CENTRE FOR DISTANCE AND ONLINE EDUCATION
BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI - 620 024.

M.Sc. ZOOLOGY: CHOICE BASED CREDIT SYSTEM - LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2026-27 onwards)

Sem.	Courses	Title	Credit	Exams Hrs	Marks		Total
						Ext	
I	Core Course I (CC)	Structure and Function of Invertebrates	5	3	25	75	100
	Core Course II (CC)	Comparative Anatomy of Vertebrates	5	3	25	75	100
	Core Course III (CC)	Endocrinology	5	3	25	75	100
	Core Practical I (CP)	Structure and Function of Invertebrates and Comparative Anatomy of Vertebrates	4	3	40	60	100
	Elective Course I (EC)	Entomology	3	3	25	75	100
	Total		**22**	-	-	-	**500**
II	Core Course IV (CC)	Developmental Biology	5	3	25	75	100
	Core Course V (CC)	Cell and Molecular Biology	5	3	25	75	100
	Core Course VI (CC)	Research Methodology and Techniques in biology	5	3	25	75	100
	Core Practical II (CP)	Developmental Biology and Cell and Molecular Biology	4	3	40	60	100
	Elective Course II (EC)	Aquaculture	3	3	25	75	100
	Non-Major Elective Course I		2	3	25	75	100
	Total		**24**	-	-	-	**600**

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

Sl. No.	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	Core Courses	11	55	1100
2.	Core Practicals	3	12	300
3.	Elective Courses	3	9	300
4.	Project	1	10	100
5.	Non-Major Elective Courses	2	4	200
	Total	**20**	**90**	**2000**

PROGRAMME OBJECTIVE:

The students will be able to:

- Demonstrate (i) advanced and systematic knowledge in field of biological sciences, specifically in the domain of animal system, and inter disciplinary subjects; (ii) qualified to pursue their career in research and development, teaching, and government and public service; (iii) technical skills in specialized areas to face the challenges in current developments in the field of biological sciences.
- Hone higher order thinking skills required for identifying and relating problems and issues in Life Sciences.
- Integrate knowledge in across the biological science discipline and incorporate into the existing conceptual frame work.
- Communicate effectively in multiple forms, including oral, written and electronic format.
- Meet one's own learning needs, drawing on a range of current research and development work and professional materials.
- Able to design conceptual models and explain the advantage/ disadvantage to address the biological questions.
- Apply the process of science in evidence-based, formal observation with critical thinking and testing with experimentations.
- Demonstrate subject-related and transferable skills that are relevant to Life Sciences related job trades and employment opportunities.
- Able to work precisely in future careers in agriculture, biotechnology, health sciences, environmental management, teaching, and research.
- Able to apply the principles of physical/ chemical sciences and other related disciplines to test hypothesis in biological sciences.
- Apply their knowledge in global perspectives in an ethical manner to sustainable environment/ development in human society.

PROGRAMME OUTCOME:

At the successful completion of programme, the students will be able to:

- Understand inter-disciplinary subjects and their wide range of applicability in research.
- Demonstrate integrative thinking ability to apply critically and analyse to solve biological problems.
- Describe the characteristics of major taxa, differences/similarities in their anatomical, physiological characteristics, and adaptation to their habitat.
- Demonstrate comprehensive knowledge in across the discipline at varying scales from Ecosystem to Molecules (diversity-evolution-structure and function-information exchange/flow – pathways and transformations of signals/energy).
- Apply the scientific methods to design and conduct biological research.
- Demonstrate knowledge and application of broad-based concepts in an interdisciplinary framework in unifying them in biology.
- Describe the safety procedures of handling the instruments, chemicals, microorganism, body fluids and other biological samples.
- Become eligible eventual employment in teaching and/or research positions in academia, industry, government, or non-profit agencies.

*****

First Year **CORE COURSE I** **Semester I**

STRUCTURE AND FUNCTION OF INVERTEBRATES

(Theory)

COURSE OBJECTIVES:

- To familiarize with the basis of the taxonomic classification of species.
- To make them relate to the diverse physiology of invertebrates.
- To provide the importance to understand the larval form of invertebrates.
- To signify the role of minor phyla and its significance.
- To impart the significance of organization and evolution of coelom with examples.

UNIT – I TAXONOMY:

Principles of taxonomy -general characteristics and classification of animal Kingdom, taxonomy. International Code of Zoological Nomenclature (ICZN). New trends in taxonomy -animal collection- Molecular taxonomy and application of bioinformatics tools - handling and preservation.

