 5** | Critically evaluate the theories of chordate origin, such as the Dipleurula concept and the echinoderm theory. Assess the phylogenetic significance of Prototheria in the evolution of mammals. Evaluate the ecological and adaptive significance of metamorphosis in amphibians. | PO 4,5 | PSO 4,5 | E |
| **CO – 6** | Integrate the knowledge of classification and adaptations to trace the evolutionary lineage and ecological niches of vertebrate groups. Propose a framework to understand the interplay between anatomical features, ecological adaptations, and biogeographical distribution of chordates. Design a conceptual model of adaptive radiation in mammals using examples of locomotory appendages. | PO 6 | PSO 6 | An |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Book:**

• Biology of the Invertebrates by Jan A Pechenik, Mcgrew-Hill, 2014

Or

• Invertebrates by Brusca and Brusca 2nd Ed, Sinauer Associates

**Referrence:**

1. An introduction to Invertebrates by Janet Moore 2nd ed.

2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science

3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

4. Chaudhury,S.(2017). Economic Zoology. New Central Book Agency

5. Invertebrate Zoology: Third Edition; Paul A Meglitsch, Frederick R Schram January 2020 , OXFORD UNIVERSITY PRESS

6. (https://www.nature.com/articles/nature16150) for hemichordate phylogenetic relationships\*

7. Students are encouraged to explore authentic websites (for e.g. Wikipedia, different university websites and OCWs) on internet for reading/audio-visual materials on a particular topic if they do not find enough in the text books or otherwise).

**B.Sc. in Zoology 1st Year Semester – II (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Physiology and Biochemistry |
| Code | ZOOCOR202T/ ZOOMIN202T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Understand, analyze, differentiate and illustrate the structure of nerve and muscle and explain comprehensively the molecular basis of their function. |
|  | * Make a list on digestive enzymes along with their substrate and product. Explain and analyze the absorption procedure of three major macromolecules. |
|  | * Understand, explain, and illustrate the various physiological function of respiration. |
|  | * Understand, explain, and illustrate the various physiological function of excretion. |
|  | * Understand, explain, and illustrate the structure and function of cardiovascular system. |
|  | * Understand, explain, and illustrate the structure and function of reproduction and endocrine glands. |
|  | * Understand, explain, analyze and illustrate the structure of carbohydrate and its metabolism. |
|  | * Understand, explain, analyze and illustrate the structure of proteins and its metabolism. |
|  | * Understand, explain, analyze and illustrate the structure of lipids and its metabolism. |
|  | * Understand, classify, explain and analyze the structure of enzyme and its properties and mechanism of action. |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Aves |
|  | * Understand the classification, characteristics and analyze the structural organization with some special features of Mammalia |

**Unit-1 Nerve and muscle**

1. Structure of a neuron, resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres.

2. Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction.

**Unit-2 Digestion**

Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

**Unit-3 Respiration**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

**Unit-4 Excretion**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

**Unit-5 Cardiovascular system**

Composition of blood, Homeostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle.

**Unit-6 Reproduction and Endocrine Glands**

Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of pituitary, thyroid, pancreas and adrenal

**Unit 7 Carbohydrate: Structure and Metabolism**

Introduction to Carbohydrates, Structure & Types of Carbohydrates, Isomerism, Introduction to Intermediary metabolism: Glycolysis, Krebs cycle, Pentose phosphate pathway, Gluconeogenesis, Electron transport chain

**Unit-8 Lipid: Structure and Metabolism**

Introduction to Lipids: Definitions; fats and oils; classes of lipids; Lipoproteins; Biosynthesis and β oxidation of palmitic acid

**Unit-9 Protein: Structure and metabolism**

Proteins and their biological functions, functions of amino acids, physicochemical properties of amino acids. Peptides – structure and properties; primary structure of protein, secondary, tertiary and quaternary structures. Transamination, Deamination and Urea Cycle.

**Unit-10 Enzymes**

Introduction, Classification of Enzymes, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

**B.Sc. in Zoology 1st Year Semester – II (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Physiology and Biochemistry Lab |
| Code | ZOOCOR202P / ZOOMIN202P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Preparation of haemin crystals

2. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland, small intestine, liver, lung, kidney

3. Qualitative tests to identify functional groups of carbohydrates in given solutions: Glucose (Benedict’s test),Sucrose (Iodine test)

4. Quantitative estimation of total protein in given solutions by Lowry’s method.

5. Study of activity of salivary amylase under optimum conditions.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSO**  **Addressed** | **Cognitive level** |
| **CO – 1** | Recall and label the structure of a neuron, including its components and functions. Remember the physiological processes involved in digestion, respiration, excretion, cardiovascular function, reproduction, and metabolism. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the mechanisms underlying nerve impulse generation, propagation, and muscle contraction. Summarize several physiological processes involved in digestion, respiration, excretion, cardiovascular function, reproduction, and metabolism. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of nerve and muscle physiology to explain the processes of action potential generation, muscle contraction, digestion, respiration, excretion, cardiovascular function, reproduction, and metabolism. Utilize knowledge of enzyme kinetics, inhibition, and regulation to analyze biochemical reactions involved in metabolism. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the structure and function of neurons, muscles, and other physiological systems to understand their roles in the body. Distinguish metabolic pathways such as glycolysis, Krebs cycle, gluconeogenesis, and lipid and protein metabolism to understand their regulation and significance. | PO 4 | PSO 4 | An |
| **CO – 5** | Assess the effectiveness of different physiological processes in maintaining homeostasis within the body. Evaluate the importance of enzyme activity and metabolic regulation in cellular function and overall health. | PO 5, 4 | PSO 5,4 | An,E |
| **CO – 6** | Compile various informations from deferent physiological systems to describe integrated functions of the nervous system, muscles, digestion, respiration, excretion, cardiovascular system, reproduction, and metabolism. Synthesize knowledge of enzyme classification, mechanism of action, and regulation to propose hypotheses or models regarding enzyme function and metabolic regulation. | PO 6 | PSO 4 | An, E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Suggested Readings**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edn. W.H Freeman & Co.

2. Chatterjea, MN and Shinde, R (2012 ) . A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi

3. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company

4. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper’sIllustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

5. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.

6. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole

7. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.

8. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander’s Human Physiology, XI Edition., McGraw Hill

9. Elaine N. Marieb, 2006. Human Anatomy & Physiology, Pearson Education.

**B.Sc. in Zoology 1st year Semester – III (Hons)**

|  |  |
| --- | --- |
| Course Title | Advanced Non-chordates and Chordates |
| Code | ZOODSC303T: DS-3 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

* This course aims to provide a comprehensive understanding of the structural, functional, and ecological adaptations in various invertebrates and vertebrates.
* It focuses on life cycles, pathogenicity, and parasitic adaptations of key organisms, as well as physiological mechanisms like excretion, osmoregulation, respiration, and nervous system organization across different phyla.
* The course also explores specialized topics such as coral reefs, torsion in mollusks, filter feeding in hemichordates, parental care in amphibians, and advanced adaptations like echolocation in mammals and migration in birds.
* Emphasis is placed on understanding the evolutionary and ecological significance of these traits.

**Unit 1: 5 classes**

Life cycle and pathogenicity of *Entamoeba histolytica, Plasmodium vivax, Giardia intestinalis*and *Leishmania donovani*

Locomotion and Reproduction in Protista (*Amoeba, Paramoecium* and *Euglena*)

**Unit 2: 2 classes**

Corals and coral reefs: types, formation, distribution, conservation significance

**Unit 3: 5 classes**

Life cycle and pathogenicity of *Fasciola hepatica, Taenia solium, Ascaris lumbricoides* and *Wuchereria bancrofti*

Parasitic adaptations in helminths

**Unit 4: 6 classes**

Excretion and osmoregulation in Annelida

Respiration in Arthropoda

**Unit 5: 5 classes**

Nervous System and respiration in Mollusca

Torsion and detorsion in Gastropoda

**Unit 6: 2 classes**

Water-vascular system in Asteroidea

**Unit 7: 4 classes**

Filter feeding in *Balanoglossus*

Chordate Features and Feeding in *Branchiostoma*

**Unit 8: 6 classes**

Accessory respiratory organ, osmoregulation and swim bladder in fishes.

Parental care in Amphibia

**Unit 9: 3 classes**

Poison apparatus and biting mechanism in snake

**Unit 10: 7 classes**

Respiration and migration in birds

Echolocation in Microchiropterans and Cetaceans

**B.Sc. in Zoology 1st Year Semester – III (Hons)**

|  |  |
| --- | --- |
| Course Title | Advanced Non-Chordates and Chordates Lab |
| Code | ZOODSC303P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Mount of mouth parts and dissection of digestive system, nervous system and reproductive system of Periplaneta
2. To submit a Project Report on coral reefs Or on study of life cycle of mosquitoes Or butterfly/moth.
3. Study of sections of *Balanoglossus* through proboscis and branchiogenital regions, sections of *Amphioxus* through pharyngeal, intestinal and caudal regions, *Herdmania* spicules.
4. Mount of weberian ossicles of *Mystus* or any Carp, Pecten from Fowl head.
5. Making a key for identification of poisonous and non- poisonous snakes.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Identify the life cycles and pathogenicity of major parasites, including *Entamoeba histolytica*, *Plasmodium vivax*, *Fasciola hepatica*, and *Wuchereria bancrofti*. Recall structural and functional features of Protista, coral reefs, helminths, mollusks, and chordates. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the mechanisms of locomotion and reproduction in Protista (*Amoeba*, *Paramecium*, and *Euglena*). Explain the types, formation, and conservation significance of coral reefs. Describe physiological processes such as excretion and osmoregulation in annelids, respiration in arthropods and mollusks, and the function of the water-vascular system in *Asteroidea*. | PO 2,4 | PSO 2,4 | Un |
| **CO – 3** | Relate parasitic adaptations in helminths to their life cycles and pathogenicity. Illustrate the role of torsion and detorsion in gastropod evolution and behavior. Apply knowledge of osmoregulation and respiratory adaptations to understand the ecological roles of fishes and amphibians. | PO 3,4 | PSO 3,4 | Ap |
| **CO – 4** | Compare and contrast respiratory mechanisms across arthropods, mollusks, and birds. Analyze the filter-feeding mechanisms in *Balanoglossus* and chordate features in *Branchiostoma*. Examine the evolutionary and ecological significance of parental care in amphibians and echolocation in mammals. | PO 4,5 | PSO 4,5 | An |
| **CO – 5** | Assess the conservation significance of coral reefs and propose strategies for their protection. Evaluate the ecological roles of accessory respiratory organs and swim bladders in fishes. Critically assess the adaptive significance of migration in birds and poison mechanisms in snakes. | PO 5 | PSO 5 | E |
| **CO – 6** | Integrate knowledge of physiological mechanisms and ecological adaptations to develop a comprehensive understanding of organismal diversity. Design a conceptual framework to understand the interdependence of evolutionary traits, habitat adaptations, and species survival. | PO 6 | PSO 6 | C |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**B.Sc. in Zoology 1st Year Semester – III (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Insect, Vectors and Diseases |
| Code | ZOOCOR303T/ ZOOMIN303T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The learner will be able to

|  |  |
| --- | --- |
|  | * Understand the general and morphological features of insects |
|  | * Differentiate the vectors among other insects. |
|  | * Analyze the insect orders serves as vectors. |
|  | * Explain the role of Dipterans as vectors; summarize the role of mosquitoes in spreading diseases like Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis. Design plans to control mosquitoes |
|  | * Explain the role of Siphonapterans as vectors; to spread diseases like Plague, Typhus fever, Design plans to control fleas. |
|  | * Explain the role of Siphunculata as vectors and its control. |
|  | * Explain the role of Hemiptera as vectors and its control. |

**Unit-1 Introduction to Insects**

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with respect to feeding habit

**Unit-2 Concept of Vectors**

Brief introduction to Vectors (mechanical and biological), Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity

**Unit-3 Insects as Vectors**

Detailed features of insect orders as vectors – Diptera, Siphonoptera, Siphunculata, Hemiptera

**Unit-4 Dipteran as Disease Vectors**

Study of important Dipteran vectors – Mosquitoes, Sand fly, Houseflies Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes

**Unit-5 Siphonaptera as Disease Vectors**

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

**Unit-6 Siphunculata as Disease Vectors**

Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse

**Ùnit-7 Hempitera as Disease Vectors**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

**B.Sc. in Zoology 2nd year Semester – III (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Insect, Vectors and Diseases Lab |
| Code | ZOOCOR303P/ ZOOMIN303P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 25 |

1. Mounting and Study of different kinds of mouth parts of insects

2. Spot identification of following insect vectors through permanent slides/photographs:Aedes,Culex,Anopheles, Pediculus humanuscapitis, Pediculus humanuscorporis, Phithiruspubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica

3. Study of different diseases transmitted by above insect vectors

4. Submission of a project report on any one of the insect vectors and disease transmitted

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the general features of insects, including their morphological characteristics and feeding habits.  Remember the concept of vectors of different orders such as Diptera, Siphonaptera, Siphunculata, and Hemiptera and their classification into mechanical and biological vectors. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the relationship between insects and disease transmission, including reservoirs and host-vector relationships.  Comprehend the adaptations of insects as vectors and their host specificity.  Demonstrate the morphology and behavior of insect vectors belonging to Diptera, Siphonaptera, Siphunculata, and Hemiptera orders. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of insect morphology and feeding habits to identify potential disease vectors. Apply understanding of vector biology to assess the risk of disease transmission. Construct knowledge of vector control measures to develop strategies for disease prevention and control. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the role of important Dipteran vectors, such as mosquitoes and sand flies, in transmitting diseases like malaria, dengue, and filariasis. Compare the specific characteristics and behaviors of Siphonaptera and Siphunculata vectors in disease transmission. Analyze the impact of Hemiptera vectors in spreading diseases like Chagas disease and typhus fever. | PO 4 | PSO 4 | An |
| **CO – 5** | Evaluate the effectiveness of control measures for different insect vectors, including insecticides and environmental management. Explain the importance of vector surveillance and monitoring in disease prevention efforts. Interpret the socio-economic implications of insect-borne diseases and the importance of vector control in public health. | PO 5 | PSO 5 | E, An |
| **CO – 6** | Create and develop strategies for integrated vector management to control the spread of insect-borne diseases. | PO 6 | PSO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Suggested Readings**

1. Anathakrishnan : Bio resources Ecology 3rdEdition

2. Goldman : Limnology, 2ndEdition

3. Odum and Barrett : Fundamentals of Ecology, 5thEdition

4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition

5. Trivedi and Goyal : Chemical and biological methods for water pollution studies

6. Welch : Limnology Vols. I-II

7. Wetzel : Limnology, 3rdedition

8. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Comparative Anatomy and Physiology of Vertebrates |
| Code | ZOODSC404T: DS-4 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

 **Comparative Anatomy**

* Understand the structure, function, and evolutionary significance of the integumentary system in amphibians, birds, and mammals.
* Explore the structural organization of axial and appendicular skeletons, jaw suspension mechanisms, and visceral arches, emphasizing their functional and evolutionary implications.
* Analyze the adaptations and diversity in mammalian dentition.
* Examine the general plan of circulation and provide a comparative account of the heart and aortic arches across vertebrates.
* Investigate the respiratory organs in fish, amphibians, birds, and mammals, highlighting adaptive mechanisms.
* Study the evolution of the kidney and urinogenital ducts, focusing on functional adaptations in vertebrates.
* Compare the brain structure and functionality in fish, birds, and mammals to understand vertebrate neural evolution.

 **Physiology**

* Learn the structure, classification, and functions of epithelial, connective, and muscular tissues.
* Understand the structural organization and functions of the digestive system, including specialized adaptations in ruminants.
* Analyze respiratory mechanisms, gas exchange processes, and the role of respiratory pigments in oxygen and carbon dioxide transport.
* Study the molecular basis of skeletal muscle contraction and the ultrastructure of muscle fibers.
* Explore the cardiac conduction system, the cardiac cycle, and the physiological roles of blood components, including blood clotting mechanisms.
* Understand the structure and function of neurons, the propagation of action potentials, and synaptic transmission.
* Study thermoregulation strategies, including adaptations like hibernation, aestivation, and antifreeze mechanisms in polar species.
* Investigate renal physiology, focusing on the kidney's functional unit and mechanisms of hypertonic urine formation.
* Analyze reproductive physiology, including gametogenesis and the histological structures of mammalian reproductive organs.

**Comparative Anatomy:**

**Unit 1: 2 classes**

Structure, function and derivatives of integument in amphibians, birds and mammals.

**Unit 2: 3 classes**

Overview of axial and appendicular skeleton; Jaw suspension; Visceral arches.

