## Semester -I

### Major Course 1 (MJC-1)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Diversity of Non-Chordata | 6 | 4 | 2 |

**Course outcomes:** After completion of the course, students should be able to:

**CO-1:** Learn about the importance of systematics, taxonomy, and structural organization of non-chordates.

**CO-2:** Understand & Appreciate the diversity of non-chordates living in varied habits and habitats.

**CO-3:** Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.

**CO-4:** Critically analyse the organization, complexity and characteristic features of non chordates.

**CO-5:** Recognize the life functions and the ecological roles of the animals belonging to different phyla.

**CO-6:**Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

| MJC-1: Diversity of Non-Chordata (Theory: 4 credits) 40 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Introduction to Non-chordates:<br>General characteristics and classification (up to order) of the following Phyla: Protozoa, Porifera, Cnidaria, Ctenophora, Platyhelminthes and Nemathelminths, Annelida, Arthropoda, Mollusca, Echinodermata. | 8 |
| 2 | 2.1. Protozoa: Structure and Life cycle of Paramecium, Plasmodium, Entamoeba histolytica, Trypanosoma, L. donovani<br>2.2. Porifera: Spicules and Canal system in sponges; affinities of the Phylum | 10 |
| 3 | 3.1. Cnidaria: Structure and Life Cycle: Obelia, Aurelia<br><br>3.2. Ctenophora: General organization of Hormiphora; affinities of the phylum.<br><br>3.3 Platyhelminthes and Nemathelminthes: Structure and Life cycle of *Fasciola hepatica, Taenia solium, Ascaris lumbricoides.* | 10 |
| 4 | 4.1. Annelida: Earthworm, Leech: Structure, locomotion, alimentary canal Reproduction.<br><br>4.2. Arthropoda: Peripatus, Adaptive variations in insect mouth parts.<br><br>4.3. Mollusca: Structure and Life cycle: Unio, Pila. Torsion and Detorsion in Gastropoda<br><br>4.4. Echinodermata: Structure: Star fish, Larval forms in Echinoderms: Water Vascular System in Echinoderms | 12 |
| | **TOTAL** | **40** |



14.06.23 14/6/23 14/06/2023

| MJC-1: Diversity of Non-Chordata (Practical: 2 credits) 20 hrs |
|---|
| **Practical:**<br><br>1. Study of whole mount of Euglena, Amoeba, Paramecium,Monocystis; Binary fission and Conjugation in Paramecium.<br>2. Study of Sycon; T.S. of Sycon, L.S. of Sycon; Gemmule, Hyalonema.<br>3. Permanent stained preparation of spicules of sponges.<br>4. Study of *Obelia, Aurelia, Metridium ,Physalia.*<br>5. Specimen/slide of any one Ctenophore.<br>6. Study of adult *Fasciola hepatica, Taenia solium*and*Ascaris* (male & female).<br>7. Study of Aphrodite, Septal nephridia and Ovary of Earthworm; Jaws of leech;Trochophore larva.<br>8. Study of T.S. through pharynx, gizzard, and typhlosolar region of earthworm.<br>9. Study of Limulus, Scolopendra, Grasshopper, Phyllium,Praying mantis, &Palaemon, Sacculina, Cancer, Eupagurus, Apis, Musca. Salivary gland of Cockroach,Mouth parts of Mosquito.<br>10. Study of Chiton, Dentalium, Octopus, Glochidim larva.<br>11. Study of Asterias, Echinus, Antedon. |

**Suggested Books:**


1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson.
4. Verma P S, Jordan E L. (2009). Invertebrate Zoology. S. Chand publishers.
5. Brusca R C (2016). Invertebrates. Published by Sinauer Associates, an imprint of Oxford University Press.
6. S.S.Lal, Practical Zoology Invertebrate.


