**POOMPUHAR COLLEGE (AUTONOMOUS), MELAIYUR - 609 107.**

**(Accredited with 'B+' Grade by National Assessment and Accreditation Council (NAAC)**
**(Affiliated to Annamalai University, Chidambaram)**

**M.Sc. Zoology**

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

| Part | Course Code | Study Components & Course Title | Credit | Hours/ Week | Maximum Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | CIA | ESE | Total |
| | | **SEMESTER – I** | | | | | |
| A | | **Core - I:** Structure and functions of Invertebrates | 5 | 7 | 25 | 75 | 100 |
| | | **Core - II:** Comparative Anatomy of Vertebrates | 5 | 7 | 25 | 75 | 100 |
| | | **Core - III:** Practical – I<br><br>(Covering & ) | 4 | 6 | 25 | 75 | 100 |
| | | **Elective – I:**<br><br>Molecules and their interaction relevant to Biology (or)<br><br>Medical Entomology | 3 | 5 | 25 | 75 | 100 |
| | | **Elective-II :**<br><br>Biostatistics (or)<br><br>Toxicology | 3 | 5 | 25 | 75 | 100 |
| | | **Total** | **20** | **30** | | | **500** |
| | | **SEMESTER – II** | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | | **Core - IV:** Cellular and Molecular Biology | 5 | 6 | 25 | 75 | 100 |
| | | **Core - V:** Developmental Biology | 5 | 6 | 25 | 75 | 100 |
| | | **Core - VI:** Practical - II<br><br>(Covering & ) | 4 | 6 | 25 | 75 | 100 |
| | | **Elective – III:**<br><br>Economic Entomology (or)<br><br>Biodiversity and Conservation | 3 | 4 | 25 | 75 | 100 |
| | | **Elective – IV:**<br><br>Research Methodology (or)<br><br>Basic Biotechnology | 3 | 4 | 25 | 75 | 100 |
| B (i) | | **Skill Enhancement Course (SEC-I):**<br><br>Poultry Farming | 2 | 4 | 25 | 75 | 100 |
| | | **Total** | **22** | **30** | | | **600** |

**Credit Distribution**

| Study Components | Papers | Total Credits | Marks/Sub | Total Marks |
|---|---|---|---|---|
| Core Theory | 9 | 43 | 100 | 900 |
| Core Electives | 6 | 18 | 100 | 600 |
| Core Practical | 4 | 14 | 100 | 400 |
| Skill Enhancement Courses<br><br>SEC1, SEC2, SEC3 | 3 | 6 | 100 | 300 |
| Internship/Industrial Activity<br><br>(Carried out in Summer Vacation at the end of I Year – Two Weeks Period) | 1 | 2 | 100 | 100 |
| Project | 1 | 7 | 100 | 100 |
| Extension Activity | 1 | 1 | 100 | 100 |
| | **25** | **91** | | **2500** |

**Credit Distribution for PG Science Programme**

| Part | Course Details | No. of courses | Total Credit |
|---|---|---|---|
| **A** | Core Theory | 9 | **43** |
| | Core Practical | 4 | **14** |
| | Elective Course | 6 | **18** |
| | Project Work with VIVA-VOCE | 1 | **7** |
| **B(i)** | Skill Enhancement Course | 3 | **6** |
| **B(ii)** | Summer Internship | 1 | **2** |
| **C** | Extension Activity | 1 | **1** |
| | | 25 | **91** |

**Component-wise Credit Distribution**

| Part | Courses | Sem I | Sem II | Sem III | Sem IV | Total |
|---|---|---|---|---|---|---|
| **A** | Core (including Practical and Project) | 14 | 14 | 19 | 17 | **64** |
| | Elective | 6 | 6 | 3 | 3 | **18** |
| **B(i)** | Skill Enhancement Course | - | 2 | 2 | 2 | **6** |
| **B(ii)** | Summer Internship | - | - | 2 | - | **2** |
| **C** | Extension Activity | - | - | - | 1 | **1** |
| | | | | | | **91** |

**Part A and B(i) component will be taken into account for CGPA calculation for the post graduate programme and the other components Part B(ii) and C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining PG degree**.

| | |
|---|---|
| **Programme Outcomes (Pos)** | **PO1: Problem Solving Skill**<br><br>Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.<br><br>**PO2: Decision Making Skill**<br><br>Foster analytical and critical thinking abilities for data-based decision-making.<br><br>**PO3: Ethical Value**<br><br>Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.<br><br>**PO4: Communication Skill**<br><br>Ability to develop communication, managerial and interpersonal skills.<br><br>**PO5: Individual and Team Leadership Skill**<br><br>Capability to lead themselves and the team to achieve organizational goals.<br><br>**PO6: Employability Skill**<br><br>Inculcate contemporary business practices to enhance employability skills in the competitive environment.<br><br>**PO7: Entrepreneurial Skill**<br><br>Equip with skills and competencies to become an entrepreneur. |

| | |
|---|---|
| | **PO8: Contribution to Society**<br><br>Succeed in career endeavors and contribute significantly to society.<br><br>**PO 9 Multicultural competence**<br><br>Possess knowledge of the values and beliefs of multiple cultures and<br><br>a global perspective.<br><br>**PO 10: Moral and ethical awareness/reasoning**<br><br>Ability to embrace moral/ethical values in conducting one's life. |
| **Programme Specific Outcomes**<br><br>**(PSOs)** | **PSO1 – Placement**<br><br>To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.<br><br>**PSO 2 - Entrepreneur**<br><br>To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.<br><br>**PSO3 – Research and Development**<br><br>Design and implement HR systems and practices grounded in research that complies with employment laws, leading the organization towards growth and development.<br><br>**PSO4 – Contribution to Business World**<br><br>To produce employable, ethical and innovative professionals to |

| | |
|---|---|
| | sustain in the dynamic business world.<br><br>**PSO 5 – Contribution to the Society**<br><br>To contribute to the development of the society by collaborating with stakeholders for mutual benefit. |

| Semester | CORE COURSE - I | H/W | C |
|---|---|---|---|
| I | STRUCTURE AND FUNCTIONS OF INVERTEBRATES | 7 | 5 |

**Course Objective:**

| | |
|---|---|
| 1 | To understand the concept of classification and their characteristic features of major group of invertebrates. |
| 2 | To realize the range of diversification of invertebrate animals. |
| 3 | To enable to find out the ancestors or derivatives of any taxon. |
| 4 | To know the functional morphology of system biology of invertebrates. |