UNIT – II LOCOMOTION, NUTRITION AND DIGESTION:

Pseudopodia - flagella and ciliary movement in Protozoa - hydrostatic movement in Coelenterata, Annelida and Echinodermata. Nutrition and digestion - patterns of feeding and digestion in lower metazoan - filter feeding in Polychaetes, Mollusca and Echinodermata.

UNIT – III RESPIRATION, EXCRETION AND OSMOREGULATION:

Organs of respiration - gills - trachea and lungs. Respiratory pigments - mechanism of respiration. Excretion - organs of excretion - Malphigian tubules - mechanisms of excretion - osmoregulation in aquatic fishes.

UNIT – IV NERVOUS SYSTEM AND EVOLUTION:

Primitive nervous system - Coelenterata and Echinodermata -advanced nervous system - Annelida - Arthropoda (Class - Crustacea and Insecta) and Mollusca (Class - Cephalopoda). Evolution of nervous system in Invertebrates

UNIT – V INVERTEBRATE LARVAE AND MINOR PHYLA:

Larval forms of free-living Invertebrates -larval forms of parasites. Minor phyla - organization - general characters and structural features -Rotifera -Ectoprocta - Endoprocta and Phoronida.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Advanced detecting tools- acoustic and vibration sensing - hyperspectral imaging systems-Dohron scenario of Invertebrates-water expulsion vesicles in Protozoa –

Protostomia-Deuterostomia. Biologically inspired learning as a model for intelligent robot control and sensing technology.

REFERENCES:

1. Ayyar. E.M. (1966). A Manual of Zoology Part I, Invertebrata, S. Viswanathan Pvt. Ltd., Chennai.
2. Harzsch, S., Purschke, G. and Schmidt-Rhaesa, A. (2015). Structure and Evolution of Invertebrate Nervous Systems. United Kingdom: OUP Oxford.
3. Serge N. Vinogradov, and Oscar H. Kapp. (2011). Structure and Function of Invertebrate Oxygen Carriers. United States: Springer New York.
4. Calow, P. (2012). Invertebrate Biology: A Functional Approach. United States: Springer, US.
5. Pechenik, J. A. (2005). Biology of the Invertebrates. United Kingdom: McGraw-Hill, Higher Education.
6. Moore, J. (2006). An Introduction to the Invertebrates: Cambridge University Press.
7. Edgecombe, G. D. and Giribet, G. (2020). The Invertebrate Tree of Life. United Kingdom: Princeton University Press.
8. DeSalle, R. and Schierwater, B. (2021). Invertebrate Zoology: A Tree of Life Approach. United States: CRC Press.
9. Bhate, A. and Puranik, P. (2007). Animal Forms and Functions: Invertebrata. India: Sarup& Sons.
10. Borradaile, L. A. (2016). The Invertebrata: A Manual for the Use of Students (Classic Reprint). United States: Fb&c Limited.
11. Ehrlich, H. (2019). Marine Biological Materials of Invertebrate Origin. Germany: Springer International Publishing.
12. Barnes, R.D. (1963), Invertebrate Zoology. (III edition). W.B. Saunders Co., Philadelphia.
13. Barrington, E.J.W, (1972), Invertebrate Structure and Function. Thomas Nelson and Sons Ltd., London.
14. Hyman, L.H. (1923), The invertebrates. (Vol.I). Protozoa through Ctenophora, McGraw Hill Co., New York.
15. Hyman, L.H. (1951), The Invertebrates. (Vol. II). McGraw Hill Co., New York.
16. Hyman, L.H(1940). The Invertebrates. (Vol. VIII). McGraw Hill Co., New York and London.
17. Hyman, L.H (1959). The Invertebrate Smaller Coelomate Groups. (Vol.V). McGraw Hill Co., New York.
18. Kotpal. (1990). Minor Phyla. Rastogi Publication, Meerut.
19. Russel-Hunter, W.D. (1969). A biology of Higher Invertebrates. Macmillan Co. Ltd., London.
20. Read, C.P (1972). Animal Parasitism. Prentice Hall Inc., New Jersey.
21. https://www.uou.ac.in/sites/default/files/slm/MSCZO-501.pdf
22. https://www.pdfdrive.com/biosystematics-structure-and-functions-of-invertebrates-e34328227.html
23. http://assets.vmou.ac.in/MZO01.pdf
24. https://adventisteducationbydesign.com/wp-content/themes/bydesign/assets/downloads/sample_lessons/student_editions/KH_BD1_SEG7_U1C2_Lesson_1_sample.pdf
25. https://pdflife.one/download/4660813-biology-form-and-function-in-invertebrates-answers