14.06.23 14/6/23 14/06/2023

| MJC-1: Diversity of Non-Chordata (Practical) 10 hrs | (1 credit ) |
|---|---|

**Practicals :**

1. Study of whole mount of *Euglena, Paramecium, Leishmania*
2. Study of Sycon, Spongilla, T.S. of Sycon, L.S. of Sycon.
3. Study of *Obelia, Aurelia, Gorgonia*
4. Study of adult *Fasciola hepatica, Taenia solium*and their life stages
5. Study of *Pheretima, Hirudinaria*
6. Study of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
7. Study of *Limulus, Palaemon, Apis.*
8. Mouth parts of Mosquito and Cockroach.
9. Study of *Pila, Unio.*
10. Study of *Asterias.*

**Suggested Books :**


1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates:A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Verma P S, Jordan E L. (2009). Invertebrate Zoology. S. Chand publishers
5. Brusca R C (2016). Invertebrates. Published by Sinauer Associates, an imprint of Oxford University Press.
6. S.S.Lal, Practical Zoology Invertebrate.




14.06.23 14/6/23 14/06/2023

## Semester 2

## Major Course 2 (MJC-2)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Diversity of Chordates | 6 | 4 | 2 |

**Course Outcomes:** After completion of the course, the students will be able to:

**CO-1:** Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside the phylum.

**CO-2:** Study about diversity in animals making students understand about their distinguishing features.

**CO-3:** Appreciate similarities and differences in life functions among various groups of animals in Phylum Chordata.

**CO-4:** Comprehend the circulatory, nervous and skeletal system of chordates.

**CO-5:** Know about the habit and habitat of chordates in marine, freshwater and terrestrial ecosystems.

| MJC-2: Diversity of Chordates (Theory: 4 credits) 40 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | **1.** Introduction to Chordates<br>General characteristics and classification (upto Order): Cephalochordata, Urochordata,Pisces, Amphibia, Reptilia, Aves, Mammals, Cyclostomata. | 8 |
| 2 | **2.** Origin and Evolution of Chordata.<br>**3.**Cephalochordata: Amphioxus.<br>**4.** Urochordata: Herdmania(including retrogressive metamorphosis).<br>**5.**Cyclostomata: Petromyzon. | 10 |
| 3 | **6.**Pisces: Migration, Osmoregulation, and accessory respiration.<br>**7.**Amphibia: Origin and Evolution; Parental care, Neoteny.<br>**8.** Reptilia: Poison and nonpoisionous snakes; Poision apparatus; biting and feeding mechanism in snakes. | 12 |
| 4 | **9.**Aves: Origin of birds; Flight adaptations; Migration in birds.<br>**10.** Mammals: Characters, distribution and affinities of Prototheria Metatheria, Eutheria. | 10 |
| | **TOTAL** | **40** |



14.06.'23 14/6/23 14/06/2023

| MJC-2: Diversity of Chordates (Practical: 2 credits) | 20 hrs |
|---|---|

**Practical:**

1. Amphioxus: T.S through pharyngeal, intestinal, and caudal regions.
2. Herdmania: Whole mount, Spicules.
3. Cyclostomata: Petromyzon, Myxine.
4. Fish: Scoliodon, Torpedo, Chimaera, Labeo, Exocoetus, Echeneis, Hippocampus; Scales of fishes.
5. Amphibia: Ichthyophis, Bufo, Hyla, Alytes, Salamandra,Axolotle larva.
6. Reptilia: Chelone, Hemidactylus, Varanus, Vipera, Naja, Bungarus, Uromastix, Chamaeleon, Draco,Calotes,Heloderma; Key for Identification of poisonous and non-poisonous snakes.
7. Aves: Types of beaks and claws, Study of pecten from fowl head and brain of fowl.
8. Mammalia: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous.Macropus,Echidna.*

**Suggested Books:**


1. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life*. VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. Classification from Young, J. Z. (2004) to be followed.
6. S.S.Lal, Practical Zoology Vertebrates.


14.06.23 14/6/23 14/06/2023

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life,* VIII Edition, Pearson International.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
- Hall B. K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
- Classification from Young, J. Z. (2004) to be followed.
- S. S. Lal, Practical Zoology Vertebrates.


**Semester III**

**Major Course 3 (MJC-3)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Comparative Anatomy | 5 | 3 | 2 |

**Course Outcomes:** Upon completion of the course, students should be able to:

**CO-1:** Explain comparative account of the different vertebrate systems

**CO-2:** Understand the pattern of vertebrate evolution, organization and functions of various systems.

**CO-3:** Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.

**CO-4:** Understand the evolution of heart, modification in aortic arches, structure of respiratory organs used in aquatic, terrestrial and aerial vertebrates; and digestive system and its anatomical specializations with respect to different diets and feeding habits.