**UNIT - I:** Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy

**UNIT - II:** Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata

**UNIT -III:** Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration

**UNIT - IV:** Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malphigian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervoussystem: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and lnsecta) and Mollusca (Cephalopoda); Trends in neural evolution

**UNIT -V:** Invertebrate larvae: Larval forms of free living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

| | |
|---|---|
| **1** | Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms. |
| **2** | Understand the evolutionary process. All are linked in a sequence of life patterns. |
| **3** | Apply this for pre-professional work in agriculture and conservation of life forms. |
| **4** | Evaluate and to create the perfect phylogenetic relationship in classification**.** |

**TEXTBOOKS**


1. Arumugam,N.,T.Murugan,B.RamanathanandM.G.Ragunathan.(2019).*ATextBookofInvertebrates,* Saras Publications,Nagercoil,TamilNadu.
2. EkambaranathaAyyar,M.(1973).*AManualofZoology– PartI:Invertebrata*.S.Viswanathan(Printersand Publishers)Pvt.,Ltd.Madras.
3. EkambaranathaAyyar,M.(1973).*AManualofZoologyPart–II:Chordata*. S.VishvanathanPrinters and Publishers,Pvt.Ltd.,Madras.
4. Jordan,E.L.andP.S.Verma,(2017).*ChordateZoologyandElementsofAnimalPhysiology,* S.Chand &Co.,Ltd.,NewDelhi.
5. Jordon,E.L.andP.SVerma,(2015).*InvertebrateZoology*.S.Chandand Co. Ltd.,New Delhi.
6. Saxena,R.K.andS. Saxena.(2015).*Comparative Anatomy of Vertebrates*,M.V.Learning,UK.
7. Wells,H.G.(2018). *TextBookofBiology,Part1:Vertebrata,*CreatespacePublishingCompany,USA.


**REFERENCE BOOKS**


1. Arumugam,N.(2014).*AnimaldiversityVolume-1– Invertebrata.*SarasPublication,Nagercoil, TamilNadu.
2. Arumugam,N.(2014).*AnimaldiversityVolume-2– Chordata*.SarasPublication,Nagercoil, TamilNadu.
3. BarringtonE.J.W.(2012).*Invertebratestructureandfunction.*AffiliatedEastWest PressPvt.Ltd.,NewDelhi.
4. Brusca, R.C., W. Moore and S.M. Shuster. (2016). *Invertebrates.* OxfordUniversityPress,USA.
5. Kent,G.C.(2015).*ComparativeAnatomyoftheVertebrates*.McGrawHill,NewYork.

**Outcome Mapping**

| Mapping with Programme Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 2 |

*3 - Strong; 2 - Medium; 1– Low

| Semester | CORE COURSE - II<br>COMPARATIVE ANATOMY OF VERTEBRATES | H/W | C |
|---|---|---|---|
| I | | 7 | 5 |

**Course Objective:**

| | |
|---|---|
| **1** | Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates. |
| **2** | Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces. |
| **3** | Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals |
| **4** | Imparting conceptual knowledge about the animal life in the air and their behaviours. |
| **5** | Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates. |

**UNIT - I:** Origin of vertebrates: Concept ofProtochordata; The nature of vertebrate morphology; Definition, scope and relation to other disciplines; Importance of the study of vertebratemorphology

**UNIT - II:** Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development,generalstructureandfunctionsofskinanditsderivatives; Glands, scales, horns, claws, nails, hoofs, feathers andhairs.

**UNIT -III:** General plan of circulation in variousgroups; Blood; Evolution of heart; Evolution of aortic arches and portalsystems. Respiratory system: Characters of respiratorytissue; Internal and external respiration; Comparative account of respiratoryorgans

**UNIT - IV:** Skeletalsystem: Form, function, body size and skeletal elements of thebody; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrateseries

**UNIT –V:** Senseorgans: Simplereceptors; Organs of Olfaction andtaste; Lateral line system; Electroreception. Nervous system: Comparative anatomy of the brain in relation to itsfunctions; Comparative anatomy of spinalcord; Nerves-Cranial, Peripheral and Autonomous nervous systems

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

| | |
|---|---|
| **1** | Understand the morphological features and physiological functions like Respiration, reproduction and nervous system of Vertebrates |
| **2** | Understand the various salient features of higher Vertebrates |
| **3** | Differentiate the patterns of functioning of various organ systems in vertebrates |
| **4** | Know the structural organization and functioning of various organs in Vertebrates. |

**TEXT BOOKS**


1. EkambaranathaAyyar, M. (1973). *A Manual of Zoology Part – II: Chordata*. S. Vishvanathan Printers and Publishers, Pvt. Ltd., Madras.
2. Jordan, E. L. and P. S Verma. (2017). *Chordate Zoology and Elements of Animal Physiology,* S. Chand & Co., Ltd., New Delhi.
3. Saxena, R.K. and S. Saxena. (2015). *Comparative Anatomy of Vertebrates*, M.V.Learning, UK.
4. Wells, H.G. (2018). *Text Book of Biology, Part 1: Vertebrata,* Createspace Publishing Company, USA.
5. Young, J.Z. (2004). *The life of Vertebrates*. Oxford University Press, Oxford


**REFERENCE BOOKS**


1. Arumugam, N. (2014). *Animal diversity Volume-2: Chordata*. Saras Publication, Nagercoil, Tamil Nadu.
2. Kent, G.C. (2015). *Comparative Anatomy of the Vertebrates*. McGraw Hill, New York, USA.