**Unit 3: 2 classes**

Dentition in mammals

**Unit 4: 3 classes**

General plan of circulation, Comparative account of heart and aortic arches

**Unit 5: 3 classes**

Respiratory organs in fish, amphibian, birds and mammals

**Unit 6: 2 classes**

Succession of kidney, Evolution of urinogenital ducts

**Unit 7: 3 classes**

Comparative account of brain in vertebrates: fish, bird and mammal

**Physiology:**

**Unit 8: Tissues 2 classes**

Structure, classification and functions of epithelial tissues, connective tissues and muscular tissues

**Unit 9: Digestive System 4 classes**

Structural organization and functions of Gastrointestinal tract and associated glands; modification of digestive tract in ruminants

**Unit 10: Respiratory System 4 classes**

Mechanism of Respiration, Respiratory volumes and capacities, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, respiratory pigments.

**Unit-11: Muscular system 2 classes**

Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction.

**Unit 12: Circulatory System 4 classes**

Structure and working of conducting myocardial fibers, Origin and conduction of cardiac impulses; Cardiac Cycle and cardiac output, Components of Blood and their functions (blood buffering mechanism); Haemostasis; Blood clotting system.

**Unit 13: Nervous System 4 classes**

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and Neuromuscular junction.

**Unit 14: Thermoregulation 3 classes**

Physiological classification based on thermal biology. Thermal biology of endotherms; Hibernation, torpor aestivation; anti-freezing mechanism in polar fish

**Unit 15: Urinary System 2 classes**

Structure of Kidney and its functional unit, Mechanism of hyper tonic urine formation,

**Unit 16: Reproductive System 2 classes**

Gametogenesis of mammals; histology of ovary and testis

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Comparative Anatomy and Physiology Lab |
| Code | ZOODSC404P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs

2. Study of disarticulated skeleton of Pigeon and Guineapig

3. Dissection of Tilapia: circulatory system, brain, pituitary, urinogenital system

4. Determination of ABO Blood group.

5. Total count and differential count of blood.

6. Preparation of Haemin crystals.

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| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the structure and function of key anatomical features in vertebrates (integument, skeletal system, circulatory system, respiratory organs, etc.). Identify the major anatomical differences in organs and systems across amphibians, birds, and mammals. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the structure and function of tissues and organs such as the kidney, digestive, and respiratory systems across different vertebrates. Describe the evolutionary adaptations in vertebrates related to circulatory, respiratory, and thermoregulatory systems. | PO 2,4 | PSO 2,4 | Un |
| **CO – 3** | Apply knowledge of comparative anatomy to assess physiological differences in vertebrates (e.g., comparing heart structure or respiratory organs). Demonstrate understanding by analyzing the functional significance of adaptations in various vertebrate groups. | PO 3,4 | PSO 3,4 | Ap, An |
| **CO – 4** | Compare the anatomical and physiological features of different vertebrate species (e.g., skeletal structure, brain anatomy, and dentition). Analyze how the structure of organs such as the heart or brain supports specific physiological functions in different vertebrate groups. | PO 4,5 | PSO 4,5 | An |
| **CO – 5** | Interprate knowledge of various physiological and anatomical systems to form a comprehensive understanding of vertebrate biology. Construct and evaluate detailed diagrams or models illustrating the structural differences and adaptations in organs across species. | PO 5 | PSO 5 | E |
| **CO – 6** | Construct the evolutionary significance of key anatomical structures (e.g., jaw suspension, brain structure, and kidney evolution). Evaluate the impact of anatomical differences on the survival and adaptation of vertebrates in different environments. | PO 6 | PSO 6 | An,E |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Comparative Anatomy of the Vertebrates 9th Ed (2015) by Kent; McGrew-Hill

2. Elements of Chordate Anatomy by Weichert and Presch, 2017, Amazon.in

3. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman,

Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.

4. Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. 6th Edn. Jaypee.

5. Ganong’s Review of Medical Physiology by Barret; 25th Ed, McGrew-Hill, 2016

References:

1. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons

2. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. McGraw Hill 4th Ed. 2005.

3. Elaine N. Marieb, 2006. Human Anatomy & Physiology, Pearson Education.

4. Eroschenko VP. 2008. diFiore’s Atlas of Histology with Functional correlations. XII Edition. Lippincott & Wilkins.

5. Fox SI. 2011. Human Physiology. 12th Edn. Mc Graw Hill

6. Gunstream SE. 2010. Anatomy and Physiology with integrated study guide. 4th Edn., Mc Graw Hill.

7. Guyton AC, Hall JE. 2006. Textbook of Medical Physiology. XI Edn. Hercourt Asia PTE Ltd. W.B. Saunders Company.

8. Hill RW, Wyse GA, Anderson M. 2012. Animal Physiology. 3rd Edn. Sineuer Associaes.

Sembulingam K, Sembulingam P. 2012. Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi

9. Sherwood L. 2013. Human Physiology from cells to systems. 8th Edn., Brooks & Cole

10. Tortora GJ, Grabowski S. 2006. Principles of Anatomy & Physiology. XI Edition John Wiley & son

11. Vander A, Sherman J, Luciano D. 2014. Vander's Human Physiology:The Mechanism of Body Function. XIII Edn. McGraw Hills

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Ecology |
| Code | ZOODSC405T: DS-5 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

* The aim of the course is that the students understand nature in the context of ecosystem dynamics, ecosystem functioning and provision of ecosystem services.
* The course would demonstrate a broad understanding of the processes that shape the distribution and abundance of organisms from the micro-habitat to the globe; recognize that the distribution of organisms is a product of positive and negative interactions within and across trophic levels, including competition, mutualism, predation, and parasitism.
* The course will provide information on key factors that influence the habitat including climate, energy input, spatial/temporal complexity, and resource availability.
* Students will develop an appreciation of the ecosystem services and would appreciate the modern scopes of scientific inquiry in the field of Ecology.
* They will develop an understanding of the differences in the structure and function of different types of ecosystems and will learn techniques of data analysis as well as methods of presenting scientific information in figures and tables.
* They will develop an appreciation of the natural world through direct experience with local ecosystems; learn techniques for gathering data in the field.

**Unit 1: Introduction to Ecology 4 classes**

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, biomes.

**Unit 2: Population 20 classes**

Concept of population and metapopulation

Unique and group attributes of population: Demographic factors, life tables, fecundity tables, survivorship curves, dispersal and dispersion.

Geometric, exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density- dependent and independent factors

**Unit 3: Community 8 classes**

Population Interactions: Gause’s Principle with laboratory and field examples, Lotka-Volterra equation for competition. Community characteristics: species diversity, measures of diversity; abundance, dominance, richness, Vertical stratification, Ecotone and edge effect. Ecological succession and examples of it.

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**Unit 4: Ecosystem 8 classes**

Food chains, Food web, Ecological pyramids, Energy flow through the ecosystem, Ecological efficiencies, Biogeochemical cycles (Nitrogen cycle and water cycle), Human modified ecosystem.

**Unit 5: Applied Ecology 5 classes**

Introduction to Indian ecosystems (outline idea of mangrove, desert, wetland, montane);

Concept of Ramsar site; Ramsar sites of India; Ecosystem services with special reference to wetlands.

Sustainable environment; SDG goals; Outline ideas and objective of Indian Environmental Laws.

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Ecology Lab/Field |
| Code | ZOODSC405P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided

2. Determination of population density of a natural/hypothetical population. Study of species diversity of a community by quadrat or any other suitable sampling method and calculation of diversity indices.

3. Study of an aquatic ecosystem: Sampling of zooplankton, Measurements of temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler’s method), free CO2.

4. Field Study: Visit to a National Park/Wildlife Sanctuary/ any other Protected Forest/ any natural habitat. Report (including the actual field diary) on the study of the landscape and habitat features, Survey on: Types of Forests, Major Flora and Fauna, Man-animal conflicts and other problems.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSO**  **Addressed** | **Cognitive level** |
| **CO – 1** | Recall the history of ecology and fundamental concepts such as autecology, synecology, and levels of organization within ecosystems. Remember the laws of limiting factors and the physical factors influencing ecosystems, as well as the components of the biosphere. | PO 1 | PSO 1 | R, |
| **CO – 2** | Understand the unique attributes of unitary and modular populations, including demographic factors and dispersal patterns.  Comprehend the principles of geometric, exponential, and logistic population growth, as well as the factors regulating population density. | PO 2,4 | PSO 2,4 | Un |
| **CO – 3** | Apply Gause’s Principle and the Lotka-Volterra equation to analyze population interactions, with laboratory and field examples. Apply knowledge of community characteristics and ecological succession to identify and interpret community dynamics in various ecosystems. | PO 3,4 | PSO 3,4 | A |
| **CO – 4** | Analyze the characteristics of different types of ecosystems, food chains, and food webs, including their structures and functions.  Analyze ecological pyramids and efficiencies to understand energy flow and nutrient cycling within ecosystems, including human-modified ecosystems. | PO 3 | PSO 3 | An |
| **CO-5** | Evaluate wildlife conservation strategies, considering ecological, social, and legal factors such as the Wildlife Protection Act (1972) including in-situ and ex-situ conservation methods, and assess their effectiveness. | PO 5 | PSO 5 | E |
| **CO-6** | Create a comprehensive sampling protocol for studying an aquatic ecosystem, including methods for sampling phytoplankton and zooplankton, and measuring environmental parameters such as temperature, turbidity, pH, dissolved oxygen, chemical oxygen demand, and free CO2. Plan and organize a field excursion to a National Park, Wildlife Sanctuary, or Protected Forest within West Bengal, and prepare a detailed report documenting landscape and habitat features, forest types, major flora and fauna, man-animal conflicts, and management and conservation measures implemented. | PO 6 | PSO 6 | C |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Ecology: Theories and Applications by Peter Stiling; Pearson 4th Ed. 2001.

2. Ecology: The Experimental Analysis of Distribution and Abundance (Indian Paperback edition) by Charles Krebs

3. Ecology: Principles and Applications by J. L. Chapman, ‎M. J. Reiss • 1999. Cambridge University Press

4. Townsend C and Michael Begon. (2008). Essentials of Ecology. Blackwell.

5. Michael Dobson and Chris Frid. (2008). Ecology of Aquatic Systems. OUP.

6. Charles J. Krebs. Ecology : The experimental analysis of distribution and abundance. (2009). Edition 6th ed. Benjamin Cummings.

7. Manuel Molles and Anna A Sher. (2009). Ecology: Concepts and Applications 8th Edition. McGraw-Hill.

8. William D. Bowman and Sally D. Hacker. (2009). Ecology, 5th Edition. Sinauer Associates.

9. David T. Krohne. (2009). Ecology: Evolution, Application, Integration 2nd Edition. Oxford University Press.

10. Nicholas B. Davies, John R. Krebs, Stuart A. West (2010). An Introduction to Behavioural Ecology 4th Edition. Wiley-Blackwell

**Referrences:**

1. A Primer of Ecology by Gotelli; 3rd Ed. Sinauer Associates. 2000.
2. Students are encouraged to explore authentic websites (for e.g. Wikipedia, different university websites and OCWs) on internet, for reading/audio-visual materials on a particular topic if they do not find enough in the text books or otherwise).

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Cell Biology |
| Code | ZOODSC406T : DS-6 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Remember, understand, distinguish and illustrate the structural aspects of Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions. |
|  | * Remember, understand, describe and illustrate the structure and role of the plasma membrane. |
|  | * Remember, understand, describe and illustrate the structure and role of the endomembrane system. |
|  | * Remember, understand, describe and illustrate the structure and role of the mitochondria and peroxisome. |
|  | * Remember, understand, describe and illustrate the structure and role plasma membrane. |
|  | * Understand, describe and illustrate the structure and function of cytoskeleton. |
|  | * Remember, understand, describe and illustrate the structure and role of the nucleus. |
|  | * Remember, understand, describe, illustrate and apply the cell cycle and cell division events and also can relate and interpret the role of cell cycle with the formation of cancer. |
|  | * Remember, understand, analyze and illustrate the cell signaling pathways and its role. |

**Unit 1: Overview of Cells 3 classes**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

**Unit 2: Plasma Membrane 10 classes**

Various models of plasma membrane

Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions

Extracellular Matrix-Cell Interactions

**Unit 3: Endomembrane System 4 classes**

Structure and Functions: Golgi Apparatus, Endoplasmic Reticulum, Lysosomes

**Unit 4: Mitochondria and Peroxisomes 8 classes**

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis; Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis; Peroxisomes

**Unit 5: Cytoskeleton 2 classes**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments

**Unit 6: Nucleus 6 classes**

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

**Unit 7: Cell Division 8 classes**

Mitosis and Meiosis

Cell cycle and its regulation

Cancer (Concept of oncogenes and tumor suppressor genes) Mechanisms of cell death: brief overview

**Unit 8: Cell Signaling 4 classes**

Cell signaling transduction pathways; Types of signaling molecules and receptors GPCR and Role of secondary messenger (cAMP)

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Cell Biology Lab |
| Code | ZOODSC406P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis

2. Study of various stages of meiosis ( from grass hopper testis or in pre prepared slides and or in photographs obtained from Website).

3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

4. Preparation of permanent slide to demonstrate: DNA by Feulgen reaction

5. Cell viability study by Trypan Blue staining

6. Mitochondrial staining from cheek cells.

7. Blood Smear preparation and Identification of blood cells

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall, identify, describe and distinguish the structure and function of the Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions with illustration. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the structure and functions of the endomembrane system, including the endoplasmic reticulum, Golgi apparatus, and lysosomes. Compare the structure and functions of mitochondria, peroxisomes, and the cytoskeleton within the cell. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of transport mechanisms across membranes to explain how substances move into and out of cells.  Develop knowledge of mitosis, meiosis, and the cell cycle to describe the processes of cell division and their regulation. | PO 3,4 | PSO 3,4 | Ap, An |
| **CO – 4** | Analyze the structure and functions of the nucleus, including the nuclear envelope, nucleolus, and chromatin organization.  Compare the mechanisms of cell signaling transduction pathways and the role of signaling molecules and receptors. | PO 4 | PSO 4 | An, |
| **CO – 5** | Evaluate the significance of the endosymbiotic hypothesis in explaining the origin of mitochondria. Interpret the role of oncogenes and tumor suppressor genes in the development of cancer. | PO 5 | PSO 5 | E |
| **CO – 6** | Synthesize information from various units to describe the integrated functioning of the cell, including cell division, signaling pathways, and organelle functions. | PO 6 | PSO 6 | C |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017

2. Cell Biology by Gerald Karp; Wiley, 7th Ed. 2013

**References:**

1. Essentials of Cell Biology by Bruce Albert et al.; W.W. Norton Co., 4th Ed, 2013 Or

2. Molecular Cell Biology by Hurvey Lodish et al.; W. H. Freeman, 6th Ed.2013

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

|  |  |
| --- | --- |
| Course Title | Biochemistry |
| Code | ZOODSC407T : DS-7 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The learner will be able to

|  |  |
| --- | --- |
|  | * Understand the fundamentals of biochemical reactions and metabolism. |
|  | * Understand the structure and biological importance of carbohydrate, proteins and lipids. |
|  | * Understand the metabolism of carbohydrate, proteins and lipids. |
|  | * Understand the structure and biological importance of nucleic acids and its metabolism. |
|  | * Understand the classification, structure and biological importance of enzymes. |
|  | * Explain the mechanism of enzyme action |
|  | * Understand the Oxidative phosphorylation in relation with Electron Transport Chain. |

**Unit 1: Fundamentals of biochemical reactions and metabolism 4 classes**

Thermodynamics, concept of Free energy changes, Ionization of water, weak acids and bases, buffering and pH changes in living systems

**Unit 2: Carbohydrates 5 classes**

Basic Structure of carbohydrate structure, isomerism. Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis

**Unit 3: Lipids 6 classes**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpenoids.

Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis

**Unit 4: Proteins 8 classes**

Amino acids Structure, Classification, General and Electro chemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids

Proteins Bonds stabilizing protein structure; Levels of organization

Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids

**Unit 5: Nucleic Acids 8 classes**

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids

Types of DNA and RNA, Complementarity of DNA, Hypo- Hyperchromaticity of DNA, Outlines of nucleotide metabolism

**Unit 6: Enzymes 10 classes**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes;

Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver- Burk plot; Factors affecting rate of enzyme-catalyzed reactions;

Enzyme inhibition; Allosteric enzymes and their kinetics; Strategy of enzyme action- Catalytic and Regulatory (Basic concept with one example each)

**Unit 7: Oxidative Phosphorylation 4 classes**

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

**B.Sc. in Zoology 1st year Semester – IV (Hons)**

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| --- | --- |
| Course Title | Biochemistry Lab |
| Code | ZOODSC407P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.