26. https://www.researchgate.net/profile/Huajian-Liu-3/publication/307529800_A_review_of_recent_sensing_technologies_to_detect_invertebrates_on_crops/links/5c0faab1299bf139c7509a61/A-review-of-recent-sensing-technologies-to-detect-invertebrates-on-crops.pdf
27. https://www.google.com/search?q=trends+in+neural+evolution+in+invertebrates&biw=1252&bih=589&sxsrf=ALiCzsb8PT14ZOnDinR-tY-VmnwhmG-TbQ%3A1655720292131&ei=ZEmwYrjZB5ubseMPjNqE-AE&oq=Trends+in+neural+evolution&gs_lcp=Cgdnd3Mtd2l6EAEYADIKCAAQgAQQhwIQFDIFCAAQgAQyBQgAEIAEMgUIABCABDIFCAAQgAQyBggAEB4QFjoHCAAQRxCwA0oECEEYAEoECEYYAFC4BFi4BGDMGmgBcAF4AIABwgSIAcIEkgEDNS0xmAEAoAECoAEByAEIwAEB&sclient=gws-wiz
28. https://infinitylearn.com/surge/biology/difference-between-protostomes-and-deuterostomes/
29. https://www.researchgate.net/publication/11355321_Robots_in_invertebrate_neuroscience

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Classify the animal species based on the characteristic features.
- Identify the behavior pattern of various invertebrates.
- Explain the similarities and differences in the morphology of organs in a functional view.
- Describe and signify the role of larval forms of invertebrates in the ecosystem.
- Understand the concept of regulation among species.

*****

First Year **CORE COURSE II** **Semester I**

COMPARATIVE ANATOMY OF VERTEBRATES

(Theory)

COURSE OBJECTIVES:

- To incorporate the comparative morphology and functional anatomy of vertebrates.
- To make them understand the role of organs and their regulation in secretion during feeding and stimulation in sensory response.
- To compare studies about circulation and respiration in vertebrate animals.
- To study the sense organs and nervous systems of vertebrates.
- To know about the skeletal system and urinogenital system of vertebrates.

UNIT – I PROTOCHORDATES AND CHORDATES:

General characters - classification of Protochordata.Origin of chordates -nature of vertebrate morphology - scope and relation to other disciplines - importance of vertebrate morphology.

UNIT – II INTEGUMENTARY SYSTEM AND DIGESTIVE SYSTEM:

Integumentary system - derivatives of integument - development - structure - function -skin and its derivatives, - glands -scales - feathers and hairs - Digestive system - comparative account of digestive system- feeding habits- herbivores - carnivores - omnivores.

UNIT – III CIRCULATORY SYSTEM AND RESPIRATORY SYSTEM:

Circulatory system of vertebrates – Human heart- blood - evolution of heart - evolution of aortic arches. Respiratory system - comparative account on respiratory organs – gills in fishes - skin, gills and lungs in amphibians - air sacs in birds – lungs in mammals.

UNIT – IV NERVOUS SYSTEM AND SENSORY ORGANS:

Nervous system - comparative anatomy of brain of Fish,Frog , Calotes ,Pigeon and Rat. Anatomy of spinal cord –nerves – cranial -peripheral and autonomous nervous system. Sensory organs - organs of vision and gustatory.

UNIT – V SKELETAL SYSTEM AND URINOGENITAL SYSTEM:

Skeletal system –form - function - body size -skeletal elements of body - comparative account of jaw suspension - vertebral column - girdles and limbs. Urinogenital system - evolution of urinogenital system (nephron) in vertebrate groups.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Vertebrate fossils - Palaeospondylus -long-standing mystery of vertebrate evolution-Lamprey as a simple vertebrate evolutionary model –Physostomous – Physoclistous. Odorant receptors - Tas1r-expressing taste cells and taste attraction-Tas2r-expressing taste cells and avoidance.