**CO-5:** Learn the evolution of brain, sense organs and excretory organs to a complex, highly evolved form in mammals;

**CO-6:** Learn to analyze and critically evaluate the structure and functions of vertebrate systems, which helps them to discern the developmental, functional and evolutionary history of vertebrate species.

| MJC-3: Comparative Anatomy of Vertebrates (Theory: 3 credits) 30 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of lectures** |

| | | |
|---|---|---|
| 1 | 1. Integumentary System:<br>Structure and derivatives of integument, functions of skin. | 4 |
| 2 | 2. Skeletal System:<br>Basic plan of axial and appendicular skeleton. | 4 |
| 3 | 3. Digestive System:<br>Alimentary canal and associated glands. | 4 |
| 4 | 4. Respiratory System:<br>Respiratory organs and accessory respiratory organs. | 5 |
| 5 | 5. Circulatory System:<br>5.1 General plan of circulation.<br>5.2 Evolution of heart and aortic arches. | 4 |
| 6 | 6. Urinogenital System:<br>Evolution of kidney and urinogenital ducts. | 4 |
| 7 | 7. Nervous System:<br>Comparative account of Central nervous system and Peripheral nervous system. | 5 |
| | **Total** | **30** |

| MJC-3: Comparative Anatomy (Practical: 2 Credits) 20 hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours<br>70 | | Full Marks- |
| Sl. No. | Name of Practicals/Experiments | Marks |
| 1 | Study of placoid, cycloid and ctenoid scales of fish through permanent slides. | 15 |
| 2 | Study of afferent and efferent branchial vessels of Scoliodon through videos/models. | 15 |
| 3 | Study of digestive tract of frog/ rat through videos/models. | 10 |
| 4 | Disarticulated skeleton of Frog, Varanus, Fowl and Rabbit (Skull, Limb bones, Vertebral Column, Sternum, Girdles, Ribs) | 10 |
| 5 | Practical Records/Charts/Models. | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**


• Kardong, K.V. (2005). Vertebrate's Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.

• Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.

• Kotpal, R. L. (2010). Modern text book of zoology: vertebrates. Rastogi Publications.


**Online Tools and Web Resources:**

• SWAYAM (Structure of heart), Link https://www.swayamprabha.gov.in/index.php/program/archive/9.

• COURSERA (PALEONTOLOGY: Early vertebrate evolution, Link – https://www.coursera.org/learn/early-vertebrate-evolution).

## Major Course 4 (MJC-4)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Physiology | 4 | 3 | 1 |

**Course Outcomes**: Upon completion of the course, students will be able to:

**CO-1:** Know the principles of normal biological function in human body.

**CO-2**: Outline basic human physiology and correlate with histological structures.

**CO-3**: Comprehend and analyse problem-based questions on physiological aspects.

**CO-4**: Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body; and use of feedback loops to control the same.

**CO-5**: Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.

| MJC-4: Physiology (Theory: 3 Credits) 30 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of lectures** |
| 1 | 1. Digestive System:<br>1.1 Digestion, Absorption and Assimilation of Carbohydrates, Protein and Lipid.<br>1.2 Digestive glands. | 5 |
| 2 | 2. Neuromuscular Physiology:<br>2.1 Structureof neuron, Propugation of nerve impulse.<br>2.2 Structure of skeletal muscle, Mechanism of muscle contraction<br>2.3 Neuromuscular junction. | 5 |
| 3 | 3. Respiratory Physiology:<br>3.1 Ventilation and Internal Respiration.<br>3.2 Respiratory pigments.<br>3.3 Transport of gases in blood. | 4 |
| 4 | 4. Cardiovascular System:<br>4.1 Components of blood and their function, blood coagulation.<br>4.2 Coronary circulation and heart beat.<br>4.3 Cardiac cycle and ECG.<br>4.4 Nervous and chemical regulation of heart rate. | 8 |