**Outcome Mapping**

| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 1 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 1 | 2 | 2 |
| **CO4** | 3 | 1 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 1 |
| **CO5** | 3 | 2 | 1 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |

*3 - Strong; 2 - Medium; 1– Low

| Semester | CORE COURSE - III<br>PRACTICAL I -<br>INVERTEBRATES & VERTEBRATES | H/W | C |
|---|---|---|---|
| I | | 6 | 4 |

**Course Objective:**

| | |
|---|---|
| **1** | Understand the structure and functions of various systems in animals |
| **2** | Learn the adaptive features of different groups of animals |
| **3** | Learn the mounting techniques |
| **4** | Acquire strong knowledge on the animal skeletal system |
| **5** | Understand the structure and functions of various systems in animals |

## INVERTEBRATES

**Dissection**

Earthworm : Nervous system

*Pila* : Digestive and nervous systems

*Sepia* : Nervous system

Cockroach : Nervous system

Grasshopper : Digestive system and mouth parts

Prawn : Appendages, nervous and digestive systems

Crab : Nervous system

**Study of the following slides with special reference to their salient features and their modes of life**

1. *Amoeba*
2. *Entamoebahistolytica*

3. *Paramecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria*larva
7. *Tape worm (Scolex)*
8. *Ascaris*T. S.
9. Mysis of prawn

**Spotters**

1. Scorpion
2. *Penaeusindicus*
3. *Emerita* (*Hippa*)
4. *Pernaviridis*

**Mounting**

Earthworm : Body setae

*Pila* : Radula

Cockroach : Mouth parts

Grasshopper : Mouth parts

## CHORDATES

**Study the nervous system of Indian dog shark - Dissection**

1. Nervous system of *Scoliodonlaticaudatus* – $5^{th}$ or Trigeminal nerve
2. Nervous system of *Scoliodonlaticaudatus* – $7^{th}$ or Facial nerve
3. Nervous system of *Scoliodonlaticaudatus* – $9^{th}$ and $10^{th}$

   or Glossopharyngeal &Vagus nerve

**Study of the following specimens with special reference to their salient features and their modes of life**

1. *Amphioxus* sp. (Lancelet)
2. *Ascidia* sp. (sea squirt)
3. *Scoliodonlaticaudatus*(Indian dog shark)
4. *Trygon*sp. (Sting ray)
5. *Torpedo* sp. (Electric ray)
6. *Arius maculatus*(Cat fish)
7. *Belonecancila*(Flute fish)
8. *Exocoetuspoecilopterus*(Flying fish)
9. *Mugilcephalus*(Mullet)
10. *Tilapia mossambicus*(Tilapia)

11. *Rachycentroncanadum*(Cobia)
12. *Tetrodonpunctatus*(Puffer fish)
13. *Dendrophis*sp. (Tree snake)

**Study of the different types of scales in fishes**

1. Cycloid scale
2. Ctenoid scale
3. Placoid scale

**Study of the frog skeleton system (Representative samples)**

1. Entire skeleton
2. Skull
3. Hyoid apparatus
4. Pectoral girdle and sternum
5. Pelvic girdle
6. Fore limb
7. Hind limb

**Mounting**

1. Weberianossicles of fish

**Text Books:**


1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528


**Reference Books:**


1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjeee, P. Chattopadhya. 2011. Advanced Practical Zoology, ArunabhaSen Publishers, pp-1070.


**Outcome Mapping**

| **Mapping with Programme Outcomes*** |
|---|

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 2 |
| **CO4** | 3 | 3 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 1 |
| **CO5** | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 2 |

*3 - Strong; 2 - Medium; 1 - Low

## ELECTIVE COURSES:

| Semester | Elective Course - I : (Generic / Discipline Centric): | H/W | C |
|---|---|---|---|
| I | MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY | 5 | 3 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | To learn the structure, properties, metabolism and bioenergetics of biomolecules |
| 2 | To acquire knowledge on various types of enzymes, classification, their mechanism of action and regulation |
| 3 | To understand the importance and applications of methods in conforming the structure of biopolymers |
| 4 | To know the structural organization of proteins, carbohydrates, nucleic acids and lipids |
| 5 | To familiarize the use of methods for the identification, characterization and conformation of biopolymer structures |

**UNIT - I:** Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

**UNIT - II:** Biomolecular interactions and their properties: Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. - Composition, structure, metabolism and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

**UNIT - III:** Bioenergetics and enzymology: Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes

**UNIT - IV** Structural conformation of proteins and nucleic acids:Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds) - Conformation of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA).

**UNIT - V:** Stabilizing interactions in biomolecules:Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| 1 | Learn the structure, properties, metabolism and bioenergetics of biomolecules |
| 2 | Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation |
| 3 | Understand the fundamentals of biophysical chemistry and biochemistry, importance and applications of methods in conforming the structure of biopolymers |
| 4 | Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids |
| 6 | Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures |

**Text Books**


1. Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Ed., W.H. Freeman & Co., New York, pp-1050.
2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.
3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.
4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.
5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.


**Reference Books**


1. Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280.
2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw-Hill Companies, Inc., USA, pp-704.
3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.
4. Voet D. and J.G. Voet. 2011. Biochemistry. (4th Edition). John Wiley & Sons (Asia) Pvt. Ltd., pp-1428.

| Mapping with Programme Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | S | M | S | L | S | M | S | M | M |
| **CO2** | S | S | L | S | S | S | M | M | M | S |
| **CO3** | M | M | M | S | M | S | S | S | S | L |
| **CO4** | S | M | S | M | S | M | S | S | S | M |
| **CO5** | M | S | S | M | M | S | M | L | S | M |

*S - Strong; M - Medium; L-Low

| Semester | Elective Course - I : (Generic / Discipline Centric): MEDICAL ENTOMOLOGY | H/W | C |
|---|---|---|---|
| I | | 5 | 3 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| **1** | To acquire Knowledge of the Classification of Arthropod Vector insects in Medical Entomology. |
| **2** | To study the life Cycles of Vector Insects. |
| **3** | To Learn Various Vector borne diseases - Transmission and Control Measures. |

**UNIT - 1:Introduction**

Scope of Medical Entomology- Classification of Arthropoda.Classification of Arthropods of Medical and Public Health importance. Mechanism of Transmission of diseases by Arthropods - Mechanical and Biological; Metamorphosis – Complete and Incomplete. Insect Mouth Parts – Chewing and Sucking.