2. Paper chromatography of amino acids.

3. Quantitative estimation by Lowry Method.

4. Demonstration of separation of proteins by SDS-PAGE.

5. Study of the enzymatic activity of amylase: effect of temperature and pH

1. Performing Acid and Alkaline phosphatase assay from serum/tissue.

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| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall fundamental biochemical reactions and metabolic pathways. Remember the structures, classifications, and biological significance of carbohydrates, lipids, proteins, nucleic acids, and enzymes. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the principles of ionization, buffering, and pH changes in living systems.  Comprehend the concepts of catabolism, anabolism, and compartmentalization of metabolic pathways. Summarize the structures and functions of macromolecules and enzymes, as well as their metabolic pathways. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of biochemical reactions and metabolism to analyze and interpret metabolic pathways and their regulation.  Apply understanding of enzyme kinetics to predict the effects of enzyme inhibitors and allosteric regulators on metabolic pathways.  Relate knowledge of oxidative phosphorylation to explain the role of electron transport system. | PO 3,4 | PSO 3,4 | Ap |
| **CO – 4** | Analyze the structures and functions of biomolecules and enzymes and its mechanism of action and kinetics. Categorize the metabolic pathways involved in carbohydrate, lipid, protein, and nucleic acid metabolism. | PO 4,5 | PSO 4,5 | An |
| **CO – 5** | Evaluate the significance of biochemical reactions and metabolic pathways in cellular energy production, biosynthesis, and regulation. Assessing the importance of cofactors, reducing equivalents, and shuttle systems in metabolic processes. Interpret the impact of enzyme inhibition and regulation on metabolic flux and cellular function. | PO 5,3 | PSO 4,5 | Ap, E |
| **CO – 6** | Create connections between different metabolic pathways and their physiological roles in maintaining cellular homeostasis.  Develop strategies for manipulating metabolic pathways for therapeutic or research purposes. | PO 6 | PSO 6 | C |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Textbooks:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson, 2017.

2. Cox, M.M and Nelson, D.L. (2008). Lehninger’s Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York

**References:**

1. Principles of Biochemistry by Voet, Pratt and Voet; Wiley International Student Ed. 2012
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper’s Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

**B.Sc. in Zoology 3rd year Semester – IV (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Applied Zoology |
| Code | ZOOCOR404T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Understand the general idea on host-parasite interaction. |
|  | * Understand and analyze the epidemiology of tuberculosis and typhoid |
|  | * Recall and summarize Brief account of *Rickettsia prowazekii, Borrelia recurrentis and Treponema pallidum.* |
|  | * Understand and analyze the life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax and Trypanosoma gambiense* |
|  | * Understand and analyze the life history and pathogenicity of *Ancylostoma duodenale and Wuchereria bancrofti* |
|  | * Understand and analyze the biology, Control and damage caused by *Helicoverpa armigera, Pyrilla perpusilla and Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum* |
|  | * Understand and analyze the Medical importance and control of *Pediculus humanus corporis, Anopheles, Culex, Aedes, Xenopsylla cheopis* |
|  | * Recall the method of preservation of semen and artificial insemination in cattle |
|  | * Recall and apply the methods of poultry farming |
|  |  |

**Unit-1 Introduction to Host-parasite Relationship**

Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

**Unit-2 Epidemiology of Diseases**

Transmission, Prevention and control of diseases: Tuberculosis, Typhoid

**Unit-3 Rickettsia and Spirochetes**

Brief account of Rickettsia prowazekii, Borrelia recurrentis and Treponema pallidum.

**Unit-4 Parasitic Protozoa**

Life history and pathogenicity of Entamoeba histolytica, Plasmodium vivax and Trypanosoma gambiense

**Unit-5 Parasitic Helminthes**

Life history and pathogenicity of Ancylostoma duodenale and Wuchereria bancrofti

**Unit-6 Insects of Economic Importance**

Biology, Control and damage caused by Helicoverpa armigera, Pyrilla perpusilla and Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum

**Unit-7 Insects of Medical Importance**

Medical importance and control of Pediculus humanus corporis, Anopheles, Culex, Aedes, Xenopsylla cheopis

**Unit-8 Animal Husbandry**

Preservation of semen and artificial insemination in cattle

**Unit-9 Poultry Farming**

Principles of poultry breeding, Management of breeding stock and broilers, Processing andpreservation of eggs

**B.Sc. in Zoology 3rd year Semester – IV (DSE/GE)**

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| --- | --- |
| Course Title | Applied Zoology Lab |
| Code | ZOOCOR404P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study and Identification of Plasmodium vivax, Entamoeba histolytica, Ancylostoma duodenale and Wuchereria bancrofti and their life stages through permanent slides/photomicrographs or specimens.

2. Study and Identification of arthropod vectors associated with human diseases: Pediculus, Culex,Anopheles, Aedes and Xenopsylla.

3. Study and Identification of insect damage to different plant parts/stored grains through damaged products/photographs.

4. Identifying features and economic importance of Nilaparvata lugens, Apion corchori, Scirpophaga incertulus, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum

5. Visit to poultry farm/ animal breeding centre/ vector biology/ parasitology Centre. Submission of visit report

6. Maintenance of freshwater aquarium

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| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the basic concepts related to host-parasite relationships, epidemiology of diseases, and Remember the characteristics of various parasitic organisms and insects discussed in the course. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the principles of epidemiology, transmission, prevention, and control of diseases such as tuberculosis and typhoid. Comprehend the biology, life history, and pathogenicity of various parasitic organisms, as well as the economic and medical importance of insects. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of host-parasite relationships to analyze and interpret data related to disease transmission, prevention, and control strategies. Apply their knowledge to devise methods for the management and control of economically and medically important insects. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the life histories and pathogenicity of parasitic organisms and insects, as well as the economic and medical implications of their presence. Critically evaluate various control measures and their effectiveness in managing disease vectors and pests. | PO 3,4 | PSO 3,4 | Ap, An, |
| **CO – 5** | Evaluate the impact of host-parasite relationships on human and animal health, as well as on agricultural and economic sectors. Assess the effectiveness of different strategies for disease prevention and control, as well as for managing insect pests in agriculture and public health. | PO 4,5 | PSO 4,5 | An, Ap |
| **CO - 6** | Create plans and proposals for disease prevention and control programs, as well as for integrated pest management strategies. Design experiments or interventions to address specific issues related to host-parasite relationships, disease transmission, or insect control. | PO 6 | PSO 6 | An |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Suggested Readings**

1. Arora, D. R and Arora, B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors.

2. Atwal, A.S. (1986). Agricultural Pests of India and South East Asia, Kalyani Publishers.

3. Banerjee, G.C. (). Animal husbandry.

4. Banerjee, G.C. (). Animal husbandry.

5. Chatterjee, K. D. (2009).Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors(P) Ltd

6. Dennis, H. (2009). Agricultural Entomology. Timber Press (OR).

7. Dunham R.A. (2004). Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.

8. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher

9. Kumar and Corton. Pathological Basis of Diseases.

10. Paniker, C.K.J., Ghosh, S. [Ed} (2013). Paniker’s Text Book of Medical Parasitology. Jaypee, New Delhi.

11. Parija, S.C. Text book of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi

12. Park, K. (2007). Preventive and Social Medicine. XVI Edition. B.B Publishers.

13. Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Molecular Biology |
| Code | ZOODSC508T : DS-8 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

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| --- | --- |
|  | * Remember and understand the structure of DNA and RNA structure. |
|  | * understand, apply and analyze the process of replication and transcription of DNA |
|  | * Understand, apply and analyze the structure and functions of RNA and synthesis of proteins. |
|  | * Understand, apply and analyze Post Transcriptional Modifications and Processing of Eukaryotic RNA. |
|  | * Understand, apply and analyze the process of gene Regulation. |
|  | * Understand, apply and analyze the process of DNA repair mechanisms. |
|  | * Understand and apply different molecular lab techniques. |

**Unit 1: Nucleic Acids 4 classes**

Salient features of DNA and RNA; Watson and Crick Model of DNA

**Unit 2: DNA Replication 6 classes**

Mechanism of DNA Replication in Prokaryotes, Semi-conservative, bidirectional and discontinuous replication, RNA priming, Replication of telomeres

**Unit 3: Transcription 6 classes**

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.

**Unit 4: Translation 8 classes**

Mechanism of protein synthesis in prokaryotes, Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

**Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA 6 classes**

Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

**Unit 6: Gene Regulation 6 classes**

Regulation of Transcription in prokaryotes: lac operon and trp operon; Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting

**Unit 7: DNA Repair Mechanisms 4 classes**

Types of DNA repair mechanisms, RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair

**Unit 8: Molecular Lab Techniques 5 classes**

PCR, Western and Southern blot, Northern Blot, Sanger DNA sequencing, cDNA technology

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Molecular Biology Lab |
| Code | ZOODSC508P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Demonstration of polytene Chromosome from Drosophila /Chironomid larvae
2. Isolation and quantification of genomic DNA using spectrophotometer (A260 measurement)
3. Agarose gel electrophoresis for DNA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the salient features of DNA and RNA, including the Watson and Crick model of DNA. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the mechanism of DNA replication in prokaryotes, including semi-conservative, bidirectional, and discontinuous replication, as well as the replication of telomeres. Comprehend the process of transcription in both prokaryotes and eukaryotes, including the roles of transcription factors and the differences between prokaryotic and eukaryotic transcription. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of translation to understand the mechanism of protein synthesis in prokaryotes, including ribosome structure, fidelity of protein synthesis, genetic code, and inhibitors of protein synthesis. Apply understanding of post-transcriptional modifications and processing of eukaryotic RNA, including capping, poly A tail formation, splicing mechanisms, and processing of tRNA. | PO 2,3 | PSO 2,3 | Un,Ap, |
| **CO – 4** | Analyze gene regulation mechanisms in prokaryotes and eukaryotes, including the lac operon, trp operon, transcriptional activators, enhancers, silencers, repressors, miRNA-mediated gene silencing, and genetic imprinting. Distinguish DNA repair mechanisms, including nucleotide and base excision repair, SOS repair, and the RecBCD model in prokaryotes. | PO 4 | PSO 4 | An |
| **CO – 5** | Evaluate the effectiveness and applications of molecular laboratory techniques such as PCR, Western blot, Southern blot, Northern blot, Sanger DNA sequencing, and cDNA technology in genetic research and diagnostics. | PO 3,5 | PSO 3,5 | Ap, E |
| **CO - 6** | Create experimental designs and protocols using molecular laboratory techniques for specific research purposes. Develop strategies for studying gene regulation and DNA repair mechanisms in various organisms and contexts. Construct educational materials or presentations to explain complex concepts in nucleic acids and molecular biology to others. | PO 6 | PSO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Book:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.
2. Molecular Biology of The Gene by Watson. 7th Edition. Pearson.

**References:**

1. Molecular Cell Biology by Harvey Lodish. 7th Edition. W.H. Freeman.
2. iGenetics: A Molecular Approach by Peter. J. Russell. 3rd edition. Pearson Benjamin Cummings.
3. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Cambridge Univ. Press, Paperback

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Genetics |
| Code | ZOODSC509T: DS-9 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * understand and analyze the Mendelian experiments, inheritance of multiple alleles, Incomplete dominance and co-dominance, Epistasis, Lethal alleles, Pleiotropy, Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance |
|  | * Understand and analyze the concept of Linkage, Crossing Over and Chromosomal Mapping. |
|  | * Understand, apply and analyze the types of chromosomal and gene mutations and its effect on humans. |
|  | * Understand and analyze the sex determination of human and *Drosophila* |
|  | * Understand the concept of extra-chromosomal inheritance. |
|  | * Interpret the procedure of bacterial reproduction and complementation test. |
|  | * Understand and apply the concept of transposable elements. |

**Unit 1: Mendelian Genetics and its Extension 8 classes**

Background of Mendel’s experiments, Principles of Mendelian inheritance,

Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Lethal alleles, Pleiotropy, Sex-linked, sex- influenced and sex-limited inheritance, Polygenic Inheritance.

**Unit 2: Linkage, Crossing Over and Chromosomal Mapping 8 classes**

Linkage and Crossing Over, molecular basis of crossing over, Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence.

**Unit 3: Mutations 10 classes**

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Chromosomal aberrations, gene mutations and human diseases (Down’s, Klienfelter’s, Turner’s, Cri du Chat, Sickle cell, Haemophilia, Thallassimia, Albinism – only genetical aspects here, details of physiological consequences not required), Sex chromosomes and sex-linked inheritance

Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

**Unit 4: Sex Determination 6 classes**

Mechanisms of sex determination in Drosophila with reference to alternative splicing

Sex determination in mammals

Dosage compensation in Drosophila & Human

**Unit 5: Extra-chromosomal Inheritance 6 classes**

Criteria for extra chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Kappa particle in Paramecium, Shell spiraling in snail

**Unit 6: Recombination in Bacteria and Viruses 5 classes**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

**Unit 7: Transposable Genetic Elements 2 classes**

Transposons in bacteria,

Ac-Ds elements in maize and P elements in Drosophila, LINE, SINE, Alu elements in humans

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Genetics Lab |
| Code | ZOODSC509P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Chi-square analyses

Statistical tests of data and decision making

Chi square test for goodness of fit

1. Pedigree analysis of some inherited traits in human
2. Identification of chromosomal aberration in Drosophila from photographs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the background of Mendel's experiments, principles of Mendelian inheritance, types of gene mutations, chromosomal aberrations, mechanisms of sex determination in various organisms, and types of extra-chromosomal inheritance. | PO 1 | PSO 1 | R |
| **CO – 2** | Comprehend the concepts of incomplete dominance, co-dominance, epistasis, multiple alleles, lethal alleles, pleiotropy, sex-linked, sex-influenced, and sex-limited inheritance, as well as linkage, crossing over, chromosomal mapping, and the molecular basis of mutations. | PO 2 | PSO | Un |
| **CO – 3** | Apply understanding of Mendelian genetics to solve problems related to inheritance patterns, linkage analysis, and chromosomal aberrations. They will also be able to analyze data from three-factor crosses and predict recombination frequencies. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the molecular basis of mutations induced by UV light and chemical mutagens, as well as the relationship between chromosomal aberrations, gene mutations, and human diseases. Compare the mechanisms of recombination in bacteria and viruses. | PO 3,4 | PSO 4 | An, Ap |
| **CO – 5** | Evaluate the significance of different types of mutations and chromosomal aberrations in the context of human health and disease. Interpret the mechanisms of extra-chromosomal inheritance and their implications in microbial evolution. | PO 4,5 | PSO 4,5 | AP, E |
| **CO - 6** | Create models or diagrams to illustrate the processes of linkage, crossing over, chromosomal mapping, and mechanisms of sex determination. Propose experiments to study the effects of mutations or investigate the role of transposable genetic elements in genetic variation. | PO 6 | PSO 6 | C |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.

2. Principles of Genetics by Robert Tamarin; McGraw Hill, 7th Ed. 2017 Or

Principles of Genetics by Snustad, D.P., Simmons, M.J. (2009). 5th Ed. John Wiley and Sons Inc

**References:**

1. Developmental biology by Scott. F. Gilbert, 9th edition.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
3. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Animal Behaviour and Chronobiology |
| Code | ZOODSC510T: DS-10 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Remember the brief history of animal behavior and roll of various scientists in this field. |
|  | * Understand and apply the concept of instinct and learning behavior. |
|  | * Understand, apply and analyze the types of chromosomal and gene mutations and its effect on humans. |
|  | * Understand, analyze and apply social and sexual behavior of animals. |
|  | * Understand the concept of chronobiology. |
|  | * Interpret the procedure of bacterial reproduction and complementation test. |
|  | * Understand and explain the concept of biological rhythm. |

**Unit 1: Introduction to Animal Behaviour 8 classes**

A brief history and schools of animal behaviour studies including the works of Fabre, Darwin, Von Frisch, Lorenz, Tinbergen, Jane Goodal, Biruté Galdikas, Dian Fossey, Salim Ali, Gopal Bhattacharyya, M. K. Chandrashekhar, Raghavendra Gadagkar.

The objectives of modern animal behaviour studies: Tinbergen’s four questions.

Methods of studying behaviours: Observation vs Watching, Ad libitum observations, Focal animal studies, Instantaneous scan, etc.

**Unit 2: Behaviours of Individuals 10 classes**

Reflexes and Orientations

Instinct

Learning: Imprinting and other Programmed Learning, Habituation, Innovations and Cultural Transmission / Social Learning

**Unit 3: Social and Sexual Behaviour 14 classes**

Social Behaviour: Concept of Sociality, Types of animal Society with examples, Altruism

Communications in animals- different types (e.g. pheromones, visuals, tactile, acoustics, etc) with common examples

Insects’ society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

**Unit 4: Introduction to Chronobiology 7 classes**

Historical developments in chronobiology;

Biological oscillation: the concept of Average, amplitude, phase and period

Adaptive significance of biological clocks

**Unit 5: Biological Rhythm 6 classes**

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms;

Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms;

Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Animal Behaviour and Chronobiology Lab |
| Code | ZOODSC510P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of nests (non-invasively) and nesting habits of birds (observation/drawing/exsting photographs) and social insects (e.g. social wasps).