REFERENCES:

1. Ayyar. E.M. and Anantha Krishnan T.N. (1995). Manual of Zoology Vol.II, Part I & II. (Chordata), S. Viswanathan Pvt. Ltd.,
2. Kriska, G., Zboray, G., Kovács, Z., Palfia, Z. and Molnr, K. (2011). Atlas of Comparative Sectional Anatomy of 6 Invertebrates and 5 Vertebrates. Austria: Springer Vienna.
3. Harris, R. J. and Mcmillan, D. (2018). An Atlas of Comparative Vertebrate Histology. Netherlands: Elsevier Science.
4. Webster, D. and Webster, M. (2013). Comparative Vertebrate Morphology. United States: Elsevier Science.
5. Lombardi, J. (2012). Comparative Vertebrate Reproduction. United States: Springer US.
6. Satoh, N. (2016). Chordate Origins and Evolution: The Molecular Evolutionary Road to Vertebrates. Netherlands: Elsevier Science.
7. Wise, J., Fowler, S. and Roush, R. (2018). Concepts of Biology. Hong Kong: Samurai Media Limited.
8. Mathur, V. and Pandey, B. N. (2018). Biology of Chordates. India: PHI Learning Pvt.Ltd..
9. Linzey, D. W. (2020). Vertebrate Biology: Systematics, Taxonomy, Natural History, and Conservation. United States: Johns Hopkins University Press.
10. Jameson, E. W. (2012). Patterns of Vertebrate Biology. United States: Springer New York.
11. Alexander, R.M. (1975). The Chordata. Cambridge University Press, London.
12. Carter, G.S. (1967). Structure and habit in vertebrate evolution. Sedgwick and Jackson, London.
13. Kingsley, J.S. (1926). Outlines of Comparative Anatomy of Vertebrates. Central Book Depot, Allahabad.
14. Malcom Jollie. (1962). Chordata Morphology. East-West Press Pvt. Ltd., New Delhi.
15. Millton Hilderbrand. (1988). Analysis of Vertebrate Structure. (IV Edition). John Wiley and Sons Inc., New York.
16. McNeill Alexander, R. (1981). The Chordates. Cambridge University Press, London
17. Smith, H.S. (1960). Evolution of Chordate Structure. Hold Rinehart and Winstoin Inc., NewYork
18. Tansley, K. (1965). Vision in Vertebrate. Chapman and Hall Ltd., London
19. Torrey, T.W. (1991). Morphogenesis of Vertebrates. (V Edition), John Wiley and Sons Inc.,New York, London
20. Walters, H.E. and Sayles, L.D. (1902). Biology of vertebrates. Macmillan & Co., New York.
21. Wolstenholnf, E.W. and Knight, J. (1970). Taste and Smell in vertebrates. J&A Churchill, London.

22. Weichert, C.K. and Presch, W. (1975). Elements of Chordate Anatomy. (IV Edition), McGraw Hall Books Co., New York.
23. Montagna, W. (1959). Comparative anatomy. John Wiley and Sons Inc.
24. Kotpal, R.L. (2019). Modern Text Book of Zoology (V Edition) – Vertebrata. Rastogi and Company, Meerut, India.
25. https://www.syllabusfinder.com/university-of-toronto/eeb266-introduction-to-animal-biodiversity---invertebrates-fall-2014 (Toronto University, Canada)
26. https://fas.calendar.utoronto.ca/course/eeb266h1 (Toronto University, Canada).
27. https://www.syllabusfinder.com/university-of-toronto/eeb263-comparative-vertebrate-anatomy-fall-2014 (Toronto University, Canada)
28. https://www.syllabusfinder.com/static/syllabus/EEB263-Comparative-Vertebrate-Anatomy-Fall-2014.pdf(Toronto University, Canada)
29. https://www.eurekalert.org/news-releases/953666
30. http://ppup.ac.in/download/econtent/pdf/JNL%20College%20(%20Medhavi%20Sudarshan%20for%20Zoology%20B.Sc%20Part%20II%20Paper%20IV)%20Topic-Comparative%20anatomy%20of%20Resperitory%20system%20different%20Vertebrates.pdf
31. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3594521/

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the morphology and functional anatomy of chordates.
- Relate the comparative anatomy of vertebrate integument and digestive system according to their habit and habitat.
- Analyze the integration of physiology of circulation and respiration in Vertebrates.
- Compare the distinct organ structure of vision, hearing, olfaction, taste, etc.,
- Gain detailed knowledge about the complexity of the skeletal and urinogenital systems in vertebrates.