**UNIT - 2: Mosquitoes and Louse**

MOSQUITO: Morphology – Life history, vectors - diseases transmission– Control Measures.

LOUSE :- Morphology - Life history - Public Health importance – Control Measures

**UNIT - 3** :**Tsetse fly and Sand fly**

TSETSE FLY: Morphology - Life history - Public Health importance - Control Measures.

SAND FLY :- Morphology – Life history - Public Health importance – Control Measures.

**UNIT - 4** :**Fleas and House fly**

FLEAS: Morphology – Life history - Public Health importance – Control Measures.

HOUSE FLY:- Morphology – Life history - Public Health importance – Control Measures.

.**UNIT - 5** :**Ticks and Mites**

TICKS : Morphology - Life history - Public Health importance – Control Measures.

MITES : Morphology – Life history - Public Health importance – Control Measures.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| **1** | **Identify insects based on morphological features** |
| **2** | **Start entrepreneurial activities** |
| **3** | **Take up jobs in vector control and public health departments** |
| **4** | **Take up integrated pest management activities** |

**Text Books:**


1. Tembhare, D.B. (2012). *Modern Entomology*, Himalaya Publishing House, New Delhi.
2. Tyagi , B.K. (2012). *Medical Entomology*, Scientific publishers, Chennai


**Reference Book**


1. Rathanswamy, G.K, (2010). A Hand book of Medical Entomology. S.Viswanatham Printers & Private & Ltd., Chennai
2. VasantharajDevid, and V.V. Ramamurthy, (2011). Elements of Economic Entomology.Namrutha Publications , Chennai -600116


**Outcome Mapping**

| **CO/ PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | L | S | S | S | S | S |
| **CO2** | S | S | S | S | L | S | S | S | M | S |
| **CO3** | M | S | S | S | L | S | S | S | S | S |
| **CO4** | S | S | S | S | L | S | S | S | S | S |

*S - Strong; M - Medium; L-Low

| Semester<br><br>I | Elective Course - II:<br>(Generic / Discipline Centric):<br>BIOSTATISTICS | H/W<br><br>5 | C<br><br>3 |
|---|---|---|---|

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | To understand the importance of analysis of qualitative and quantitative information from biological studies. |
| 2 | To acquire skills to perform various statistical analyses using modern statistical techniques and software. |
| 3 | To Know the merits and limitation of practical problems in biological/ health management study |
| 4 | To propose and implement appropriate statistical design/ methods of analysis. |

**UNIT - I:** Definition, scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.

**UNIT - II:** Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error and coefficient of variation.

**UNIT - III:** Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.

**UNIT – IV:** Hypothesis testing: Students '*t*' test - paired sample and mean difference'*t*' tests. Correlation: Types - Karl Pearson's Co-efficient, Rank correlation, Significance test for correlation coefficients.

**UNIT - V:** Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction. Analysis of variance: one way and two way classification.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| 1 | Clear understanding of design and application of biostatistics relevant to experimental and population studies. |
| 2 | Acquired skills to perform various statistical analyses using modern statistical techniques and software. |
| 3 | Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/ methods of analysis. |

**Text Books**


1. Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447.
2. Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407.
3. Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363.
4. Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount Publications, Tamil Nadu, pp-264.


**Reference Books**


1. Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48.
2. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467.
3. Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859.
4. Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.
5. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.
6. Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons Inc, USA, pp-443.
7. Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.
8. Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp-525.


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | M | L | M | S | S | M | S | M | M |
| **CO2** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | M | S | S | S | S | S | S | S | S | L |
| **CO4** | M | M | S | L | M | M | M | S | L | M |
| **CO5** | M | M | S | L | M | S | M | L | S | M |

*S - Strong; M - Medium; L- Low

| Semester | Elective Course - II : (Generic / Discipline Centric): TOXICOLOGY | H/W | C |
|---|---|---|---|
| I | | **5** | **3** |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | **To learn the concepts and processes involved in toxicology** |
| 2 | To understand the various methods to know absorption and distribution of toxicants |
| 3 | To study the biotransformation and excretion of toxicants |
| 4 | To learn the impacts of toxicants and human beings. |
| 5 | To learn the application of antidotes |

**UNIT - I: Introduction to Toxicology**

Definition – Brief history of toxicology– Toxicity methods – Acute toxicity tests – Sub-acute toxicity test – Chronic toxicity test – Bio-assay – Determination of $LC_{50}$ and $LD_{50}$ – Dose - Response relationship.

**UNIT - II: Exposure Route, Absorption and Distribution of Toxicants**

Route of exposure of Toxicants: Dermal route – Inhalation route – Ingestion route. Absorption of Toxicants: Introduction – Mechanism of absorption – Passive transport and carrier mediated transport – Factors affecting absorption. Distribution of Toxicants: Membrane barriers.

**UNIT - III: Biotransformation and Excretion of Toxicants**

Biotransformation: Pattern of Biotransformation - Phase I reaction – Oxidation – Mixed Function Oxidase System – Reduction reaction – Hydrolysis – Phase II reaction – Biochemical conjugation – Glucuronidation – conjugation with Glutathione – Sulphate conjugation – Acetylation and Methylation – Amino acid conjugation - Excretion of Toxicants: Urinary excretion – Biliary excretion.

**UNIT - IV: Toxic effects on human**

Categories of toxic effects – Local and systemic effects – Reversible and irreversible effects – Immediate and delayed effects - Effects on target organs: Neurotoxic effects – Hepatotoxic effects – Genotoxic effects – mutagenic – Teratogenic – carcinogenic effects.