2. Study of the behavioural responses of rice weevil/wood lice to dry and humid conditions.

3. Study of geotaxis behaviour in earthworms.

4. Study of the phototaxis behaviour in insects/defensive behaviour in mosquito larvae.

5. Visit to Biodiversity Park/Zoological Park/ any natural habitat to study behavioural activities of animals and prepare a short report.

6. Study and actogram construction of locomotor activity of suitable animal models.

7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

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| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall key historical figures and their contributions to the field of animal behavior studies, including Fabre, Darwin, Von Frisch, Lorenz, Tinbergen, Jane Goodall, and others. Remember Tinbergen's four questions and the various methods of studying behaviors. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the objectives of modern animal behavior studies, including Tinbergen's four questions, and comprehend the different branches of animal behavior studies. Demonstrate the concepts of reflexes, instincts, learning mechanisms, social behaviors, sexual behaviors, chronobiology, and biological rhythms. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of animal behavior concepts to analyze and interpret behavioral data, design behavioral studies using appropriate observational methods, and investigate specific aspects of animal behavior, such as social interactions, mating behaviors, and biological rhythms. | PO 2,3 | PSO 3 | Ap |
| **CO – 4** | Analyze the adaptive significance of biological clocks and rhythms, as well as the mechanisms underlying social and sexual behaviors in animals. Critically evaluate different types of communication in animals and assess the impact of environmental factors on biological rhythms and reproductive behaviors. | PO 4 | PSO 4 | An |
| **CO – 5** | Evaluate the effectiveness of observational methods in studying animal behavior, assess the ethical implications of studying animal behaviors, and assess the impact of environmental factors on biological rhythms and reproductive behaviors. | PO 3,4 | PSO 3,4 | E |
| **CO - 6** | Create hypotheses and design experiments to investigate specific aspects of animal behavior, such as social interactions, mating behaviors, and biological rhythms. Design models or presentations to explain complex concepts in animal behavior to others. | PO 6 | PSO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Animal Behaviour: Mechanisms. Ecology. Evolution by Drickamar, Vessey, 5th Ed. Jakob; McGraw Hill.
2. Survival Strategies by Raghavendra Gadagkar, University Press

**References:**

1. An Introduction to Animal Behaviour by Manning and Dawkins; 5th Ed. Cambridge Univ. Press
2. Measuring Behaviour: An Introductory Guide by Martin and Bateson; 3rd Ed.Cambridge Univ. Press
3. Introduction to Behavioural Ecology by Krebs and Davies; Wiley-Blackwell

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Endocrinology, Histology and Histochemistry |
| Code | ZOODSC511T: DS-11 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

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| --- | --- |
|  | * Explain the general idea of endocrine system and classify the hormones. |
|  | * Describe the structure and function of various endocrine glands with illustration. |
|  | * Prepare table of disorders with their causes and symptoms. |
|  | * Analyze and evaluate the mechanism of hormone action |
|  | * Explain, analyze and compare the reproductive cycle of mammals. * Understand and explain the theory and principles of various histological and histochemical staining procedures, including the use of fixatives and decalcification in tissue preparation. * Demonstrate proficiency in analyzing normal and abnormal tissues, such as bone, cartilage, liver, and cancerous tissue, using appropriate histological methods. * Compare and contrast histological structures from normal and diseased tissues, with a focus on recognizing histopathological changes in cancer.   **Endocrinology**  **Unit 1: Introduction to Endocrinology 2 classes**  General idea of Endocrine systems, Classification, Characteristics and Transport of Hormones, Neurosecretions and Neurohormones  **Unit 2: Epiphysis, Hypothalamo-hypophysial Axis 8 classes**  Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction; Structure of pituitary gland, hormones and their functions, disorders, hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control, hypothalamo-hypophysial portal system.  **Unit 3: Peripheral Endocrine Glands 8 classes**  Thyroid, parathyroid, adrenal, pancreas, ovary and testis: structure, hormones, functions, regulations and disorders  **Unit 4: Mechanism of Hormone Action 8 classes**  Mechanism of hormone action, signal transduction pathways for steroidal and non steroidal hormones and receptors, bioassays of hormones using RIA & ELISA; estrous cycle in rat and menstrual cycle in human; hormonal regulation of parturition  **Histology and Histochemistry**  **Unit 5: Theory and principles of different staining procedures in Histology. 4 classes**    **Unit 6: Theory and principles of different staining procedures in Histochemistry; Fixatives & Staining solutions; decalcification of calcified tissue before sectioning. 6 classes**    **Unit 7: Immunohistochemistry. 3 classes**  **Unit 8: Study of histology 4 classes**    Bone, cartilage, stomach, small intestine, large intestine, liver, spleen, kidney, cardiac muscle, ovary, testis.    **Unit 9: Histopathology in cancer tissue 2 classes**  Comparing normal and abnormal tissue |

**B.Sc. in Zoology 1st year Semester – V (Hons)**

|  |  |
| --- | --- |
| Course Title | Endocrinology, Histology and Histochemistry Lab |
| Code | ZOODSC511P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

**Course Objectives**

1. Microtomy: Preparation of permanent H/E stained slide of any **one** (liver, heart, kidney, adrenal, thyroid, pancreas, Testis, Ovary, lung, salivary gland, stomach, small intestine, large intestine (bird/rat).

2. Study of permanent slides of Mammalian skin, Cartilage, Bone, Liver, Kidney, Heart, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid

3. Demonstration of Endocrine glands in rat.

4. Estimation of plasma level of any hormone using ELISA

5. Preparation of slide and staining mucopolysaccharides by PAS reaction

6. Preparation of slide and staining proteins by Mercurobromophenol blue/Fast Green

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| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the general idea of endocrine systems, including the classification of hormones and neurosecretions, as well as the characteristic features and modes of transport of hormones. Identify the fixatives, staining solutions, and techniques used for tissue preparation and decalcification. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the structure and functions of the epiphysis, hypothalamo-hypophysial axis, and peripheral endocrine glands, including the regulation of neuroendocrine glands and feedback mechanisms. comprehend the mechanisms of hormone action, including the role of receptors, and the hormonal regulation of reproductive cycles and parturition. Explain the principles of immunohistochemistry and its applications in identifying tissue-specific biomarkers. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of endocrinology concepts to analyze and interpret data from hormone assays using techniques like RIA and ELISA. Apply knowledge to explain the multifaceted roles of hormones such as vasopressin and oxytocin in various physiological processes. Use immunohistochemistry methods to analyze specific tissue components and disease markers | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the disorders associated with the pituitary gland and other peripheral endocrine glands, as well as the mechanisms underlying hormonal regulation of homeostasis and reproductive cycles. Critically evaluate the impact of hormonal dysregulation on human health. Evaluate the effects of decalcification and staining on tissue quality and diagnostic accuracy | PO 3,4 | PSO 3,4, | Ap,An |
| **CO – 5** | Evaluate the effectiveness of different assays used to measure hormone levels and assess the significance of hormonal regulation in maintaining physiological balance. Assess the role of hormones in coordinating complex processes like parturition. Formulate a comprehensive histological approach for studying and diagnosing diseases such as cancer | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Create hypotheses to explain hormonal regulation in specific physiological processes and design experiments to investigate the mechanisms of hormone action. Create educational materials or presentations to communicate complex endocrinology concepts to others. Assess the accuracy and effectiveness of staining techniques in the histological study of tissues | PO 6 | PSO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Hall JE. 2015. Guyton and Hall Textbook of Medical Physiology. 13th Edition. Saunders publication.

2. Ross MH, Pawlina W. 2010. Histology: A Text and Atlas. Sixth Edition. Lippincott Williams and Wilkins.

3. Norris DO, Carr JA. 2013. Vertebrate Endocrinology. 5 editions Academic Press.

**References:**

1. Fox T, Brooks A, Baidya B. 2015. Endocrinology. JP Medical, London.

2. Gardner DG, Shoback D. 2011. Greenspan’s Basic and Clinical Endocrinology. 9th Edn. McGraw Hill Lange.

3. Goodman HM. 2000. Basic Medical Endocrinology. 4th Edn. Academic Press.

4. Jameson JL. 2010. Harrison’s Endocrinology. 2nd Edn. McGraw Hill.

5. Melmed S, Conn PM. 2005. Endocrinology: Basic and Clinical Principles. 2nd Edn. Humana Press.

6. Melmed S, Polonsky K, Larsen PR, Kronenberg H. 2016. William’s Text Book of Endocrinology.13th Edn. Elsevier.

7. Molina PE. 2013. Endocrine Physiology. 4th Edn. McGraw Hill Lange.

8. Neal JM. 2000. Basic Endocrinology; An Interactive Approach. Blackwell Science.

9. Norris DO. 2007. Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press.

10. Strauss JF, Barbieri RL. 2014. Yen & Jaffe’s Reproductive Endocrinology. Elsevier Sounders

11. Cormack DH. 2003. PDQ Histology. B.C. Decker Ins., London

12. Gunasegaran JP. 2010. A Text book of Histology and a Practical Guide. Elsevie

13. Junqueria LC, Carneiro J. 2005. Basic histology text and atlas

Randall D, Burggren W. 2001. Eckert Animal Physiology by. 4th edition. W. H. Freeman

14. Eroschenko VP. 2008. diFiore’s Atlas of Histology with Functional correlations. XII Edition. Lippincott & Wilkins

**B.Sc. in Zoology 3rd year Semester – V (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Aquatic Biology |
| Code | ZOOCOR505T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

* Gain knowledge about diverse aquatic biomes, including freshwater and marine systems, their unique characteristics, and ecological significance.
* Develop an understanding of the physico-chemical properties of aquatic environments and their role in shaping biodiversity and ecological interactions.
* Explore adaptations of aquatic organisms to their habitats, with a special focus on hill-stream fishes, deep-sea organisms, and coral reef ecosystems.
* Understand the impacts of human activities on aquatic ecosystems, including pollution and eutrophication, and learn about legislative and practical measures for conservation and management.
* Acquire practical skills in water quality assessment and the evaluation of ecological health through measures such as BOD and COD.

Unit-1 Aquatic Biomes 10

Brief introduction to the aquatic biomes: Fresh water ecosystem(lakes, wetlands, streams and rivers),

estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs

Unit-2 Freshwater Biology 20

Lakes:Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen, Sulphur and Phosphorous).

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill- stream fishes.

Unit-3 Marine Biology 10

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs,

Sea weeds.

Unit-4 Management of Aquatic Resources 10

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment; Water quality assessment- BOD and

COD.

**B.Sc. in Zoology 3rd year Semester – V (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Aquatic Biology Lab |
| Code | ZOOCOR505P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of transparency, Dissolved Oxygen, and Free Carbon dioxide, in water collected from a nearby lake / water body.
4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
5. A Project Report on a Sewage treatment plant/Marine bio reserve/ Fisheries Institutes.

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| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Identify and recall the characteristics of various aquatic biomes and their ecological roles. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the physico-chemical factors influencing aquatic ecosystems and their effects on biodiversity. Describe and interpret the influence of physico-chemical factors on aquatic environments. | PO 2 | PSO 2 | Un |
| **CO – 3** | Demonstrate the ability to assess water quality parameters and evaluate ecological health using BOD and COD. Use knowledge to measure and analyze water quality and ecosystem health. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Examine the adaptations of aquatic organisms and determine their survival mechanisms in diverse habitats. Investigate and interpret the adaptive mechanisms of aquatic organisms. | PO 3,4 | PSO 3,4, | Ap,An |
| **CO – 5** | Critically assess the impacts of pollution on aquatic ecosystems and propose conservation strategies. Assess human-induced threats and recommend measures for ecosystem conservation. | PO 4,5 | PSO 4,5 | An, |
| **CO - 6** | Design and suggest innovative solutions for sustainable management of aquatic resources. Formulate comprehensive strategies for sustainable utilization and management of aquatic resources. | PO 6 | PSO 6 | An |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

Suggested Readings

1. Anathakrishnan : Bio resources Ecology 3rdEdition

2. Goldman : Limnology, 2ndEdition

3. Odum and Barrett : Fundamentals of Ecology, 5thEdition

4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition

5. Trivedi and Goyal : Chemical and biological methods for water pollution studies

1. Welch : Limnology Vols. I-II
2. Wetzel : Limnology, 3rdedition
3. Chaudhuri, S. (2017). Economic Zoology, New Central Book Agency

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Biostatistics and Taxonomy |
| Code | ZOODSC612T: DS-12 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

Students will be able to:

* Understand the fundamentals of biostatistics and its importance in biological research, including population and sample concepts, types of variables, and distributions.
* Apply statistical measures (mean, median, mode, variance, standard deviation) and tests (t-tests, chi-square, ANOVA) to analyze biological data and draw meaningful conclusions.
* Compare different distributions and evaluate statistical significance, including the understanding of Type I and Type II errors, as well as the differences between parametric and non-parametric tests.
* Identify patterns in biological data through correlation, linear regression, and more advanced regression methods.
* Explain the principles of basic taxonomy, classification systems, and their application in biological research, with emphasis on the importance of biochemical, morphological, and ecological characters.
* Understand the concept of species and the different species concepts (biological, evolutionary, and phylogenetic) used in taxonomy.
* Apply the type concept and the principles of the International Code of Zoological Nomenclature (ICZN) in classifying organisms, including the creation and interpretation of taxonomic keys.
* Construct phylogenetic trees and perform molecular taxonomy and barcoding, utilizing various tree-building methods like UPGMA and NJ, and understanding the concept of tree length and parsimony analysis.

**Unit 1: Introduction to Biostatistics 10 classes**

Importance of statistics in biological research. Basic idea of population and sample. Variation– continuous versus discrete. Types of variables. Frequency and frequency distribution. Introduction to some distributions with examples – Gaussian, Poisson and Binomial. Measures of central tendency – mean, median and mode. Measures of dispersion – variance, standard deviation and standard error. Skewness and kurtosis.

**Unit 2: Comparing distributions 8 classes**

Concept of significance testing and its purpose. Type I and Type II error. Concept of parametric versus non-parametric tests. One tailed versus two tailed tests. Testing for difference of means – Student’s t test. Testing for goodness of fit – Chi square. Analysis of variance (one way).

**Unit 3: Finding patterns 4 classes**

Correlation – Pearson’s coefficient (r). Linear regression. Basic concept of multiple regression and non-linear regression.

**Unit 4: Basic taxonomy 6 classes**

Definition and explanation: taxonomy, identification, systematics, classification. Different levels (alpha, beta and gamma taxonomy, micro and macrotaxonomy). Priory and posteriori weighting, artificial and natural classification. Properties of good classification, upward and downward classification, Biochemical compounds of taxonomic importance (sex pheromones, pigments, Animal toxins, secondary plant metabolites, pyrolysis product). Taxonomic characters and character states.

**Unit 5: Special characters 2 classes**

Strong selection pressure, environmental effects, molecular sequence characters, microcharacters, cryptic characters, animal artifacts, behavioural characters, morphological, structure of genitalia, physiological; metabolic; serological; biochemical; secretions and sterility factors; ecological: food, host, season and effects due to parasitism; ethological: territoriality, courtship, mating and such others; geographical: distribution related to geography and its inter-relationship; embryological: information of ancestral, some intermediary features or characters. SEM, TEM, Repetitive DNA, mtDNA and cpDNA, G+C and A+T ratio in taxonomy, transition and transversion.

**Unit 6: Species and species concept 4 classes**

Definition: species, taxon, phenon, taxonomic category, subspecies concept and types of

subspecies. Polytopic subspecies and superspecies. other infraspecific categories. Species concept: biological species concept and its limitations, evolutionary Species Concept, phylogenetic species concept.

**Unit 7: Type concept and ICZN 4 classes**

Type concept: Typification and Essential features of typification. Categories of type, special kinds of typification. ICZN: Principle of nomenclature, authorship, priority, synonymy and homonymy. Concept of Taxonomic Key (indented, dichotomous and pictorial).

**Unit 8: Phylogenetic reconstruction 7 classes**

Basic idea on molecular taxonomy and bar-coding. Basics of phenetics and cladistics. Understanding tree topologies: tree length, parsimony analysis. Construction of phylogenetic trees (distance method, UPGMA, NJ).

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

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| --- | --- |
| Course Title | Biostatistics and Taxonomy Lab |
| Code | ZOODSC612P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Arranging data and graphical representation of data – bar diagram, histogram, box plot and scatter plot (using MSExcel/LibreOffice/MySTAT or any other suitable freely available software).