*****

First Year **CORE COURSE III** **Semester I**

ENDOCRINOLOGY

(Theory)

COURSE OBJECTIVES:

- To highlight the role of hormones and their classification.
- To provide a thorough knowledge of endocrine glands and their neurosecretion.
- To provide the chemical structure of peptide and steroid hormones.
- To understand hormonal action and its regulation.
- To enrich knowledge and applications of hormones in therapy.

UNIT – I INTRODUCTION TO ENDOCRINOLOGY:

Scope of endocrinology - hormones as chemical messengers – classification – feedback mechanism – hypothalamus – neuroendocrine system in Insects. Hormonal control of reproduction –metamorphosis and moulting–pheromones.

UNIT – II ENDOCRINE ORGANS:

Structural organization – biosynthesis of hormones -targeted organs – functions – abnormalities of thyroid , parathyroid , pancreas , adrenal ,testis and ovary. Role of hormones in sexual cycle – menopause – pregnancy - parturition – lactation – role of prostaglandins.

Unit – III STRUCTURE OF PROTEIN AND STEROID HORMONES:

Purification and characterization of hormones – structure – functional relationship. Phylogenic analysis of hormonal structure and function. Biosynthesis of hormones . Transcriptional and post transcriptional mechanisms of hormone biosynthesis and secretion.

UNIT – IV HORMONAL EFFECTS AND ACTIONS:

Mechanisms of hormone action and signal attenuation – signal discrimination, signal transduction and amplification. Hormone – receptor interactions - receptor antagonists and their applications. Metabolism of hormones by target and non-target tissues and their hormones.

UNIT – V HORMONES AS THERAPEUTIC AGENTS:

Production of hormonal contraceptives – recombinant protein hormones – applications in regulation of fertility in farm animals and humans – Hormones Replacement Therapy (HRT) -genetic engineering for commercial production of insulin.Hormone Assays- Follicle Stimulating Hormone (FSH)- Thyroid stimulating Hormone (TSH).

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Unraveling mechanisms of hormones and sex chromosomes in DNA damage-novel tools for treating Late-Onset Hypogonadism (LOH) syndrome-Wnt/β-Catenin pathway in uterine leiomyoma- mechanistic target of the rapamycin (mTOR) signaling in healthy physiology and disease – emerging endocrine disrupting chemicals.

REFERENCES:

1. Peery, H., Holt, E. H., Lupsa, B., Lee, G. S. and Bassyouni, H. (2021). Goodman's Basic Medical Endocrinology. Netherlands: Elsevier Science.
2. Lohar.P.S., (2019). Endocrinology: Hormones and Human Health. United States. MJP Publisher.
3. Norris, D. O.and Carr, J. A. (2020).Vertebrate.Endocrinology. Netherlands: E lsevier Science.
4. Rumsby, G. and Farrow, S. M. (2020). Molecular Endocrinology: Genetic Analysis of Hormones and Their Receptors. Netherlands: CRC Press.
5. Mehra, P., Khardori, R. and Bansal, D. D. (2017). Introductory Endocrinology: A Concise and Applied Digest. India: Jaypee Brothers Medical Publishers Pvt. Limited.
6. Levine, J. E. and Hadley, M. E. (2007). Endocrinology. United Kingdom: Pearson Prentice Hall.
7. Litwack, G. (2022). Hormones. (IV Edition) United Kingdom: Elsevier Science.
8. Frieden, E. (2012). Chemical Endocrinology. United Kingdom: Elsevier Science.
9. Westphal, U. (2012). Steroid-Protein Interactions. Three Island Press.
10. Rossmanith, W. G. and Kleine, B. (2019). Hormones and the Endocrine System: Textbook of Endocrinology. Springer International Publishing.
11. Sherif, K. (2013). Hormone Therapy: A Clinical Handbook. United States: Springer New York.
12. Keenan, E. J. and Thomas, J. A. (2012). Principles of Endocrine Pharmacology. Germany: Springer US.
13. Haris, G.W. and B.T. Donovan. (1968). The Pituitary Gland. S. Chand and Co.,
14. Bentley, P.J. (1985). Comparative Vertebrate Endocrinology. (II Edition). Cambridge University Press. Cambridge.
15. Hadley. M. (1992), Endocrinology. (III Edition), Prentice – Hall Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey. USA.
16. Ingleton, P.M. and J.T. Bangara (1986). Fundamentals of Comparative vertebrate endocrinology. Kluwer Academic Publishers.
17. Turner, C.D. and Bangara, J. T.(1986).General Endocrinology. Saunders international student edition. Toppan Company Limited. Tokyo.
18. Barrington, E.J.W. (1985). An Introduction to General and Comparative Endocrinology. Claredon Press Oxford.
19. Freedman L.P. (1998). Molecular Biology of Steroid and Nuclear Hormone Receptors. Birkhauses, Boston, USA
20. Litwack, G. (1985). Biochemical action of Hormones. Academic Press, New York, USA.