| | | |
|---|---|---|
| 5 | 5. Renal and Reproductive Physiology:<br>5.1 Structure of nephron and renal blood supply.<br>5.2 Mechanism of urine formation and its regulation.<br>5.3 Acid- Base balance.<br>5.4 Spermatogenesis and oogenesis.<br>5.5 Menstrual cycle. | 8 |
| | **Total** | **30** |

| **MJC-4: Physiology (Practical: 1 Credit) 10hrs** | | |
|---|---|---|
| **End Semester Examination**<br>**Time – 3 hours** **Full Marks-70** | | |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Enumeration of red blood cells and white blood cells using haemocytometer, | 10 |
| 2 | Determination of erythrocyte sedimentation rate. | 10 |
| 3 | Estimation of haemoglobin. | 10 |
| 4 | Examination of histological sections of mammalian oesophagus, stomach, duodenum, ileum, rectum, trachea, lung, Testis and Ovary. | 20 |
| 5 | Practical Records/Charts/Models. | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**

- Tortora, G.J.& Grabowski, S (2006) Principles of Anatomy & Physiology, XI edition. John Wiley & Sons
- Vander A, Sherman J, and Luciano D (2014). Vander's Human Physiology: The mechanism of Body Function. XIII Edition, Mc Graw Hills.
- Guyton, A.C & Hall, J.E. (2006). Textbook of Medical Physiology, XI Edition. Hercourt Asia PTE Ltd/W.B. Saunders Company

**Online Tools and Web Resources:**

- e portals like SWAYAM
- http://nsdl.niscair.res.in

John Wiley & Sons
- Vander A, Sherman J, and Luciano D (2014). Vander's Human Physiology: The mechanism of Body Function. XIII Edition, Mc Graw Hills.
- Guyton, A.C & Hall, J.E. (2006). Textbook of Medical Physiology, XI Edition. Hercourt Asia PTE Ltd/W.B. Saunders Company

**Online Tools and Web Resources:**
- e portals like SWAYAM
  http://nsdl.niscair.res.in

**Semester IV**
**Major Course 5 (MJC-5)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Cell Biology | 5 | 3 | 2 |

**Course Outcome:** Upon completion of the course, students should to be able to:
**CO-1:** Understand fundamental principles of cell biology.
**CO-2:** Explain structure and functions of cell organelles involved in diverse cellular processes.
**CO-3:** Appreciate how cells grow, divide, survive, die and regulate these important processes.
**CO-4:** Comprehend the process of cell signaling and its role in cellular functions.
**CO-5:** Have an insight of how defects in functioning of cell organelles and regulation of cellular processes can develop into diseases.
**CO-6:** Learn the advances made in the field of cell biology and their applications.

| MJC-5: Cell Biology (Theory: 3 Credits) 30 hrs | | |
|---|---|---|
| Unit | Topics to be covered | No. of lectures |
| 1 | 1. Overview of Virus, Prokaryotic and Eukaryotic cells. | 2 |
| 2 | 2. Plasma Membrane:<br>2.1 Various models of plasma membrane.<br>2.2 Transportacross membranes (passive and active transport). | 6 |
| 3 | 3. Cytoplasmic organelles:<br>3.1 Endoplasmic Reticulum – Structure, Signal hypothesis.<br>3.2 Golgi apparatus – Structure, Protein sorting.<br>3.3 Lysosomes and Peroxisomes.<br>3.4 Mitochondria – Structure, Respiratory chain and oxidative phosphorylation. | 10 |

| | | |
|---|---|---|
| 4 | 4. Nucleus:<br>4.1 Structure of Nucleus.<br>4.2 Euchromatin and Heterochromatin. | 6 |
| 5 | 5. Cell Division:<br>5.1 Cell cycle and Molecular basis of its regulation.<br>5.2 Mitosis and Meiosis. | 6 |
| | **Total** | **30** |

| MJC-5: Cell Biology (Practical: 2 Credits) 20hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours Full Marks-70 | | |
| Sl. No. | Name of Practicals/Experiments | Marks |
| 1 | Vital staining of mitochondria in buccal epithelium | 10 |
| 2 | Preparation of temporary stained squash of onion root tip to study various stages of mitosis. | 15 |
| 3 | Study of various stages of meiosis through permanent slides. | 10 |
| 4 | Preparation of temporary stained mount to show the presence of Barr body in human female blood cells/ cheek cells.<br>or<br>Preparation of polytene chromosome from salivary gland of Chironomus larva. | 15 |
| 5 | Practical Records/Charts/Models. | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**