2. Calculation of mean, median, mode, variance and standard deviation from a data set (previously arranged and displayed graphically) using MSExcel/LibreOffice/MySTAT/R or any other freely available software.

3. Performing t test on a data set (previously arranged and displayed graphically) using MySTAT/R or any other freely available software.

4. Performing correlation and linear regression on a data set (previously arranged and displayed graphically) using MySTAT/R or any other freely available software.

5. Study and identification of insect upto order using dichotomous key based on taxonomic characters.

7. Construction of phylegenetic tree from hypothetical data (distance method and UPGMA).

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| **CO No.** | **Course Outcomes** | **PO Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall key terms and concepts related to biostatistics, taxonomy, and phylogenetic reconstruction (e.g., population, sample, Gaussian distribution, biological species concept, taxonomic categories, phylogenetic tree construction, etc.). Identify and list common statistical distributions, tests, and methods in biological research. Recognize and define major species concepts and typification principles in taxonomy. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the importance of statistics in biological research and how different statistical distributions and tests are applied to biological data. Discuss various species concepts and their limitations, as well as the role of molecular data in taxonomy. Illustrate the process of constructing phylogenetic trees and understanding tree topologies. | PO 2 | PSO 2 | Un |
| **CO – 3** | Use statistical methods such as t-tests, ANOVA, and chi-square tests to analyze biological data. Apply correlation and regression analysis to identify patterns and relationships in biological data. Construct and interpret taxonomic keys, and apply species concepts to classify organisms. Utilize molecular taxonomy techniques and barcoding to aid in species identification and phylogenetic reconstruction. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Differentiate between parametric and non-parametric tests, as well as between one-tailed and two-tailed tests. Analyze patterns in biological data using correlation coefficients and regression models. Compare and contrast various species concepts and their applications in taxonomic classification. Evaluate different methods of phylogenetic tree construction, including UPGMA and NJ methods. | PO 3,4 | PSO 3,4, | Ap,An |
| **CO – 5** | Assess the validity and significance of statistical results, considering Type I and Type II errors, and the appropriateness of statistical tests for biological data. Critically evaluate different taxonomic characters (e.g., molecular, morphological, behavioral) and their use in classification. Evaluate the accuracy and utility of phylogenetic trees constructed using various methods, and discuss potential limitations in molecular barcoding. | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Design experiments using appropriate statistical methods to test hypotheses in biological research. Construct taxonomic keys for organism identification based on various characters. Create phylogenetic trees using phenetic and cladistic approaches, interpreting tree topology and length in the process. | PO 6 | PSO 6 | C |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Textbooks:**

1. Zar JH. Biostatistical Analysis. Prentice Hall/Pearson. 2014. 1. Arranging data and graphical representation of data – bar diagram, histogram, box plot and scatter plot (using MSExcel/LibreOffice/MySTAT or any other suitable freely available software).

2. Calculation of mean, median, mode, variance and standard deviation from a data set (previously arranged and displayed graphically) using MSExcel/LibreOffice/MySTAT/R or any other freely available software.

3. Performing t test on a data set (previously arranged and displayed graphically) using MySTAT/R or any other freely available software.

4. Performing correlation and linear regression on a data set (previously arranged and displayed graphically) using MySTAT/R or any other freely available software.

5. Study and identification of insect upto order using dichotomous key based on taxonomic characters.

7. Construction of phylegenetic tree from hypothetical data (distance method and UPGMA).

2. Van Emden HF. Statistics for terrified biologists. 2nd edition. Wiley Blackwell. 2019.

3. Dytham C. Choosing and using statistics: a biologist’s guide. 3rd edition. Wiley-Blackwell. 2011.

4. Theory And Practice Of Animal Taxonomy, 6th ed, Kapoor V C, Oxford and IBH Publishing, 2008 - 272 pages

5. Principles of Systematic Zoology. Ernst Mayr and Peter D Ashlock, 475 pages, Tabs, figs, Publisher: McGraw Hill

6. Principles and Techniques of Contemporary Taxonomy by Donald L. J. Quicke

Publisher ‏ : ‎ Kluwer Academic Publishers (1 July 1993), ISBN-10 ‏ : ‎ 075140019X, ISBN-13 ‏ : ‎ 978-0751400199

**References:**

1. Sokal RR & Rohlf J. Biometry. WH Freeman. 1995.

2. Le CT. Introductory Biostatistics. John Wiley & Sons Publication. 2003.

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Developmental Biology |
| Code | ZOODSC613T: DS-13 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Understand the general concept of developmental biology |
|  | * Understand and analyze the early embryonic development |
|  | * Understand, apply and analyze the late embryonic development |
|  | * Understand, apply and analyze the post embryonic development and regeneration |
|  | * Understand, summarize and apply the knowledge of developmental biology |

**Unit 1: Introduction 3 classes**

Basic concepts: Phases of Development; morphogenetic movements, Cell-cell interaction, Differentiation and growth; Differential gene expression

**Unit 2: Early Embryonic Development 14 classes**

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; (Amphibia and Fish)

Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula.Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

**Unit 3: Late Embryonic Development 6 classes**

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

**Unit 4: Post Embryonic Development 10 classes**

Development of brain and eye in Vertebrate Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each)

**Unit 5: Development in murine model 8 classes**

Early Mammalian Development; Cleavage in Mammals; Escape from the Zona Pellucida;

Gastrulation in Mammals; Mammalian Anterior-Posterior Axis Formation; The Dorsal-Ventral and Left-Right Axes in Mammals

**Unit 6: Implications of Developmental Biology 4 classes**

Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Developmental Biology Lab |
| Code | ZOODSC613P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)

2. Study of different sections of placenta (microphotographs/ slides)

3. Project report on Drosophila culture/chick embryo development

4. Zebrafish embryo as a model to study developmental biology/ Study of ovarioles and ootheca from cockroach.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall and understand the basic concepts of developmental biology, including the phases of development, cell-cell interactions, differentiation, growth, and differential gene expression. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the processes involved in early embryonic development, such as gametogenesis, fertilization, cleavage, blastula formation, and embryonic induction. Comprehend late embryonic development, including the fate of germ layers, extra-embryonic membranes, implantation, and placental structure and function. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of developmental biology concepts to analyze and interpret data related to embryonic development, fate maps, and modes of regeneration. Build knowledge to predict the effects of teratogenic agents on embryonic development and understand the implications of techniques such as in vitro fertilization and amniocentesis. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the patterns and mechanisms of early and late embryonic development, as well as the factors influencing developmental outcomes. Distinguish different modes of regeneration and assess the risks associated with teratogenic agents. | PO 4 | PSO 4 | An |
| **CO – 5** | Evaluate the ethical implications of developmental biology techniques such as in vitro fertilization and stem cell research. Assess the effectiveness of different methods for studying and manipulating embryonic development. | PO 3,4 | PSO 3,4 | An, E |
| **CO - 6** | Create hypotheses and design experiments to investigate specific aspects of embryonic development or regeneration. Propose strategies for preventing or mitigating the effects of teratogenic agents and discuss the potential applications of developmental biology research in various fields. | PO 6 | PSO 6 | An, E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece, Published by Pearson Copyright © 2017.

2. Developmental Biology by Gilbert, S. F. (2010), IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA

**References:**

1. Principles of Development by Wolpert and Beddington; OUP Oxford, 2nd Ed., 2001
2. Essential Developmental Biology by Slack JMW; 3rd Ed., Wiley

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Evolutionary Biology |
| Code | ZOODSC614T: DS-14 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Understand the general concept of evolutionary biology and origin of life |
|  | * Enumerate and analyze the timescale of evolution and fossil records. |
|  | * Explain the sources of variation |
|  | * Understand, apply and analyze the population genetics. |
|  | * Understand, interpret and summarize the origin and types of speciation and isolating mechanism. |
|  | * Interpret the concept of extinction and its effect on biodiversity |
|  | * Describe the origin of man |
|  | * Understand the basic concept of molecular phylogeny. |

**Unit 1: Origin of earliest life 4 classes**

Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes, three domains of life with special reference to LUCA hypothesis

**Unit 2: Historical review of evolutionary concept 5 classes**

Pre-Darwinian Concepts and theories including Lamarckism, Wallace and Darwin’s Theory

Neo-Darwinian Synthesis

**Unit 3: Evidences in favor of Evolution 4 classes**

Fossil records: types of fossils, geological time scale, transitional forms: examples of fossils depicting the evolutionary stages of the modern horses

Molecular (universality of genetic code and protein synthesis machinery) evidences

**Unit 4: Sources of variations 3 classes**

Heritable variations present in natural populations (classical study of Lewontin and Hubby, 1966 in Drosophila, as example)

**Unit 5: Evolutionary genetics: 12 classes**

Concept of Populations and calculation of allele frequencies in a population

Gene pool and calculation of allele frequencies in a population; Hardy-Weinberg Law and equilibrium (derivations, applications of law to find gene and genotype frequencies in human Populations)

Evolutionary forces disrupting H-W equilibrium-

Natural selection: Definition as the differential rate of reproductions and survivals of competing alleles, concept of fitness, selection coefficient, Types of natural selection with examples- Disrupting, Stabilizing, Directional.

Genetic Drift- outline of its mechanism, basic concepts and examples of founder’s effect, bottleneck phenomenon;

Role of Gene flow and Mutation rates in changing allele frequencies in a population (No mathematical models)

**Unit 6: Products of evolution 6 classes**

Inter-population variations: modes of speciation (just outlines of Allopatric, Sympatric and Parapatric speciation models with examples), Isolating mechanisms Adaptive radiations/ macroevolution as exemplified by Galapagos finches

**Unit 7: Geological time scale 2 classes**

Macro-evolution through Geological time scale; K-T extinction.

**Unit 8: Origin and evolution of man 4 classes**

Unique hominin characteristics contrasted with primate characteristics (including social and cultural ones), Primate phylogeny with reference to origin of man; Molecular evidences of human origin and migrations (brief outline)

**Unit 8: Molecular Phylogeny 5 classes**

The basic concept of molecular phylogeny, Neutral theory of molecular evolution, molecular clock (brief introduction), Example of evolution in vertebrate globin genes.

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Evolutionary Biology Lab |
| Code | ZOODSC614P |
| Course Type | Practical |
| Credits | 3 |
| Marks | 50 |

1. Study of fossils from models/ photographs; Archaeopteryx, horses.
2. Study of homology and analogy from suitable specimens (from Photographs/models)
3. Verification of Hardy-Weinberg equilibrium in a population by chi square analysis
4. Collection of a sample of height, weight, age, sex data from at least 100 individuals and applying of different statistical analyses (frequency distribution, mean, mode, standard deviations, correlations, etc) and graphical representations.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the theories and concepts related to the origin and evolution of life, including chemogeny, RNA world, biogeny, origin of photosynthesis, evolution of eukaryotes, and the three domains of life. Remember the historical development of evolutionary theory, including pre-Darwinian concepts, Darwinian theory, Neo-Darwinian synthesis, and anti-evolutionary ideas. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the evidence supporting the theory of evolution, including fossil records, molecular evidence, sources of variations, population genetics, and the mechanisms of natural selection, genetic drift, gene flow, and mutation. Comprehend the concepts of inter-population variations, species concepts, modes of speciation, adaptive radiations, and extinctions. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of evolution to analyze and interpret data related to fossil records, allele frequencies, Hardy-Weinberg equilibrium, natural selection, genetic drift, and speciation. Apply their knowledge to predict the outcomes of evolutionary processes and their impacts on biodiversity. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the mechanisms driving evolutionary change, including natural selection, genetic drift, gene flow, and mutation. Critically evaluate the evidence supporting evolutionary theory and assess the impact of extinction events on biodiversity. | PO 3,4 | PSO 3,4 | Ap, An |
| **CO – 5** | Evaluate the strengths and weaknesses of different theories and concepts related to the origin and evolution of life. Assess the implications of evolutionary processes on the diversity of life forms and ecosystems. | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Create hypotheses and design experiments to investigate specific aspects of evolution, such as speciation mechanisms or the role of genetic drift in population dynamics. Develop strategies for conservation and management based on evolutionary principles. | PO 6 | PSO 6 | Ap, An |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.

2. Evolution by Ridley,M. 3rd Ed.(2004) Blackwell publishing Or

3. Evolutionary Biology Douglas, J. Futuyma (1997); Sinauer Associates

**References:**

1. Evolution by Barton et al, 1st Ed. 2007 Cold Spring Harbor Lab Press
2. Why Evolution is True by Jerry Coyne; 2010, Penguin India
3. Strickberger’s Evolution by Hall and Halgrimmson; 5th Revised Ed., 2013, Jones and Bartlett

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Immunology |
| Code | ZOODSC615T:DS-15 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

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| --- |
| * Understand the basic concept of immune system |
| * Remember, understand and evaluate innate and adaptive immunity |
| * Remember, understand and analyze antigen presentation mechanism and structure and function of MHC |
| * Understand and evaluate T cell development |
| * Remember, understand and analyze the structure and function of immunoglobulins. |
| * Understand and analyze the mechanism of cytokines |
| * Understand and apply the basic concept of complement system and its mechanism. |
| * Evaluate the immunological cause of some diseases. |
| * Understand and apply the knowledge of types of vaccines and its mechanism of action. |

**Unit 1: Overview of Immune System 6 classes**

Historical perspective of Immunology, Organs (Primary & Secondary lymphoid organs and its importance) and Cells of the Immune system,

Concept of Haematopoiesis and development of progenitor cells of the Immune system (Brief idea)

**Unit 2: Innate and Adaptive Immunity 6 classes**

Principle of Innate .

* Components of innate immunity
* Epithelial barriers (skin and mucosal membranes [concept])
* Cellular mechanisms (phagocytes, NK cells, mast cells, eosinophils, inflammation [concept])
* Humoral mechanisms (complement, cytokines, chemokines etc. [concept])

Adaptive Immunity

* Components of adaptive immunity
* Cellular mechanisms (Cell-Mediated Immune System (CMIS) or Т- Cell Immunity [concept])
* Humoral mechanisms (Formation of Plasma В cells and Memory В cells [concept])

**Unit 3: Antigen, Antigen presentation & MHC 8 classes**

Concept of Antigen, Immunogen, Allergen & Pathogen.

Adjuvants and haptens, Factors influencing immunogenicity, Epitope. Types of Antigen Presenting Cells (APC),

Structure of Major Histocompatibility Complex (MHC) molecules.

Mechanism of antigen presentation and involvement of MHC molecules (both MHC-I & MHC-II) in details.

Co-stimulatory molecules on APC.

**Unit 4: T Cell development and differentiation 6 classes**

Structure of T cell receptors, Co-stimulatory molecules on T cells

Concept of synapse between APC & T cells (between MHC≈TCR & between Co- stimulatory molecules) in details.

Central differentiation of T cells; T cell selection in thymus Peripheral differentiation of T cells; Th1 & Th2

**Unit 5: Immunoglobulins 6 classes**

Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridoma technology, Monoclonal antibody production

**Unit 6: Complement System 2 classes**

Components and pathways of complement activation.

**Unit 7: Hypersensitivity 2 classes**

Gell and Coombs’ classification and brief description of various types of hypersensitivities.

**Unit 8: Immunology of diseases 6 classes**

Malaria, Visceral Leishmaniasis, Filariasis, Dengue and Tuberculosis

**Unit 9: Vaccines 3 classes**

Various types of vaccines. Active & passive immunization (artificial and natural).

**B.Sc. in Zoology 1st year Semester – VI (Hons)**

|  |  |
| --- | --- |
| Course Title | Immunology |
| Code | ZOODSC615P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Demonstration of lymphoid organs.

2. Histological study of spleen, thymus and lymph nodes through slides/ photographs

3. Macrophage isolation

(The experiments can be performed on white rats/ mice).