21. Mishell, D., Yen, S., Jaffe, R., & Barbieri, R. (1999). Reproductive Endocrinology, Physiology, Pathophysiology, and Clinical Management. Saunders Publisher, USA.
22. http://www.aace.com
23. https://www.classcentral.com/course/swayam-endocrinology-19855
24. https://academic.oup.com/endo/article/162/12/bqab213/6383446?searchresult=1
25. https://academic.oup.com/endo/article-
26. abstract/162/12/bqab202/6373541?redirectedFrom=fulltext
27. https://academic.oup.com/endo/article-
28. abstract/162/12/bqab211/6382454?redirectedFrom=fulltext
29. https://academic.oup.com/endo/article/163/6/bqac041/6562776
30. https://www.nature.com/articles/s41598-022-13489-3

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Understand the basics and scope of endocrinology.
- Know the structure and functions of endocrine glands and their regulation.
- Comprehend the structural and functional roles of hormones in signal transduction.
- Learn the importance of receptor sites and hormonal actions.
- Get deep knowledge of hormones in reproduction and its assisted techniques.

*****

First Year **CORE PRACTICAL I** **Semester I**

STRUCTURE AND FUNCTION OF INVERTEBRATES AND COMPARATIVE ANATOMY OF VERTEBRATES (Practical)

COURSE OBJECTIVES:

- To impart practical knowledge on the functional aspects of a different system of invertebrates.
- To comprehend the internal organ system of invertebrates.
- To enrich the knowledge of the invertebrate evolution and types of the coelom.
- To highlight various species and their affinities with other phyla and provides an idea on methods of preservation of specimens.
- To relate the comparative study of digestive, nervous, and reproductive systems of vertebrates.
- To reflect the organization of the brain of fish and other vertebrate animals.

STRUCTURE AND FUNCTION OF INVERTEBRATES

Dissections (Virtual mode)

Dissection of digestive, nervous and reproductive system of Earthworm, Prawn, Squilla and Pila.

Mountings

Mounting of Mouthparts of Apis (Honey bee), Periplanata (Cockroach), *Musca domestica* (Housefly), Culex/Aedes (Mosquito).Pedicellaria of Seaurchin (Echinus).Mounting of Radula–Pila (Apple snail).

Identification of Invertebrate animals:

Trypanosoma, Leishmania, Plasmodium, Nereis, Parapodium of Nereis, Peripatus, Sacculina on Crab, Limulus, Sepia, Octopus, Holothuria (Sea cucumber), Echinus (Sea urchin), Asterias (Starfish), Trochophore larva, Veliger larva, Ophiopluteus larva, Echinopluteus larva, Bipinnaria larva.Minor phyla: Rotifera, Endoprocta, Ectoprocta.

COMPARATIVE ANATOMY OF VERTEBRATES

Dissections(Virtual mode)

Comparative study of digestive system, nervous system and reproductive system of of Scoliodon, Rana, Calotes, Columbia and Oryctolagus.

Mounting
Placoid scale of fish.

Brain of fish and rat.

Spotters:

1. Prochordates: Branchiostoma (Amphioxus), Balanoglossus and Ascidia.
2. Pisces: Scoliodon, Ray, Echeneis, Hippocampus (Sea horse), Exocoetus, Catla, Labeo (Rohu), Cirrhinus (Mrigal) and Oreochromis (Tilapia).
3. Amphibia: Rana, Tadpole larva, Axolotl larva, Hyla, Salamander, Ichthyophis.
4. Reptilia: *Naja naja*, Viper, Draco, Chamaeleon, Phrynosoma, Sphenodon.
5. Aves: Columbia (Pigeon), Psittacula (Parrot), Alcedo (King fisher), Bubo (Owl), Quill feather.
6. Mammalia: Megaderma (Bat), Loris, Oryctolagus (Rabbit), Rattus (Rat), Echidna, Ornithorhynchus (Duck-billed Platypus).
7. Dentition in Mammals: Cat, Rabbit, Dog, Rat, Horse/Pig/Mole, Squirrel, Cow/sheep/goat, Kangaroo, Opossum, Lemur, Elephant, Monkey and Man.
8. Osteology: Pigeon – Synsacrum, Rabbit – Pectoral and pelvic girdles, Forelimb and hindlimb bones.