- Cooper, G.M., Hausman, R.E. (2009) The Cell: A Molecular Approach. V Edition, ASMPress and Sinauer Associates.
- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments, VI Edition, JohnWiley & Sons Inc.
- Powar, C. B. (1991) Cell Biology, Himalaya Publishing House


**Online Tools and Web Resources:**

- https://swayam.gov.in/course/150-cell-biology
- https://swayam.gov.in/courses/5173-biochemistry-and-cell-biology
- https://www.jove.com/science-education-library/9/cell-biology
- https://www.khanacademy.org/science/biology

## Major Course 6 (MJC-6)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| **Endocrinology** | 5 | 3 | 2 |

**Course Outcome:** After completion of the course the students will be able to:

**CO-1:** Understand endocrine system and the basic properties of hormones.

**CO-2:** Appreciate the importance of endocrine system and the crucial role it plays along with thenervous system in maintenance of homeostasis.

**CO-3:** Gain insight into the molecular mechanism of hormone action and its regulation.

**CO-4:** Know the regulation of physiological process by the endocrine system and its implication indiseases.

**CO-5:** Gain knowledge about the prevalent endocrine disorders and critically analyze their ownand their family's health issues.

| MJC-6: Endocrinology (Theory: 3 Credits) 30 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of lectures** |
| 1 | 1. Introduction to Endocrinology:<br>1.1 Overview of the endocrine system.<br>1.2 Classification of hormones and their synthesis. | 6 |
| 2 | 2. Hypothalmo-hyphophysial system:<br>2.1 Structure of hypothalamus and its role in neuroendocrine regulation.<br>2.2 Structure of pituitary gland, its hormones and function.<br>2.3 Hormonal dysfunction associated with pituitary gland. | 10 |
| 3. | 3. Peripheral Endocrine Glands:<br>3.1 Functional histology, hormones and function of Thyroid, Parathyroid, Adrenal, Islets of Langerhans and Gonads.<br>3.2 Disorders related to hypersecretion and hyposecretion of hormones. | 8 |
| 4. | 4. Molecular Endocrinology:<br>4.1 Hormone receptors.<br>4.2 Mechanism of hormone action (Steroid and Non-steroid).<br>4.3 Regulation of hormone action. | 6 |
| | **Total** | **30** |

| MJC-6: Endocrinology (Practical: 2 Credits) 20 hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours | | Full Marks-70 |
| **Sl. No.** | **Name of practicals/experiments** | **Marks** |
| 1 | Display of gonads, thyroid, adrenal, pancreas in mammal through videos/models | 15 |
| 2 | Study of the permanent slides of Pituitary, Adrenal, Ovary, Testes, Islets of Langerhan's, Thymus, Thyroid and Parathyroid, Study of the permanent slide of vaginal smears | 4x5=20 |
| 3 | Estimation of plasma level of any hormone using ELISA<br>Or<br>Chromatographic separation of steroid hormones using paper chromatography. | 15 |
| 4 | Practical Records/Charts/Models | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books:**

- J. Larry Jameson Leslie De Groot (2010). Endocrinology. VI Edition.
- David O. Norris. Vertebrate Endocrinology. V Edition, Elsevier Academic press.
- Franklin F. Bolander. Molecular Endocrinology. III Edition, Academic Press, USA.