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| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the basic concepts of the immune system, including the organs and cells involved. Remember the principles of innate and adaptive immunity and their components. Recall the concepts of antigens, antigen presentation, major histocompatibility complex (MHC), T cell development, immunoglobulins, cytokines, chemokines, complement system, hypersensitivity, immunology of diseases, and vaccines. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the historical perspective of immunology and the principles of health and disease. Comprehend the structure and function of innate and adaptive immune system components, including epithelial barriers, phagocytes, T cells, B cells, antibodies, cytokines, and chemokines.  Understand the mechanisms of antigen presentation, T cell development, immunoglobulin structure and function, cytokine and chemokine actions, complement system activation, hypersensitivity reactions, and immunological responses to specific diseases. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of immune system components and functions to analyze and interpret immunological processes and responses. Apply understanding of antigen presentation, T cell development, antibody production, cytokine actions, and complement activation in the context of immune responses to diseases and vaccines. | PO 2,3 | PSO 2,3 | Un, Ap |
| **CO – 4** | Analyze the mechanisms of antigen recognition, T cell activation, antibody production, and immune cell interactions in the context of immune responses.  Compare the different types of hypersensitivity reactions and their underlying mechanisms. Categorize the immunological aspects of various diseases, including malaria, visceral leishmaniasis, filariasis, dengue, and tuberculosis, and the principles of vaccination in disease prevention. | PO 4 | PSO 3,4, | An |
| **CO – 5** | Evaluate the effectiveness of immune responses in combating diseases and preventing infections.  Justify the role of vaccines in providing immunity against various pathogens and their effectiveness in disease control.  Interpret the implications of hypersensitivity reactions and immunological dysfunctions in disease pathology. | PO 5 | PSO 4,5 | An, E |
| **CO - 6** | Create hypotheses or models to explain immunological processes and responses to diseases and vaccines. construct educational materials to raise awareness about the immune system, immunological diseases, and vaccination. | PO 6 | PSO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.

2. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication

**References:**

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
2. Abbas, K. Abul and Lechtman H. Andrew (2003.) Basic Immunology E-Book: Functions and Disorders of the Immune System; 2012 Saunders Publication

**B.Sc. in Zoology 2nd year Semester – VI (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Environment and Public Health |
| Code | ZOOCOR606T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

|  |  |
| --- | --- |
|  | * Understand the basic concept of environmental hazards and toxicity. |
|  | * Understand and explain the cause of climate change |
|  | * Remember, understand and evaluate innate and adaptive immunity |
|  | * Understand the causes, effects and remedies of different pollutions. |
|  | * Understand and evaluate different types of waste management technologies. |
|  | * Remember, understand and prepare list of causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis |

**Unit 1: Introduction**

Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Dose response evaluation, Exposure assessment

**Unit 2: Climate Change**

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

**Unit 3: Pollution**

Air, water, noise pollution sources and effects, Pollution control

**Unit 4: Waste Management Technologies**

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants.

**Unit 5: Diseases**

Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid, filariasis

**B.Sc. in Zoology 2nd year Semester – VI (DSC/GE)**

|  |  |
| --- | --- |
| Course Title | Environment and Public Health Lab |
| Code | ZOOCOR606P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. To determine pH, Cl, SO4, NO3 in soil and water samples from different locations.

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| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the sources of environmental hazards and their identification. Remember the fate of toxic and persistent substances in the environment. Recall the concepts of dose-response evaluation and exposure assessment in environmental health. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the mechanisms and effects of climate change, including greenhouse gases, global warming, acid rain, ozone layer destruction, and their impacts on public health. Comprehend the sources, effects, and control measures of air, water, and noise pollution. DEmonstrate the technologies and methods used in waste management, including sewage disposal, solid waste disposal, biomedical waste handling, nuclear waste handling, and thermal power plant waste management. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of environmental hazards and pollution sources to assess and mitigate environmental risks. Apply understanding of climate change and its effects to develop strategies for adaptation and mitigation.  Develop knowledge of pollution control measures and waste management technologies to address environmental challenges. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the causes, symptoms, and control measures of diseases associated with environmental factors, such as tuberculosis, asthma, cholera, Minamata disease, typhoid, and filariasis. Compare the impacts of environmental hazards and pollution on public health and ecosystems. categorize the effectiveness of different pollution control and waste management strategies in reducing environmental risks. | PO 3,4 | PSO 3,4 | An, Ap |
| **CO – 5** | Evaluate the effectiveness of policies and regulations in addressing environmental hazards and pollution and implications of climate change on public health and well-being. Assess the success of disease control measures and interventions in reducing the burden of environmentally-related diseases. | PO 5 | PSO | An |
| **CO - 6** | Create proposals for sustainable environmental management practices and policies. Develop educational materials to raise awareness about environmental hazards, pollution, and their impacts on health. Create action plans for addressing specific environmental health challenges, such as waste management and disease control. | PO 6 | PO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Suggested Readings**

1. Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.

2. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff “Risk Assessment and Management Handbook”, McGraw Hill Inc., New York, 1996.

3. Kofi Asante Duah “Risk Assessment in Environmental management”, John Wiley and sons, Singapore, 1998.

4. Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V. N. University Press, New York, 2003.

5. Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

6. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

**B.Sc. in Zoology 1st year Semester – VII (Hons)**

|  |  |
| --- | --- |
| Course Title | Entomology and Vector Biology |
| Code | ZOODSC716T: DS-16 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

* Identify and classify insects up to the order level, recognizing their key structural and functional adaptations, including flight, vision, and reproductive systems.
* Explain the hormonal regulation of insect metamorphosis and its significance in their life cycle and ecology.
* Analyze the economic and ecological importance of beneficial insects, such as honeybees, lac insects, and silk moths, along with their management and culture techniques.
* Evaluate the impact of insect pests on agriculture and the environment, and devise strategies for their management using chemical, biological, and integrated pest management (IPM) approaches.
* Understand the biology of insect vectors involved in transmitting major human diseases such as malaria, dengue, Japanese encephalitis, and leishmaniasis, including the roles of ticks and mites in disease transmission.
* Develop insights into the methods of vector control and the applications of forensic entomology in legal investigations.

**Unit 1: General Entomology 17 classes**

Classifications of Insects with salient identifying characters (till Order level)

Important insect structures and functions (flight, vision, reproductive structures and systems, digestive systems)

Insect metamorphosis with special reference to role of hormones.

**Unit 2: Applied Entomology 18 classes**

Economically Beneficial Insects and their cultures: Honey bees, Lac insect and Mulberry Silk Moths.

Insect Pests: Agricultural Pests (Rice, wheat, vegetable crops)

Insecticides: Chemical and Biological Controls, Insecticide resistance and mechanism of resistance, IPM (Integrated Pest Management)

**Unit 3: Medical Entomology 10 classes**

Vector Biology of *Plasmodium* sp, Japanese Encephalitis, Dengue, Leishmaniasis. Brief concept of Ticks and Mites and their role in disease propagation and allergy.

Methods of Vector Control

Forensic entomology

**B.Sc. in Zoology 1st year Semester – VII (Hons)**

|  |  |
| --- | --- |
| Course Title | Entomology and Vector Biology Lab/Field |
| Code | ZOODSC716P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Identification: honey bees, mosquitoes, sandfly, lac insect, silkworms

2. Collection and preservation of common invertebrates: soil microarthropods, insects from litter, garden, agricultural filed and household pests; whole mount slide preparation, insect set-pinning, dry and wet preservation.

3. Identification of pollen grains from corbicular pollen

4. Study of any crop pest- ecology, behaviour, life history strategies and control

5. Identification of different stages of Lac-insects and their host plants

6. Methods of insecticide application

7. Determination of LC50 and LD50

8. Study of the ecology, behaviours and life history strategies of major vector mosquitoes/sand flies

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Define the classifications and identifying characteristics of insect orders. List key insect structures and their functions, including flight, vision, reproduction, and digestion. Recall the roles of insect vectors in transmitting diseases like malaria, dengue, and leishmaniasis. | PO 1 | PSO 1 | R |
| **CO – 2** | Describe the hormonal regulation of insect metamorphosis and its ecological significance. Explain the economic importance of beneficial insects and their management techniques (apiculture, sericulture, lac culture). | PO 2 | PSO 2 | Un |
| **CO – 3** | Illustrate the lifecycle of insects with economic or medical significance, such as silk moths or disease vectors. Demonstrate the use of biological and chemical controls in pest management. Employ entomological techniques in the context of forensic investigations. | PO 2,3 | PSO 2,3 | Un, Ap |
| **CO – 4** | Differentiate between insect pest species affecting major crops like rice, wheat, and vegetables. Examine the mechanisms of insecticide resistance and its implications for pest management. Compare various methods of vector control for their effectiveness and limitations | PO 3,4 | PSO 3,4, | Ap, An |
| **CO – 5** | Assess the effectiveness of integrated pest management (IPM) strategies in agricultural contexts. Critique cultural practices in apiculture, sericulture, and lac culture for sustainability. Justify the choice of vector control methods based on specific medical or ecological conditions. | PO 5 | PSO 4,5 | An, E |
| **CO - 6** | Design an IPM plan tailored to specific crops and pest challenges. Propose new or improved techniques for beneficial insect cultures. Develop innovative approaches for vector control and forensic entomology applications. | PO 6 | PSO 6 | C |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Suggested Readings:**

1. Insects by R.F. Chapman

2. Agricultural pests of South-East Asia and their management – A.S Atwal &G.S. Dhallwal

3. An Introduction to Sericulture- by J Ganga; SulachanaChetty

4. Bees & Beekeeping in India by D.P. Abrol

5. Lac-culture in India- N. Ghorai, International Books and periodical supply service, New Delhi

6. Medical Entomology – A.K. Hati

7. Medical Entomology- Bruce F. Eldridge, John D. Edman, Kluwer Academic Publishers

**B.Sc. in Zoology 1st year Semester – VII (Hons)**

|  |  |
| --- | --- |
| Course Title | Biodiversity and Wildlife Conservation |
| Code | ZOODSC717T: DS-17 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

* Define the fundamental concepts and values of biodiversity, including its patterns, levels, and hotspots, while identifying key endangered species, particularly in West Bengal.
* Analyze the causes and consequences of biodiversity depletion and extinction, as well as evaluate the significance of gene banks, germplasm conservation, and the Red Data Book.
* Describe the forest types and wildlife habitats in India, especially in West Bengal, and demonstrate methods for habitat restoration, forest fire management, and the role of corridors in wildlife conservation.
* Apply population estimation techniques to assess population density, sex ratios, and fertility status in wildlife management.
* Evaluate wildlife conservation strategies, including traditional practices, legislative measures such as the Wildlife Protection Act, and international conventions like IUCN, CITES, and TRAFFIC.
* Develop management strategies for wildlife conservation, focusing on protected areas, including tiger reserves, and assess debates like SLOSS and concepts like carrying capacity and climax persistence.
* Examine human-wildlife conflicts, propose mitigation strategies, and assess the socio-economic impacts of wildlife/ecotourism, integrating traditional practices and participatory approaches like PBR.
* Summarize the structure, purpose, and challenges of protected areas, including sanctuaries, national parks, biosphere reserves, and community reserves, with special reference to tiger conservation efforts.

**Unit-1: Introduction to Biodiversity and Wildlife 5 classes**

Definition, levels, patterns/scales and values of Biodiversity; Concept of Biodiversity Hotspots; Causes of depletion of biodiversity in India. Definition and endangered animals of West Bengal.

**Unit 2: Evaluation and management of biodiversity 4 classes**

An overview of Climatic Zones and Biodiversity; Background and current rates of extinction; Extinction vortices; Red Data Book and its significance; Significance of gene banks and germplasm conservation

**Unit 3: Management of Forest Habitats 10 classes**

Major forest types of India and West Bengal; Forest cover estimation: remote sensing and GIS; Management of Successional wild habitats; Forest fire; Fragmentation and corridors; Restoration of degraded wild habitats (the above topics should be learnt mostly in reference to the protected areas in West Bengal); Joint forest management.

**Unit 4: Population estimation 3 classes**

Populations and population density estimations: different methods in practice; Sex Ratio computation and Fertility status

**Unit 5: Wildlife conservation practices in India 3 classes**

Traditional Conservation ethics and practices in India; Conservation strategies and Practices: Wildlife ProtectionActs, IUCN, CITES, TRAFFIC.Wildlife Conservation (in-situ and ex-situ conservation). Management strategies for tiger conservation.

**Unit 6: Management planning of wildlife in protected areas 5 classes**

Estimation of carrying capacity; Concept of climax persistence; Ecology of perturbance; Major wildlife diseases and their control; Single Large Or Several Small (SLOSS) Debate

**Unit 7: Man and Wildlife 5 classes**

Urban biodiversity; strays and feral populations; causes and consequences of human-wildlife conflicts and mitigation; traditional practices to overcome conflict, wildlife/Ecotourism advantages and disadvantages, concept of PBR.

**Unit 8: Protected areas 10 classes**

Wildlife Reserves, Biosphere Reserves, etc.; major wildlife areas in India (Sanctuaries, National Parks in view of conservation of Tiger and other Wildlife); Community reserve: concepts and examples; Management challenges in Tiger reserve

**B.Sc. in Zoology 1st year Semester – VII (Hons)**

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| --- | --- |
| Course Title | (Practical, 2 Credits = 30 classes) Biodiversity |
| Code | ZOODSC717P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Identification of common local flora, mammalian fauna, avian fauna, herpeto-fauna

2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Range Finders, Global Positioning System, Various types of Cameras and lenses)

3. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, antlers, etc.

4. Demonstration of different habitat-specific flora and fauna

5. Quadrat and other methods for ground cover assessment, Height-Girth relationships in trees, Canopy cover assessment in a patch of vegetations.

6. Trail / transect monitoring for abundance and diversity estimation of butterflies, mammals and birds; field recording of direct and indirect evidences)

7. Field trip for Biodiversity study

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Define biodiversity, its levels, patterns, and significance, including hotspots and endangered species of West Bengal. List the causes of biodiversity depletion and endangered species in India. Identify major wildlife areas, including sanctuaries, national parks, and biosphere reserves in India. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the significance of biodiversity conservation measures, including gene banks, germplasm conservation, and the Red Data Book. Describe the different forest types of India and West Bengal, their ecological importance, and methods for habitat restoration. Summarize traditional and legislative conservation practices like the Wildlife Protection Act, IUCN, and CITES. | PO 2 | PSO 2 | Un |
| **CO – 3** | Use population estimation methods to calculate population density, sex ratios, and fertility rates in wildlife populations. Apply forest cover estimation using tools like GIS and remote sensing. Implement management strategies for wildlife conservation in protected areas. | PO 2,3 | PSO 2,3 | Un, Ap |
| **CO – 4** | Differentiate between various extinction rates and extinction vortices affecting biodiversity. Compare in-situ and ex-situ conservation methods for endangered species. Examine causes and consequences of human-wildlife conflicts and propose mitigation strategies. | PO 3,4 | PSO 3,4, | Ap, An |
| **CO – 5** | Assess the effectiveness of forest management practices such as joint forest management and habitat restoration. Evaluate the advantages and disadvantages of wildlife/ecotourism in conservation. Critique the SLOSS debate and its application to protected area management. | PO 5 | PSO 4,5 | An, E |
| **CO - 6** | Design management plans for restoring degraded wild habitats using sustainable practices. Propose innovative solutions for managing urban biodiversity and mitigating human-wildlife conflicts. Develop strategies for managing tiger reserves, considering ecological and sociopolitical challenges. | PO 5 | PSO 5 | An |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management.Blackwell Science.

2. Conservation Biology: A Primer for South Asia by Kamaljit S. Bawa, Meera Anna Oommen, and Richard B. Primack, Atree and University Press

**References:**

1. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Coexistence?Cambridge University.

2. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.

3. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences

4. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

**B.Sc. in Zoology 2nd year Semester – VII (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Ecology and evolution |
| Code | ZOOHSM705T |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

**The students will able to**

* Identify the relations between the abundance and distribution of organisms in nature.
* Distinguish the variety of ways that organisms interact with both the physical and the biological environment.
* Analyze interactions within the context of specific habitats and judge how the habitat shapes the distribution and abundance of species.
* Relate various aspects of evolution.
* Understand the morphological, population genetic and molecular approaches of evolution.
* Develope evolutionary thinking, and be able to analyse, compare and explain evolutionary trends.

**Unit 1: Introduction to Ecology 4 classes**

History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of Physical factors, biomes.

**Unit 2: Ecosystem 8 classes**

Food chains, Food web, Ecological pyramids, Energy flow through the ecosystem, Ecological efficiencies, Biogeochemical cycles (Nitrogen cycle and water cycle), Human modified ecosystem.

**Unit 3: Applied Ecology 5 classes**

Introduction to Indian ecosystems (outline idea of mangrove, desert, wetland, montane);

Concept of Ramsar site; Ramsar sites of India; Ecosystem services with special reference to wetlands.

Sustainable environment; SDG goals; Outline ideas and objective of Indian Environmental Laws.