**UNIT - V: Antidotes**

Antidotes: Classification of antidotes– Mechanism of action of antidotes-Specific antidotes for metals and pesticides.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| 1 | Carry out toxicological analysis of various environmental samples |
| 2 | Make observations and biochemical analysis of biological samples |
| 3 | Carry out toxicological testing using live specimen to determine toxicity of toxicants |
| 4 | Take up jobs in toxicological research institutions and clinical labs |

**TEXT BOOKS**


1. Lee, B.M. and S.Kacew. (2018). *Lu's Basic Toxicology,* Informa Healthcare.
2. Sharma, P. D., (1996). *Environmental biology and toxicology*. Rastogi Publication, Meerut, India
3. Frank C. Lu (1985). *Lu's Basic Toxicology*. Hemispher Publication Corporation Washington, N.Y. London.
4. Gupta, P.K., and Salunka, D.K., (1985). *Modern Toxicology*. Vol. I and II, Metropolitan, New Delhi.
5. Pandey, K., J. P. Shukla and S. P. Trivedi. (2013). *Fundamentals of Toxicology*, New Central Book Agency, New Delhi.
6. Chris Kent (1998). *Basics of Toxicology*. John Wiley & Sons. New York


**REFERENCE BOOKS**


1. VijaByung-Mu Lee, Sam Kacew and HyungSik Kim. (2017). *Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment*. CRC Press, USA.
2. Stephen M. Roberts, Robert C. James and Phillip L. Williams. (2015). *Principles of Toxicology: Environmental and Industrial Applications*. Wiley Blackwell.
3. Frank A. Barile. (2017). *Principles of Toxicology Testing*. CRC Press, USA.
4. Karen E. Stine and Thomas M. Brown. (2015). Principles of Toxicology. CRC Press, USA.
5. Barile, F.A. (2013). *Principles of Toxicology Testing*, CRC Press.
6. KamaleshwarPandey, J. P. Shuikla and S. P. Trivedi. (2011). *Fundamentals of Toxicology*. New Central Book Agency, New Delhi.


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | M | L | M | S | S | M | S | M | M |
| **CO2** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | M | S | S | S | S | S | S | S | S | L |
| **CO4** | M | M | S | L | M | M | M | S | L | M |
| **CO5** | M | M | S | L | M | S | M | L | S | M |

*S - Strong; M - Medium; L- Low

| Semester | CORE COURSE - IV<br>CELLULAR AND MOLECULAR BIOLOGY | H/W | C |
|---|---|---|---|
| II | | 6 | 5 |

**Course Objective :**

| | |
|---|---|
| **1** | To understand the molecular basis of cell structure and functions |
| **2** | To learn the structure and functions of various organization and cell membrane. |
| **3** | To learn bioenergetics and biogenesis |
| **4** | To learn structure and replication of DNA |
| **5** | To learn various molecular techniques |

**UNIT - I:** General features of the cell: Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutroplasm - cell organelles; cell theory; Diversity of cell size and shapes.

**UNIT - II** Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.

**UNIT - III** Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro- and eukaryotic cells; Genetic maps.

**UNIT - IV:** Cell communication and cell signalling: Membrane- associated receptors for peptide and steroid hormones - signalling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures

**UNIT - V:** Cancer cells: Characteristic features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, apoptosis; therapeutic interventions of uncontrolled cell growth.

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

| | |
|---|---|
| **1** | Acquire knowledge on cellular structure and functions. |
| **2** | Understand the process of energetic and genesis in cells |
| **3** | Interpret the structural and functional significances of DNA and RNA |
| **4** | Take up jobs in molecular biology labs and clinical labs |

**TEXT BOOKS**


1. De Robertis E.D.D and De. Robertis E.M.F. (2017). *Cell and Molecular Biology.* Lippincott Williams &Wilkins , USA.
2. Pollard, T.D., W.C. Earnshaw, J.L .Schwartz and G. Johnson. (2017). *Cell Biology,* Elsevier.
3. Verma P.S. and V.K. Agarwal, (2015): *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand and Company, New Delhi.
4. Gupta. P.K., (2003). *Cell and Molecular Biology*, Rastogi Publication, Meerut, India.
5. Lodish. H, Berk. A, Zipursky. SL, Matiudaira. P, Baltimore. D and Darnell J. (2000). *Molecular Biology of the cell,* W.H. Freeman and company, New York.
6. Lewin.B, (2000). *Gene VII,* Oxford University Press, London.


**REFERENCE BOOKS**


1) Verma P.S. and V.K. Agarwal. (2016). *Cell Biology*. S. Chand & Co., New Delhi.
2) Arnold Berk, Chris A. Kaiser and Harvey Ledish. (2016). *Molecular Cell Biology*. WH Freeman, USA.
3) Malathi, V. (2012). *Essentials of Biology*. Pearson Education, Chennai, India.
4) Bruce Alberts, Alexander D. Johnson and Julian Lewis. (2014). *Molecular Biology of the Cell*. W.W. Norton & Co., USA.
5) Geoffrey M.Cooper and Robert E. Hausman. (2013).*The Cell: A Molecular Approach*. Sinauer Associates Inc., USA.


**Outcome Mapping**

| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 3 |
| **CO4** | 2 | 2 | 3 | 1 | 3 | 3 | 1 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |

*3 - Strong; 2 - Medium; 1–Low

| Semester | CORE COURSE - V | H/W | C |
|---|---|---|---|
| II | DEVELOPMENTAL BIOLOGY | 6 | 5 |

**Course Objective:**

| | |
|---|---|
| **1** | Define the concepts of embryonic development |
| **2** | Observe various stages of cell divisions under microscope |
| **3** | Understand the formation of zygote |
| **4** | Differentiate the blastula and gastrula stages |
| **5** | Learn the distinguishing features of three different germ layers and formation of various tissues and organs |

**UNIT - I** Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians

**UNIT - II:** Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitating in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation – Parthenogenesis

**UNIT - III:** Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in respective animal embryos (Sea urchin, *Amphioxus*, Amphibians, Aves, Mammals); Fate maps - (Amphibian and Chick),Epigenesis and preformation – Formation of primary germ layers.