**Online Tools and Web Resources:**

- https://www.endocrine.org/topics

## Major Course 7 (MJC- 7)

**Course Outcome:** Upon completion of the course, students should be able to:

**CO-1:** Demonstrate an understanding of key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors.

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Ecology | 5 | 3 | 2 |

**CO-2:** Comprehend the population characteristics, dynamics, growth models and interactions.

**CO-3:** Understand the community characteristics, ecosystem development and climax theories.

**CO-4:** Know about the types of ecosystems, food chains, food webs, energy models and ecological efficiencies.

**CO-5:** Apply the basic principles of ecology in wildlife conservation and management.

**CO-6:** Inculcate scientific quantitative skills, evaluate experimental design, read graphs, andanalyse and use information available in scientific literature.

| MJC-7: Ecology (Theory: 3 Credits) 30 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of lectures** |
| 1 | 1. Components of Ecology:<br>1.1 Biotic factors.<br>1.2 Abiotic factors.<br>1.3 Laws of limiting factors. | 2 |
| 2 | 2. Ecosystem:<br>2.1 Definition, structure, and function of different types of ecosystems including wetland ecosystem.<br>2.2 Food chain and Food web.<br>2.3 Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies.<br>2.4 Biogeochemical cycles. | 10 |
| 3 | 3. Population ecology:<br>3.1 Study of population attributes (Natality, Mortality, Density).<br>3.2 Life tables; Exponential and logistic growth, equation and patterns, r and k strategies.<br>3.3 Population interactions; Lotka-Volterra model. | 6 |
| 4 | 4. Community Ecology:<br>4.1 Community characteristics: species richness, dominance, diversity, abundance, Ecotone and Edge effect.<br>4.2 Ecological succession with examples and types. | 4 |
| 5 | 5. Applied Ecology:<br>5.1 Biodiversity - Importance and threats.<br>5.2 Wildlife conservation and management; National Parks, Bioreserves and Sanctuaries.<br>5.3 Pollution and its hazards. | 8 |
| | **Total** | **30** |

Mayank.

| MJC-7: Ecology (Practical: 2 Credits) 20 hrs | | |
|---|---|---|
| End Semester Examination | | |
| Time – 3 hours | | Full Marks-70 |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Analysis of Soil/Pond Biota<br>Or<br>Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. | 10 |
| 2 | Determination of dissolved oxygen and pH measurements of different water samples. | 15 |
| 3 | Determination of population density in a natural/ hypothetical community by quadrate method. | 15 |
| 4 | Report on a visit to National Park/Biodiversity Park/ Wild life sanctuary/Zoo. | 10 |
| 5 | Practical Records/Charts/Models. | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**


- Odum, E.P. (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Smith, R. L. (2000). Ecology and field biology. Harper and Row published

| MIC- 4: Ecology (Practical: 1 Credit) 10hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours | | Full Marks- 70 |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Analysis of Pond Biota | 10 |
| 2 | Determination of dissolved oxygen of different water samples. | 15 |
| 3 | Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided. | 15 |
| 4 | Determination of population density in a natural/ hypothetical community by quadrate method. | 10 |
| 5 | Practical Records/Charts/Models. | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**


- Odum, E.P. (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Smith, R. L. (2000). Ecology and field biology. Harper and Row publisher
- Colinvaux, P.A. (1993). Ecology. John Willey S Sons, Inc
- Krebs, C. J. (2001). Ecology. Benjamin Cummings.


## Semester V

## Major Course 8 (MJC-8)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| **Biochemistry** | **5** | **3** | **2** |

**Course Outcome:** After the completion of the course, the student will be able:

**CO1-** To understand the structure, classification and importance of Carbohydrates and Proteins.

**CO2-** To understand the structure and significance of physiologically important Lipids.

**CO3-** To understand the basic structure and types of DNA and RNA, Base pairing, denaturation and renaturation of DNA.

**CO4-** To understand the types of Enzymes, Mechanism of Enzyme Action and Enzyme Kinetics.

| MJC-8: Biochemistry (Theory: 3 credits) 30 hrs | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Elementary idea of biomolecule:<br>1.1 Structure and classification of Carbohydrates, Lipid and Protein.<br>1.2 Structure, classification and physiological importance of Amino Acids.<br>1.3 Structure, classification and physiological importance of Vitamins. | 10 |
| 2 | 2. Enzymes:<br>2.1 Nomenclature and classification, Isozymes.<br>2.2 Kinetics of enzyme-substrate reactions.<br>2.3 Regulation of enzyme action. | 6 |
| 3 | 3. Carbohydrate Metabolism:<br>3.1 Glycolysis and Citric acid cycle.<br>3.2 Pentose Phosphate Pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis. | 8 |
| 4 | 4. Lipid and Protein Metabolism:<br>4.1 Beta oxidation and omega-oxidation of fatty acids, Ketogenesis.<br>4.2 Transamination, Deamination, Urea cycle. | 6 |
| | **TOTAL** | **30** |