**Unit 4: Origin of earliest life 4 classes**

Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes, three domains of life with special reference to LUCA hypothesis

**Unit 5: Historical review of evolutionary concept 5 classes**

Pre-Darwinian Concepts and theories including Lamarckism, Wallace and Darwin’s Theory

**Unit 9: Origin and evolution of man 4 classes**

Unique hominin characteristics contrasted with primate characteristics (including social and cultural ones), Primate phylogeny with reference to origin of man; Molecular evidences of human origin and migrations (brief outline)

Neo-Darwinian Synthesis

**Unit 6: Evidences in favor of Evolution 4 classes**

Fossil records: types of fossils, geological time scale, transitional forms: examples of fossils depicting the evolutionary stages of the modern horses

Molecular (universality of genetic code and protein synthesis machinery) evidences

**B.Sc. in Zoology 2nd year Semester – VII (DSE/GE)**

|  |  |
| --- | --- |
| Course Title | Ecology and evolution Lab |
| Code | ZOOHSM705P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Determination of population density of a natural/hypothetical population. Study of species diversity of a community by quadrat or any other suitable sampling method and calculation of diversity indices.

2. Study of an aquatic ecosystem: Sampling of zooplankton, Measurements of temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler’s method), free CO2.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Remember the fundamental concepts of ecology, ecosystems, and evolutionary biology, including laws of limiting factors, biogeochemical cycles, and pre-Darwinian theories. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the relationships between ecological processes, ecosystem services, and evolutionary mechanisms like RNA world, LUCA hypothesis, and Neo-Darwinian synthesis. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply knowledge of ecological and evolutionary principles to explain human-modified ecosystems, sustainable development goals (SDGs), and Indian ecosystems (e.g., wetlands, mangroves). | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze fossil records, transitional forms, and molecular evidence to trace the evolution of life, including the origin and evolution of modern humans. | PO 3,4 | PSO 3,4, | Ap, An |
| **CO – 5** | Evaluate the impact of ecological and evolutionary theories (e.g., Darwinism) and evidence (e.g., molecular, fossil records) in understanding biological diversity and environmental challenges. | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Develop logical arguments, models, or solutions based on ecological efficiencies and evolutionary evidence to address sustainability and conservation issues. | PO 4,5 | PSO 4,5 | An |

**Text Books:**

1. Ecology: Theories and Applications by Peter Stiling; Pearson 4th Ed. 2001.
2. Ecology: The Experimental Analysis of Distribution and Abundance (Indian Paperback edition) by Charles Krebs
3. Ecology: Principles and Applications by J. L. Chapman, ‎M. J. Reiss • 1999. Cambridge University Press
4. Townsend C and Michael Begon. (2008). Essentials of Ecology. Blackwell.
5. Campbell’s Biology, 11th Edition by Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Jane B. Reece , Published by Pearson Copyright © 2017.
6. Evolution by Ridley,M. 3rd Ed.(2004) Blackwell publishing Or
7. Evolutionary Biology Douglas, J. Futuyma (1997); Sinauer Associates

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

|  |  |
| --- | --- |
| Course Title | Research Methodology & Scientific Writing |
| Code | ZOODSC818T: DS-18 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

* Describe the origins and objectives of the scientific method, the various types of research, and the steps involved in conducting research, illustrated through case studies of major scientific discoveries.
* Identify research problems, construct hypotheses, and design studies, including experimental and sampling frameworks, while conducting thorough literature reviews to develop comprehensive research plans.
* Apply appropriate methods for data collection, sampling, processing, and analysis, ensuring meaningful interpretation of research findings.
* Demonstrate effective scientific communication skills by preparing research papers, review articles, research proposals, and presentations (oral, poster, and popular science).
* Analyze ethical considerations in research, including study design, data collection, plagiarism, intellectual property rights, and authorship, while adhering to standards set by ethics and biosafety committees.

**Unit 1: Foundations of research 8 classes**

Origins of the scientific method. Meaning and objectives of research. Summary of steps involved in research. Case studies of at least 2 major scientific discoveries. Types of research: analytical versus descriptive, qualitative versus quantitative, basic versus applied.

**Unit 2: Process of research 12 classes**

Problem identification. Observation and facts. Prediction and explanation. Identifying variables. Constructing a hypothesis. Hypothesis testing. Study design, determining experimental and sampling designs. Literature review. Developing a research plan with timeline.

**Unit 3: Data collection and analysis 8 classes**

Selecting a data collection method. Sampling and sampling methods. Processing and displaying collected data. Overview of data analysis. Interpreting analysed data.

**Unit 4: Scientific writing 12 classes**

Standard practices followed in writing a research paper and review article. Covering letter and responding to referee’s comments. Publishing in reputed journals and avoiding predatory journals. Writing a research proposal. Oral presentation, poster presentation. Writing a popular science article.

**Unit 5: Research ethics 5 classes**

Ethical issues in study design and data collection from human subjects and animal experimentation/sampling (Animal Ethics Committee, Human Ethics Committee, Biosafety Committee). Plagiarism and infringement of intellectual property. Collaboration agreement and authorship agreement. Bias underlying scientific thinking.

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

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| --- | --- |
| Course Title | Research Methodology & Scientific Writing Lab |
| Code | ZOODSC818P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Performing literature review using Google Scholar, Google and Researchgate with emphasis on combination of search key words.

2. Reference management using any standard reference management and citation software like Mendeley, EndNote, etc.

3. Exercise on designing a study –how to proceed to find the answer to a given research question (students can be divided into groups and a separate question given to each group).

4. Learning about plagiarism checking, language correction using any freely available software.

5. Project on writing a review article or writing a research proposal or giving an oral presentation.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the origins and principles of the scientific method and various types of research. Outline the steps in the research process, from problem identification to hypothesis testing. Recognize ethical committees and their responsibilities in human and animal research. | PO 1 | PSO 1 | R |
| **CO – 2** | Interpret the objectives and importance of research methodologies in scientific discovery. Illustrate the components of study design, sampling techniques, and data collection methods. Paraphrase ethical considerations, including plagiarism, intellectual property, and authorship agreements. | PO 2 | PSO 2 | Un |
| **CO – 3** | Select suitable sampling and data collection methods for research projects. Develop structured hypotheses and comprehensive research plans, including timelines. Compose scientific documents such as research papers, proposals, and presentations. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Compare different types of research, such as analytical vs. descriptive or qualitative vs. quantitative. Investigate the relationships between variables to generate valid hypotheses. Interpret research data using statistical and analytical techniques | PO 3,4 | PSO 3,4, | Ap, An |
| **CO – 5** | Validate the authenticity and credibility of journals to avoid predatory practices. Appraise the ethical considerations in study designs, particularly in human and animal research. Critically examine the biases that affect scientific thinking and reasoning. | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Formulate innovative research proposals that include robust methodologies and ethical safeguards. Produce high-quality research papers, review articles, and effective presentations. Design strategies to resolve ethical challenges and improve collaboration in scientific endeavors. | PO 4,5 | PSO 4,5 | An,E |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Textbooks:**

1. Research Methodology: A Step By Step Guide For Beginners by Ranjit Kumar, 5thedition, 2019. Sage Publications.
2. Research Methodology: From Philosophy Of Science To Research Design, by Alexander M. Novikov and Dmitry A. Novikov. 2013. CRC Press.
3. Managing Science: Methodology And Organization Of Research, by Frederick Betz. 2010. Springer.
4. Mastering Scientific And Medical Writing – A Self Help Guide, by Silvia M. Rogers. 2007. Springer.
5. A Scientific Approach to Scientific Writing, by John Blackwell and Jan Martin. 2011. Springer.

**References:**

Students are encouraged to explore authentic websites (e.g. Wikipedia, different university websites and OCWs) at internet for reading materials on a particular topic if they do not find enough in the text books or otherwise.

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

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| --- | --- |
| Course Title | Toxicology & Cancer Biology |
| Code | ZOODSC819T: DS-19 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

* Understand the fundamental principles of toxicology, including dose-response relationships, toxicokinetics, and toxicodynamics, as well as the absorption, distribution, metabolism, and excretion of xenobiotics.
* Identify various toxic agents, such as heavy metals, pesticides, and pollutants, and their associated health effects.
* Explain the molecular and cellular basis of cancer biology, encompassing oncogenes, tumor suppressor genes, cell cycle regulation, apoptosis, and the processes involved in carcinogenesis.
* Describe the mechanisms of tumor development, including angiogenesis, cell migration, invasion, and metastasis, and classify cancers based on their characteristics and stages.
* Apply foundational knowledge of toxicology and cancer biology to analyze the interactions of toxicants with biological targets and evaluate their implications for human health and disease.

**Unit 1: Basics of Toxicology 22 classes**

General principles of Toxicology: Dose-Response relationships, characteristics of exposure to toxic agents

The absorption, distribution, metabolism and excretion of Xenobiotics: Toxicokinetics (Introductory level)

Interaction of toxicants with their target site: Toxicodynamics (Introductory level)

A brief introduction to various toxic agents and their health effects such as heavy metals, pesticides, pollutants.

**Unit 2: Cancer Biology 23 classes**

Cytology of Cancer cells. Fundamental concepts in the molecular biology of cancer, including oncogenes, tumor suppressor genes, cell cycle and cell cycle check points, cell proliferation and apoptosis

Nature of Cancer: Multistage carcinogenesis, classification of cancer.

Introducing key cellular mechanisms and processes that underlie cancer development, growth and spread: Basic knowledge of tumor angiogenesis, cell migration, invasion and metastasis.

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

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| --- | --- |
| Course Title | Toxicology & Cancer Biology Lab |
| Code | ZOODSC819P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Measurement of serum biochemical markers of hepatotoxicity (ALT, AST, ALP) in murine/piscine models.

2. Measurement of oxidative stress: Assessment of Lipid peroxidation in different organs of murine/piscine system.

3. Identifying the differences between normal and cancer cells (from slides)

4. Identification of nuclear anomalies in piscine peripheral blood smear in response to toxicant exposure

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Define the fundamental principles of toxicology, including dose-response relationships and toxicokinetics. List types of toxic agents, such as heavy metals, pesticides, and pollutants, and their health effects. Identify key cellular and molecular features of cancer, including oncogenes, tumor suppressor genes, and carcinogenesis stages. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the processes of absorption, distribution, metabolism, and excretion of xenobiotics. Describe the interaction between toxicants and biological targets (toxicodynamics). Summarize cellular mechanisms such as tumor angiogenesis, cell migration, invasion, and metastasis. | PO 2 | PSO 2 | Un |
| **CO – 3** | Use toxicological concepts to analyze the effects of exposure to harmful agents. Construct diagrams illustrating cell cycle regulation and checkpoints in cancer cells. Demonstrate knowledge of cancer development processes, including multistage carcinogenesis. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Differentiate between toxicokinetics and toxicodynamics in the context of xenobiotic interactions. Examine the role of oncogenes and tumor suppressor genes in cancer development. Investigate the relationships among cell migration, invasion, and metastasis in cancer progression. | PO 3,4 | PSO 3,4, | Ap, An |
| **CO – 5** | Assess the risks of exposure to toxic agents and their implications for human health. Judge the effectiveness of cellular processes such as apoptosis and cell cycle regulation in preventing cancer. Critique the stages of cancer progression to identify potential therapeutic targets. | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Construct conceptual models to illustrate how toxicants interact with biological targets and affect cellular functions. Formulate simplified frameworks to explain key cancer mechanisms, including tumor angiogenesis and metastasis. Devise innovative strategies to mitigate the adverse health effects of toxic agents and to prevent cancer development. | PO 4,5 | PSO 4,5 | Ap, An |

**Text and Reference Books:**

1. Casarett & Doull's Toxicology: The Basic Science of Poisons, 9th Edition, McGraw Hill

2. The Biology of Cancer, Author: Robert Allan Weinberg, Edition 2, Garland Science, 2014

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

|  |  |
| --- | --- |
| Course Title | Fish and Fishery |
| Code | ZOODSC820T: DS-20 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objectives**

The student will be able to

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|  | * Understand the general description and classification of fish. |
|  | * Understand and analyze the morphology and physiology of fish. |
|  | * Explain and categorize various type of fisheries and their future prospects. |
|  | * Understand, apply and analyze the population genetics. |
|  | * Understand, interpret and summarize the methods of aquaculture. |
|  | * Interpret the concept of fish research using biotechnologies. |

**Unit 1: Introduction and Classification 4 classes**

General description of fish

Feeding habit, habitat and manner of reproduction with special reference to Indian species

Classification of Indian fishes (up to Subclasses) with important examples

**Unit 2: Morphology and Physiology 10 classes**

Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Electric organ, Bioluminescence

**Unit 3: Fisheries 6 classes**

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and gears; Depletion of fishery

resources; Application of remote sensing and GIS in fisheries; Fisheries laws and regulations

**Unit 4: Aquaculture 10 classes**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of fin fish hatcheries; Preparation and maintenance of fish aquarium; Ornamental fish. Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products.

**Unit 5: Fish in research 5 classes**

Transgenic fish, Zebra fish as a model organism in research

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

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| --- | --- |
| Course Title | Fish and Fishery Lab |
| Code | ZOODSC820P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Morphometric and meristic characters of fishes in relation to identifications of species (with locally cultured non-indigenous fishes)

2. Study of external salient features in *Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas* (all from photographs)

3. Study of different types of scales (through permanent slides/ photographs).

4. Study of crafts and gears used in Fisheries

5. Water quality criteria for Aquaculture: assessment of pH, conductivity, total solids, total dissolved solids

6. Study of air breathing organs in *Channa, Heteropneustes, Anabas and Clarias*

7. Project Report on a visit to any fish farm/ pisciculture unit/Zebra fish rearing Lab.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall and describe the general characteristics of fish, including their feeding habits, habitats, and reproductive strategies. Remember the classification of fish up to subclasses and important examples within each subclass. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the morphology and physiology of fish, including the types of fins, locomotion, scales, gills, swim bladder, osmoregulation, reproductive strategies, and specialized organs such as electric organs and bioluminescence. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of fisheries to analyze the environmental factors influencing seasonal variations in fish catches, fishing crafts and gears, depletion of fishery resources, and the application of remote sensing and GIS in fisheries management. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the different methods and techniques used in aquaculture, including extensive, semi-intensive, and intensive culture of fish, pen and cage culture, polyculture, brood stock management, induced breeding, and management of fish hatcheries. Analyze the role of water quality in aquaculture and the preservation and processing of harvested fish. | PO 3,4 | PSO 3,4 | Ap, An |
| **CO – 5** | Evaluate the sustainability of aquaculture practices and assess the impacts of fish diseases on aquaculture production. Assess the ethical implications of using transgenic fish and zebrafish as model organisms in research. | PO 4,5 | PSO 4,5 | An, E |
| **CO - 6** | Create plans and strategies for sustainable aquaculture practices, including the selection of appropriate culture methods and management techniques. Propose research projects to investigate specific aspects of fish biology, aquaculture, or fisheries management. | PO 6 | PSO 6 | C |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Book:**

1. Q. Bone and R. Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.

**References:**

1. D. H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press,
2. von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
3. C.B.L. Srivastava, Fish Biology, Narendra Publishing House
4. J.R. Norman, A history of Fishes, Hill and Wang Publishers
5. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House
6. Chaudhuri, S. (2017), Economic Zoology. New Central Book Agency

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

|  |  |
| --- | --- |
| Course Title | Parasitology |
| Code | ZOODSC821T: DS-21 |
| Course Type | Theory |
| Credits | 3 |
| Marks | 50 |

**Course Objective:**

The student will be able to

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|  | * Understand the general concepts of parasitology |
|  | * Understand and recall the Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of parasitic protists. |
|  | * Understand and recall the Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of parasitic platihelminthes. |
|  | * Understand and recall the Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of parasitic nematodes. |
|  | * Understand and recall the Biology, importance and control of parasitic arthropods. |
|  | * Understand a brief account of parasitic vertebrates. |

**Unit 1: Introduction to Parasitology 4 classes**

Brief introduction of Parasitism and other animal associations, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship and zoonosis

**Unit 2: Parasitic Protists 12 classes**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis and Prophylaxis of *Trypanosoma gambiense, Plasmodum falciparum, Leishmania donovani and Toxoplasma gondii*

**Unit 3: Parasitic Platyhelminthes 12 classes**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis and Prophylaxis of *Paragonimus westermani, Schistosoma haematobium, Echinococcus granulosus and Hymenolepis nana*

**Unit 4: Parasitic Nematodes 12 classes**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis and Prophylaxis of *Ancylostoma duodenale* and *Trichinella spiralis*. Study of structure, life cycle and importance of *Meloidogyne* (root knot nematode), *Pratylencus* (lesion nematode)

**Unit 4: Parasitic Arthropoda 3 classes**

Mosquitoes and flies as vectors of human pathogen biology, importance and control of myiasis causing Diptera. Biology, importance and control of ticks, mites, *Pediculus humanus* (head and body louse), *Xenopsylla cheopis* and *Cimex lectularius*.