**UNIT – IV:** Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - *Bicoid* and

*Nanos* proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes

**UNIT - V:** Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastema – Types of regeneration in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes assosciated with regeneration. Aging and senescences: Biology of senescences-cause of aging- mechanism involved in apoptosis. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

| | |
|---|---|
| **1** | Acquire knowledge on reproduction and development |
| **2** | Understand process of fertilization |
| **3** | Understand the whole process of embryogenesis |
| **4** | Acquisition of skills in common methods and practices followed in developmental biology related laboratory activities and Take up jobs in fertility clinics and research labs |

**TEXT BOOKS**


1. Verma, P.S. and V.K. Agarwal. (2017). *Chordate Embryology (Developmental Biology),* S. Chand and Co., New Delhi.
2. Arora, P. Mohan, (2014). *Embryology*, Himalaya publishing House, New Delhi.
3. Arumugam, N. (2014). *A Text Book of Embryology (Developmental Biology)*, Saras Publications, Nagercoil, Tamil Nadu.
4. Balinsky, B.I. (2012). *An Introduction to embryology*, 4th Edition, Saunder's College Publishing Ltd, New York
5. Philip Grant (1977). *Biology of development systems,* University of Oregon
6. Berrill, N.J., and G. Karp. (1978). *Development Biology,* Tata McGraw Hill Publishing Co., Ltd, New Delhi


**REFERENCE BOOKS**


1) Madhavan K. S. (2018). *Developmental Biology.*Arjun Publishing House.
2) Subhadra Devi, V. (2018). *Inderbir Singh's Human Embryology,* Jaypee Brothers Medical Publishers, New Delhi.
3) Berry A.K. (2016). *An Introduction to Embryology*. Emkay Publications, New Delhi.
4) Lewis Wolpert, Cheryll Tickle and Alfonso Martinez Arias. (2015). *Principles of Development*. *Oxford University Press*, USA.
5) Jain P.C. (2013). *Elements of Developmental Biology*. Vishal Publishing Co., Punjab.
6) Carlson, B.M. (2014). *Pattens foundations of Embryology*, McGraw Hill
7) Sastry K.V. and Vinita Shukal. (2012). *Developmental Biology.*Rastogi Publication, Meerut, Uttar Pradesh.

**Outcome Mapping**

| Mapping with Programme Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 1 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 1 | 2 |

*3 - strong; 2 - Medium; 1 – Low

| Semester | CORE COURSE – VI<br>PRACTICAL II –<br>CELLULAR AND MOLECULAR BIOLOGY AND DEVELOPMENTAL BIOLOGY | H/W | C |
|---|---|---|---|
| II | | 6 | 4 |

**Course Objective :**

| | |
|---|---|
| **1** | Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development. |
| **2** | Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques. |
| **3** | Develop handling - skills through the wet-lab course. |
| **4** | Learn the method of culturing of *Drosophila* and identification of their wild and mutant strains |
| **5** | Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities |

## CELLULAR AND MOLECULAR BIOLOGY

1. Determination of cell size using micrometer
2. Mitosis in root meristematic cells of plants
3. Identification of various stages of meiosis in the testes of grasshopper
4. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomus
5. Detection of sex chromatin
6. Identification of blood cells in the haemolymph of the of the cockroach
7. Isolation of genomic DNA from eukaryotic tissue
8. Isolation of total RNA from bacterial cells/tissues
9. Agarose gel electrophoresis of DNA
10. SDS-Polyacrylamide gel electrophoresis

# DEVELOPMENTAL BIOLOGY

Gametogenesis - Observation of gametes from gonadal tissue sections

i. Oogenesis:

- ✓ Section through ovary of shrimp, fish, frog and mammals

ii Spermatogenesis:

- ✓ Section through testis of shrimp, fish, calotes and mammals

Fertilization

iii Induced spawning in polycheate worm *Hydroids elegans*

iv *In vitro* fertilization and development in a polycheate worm *Hydroids elegans*

v Observation of egg developmental stages in *Emerita emeritus*

Embryogenesis

vi Observation and whole mount preparation of the chick blastoderm - 18 hours of development

vii Chick embryonic stage - 24 hours of development

viii Chick embryonic stage - 48 hours of development

ix Chick embryonic stage - 72 hours of development

x Chick embryonic stage - 96 hours of development

Histological observation: Section through various developmental stages in chick embryo

Experimental Embryology

Regeneration in Frog Tadpoles

xi Blastema formation

xii Demonstration of regenerative process in tadpole

Metamorphosis

xiii Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine

Cryopreservation

xiv Demonstration of cryopreservation of gametes of fin fish/shell fish

**Outcome Mapping**

| Mapping with Programme Outcomes* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 2 | 1 | 2 |
| **CO4** | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 1 |
| **CO5** | 3 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 3 | 3 |

*3 - Strong; 2 -Medium; 1-Low

| Semester | Elective Course - III:<br>(Generic / Discipline Centric):<br>ECONOMIC ENTOMOLOGY | H/W | C |
|---|---|---|---|
| II | | 4 | 3 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | To understand taxonomy, classification and life cycle of insects. |
| 2 | To know the method of rearing and management of diseases of beneficial insects. |
| 3 | To know the type of harmful insects, and their damage potential |
| 4 | To recognize insects which act as vectors causing diseases in animals and human. |

**UNIT - I:** Basic morphological concepts – Insect taxonomy upto orders – salient features withsuitable examples of the insect orders – Odonata, Orthoptera, Coleoptera, Lepidoptera and Diptera. Elementary knowledge on insect system and function.

**UNIT - II:** Beneficial insects: Silkworm – types,life history, disease management and rearing methods - types of honey bees, life history, social organization, structural adaptation and beehive. Lac insects – life history, lac cultivation.

**UNIT – III:** Destructive insects: Insect pests - definition – categories of pests – types of damage to plants by insects – causes of pest outbreak – Economic threshold level – Biology of Paddy, cotton, sugarcane pests.

**UNIT – IV:**Pest management/Control strategies:Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.

**UNIT - V:** Vector biology and control: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| 1 | Understand taxonomy and classification of insects |
| 2 | Know the life cycle, rearing and management of diseases of beneficial insects. |
| 3 | Know the type of harmful insects, life cycle, damage potential and management of pests including natural pest control |
| 4 | Recognize insects which act as vectors causing diseases in animals and human. |
| 5 | Overall understanding on the importance of insects in human life. |

**Test Books**


1. Ayyar, L.V. R. 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp- 528.
2. Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.
3. Ross. H.H. 1965. A Text Book of Entomology, John Wiley & Sons Inc., New York, pp-746.