REFERENCES:

1. De Iuliis, G. and Pulera, D. (2006). The Dissection of Vertebrates: A Laboratory Manual. Netherlands: Elsevier Science.
2. Sinha. J., Chatterjee A.K. and Chattopadhyay P. (2011). Advanced Practical Zoology. Arunabha Sen Publishers.
3. Bhamrah, H. S. (2003). Practical Zoology Invertebrate. Dominant Publishers.
4. Hyman, L. H. (2018). A Laboratory Manual for Comparative Vertebrate Anatomy. United States: Creative Media Partners, LLC.
5. Gergus, E. W. A. and Schuett, G. W. (2000). Labs for Vertebrate Zoology: An Evolutionary Approach. United States: Biological Sciences Press.
6. Holyoak, A. (2016). Laboratory Exercises in Invertebrate Zoology. United Kingdom: CreateSpace Independent Publishing Platform.
7. Morton, D., Perry, J. B. and Perry, J. W. (2012). Laboratory Manual for Non-Majors Biology. United States: Cengage Learning.
8. Levine, J. S. and Miller, K. R. (2003). Biology: Laboratory Manual A. United States: Pearson Prentice Hall.
9. Norman K. Wessells, (1992). Vertebrates A Laboratory Text. Jones and Bartlett Publishers, Inc
10. Lucas. W. J. (1893). The book of British Butterflies: A Practical Manual for Collectors and Naturalists. Kessinger Pub Co
11. Lal, Sham Sunder. (2009). Practical Zoology Vertebrate. Rastogi Publications.
12. Lacey, Lawrence A. (2012). Manual of techniques in Invertebrate Pathology. Academic Press.
13. Lacey, Lawrence A. (1997). Manual of Techniques in Insect Pathology. Academic Press.

14. Verma, P.S. (2013). A Manual of Practical Zoology of Invertebrates. S. Chand & Company Ltd., New Delhi.

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Comprehend the adaptation and interactions of various species of invertebrates.
- Understand the importance of protozoan and helminth parasites.
- Identify the behavior and significance of various invertebrates and their larval forms.
- Compare the functional morphology and regulation of vertebrates.
- Acquire knowledge about morphological features and ecological significance of minor phyla

*****

First Year **ELECTIVE COURSE I** **Semester I**

ENTOMOLOGY

(Theory)

COURSE OBJECTIVES:

- To enrich with basic knowledge of common insect pests.
- To provide an idea on the classification of pests of crops.
- To impart ideas on the ideology behind pest management.
- To provide the importance of biological agents adopted to control pests.
- To enhance the idea on the behavior of insects towards the selective measures.

UNIT – I CLASSIFICATION OF INSECTS:

Classification of insect- classification of pests based on magnitude of damage - occurrence on crops – types of crop plants -biological success of insects – reasons for the success of insects – pest outbreak – pest resurgence – insects as phyto-pathogenic vectors.

UNIT – II BIONOMICS AND MANAGEMENT:

Bionomics and management of selected insect pests of crops – pests of paddy - cotton -pulses (green gram and black gram)-vegetables (brinjal and tomato) – fruits (Mango and Citrus). Pests of stored products. Basic requirements for storage of food grains in godowns -polyphagous insects.

UNIT – III TOOLS OF INSECT PEST MANAGEMENT (IPM):

Integrated pest management and their – legislative - cultural - physical and mechanical methods - pest survey and surveillance -forecasting - types of surveys - remote sensing methods - factors affecting survey. Political - social and legal implications of IPM -pest risk analysis -pesticide risk analysis - cost benefit rations and partial budgeting – case studies of successful IPM programs.

UNIT – IV MANAGEMENT OF BIOLOGICAL AGENTS:

Management with natural enemies -other biological agents -parasites and parasitoids -predators -microbial agents. Conservation of natural enemies – botanical pesticides. Non-conventional methods for managing insect pests– uses of Insect Growth Regulators (IGRs) -repellents - pheromones.