**Unit 6: Parasitic Vertebrates 2 classes**

A brief account of parasitic vertebrates; Cookiecutter Shark, Candiru, Hood Mockingbird and Vampire bat

**B.Sc. in Zoology 1st year Semester – VIII (Hons)**

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| --- | --- |
| Course Title | Parasitology Lab |
| Code | ZOODSC821P |
| Course Type | Practical |
| Credits | 2 |
| Marks | 50 |

1. Study of *Entamoeba histolytica, Giardia intestinalis, Trypanosoma gambiense, Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs
2. Study of *Fasciola hepatica, Schistosoma haematobium, Taenia solium* and *Hymenolepis nana* through permanent slides/micro photographs
3. Study of *Ascaris lumbricoides, Ancylostoma duodenale, Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/micro photographs.
4. Study of plant parasitic root knot nematode, *Meloidogyne* from the soil sample through permanent slides/ photographs
5. Study of Pediculus humanus (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs
6. Study of *Monogenea* from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
7. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a byproduct]

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the basic concepts of parasitology, including the definitions of parasitism, parasites, parasitoids, and vectors. Remember the characteristics of host-parasite relationships and understand the concept of zoonosis. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the morphology, life cycles, prevalence, epidemiology, pathogenicity, diagnosis, prophylaxis, and treatment of various parasitic organisms, including protists, platyhelminthes, nematodes, arthropods, and vertebrates. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of parasitology concepts to analyze and interpret data related to the prevalence and epidemiology of parasitic infections. Apply their knowledge to diagnose and treat parasitic diseases and implement preventive measures. | PO 2,3 | PSO 2,3 | Un, Ap |
| **CO – 4** | Analyze the morphological and biological characteristics of parasitic organisms and evaluate their importance in human and animal health. Critically assess the methods used for diagnosis, treatment, and control of parasitic infections. | PO 3,4 | PSO 3,4 | Ap,An |
| **CO – 5** | Evaluate the effectiveness of different control measures for parasitic diseases, including prophylaxis, treatment, and vector control. Evaluate the impact of parasitic infections on public health and the environment. | PO 5 | PSO 5 | E |
| **CO - 6** | Create plans and strategies for the prevention and control of parasitic diseases, including the development of diagnostic methods, treatment protocols, and public health interventions. Propose research projects to investigate specific aspects of parasitic organisms and their interactions with hosts. | PO 6 | PSO 6 | An, E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Book:**

1. Chatterjee K.D. (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd

**References:**

1. Bose, M.(2017). Parasitoses and Zoonoses. New Central Book Agency(P) Ltd
2. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
3. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
4. Noble, E.R. and Noble G.A. (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger
5. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
6. Rattan Lal, Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

**SKILL ENHANCEMENT COURSE**

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| --- | --- |
| Course Title | Aquarium Fish Keeping |
| Code | ZOOHSE101M : SE-1 |
| Credits | 3 |
| Marks | 25 |

**Course Objectives:**

The student will be able to

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|  | * Evaluate the potential scope of Aquarium Fish Industry and apply knowledge on Exotic and Endemic species of Aquarium Fishes, and problems of releasing aquarium fishes into natural habitats. |
|  | * Identify Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish |
|  | * Apply different methods to transport fish seed |
|  | * Apply knowledge and create new steps for maintenance of aquarium in the lab |

**Unit 1: Introduction to Aquarium Fish Keeping**

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes , problems of releasing aquarium fishes into natural habitats.

**Unit 2: Biology of Aquarium Fishes**

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

**Unit 3: Food and feeding of Aquarium fishes**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

**Unit 4: Fish Transportation**

Live fish transport - Fish handling, packing and forwarding techniques.

**Unit 5: Maintenance of Aquarium**

General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the potential scope of the aquarium fish industry as a cottage industry, including the diversity of exotic and endemic species used in aquariums. Remember the problems associated with releasing aquarium fishes into natural habitats. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the biology of common freshwater and marine aquarium fishes, including their common characteristics, sexual dimorphism, and behavior. Comprehend the importance of proper food and feeding practices for aquarium fishes. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of aquarium fish biology to select appropriate live and formulated fish feeds and to implement proper fish handling, packing, and forwarding techniques for live fish transport. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the potential challenges and considerations involved in maintaining an aquarium, including general maintenance tasks and budgeting for setting up an aquarium fish farm as a cottage industry. | PO 3,4 | PSO 3,4 | Ap,An |
| **CO - 5** | Evaluate the effectiveness of different feeding strategies and maintenance practices in ensuring the health and well-being of aquarium fishes. Assess the economic feasibility and sustainability of establishing an aquarium fish farm as a cottage industry. | PO 5 | PSO 5 | E |
| **CO - 6** | Create plans and strategies for the maintenance and operation of an aquarium fish farm, including budgeting, feeding protocols, and transportation logistics. Propose solutions to mitigate the negative impacts of releasing aquarium fishes into natural habitats. | PO 6 | PSO 6 | E |

R- Remember; Un- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Reference books:**

1. Aquarium : Fish Keeping C B L Srivastava Published by Kitab Mahal
2. Marine Aquarium (Fish: Keeping and Breeding Them in Captivity) Boruchowitz, Davie. Published by Chelsea House Publications (1998)
3. Aquarium Setting Up (Fish: Keeping and Breeding Them in Captivity) Axelrod, Herbert R. Published by Chelsea House Publications (1998)
4. The Tropical Freshwater Aquarium Problem Solver: Practical and Expert Advice on Keeping Fish and Plants Sand ford, Gina Published by Voyageur Press (MN) (1998)
5. Aquariums: The Complete Guide to Freshwater and Saltwater Aquariums, Jan 2009 by Thierry Maitre-alain (Author), Chrisitan Piednoir (Author)

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| Course Title | VERMICOMPOST PRODUCTION |
| Code | ZOOGSE 02M |
| Credits | 3 |
| Marks | 25 |

**Course Objectives:**

The student will be able to

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|  | * Evaluate the scope of and importance of vermicompost production |
|  | * Develop a method to produce vermicompost |
|  | * Demonstrate the usefulness of vermicompost in agriculture |

**Unit 1 4 classes**

Natural role of earthworms in soil fertility

**Unit 2 4 classes**

Concept of Vermicompost- the need for it

**Unit 3 6 classes**

Productions: Suitable worm species and their availability – for Large scale/small scale, Climate and Temperature

**Unit 4 4 classes**

Feedstock – for small scale or home farming / large scale or commercial

**Unit 5 8 classes**

Operations and maintenance: Smells; Moisture; Pest species; Worms escaping; Nutrient levels

**Unit 6 4 classes**

Harvesting

**Unit 7 5 classes**

Properties of the vermicompost

**Unit 8 4 classes**

Benefits of vermicompost

**Unit 9 4 classes**

Use as soil conditioner

**Unit 10 2 classes**

Applications

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the natural role of earthworms in soil fertility and the concept of vermicompost, including its need in agriculture and gardening. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the production process of vermicompost, including the selection of suitable worm species, climate and temperature considerations, and feedstock requirements for different scales of production. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of vermicompost production to operate and maintain vermicomposting systems effectively, addressing issues such as smells, moisture levels, pest control, and nutrient management. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the harvesting process of vermicompost and evaluate the properties of the produced vermicompost, including its nutrient content and physical characteristics. | PO 2,3 | PSO 2,3 | Ap, An |
| **CO – 5** | Evaluate the benefits of vermicompost, including its role as a soil conditioner and its applications in agriculture, gardening, and environmental sustainability. | PO 4,5 | PO 4,5 | An, E |
| **CO - 6** | Create plans and strategies for the use and application of vermicompost in various contexts, considering its effectiveness in improving soil health and plant growth. Design for optimizing vermicompost production and utilization based on their analysis and evaluation. | PO 6 | PO 6 | C |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text books and Reference:**

1. The Complete Technology Book on Vermiculture and Vermicompost by NPCS Board of Consultants and Engineers; Asia Pacific Business Press, 2004
2. Vermicompost production training in 24 Parganas- North: http://www.swanirvar.in/help.php
3. Audio-visual training material: https://www.google.co.in/search?rlz=1C1CHZL\_enIN766IN766&ei=2Kz2Wr6yDoPIvgTLw6aYDQ &q=vermicompost+preparation&oq=vermicompost&gs\_l=psy- ab.1.0.0i71k1l8.0.0.0.8499.0.0.0.0.0.0.0.0..0.0....0...1c..64.psy- ab..0.0.0.0.RNrPR98LJOg#kpvalbx=1
4. https://www.youtube.com/watch?v=sQKI0Y7fj24
5. https://www.youtube.com/watch?v=oGf7Oe7oP4Y
6. <http://www.ivri.nic.in/services/vermi.aspx>

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| Course Title | Poultry Farming |
| Code | ZOOHSE1/2/301M : SE-1 |
| Credits | 3 |
| Marks | 25 |

**Course Objectives:**

The student will be able to

* Distinguish the various aspects of poultry farming feasible in India.
* Design both large and small scale poutry farming coupled with the various varieties of poultry framings.
* Develope both academic and application aspects of this industry.

**Unit 1: Indian Poultry Industry 6 classes**

Overview   
Importance and Trends  
Poultry Farming in India  
Poultry Development Programmes in India

**Unit 2: Types of Poultry Farms 6 classes**

Various Types of Poultry Farms  
Rural Backyard Poultry Farming  
  
**Unit 3: Small Scale and Commercial Broiler Farming for meat 3 classes**

**Unit 4: Small Scale and Commercial Layer Farming for eggs 6 classes**

**Unit 5: Duck and Quail Farming 6 classes**

Duck Farming for Eggs and Meat  
Quail Farming for Eggs and Meat

**Unit 6: Poultry Breeds and Breeding 6 classes**

Breeds, Varieties and Strains of Poultry  
Systems of Poultry Breeding  
  
**Unit 7: Culling and Judging of Poultry 6 classes**

Culling of Birds for Profitable Poultry Farming  
Judging of Poultry for Better Performance

**Unit 8: Poultry diseases and their management 6 classes**

Symptoms, treatment, prevention and control of: Ranikhet disease, avian influenza, fowl cholera, fowl typhoid, Pullorum disease, chronic respiratory disease, gangrenous dermatitis. Significance of deworming and controlling ectoparasites.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the key concepts of poultry farming, including different types of poultry farms, breeds, and prevalent diseases. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the importance of the Indian poultry industry and its contribution to economic growth, as well as trends in poultry farming. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply and relate their knowledge of poultry management techniques to small-scale and commercial farming systems for broilers, layers, ducks, and quails. | PO 2,3 | PSO 3 | Ap |
| **CO – 4** | Analyze the performance of poultry through effective culling and judging practices to improve productivity and profitability. | PO 2,3 | PSO 2,3 | Ap, An |
| **CO – 5** | Evaluate and judge poultry health management strategies by identifying symptoms, proposing prevention methods, and controlling diseases like Ranikhet disease and avian influenza. | PO 4,5 | PO 4,5 | An, E |
| **CO - 6** | Design effective poultry farming plans that incorporate modern breeding systems, disease control methods, and developmental programs to ensure sustainable production. | PO 6 | PO 6 | E |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books and references:**

1. The Beginner’s Guide to Raising Chickens: How to Raise a Happy Backyard Flock by Anne Kuo; Rockridge Press (7 September 2021)
2. The Chicken Health Handbook, 2nd Edition: A Complete Guide to Maximizing Flock Health and Dealing with Diseaseby Gail Damerow
3. The Small-Scale Poultry Flock: An All-Natural Approach to Raising Chickens and Other Fowl for Home and Market Growers by Harvey Ussery
4. Storey’s Guide to Raising Poultry, 4th Edition: Chickens, Turkeys, Ducks, Geese, Guineas, Game Birds by Glenn Drowns
5. <https://egyankosh.ac.in/bitstream/123456789/59739/1/Poultry%20development%20programmes%20in%20india.pdf>
6. <https://www.dahd.nic.in/related-links/central-poultry-development-organization>
7. <https://egyankosh.ac.in/bitstream/123456789/59745/1/Various%20types%20of%20poultry%20farms.pdf>

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| --- | --- |
| Course Title | Apiculture |
| Code | ZOOHSE303M : SE- 2 |
| Credits | 3 |
| Marks | 25 |

**Course Objectives:**

The student will be able to

* Analyze the significance of apiculture as an economically viable enterprise in India.
* Understand about different species of honey bees, their biology and role in pollination.
* Interprets the techniques of honey bee rearing.
* Uunderstand the significance of apiculture in diversification of agriculture for rural communities to increase their income.
* Demonstrate create employment opportunities and develop skills for self-employment as a bee keeper.

**Unit 1:** **Biology of Bees 8 classes**

Historical background of apiculture.

Classification and biology of honey bees.

Social organization of the bee colony, behavioral patterns: bee dance, swarming.

**Unit 2: Rearing of Bees 11 classes**

Artificial bee rearing in apiary, beehives – Newton and Langstroth, beekeeping equipment, bee pasturage, identification of queen cells, drone cells, brood cells, pollen cells and honey cells.

Selection of bee species for apiculture – *Apis cerana, Apis mellifera*.

Methods of extraction and processing of honey (indigenous and modern).

Apiary management - honey flow period and lean period, effect of pollutants on bees.

**Unit 3:** **Diseases and Enemies 9 classes**

Diseases of honey bees: protozoan, bacterial and viral (one each) – symptoms, nature of damage and control, mite infestation and its control.

Enemies of bees and their control: predatory insects and non-insects.

**Unit 4: Bee Economy 9 classes**

Products of apiculture – honey, bees wax, propolis, royal jelly, pollen and their uses.

Modern methods in using artificial bee hives for cross pollination in horticulture and agriculture – stationary and migratory beekeeping.

**Unit 5: Entrepreneurship in Apiculture 8 classes**

Bee keeping industry – recent advancements, employment opportunities.

Economics of small and large scale beekeeping, scope of women entrepreneurs in bee keeping sector.

Development programs and organizations involved in bee keeping in India.

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the historical background, classification, and biology of honey bees, including their social organization and behavior patterns. | PO 1 | PSO 1 | R |
| **CO – 2** | Explain the process of artificial bee rearing, types of beehives, apiary management practices, and the influence of environmental factors on bee colonies. | PO 2 | PSO 2 | Un |
| **CO – 3** | Demonstrate effective methods for disease identification, pest control, and the extraction and processing of honey and other bee products. | PO 2,3 | PSO 3 | Ap |
| **CO – 4** | Examine the causes and impacts of diseases and enemies of bees to formulate appropriate strategies for maintaining healthy colonies. | PO 2,3 | PSO 2,3 | Ap, An |
| **CO – 5** | Assess the economic significance of apiculture, incorporating modern approaches like cross-pollination and migratory beekeeping to improve agricultural productivity. | PO 4,5 | PO 4,5 | An, E |
| **CO - 6** | Design viable business models for small and large-scale beekeeping, identifying entrepreneurial prospects, particularly for women, and leveraging advancements in the apiculture industry. | PO 6 | PO 6 | E |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

**Text Books:**

1. Jaiswal AG (2019) Practical handbook of apiculture. Laxmi Book Publication.
2. Conrad R (2007) Natural beekeeping – organic approaches to modern apiculture. Chelsea Geeen Publishing.
3. Singh S (1962). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
4. Mishra RC (1995) Honey bees and their management in India. Indian Council of Agricultural Research, New Delhi.
5. Prost PJ (1962) Apiculture. Oxford & IBH, New Delhi.
6. Rahman A (2017) Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
7. Gupta JK (2016) Apiculture. Indian Council of Agricultural Research, New Delhi.

**Life science as MDC**

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| Course Title | MDC ZOOLOGY |
| Code | - |
| Credits | - |
| Marks | - |

**Course Objectives:**

The student will be able to

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|  | * Evaluate the scope of and importance of infectious disease |
|  | * Evaluate the importance of ecosystem and biodiversity |
|  | * Demonstrate the usefulness of wetland and environment saving movements |

**MDC Zoology Class**

1. Vector borne infectious diseases

2. Climatic change and impact on biodiversity

3. Degradation of Wetland ecosystem and biodiversity

4. Major Indian ecosystems

5. Environmental movements in India

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| **CO No.** | **Course Outcomes** | **PO**  **Addressed** | **PSOs Addressed** | **Cognitive level** |
| **CO – 1** | Recall the name of the vectors and their role in spreading infectious diseases. | PO 1 | PSO 1 | R |
| **CO – 2** | Understand the reason of climatic changes and their impacts. | PO 2 | PSO 2 | Un |
| **CO – 3** | Apply their understanding of climate change for amelioration and sustainability. | PO 3 | PSO 3 | Ap |
| **CO – 4** | Analyze the causes of wetland degradation and its impact on environment | PO 2,3 | PSO 2,3 | Ap, An |
| **CO – 5** | Evaluate the benefits of major Indian ecosystem | PO 4,5 | PO 4,5 | An, E |
| **CO - 6** | Create plans and strategies to save the environment. | PO 6 | PO 6 | C |

R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create