**Reference Books**


1. Chapman, R.F., S.J. SimpsonandA.E.Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2. Imms, A.D., O.W.Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.
3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. McGraw-Hill Kogakusha Ltd., Tokyo, pp-564.
4. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.
5. Krishnaswami, S. 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
6. Mani, M.S. 1982. General Entomology. Oxoford& IBH Publishing Co., pp-912.
7. Wigglesworth, V.B. 1972. The Principles of Insect Physiology, ELBS & Chapman and Hall, London, pp-827.


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | S | M | S | M | M | M | S | L | M |
| **CO2** | S | S | M | S | S | S | S | S | S | L |
| **CO3** | S | M | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | S | M | M |
| **CO5** | S | S | S | M | M | S | M | L | S | M |

*S - Strong; M - Medium; L-Low

| Semester | Elective Course - III: (Generic / Discipline Centric): Biodiversity and Conservation | H/W | C |
|---|---|---|---|
| II | | 4 | 3 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | To make students to realize the structure and function of ecosystem. |
| 2 | To make students to realize the wealth of our natural resources |
| 3 | To make students to realize the conservation measures to be taken |
| 4 | To make students to realize to create awareness of the laws governing environment. |

**Unit – I: Ecosystem**

Composition of atmosphere – structure and stratification of atmosphere - Hydrological cycle-kinds of ecosystem-structure and functions of ecosystem-energy flow in ecosystem-trophic levels

**Unit – II: Natural Resources and Conservation**

Types of resources-conventional and non- conventional sources of energy-conservation of soil, land and forest - Deforestation and Afforestation – Conservation strategies (WCS &NCS) - Wild life management in India.

**Unit – III: Air and Water Pollution**

Air pollution-types of air pollutants-classification and effect of pollutants on vegetation, farm animals and human health-prevention and control of air pollution.

Water pollution-sources of water pollution-water quality standards – Eutrophication-prevention and control of water pollution.

**Unit – IV: Radiation, Noise and Industrial Pollution**

Radiation pollution-sources and effects of ionizing radiation.

Noise pollution – sources of noise pollution – effects of noise pollution – control measures. Pollution control and abatement on cement industry – leather industry – textile industry.

**Unit – V: Environmental Impact Assessment and Law**

The objective of Environmental Impact Assessment (EIA) – Environmental Appraised Committee (EAC) – The Environmental Management Plan (EMP) – Control of Environmental pollution through law – Environmental Protection Act (1986).

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| 1 | Realize the structure and function of ecosystem. |
| 2 | Understand the wealth of our natural resources |
| 3 | Know the methods of conservation of natural resources |
| 4 | Create awareness of the laws governing environment. |

**Text Books**


1. Sharma.P.D., 1995. Environmental Biology and Toxicology. Rastogi and Company, Meerut, India.
2. Trivedi P.R.,&Gurdeepraj., 1992. Environmental Biology. Akashdeep Publishing House, New Delhi.
3. Pal, B.P.,1982 Environmental Conservation and Development, Nataraj Publishers, Dehra Dun, India.
4. Agarwal, K.C., 1989. Environmental Biology. Agro Botanical Publishers, India.


**Reference Books**


5. Trivedi, P.R.&Gurdeepraj., 1992. Water Pollution. Akashdeep Publishing house, New Delhi.
6. Break Mely, W.1980. Chemicals in the Environment. Marshal Dokker INC Newyork.
7. Irving Sax, N.1974. Industrial Pollution. Van NostrandRaingold Co., Newyork.
8. Pandey G.N.&G.C.Carney, 1989. Environmental Engineering. Tata McGraw-Hill Publishing Co., Ltd.


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | S | M | S | M | M | M | S | L | M |
| **CO2** | S | S | M | S | S | S | S | S | S | L |
| **CO3** | S | M | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | M | S | M | M |
| **CO5** | S | S | S | M | M | S | M | L | S | M |

*S - Strong; M - Medium; L-Low

| Semester | Elective Course - IV:<br>(Generic / Discipline Centric):<br>RESEARCH METHODOLOGY | H/W | C |
|---|---|---|---|
| II | | 4 | 3 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | To understand the Good Laboratory Practices |
| 2 | To learn the working principles of different instruments |
| 3 | To gain the knowledge on techniques of histology and histochemistry |
| 4 | To acquire knowledge on the basic principle and application of various modules of light and electron microscopy |

**UNIT - I:** Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry

**UNIT - II:** Histology, Histochemistry, Bioinformatics and Electron microscopy.

**UNIT – III:** Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy.

**UNIT – IV:**Centrifuges, Chromatography, Electrophoresis, HPLC, GC-MS, PCR, ELISA and blotting

**UNIT - V:** Principles and Applications of tracer techniques in biology, Animal cell culture techniques.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| 1 | Understand the implications of GLP |
| 2 | Learn the working principles of different instruments |
| 3 | Gain the knowledge on techniques of histology and histochemistry |
| 4 | Acquire knowledge on the basic principle and application of various modules of light and electron microscopy |

**Text Books**


1. Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758.
2. Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.
3. Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.


**Reference books**


1. Chandler, D.E. and Roberson R.W. 2009. Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440.
2. Engelbert, B. 1960. Radioactive Isotopes in Biochemistry, Elsevier Applied Science, pp-376.
3. Wolf, G. 1964. Isotopes in Biology, Academic Press, pp-173.
4. Srivastava, B. B. 2005. Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.
5. Pantin, C. F. A. 1948. Microscopical Techniques, Cambridge University Press, London.