| MJC-8 : Biochemistry (Practical: 2 credits) 20 hrs<br>End Semester Examination<br>Time – 3 hours Full Marks-70 | | |
|---|---|---|
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Qualitative tests of carbohydrates, proteins and lipids. | 20 |
| 2 | Paper chromatography of amino acids. | 15 |
| 3 | Demonstration of impact of pH, temperature and inhibitors on the action of salivary amylase. | 15 |
| 4 | Practical Records/Charts/Models. | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books:**


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

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.\
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.


**Major Course 9 (MJC-9)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Genetics | 5 | 3 | 2 |

**Course Outcome:** After the completion of the course, the student will be able:

**CO 1-** To explain and discuss the genetic variation through linkage and crossing over.

**CO 2-** To describe sex-linked, sex limited and sex influenced inheritance.

**CO 3-** To understand the Concept behind genetic disorder, gene mutations and molecular basis of mutations and to explain the criteria for extra-chromosomal inheritance.

**CO 4-** To describe the molecular mechanisms of recombination in bacteria and to explain and distinguish the concept of transposable genetic elements in prokaryotes and eukaryotes. To Solve genetic based problems.

| MJC-9 Genetics (Theory: 3 credits) 30 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Mendelian Genetics and Linkage:<br>1.1 Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis and Pleiotropy.<br>1.2 Linkage and crossing over; its cytological basis and molecular mechanisms, Recombination frequency, Interference and coincidence. | 8 |
| 2 | 2. Mutations:<br>2.1 Gene mutation - Chemical and Physical mutagenesis.<br>2.2 Chromosomal aberrations – Structural and Numerical.<br>2.3 Detection of mutations in Drosophila - CLB method and attached *X* method. | 8 |
| 3 | 3. Sex Determination:<br>3.1 Chromosomal mechanisms of sex determination.<br>3.2 Genetic and molecular basis of sex determination in *Drosophila*.<br>3.2 Sex-linked inheritance, sex-influenced and sex-limited characters. | 6 |
| 4 | 4. Extra-chromosomal Inheritance and Quantitative Genetics: | 8 |

| | | |
|---|---|---|
| | 4.1 Criteria for extra-chromosomal inheritance.<br>4.2 Antibiotic resistance in *Chlamydomonas*, Kappa particles in *Paramoecium* and Maternal effects (Shell spiralling in *snail*).<br>4.3 Polygenic inheritance. | |
| | **TOTAL** | **30** |

| **MJC-9 : Genetics (Practical: 2 credits) 20 hrs** | | |
|---|---|---|
| **End Semester Examination**<br>**Time – 3 hours** **Full Marks-70** | | |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Identification of various mutants of *Drosophila* in the given photograph/ specimen.<br>Practical Records / charts / models.<br>Viva-voce. | 15 |
| 2 | Calculate allelic/ genotypic frequencies using Hardy-Weinberg's Principle. | 20 |
| 3 | Solving problem based on Mendelian laws and Linkage map from *Drosophila* crosses. | 15 |
| 4 | Practical Records/Charts/Models. | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books:**


- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles ofGenetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach*.III Edition. Benjamin Cummings
- Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London.

| MIC-06 : Genetics (Practical: 1 Credit) 10 hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours | | Full Marks-70 |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Preparation of Polytene chromosomes from Chironomous/Drosophila. | 20 |
| 2 | Identification of various mutants of Drosophila in the given photograph. | 15 |
| 3 | Study of pedigree analysis of human inherited traits. | 15 |
| 4 | Practical Records/Charts/Models. | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books:**


- Gardner, E. J., Simmons, M. J., Snustad, D. P. (2008). *Principles of Genetics*. VIII Edition. Wiley, India
- Snustad, D. P., Simmons, M. J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W. S., Cummings, M. R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
- Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. G S, Taylor and Francis Group, New York and London.