UNIT – V BEHAVIOUR OF INSECTS:

Chronobiology and unusual behaviour -biological rhythm in insects – foraging - reproduction and infestation – periodicity in migration of Locusts – impacts of catastrophic earthquakes on insect communities.

UNIT – VI CURRENT CONTOURS (For continuous internal assessment only):

Artificial intelligence for insect behavior-wild pollinator conservation- organic approach- national organic program-*Bacillus thuringiensis* -Pyrethrum-plant volatile organic compounds (PVOC).

REFERENCES:

1. Kumar, R. (2021). Insect Pests of Stored Grain: Biology, Behavior, and Management Strategies. Taylor & Francis Group.
2. Barnard, P. C. (2011). The Royal Entomological Society Book of British Insects. Germany: Wiley.
3. Khan, Z. R. and Pathak, M. D. (1994). Insect Pests of Rice. Manila IRRI Publishers. Philippines.
4. Bhagwat, V. R., Bhagwat, J. V., Patil, J., Kalaisekar, A. and Padmaja, P. G. (2017). Insect Pests of Millets: Systematics, Bionomics, and Management. Netherlands: Elsevier Science.
5. Stansly, P. A. (2010). Bemisia: Bionomics and Management of a Global Pest. Germany: Springer Netherlands.
6. Anwer, M. A. (2021). Biopesticides and Bioagents: Novel Tools for Pest Management. Taylor & Francis Group.
7. Chakravarthy, A. K. (2020). Innovative Pest Management Approaches for the 21st Century: Harnessing Automated Unmanned Technologies. Singapore: Springer Singapore Pvt. Limited.
8. Eubanks, M. D., Denno, R. F., Price, P. W., Finke, D. L. and Kaplan, I. (2011). Insect Ecology: Behavior, Populations and Communities. Cambridge University Press.
9. Hajek, A. E. and Eilenberg, J. (2018). Natural Enemies: An Introduction to Biological Control. Cambridge University Press.
10. Fenemore, P. G. (2006). Applied Entomology. India: New Age International (P) Limited.
11. Rice, M. E., Pedigo, L. P. and Krell, R. K. (2021). Entomology and Pest Management. United States: Waveland Press, Inc.,
12. Tembhare, D.B. (1984). Modern Entomology. Himalaya Publishing House, Mumbai.
13. Nayar, K.K., Ananthakrishnan, T. N. and David, B. V. (1986). General and Applied Entomology, Tata McGraw Hill Publications, New Delhi.
14. Vasantharaj David, B. (2001). Elements of Economic Entomology. Popular Book Depot.
15. Ambrose Dunston P. (2004). The Insects: Structure, Function and Biodiversity. Kalyani Publishers, – New Delhi
16. Chapman R.F. (1998). The Insects Structure and Function. Cambridge University Press.
17. Snodgrass, R.E. (1985). Principles of Insect Morphology, McGraw Hill and Co., New York.
18. Wigglesworth, V.B. (2001). Principles of Insect Physiology. (IX Edition). Chapman and Hall, London.
19. Metcalf, C. V and Flint, W.P. (1979). Destructive and Useful Insects: Their Habitats and Control. Tata McGraw Hill Publications, New Delhi, India.

20. Pedigo, L.P. (2003). Entomology and Pest Management. (IV Edition). Pearson Education (Singapore) Pvt. Ltd., Delhi.
21. Verma, D.K. (1999). Applied Entomology. Mittal Publications, New Delhi.
22. https://onlinecourses.swayam2.ac.in/cec20_bt02/preview
23. https://www.mooc-list.com/course/bugs-101-insect
24. https://krishijagran.com/featured/artificial-intelligence-and-impact-of-climate-change-on-insect-pests-behaviour/
25. https://www.intechopen.com/chapters/79822!
26. https://www.aces.edu/blog/topics/farming/understanding-nop-standards-for-pest-management-in-specialty-crops/
27. https://enveurope.springeropen.com/articles/10.1186/s12302-019-0203-3

COURSE OUTCOMES:

Upon successful completion of this course the students would be able to:

- Acquire basic and applied knowledge on the classification of common pests.
- Understand the role and impact of insect pests on crops.
- Get an idea of management tools and strategies for pest management.
- Understand natural enemies and biological agents.
- Know an idea on the chronobiology and its mechanism of insects.

*****