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | S | M | S | M | S | M | S | M | M |
| **CO2** | S | S | M | S | S | S | M | M | M | S |
| **CO3** | S | M | S | S | S | S | S | S | S | L |
| **CO4** | S | S | S | S | S | M | S | S | S | M |
| **CO5** | S | S | S | M | M | S | M | L | S | M |

*S - Strong; M - Medium; L-Low

| Semester | Elective Course - IV:<br>(Generic / Discipline Centric):<br>BASIC BIOTECHNOLOGY | H/W | C |
|---|---|---|---|
| II | | 4 | 3 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| 1 | To learn the basic concepts in biotechnology |
| 2 | To learn the various techniques used in biotechnology |
| 3 | To acquire biotechnological knowledge related to medical, agricultural and environmental disciplines |

**UNIT - I: Introduction**

Definition – Scope – Achievements of Biotechnology – Enzymes in genetic engineering - Restriction Enzymes, DNA ligase, DNA polymerase of Cloning vectors – Plasmids- Bacteriophage, Cosmids, Yeast plasmids.

**UNIT - II: Techniques in Biotechnology**

Southern blotting, Northern blotting, Western blotting, In-situ hybridization, DNA sequencing, PCR, DNA finger printing.

**UNIT - III: Medical Biotechnology**

rDNA Technology - Insulin, Somatotrophin, Somatostatin - hormone production, vaccines, interferons, gene therapy, monoclonal antibodies, Human Genome Project (HGP).

**UNIT - IV: Agricultural Biotechnology**

Micropropagation, protoplast culture, Biofertilizers - Symbiotic and Non symbiotic nitrogen fixation, Biopesticides - Transgenic plants and animals.

**UNIT - V: Microbial and Environmental Biotechnology**

Bioreactor, primary metabolites – Vitamins, alcohols, Secondary metabolites – Antibiotics, Toxins, Microbial enzyme production – amylase.Bioremediation, Microbial leaching.

**Expected Course Outcome (CO)**

On the successful completion of the course, student will be able to**:**

| | |
|---|---|
| **1** | Gain knowledge on the principles of biotechnology |
| **2** | Know various experiments related to biotechnology |
| **3** | Carry out biotechnological applications in the fields of medicine, agriculture and environmental fields |
| **4** | Equip themselves to take up jobs in various biotechnological companies and labs |

**TEXT BOOKS**


1. Dubey. R. C., (2018). *A Text Book of Biotechnology*. S. Chand & Co. Ltd., New Delhi.
2. Lohar, P.S. (2014). *Text Book Of Biotechnology,* MJP Publishers,Chennai, Tamil Nadu.
3. Glick, B.R. and C.L Patten. (2018). *Molecular Biotechnology : Principles and Applications of Recombinant DNA,* ASM Pres, USA.
4. Clark, D.P. and N.J. Pazdernik. (2017). *Biotechnology,* Academic Cell.
5. Lohar, P.S. (2017). *Biotechnology,* MJP Publishers,Chennai, Tamil Nadu.
6. Gupta. P. K., (2009). *Elements of Biotechnology*. Rastogi& Company, Meerut.
7. Purohit, S. S. (2007). *Biotechnology, Fundamentals and Applications.* Agrobios, New Delhi.


**REFERENCE BOOKS**


1. Bernard R. Glick and Chery L Patten. (2017). *Molecular Biotechnology.* Taylor & Francis.
2. William J. Thieman and Michael A. Palladino. (2014). *Introduction to Biotechnology.* Pearson.
3. Singh B. D. (2015). *Biotechnology:* Expanding Horizons. Kalyani.
4. Dubey R. C. (2014). *Advanced Biotechnology*. S Chand & Co., New Delhi.
5. PratibhaNallari and V. VenugopalRao. (2010). *Medical Biotechnology.* Oxford University Press, USA.
6. Kumarsan, V. and N. Arumugam. (2016). *Fundamentals of Biotechnology,* Saras Publications, Nagercoil, Tamil Nadu.


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | S | M | S | M | S | M | S | M | M |
| **CO2** | S | S | M | S | S | S | M | M | M | S |
| **CO3** | S | M | S | S | S | S | S | S | S | L |
| **CO4** | S | S | S | S | S | M | S | S | S | M |
| **CO5** | S | S | S | M | M | S | M | L | S | M |

*S - Strong; M - Medium; L-Low

## SKILL ENHANCEMENT COURSES:

| Semester | SEC – I | H/W | C |
|---|---|---|---|
| II | POULTRY FARMING | 4 | 2 |

**Course Objectives (CO):**

The main objectives of this course are:

| | |
|---|---|
| **1** | To understand the various practices in Poultry farming. |
| **2** | To know the needs for Poultry farming and the status of India in global market. |
| **3** | To apply the techniques and practices needed for Poultry farming. |
| **4** | To know the challenges in Poultry farming |

**UNIT - I:** General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming

**UNIT - II:** Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance

**UNIT - III:** Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.

**UNIT – IV:** Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.

**UNIT - V:** Selection, care and handling of hatching eggs - Egg testing. Methods of hatching.- Brooding and rearing -. Sexing of day-old chicks. - Farm and Water Hygiene - Recycling of poultry

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

| | |
|---|---|
| **1** | Understand the various practices in Poultry farming. |
| **2** | Know the status of Poultry farming. |
| **3** | Apply the techniques and practices needed for Poultry farming. |

| | |
|---|---|
| **4** | Know the difficulties in Poultry farming and be able to propose plans against it. |

**Text Books:**


1. Sreenivasaiah., P. V., 2015. Textbook of Poultry Science.1st Edition.Write & Print Publications, New Delhi 2.

2. Jull A. Morley, 2007. Successful Poultry Management.2nd Edition. Biotech Books, New Delhi"

3. Hurd M. Louis, 2003. Modern Poultry Farming.1st Edition.International Book Distributing Company, Lucknow."

4. Life and General Insurance Management"


**Reference Books:**


1. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.

2. http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf

3 .https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf

4. http://ecoursesonline.iasri.res.in/course/view.php?id=335

5. https://swayam.gov.in/nd2_nou19_ag09/preview


| **Mapping with Programme Outcomes*** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 1 | 1 |
| **CO2** | 3 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 2 |

*

*S - Strong; M - Medium; L – Low