## Semester VI

## Major Course 10 (MJC-10)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Developmental Biology | 4 | 3 | 1 |

**Course Outcome:** After the completion of the course, the student will be able:

**CO 1-** To describe the mechanism of gametogenesis, fertilization and blocks to polyspermy.

**CO 2-** To explain early embryonic development in frog and chick.

**CO 3-** To understand the concepts of late embryonic development in model organisms.

**CO4 -** To describe post embryonic development such as metamorphosis and regeneration with suitable examples and apply important experiments and project work.

| MJC-10: Developmental Biology (Theory: 3 credits) 30 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Introduction:<br>1.1 Principles and Basic concepts of development biology - Phases of development, Cell-Cell interaction, Differentiation and growth<br>1.2 Gametogenesis: Spermatogenesis and Oogenesis. | 10 |

| | | |
|---|---|---|
| | 1.3 Mechanism of fertilization, Types of eggs and cleavage, Blastulation, Fate maps (including Techniques). | |
| 2 | 2. Early and Late Embryonic Development:<br>2.1 Early development of frog and chick up to gastrulation.<br>2.2 Late Embryonic Development: Fate of Germ Layers, Extra-embryonic membranes in birds, Placentation. | 8 |
| 3 | 3. Post Embryonic Development:<br>3.1 Metamorphosis: Changes, hormonal regulations in amphibians.<br>3.2 Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each). | 6 |
| 4 | 4. Implications of Developmental Biology:<br>4.1 Teratogenesis: Teratogenic agents and their effects on embryonic development.<br>4.2 In vitro fertilization, Stem cell, Amniocentesis.<br>4.3 Basic concept of Aging and senescence. | 6 |
| | **TOTAL** | **30** |

| **MJC-10: Developmental Biology (Practical: 1 Credit) 10 hrs** | | |
|---|---|---|
| **End Semester Examination**<br>**Time – 3 hours** **Full Marks-70** | | |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages). | 2x5=10 |
| 2 | Study of whole mounts of developmental stages of chick through permanent slides (Different hours of incubation). | 5x3=15 |
| 3 | Study of the developmental stages and life cycle of Drosophila from stock culture. | 15 |
| 4 | Study of different sections of placenta (Photomicrograph/ slides). | 10 |
| 5 | Practical Records/Charts/Models. | 10 |
| 6 | Viva-voce. | 10 |

**Suggested Books:**


- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Carlson, R. F. Patten's Foundations of Embryology
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill PublishersLewis Wolpert (2002).
- Principles of Development. II Edition, Oxford University Press


**Major Course 11 (MJC-11)**

| Course Title | Credit | Credit Distribution |
|---|---|---|

| | | Theory | Practical |
|---|---|---|---|
| **Evolution** | **5** | **3** | **2** |

**Course Outcome:** After the completion of the course, the student will be able:

**CO 1-** To understand the basis of origin of life such as: chemogeny, RNA world, biogeny and evolution of eukaryotes.

**CO 2-** To obtain the various evolutionary concepts and heritable variation and to understand concept of species, isolating mechanisms, modes of speciation and adaptive radiation.

**CO 3-** To explain and different types of fossils, geological time scale, climatic conditions, hominid characteristics, primate phylogeny and evolution of horse and man.

**CO 4-** To understand Hardy-Weinberg principle of genetic equilibrium and its destabilizing forces such as Natural selection, Mutation, Migration and genetic drift.

| **MJC-11: Evolution (Theory: 3 credits) 30 hours** | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of hours** |
| 1 | 1. Origin of Life:<br>1.1 Chemogeny and RNA World.<br>1.2 Evolution of Eukaryotes. | 6 |
| 2 | 2. Evolutionary concepts:<br>2.1 Lamarckism, Darwinism and Neo-Darwinism.<br>2.2 Types and causes of Variation and their role in evolution. | 8 |
| 3 | 3. Evidences of Evolution:<br>3.1 Evidences of Organic Evolution.<br>3.2 Types of fossils and geological time scale.<br>3.2 Evolution of horse and man.<br>3.3 Human migration-Theories, Mitochondrial DNA and Y-chromosome studies. | 8 |
| 4 | 4. Population Genetics:<br>4.1 Hardy-weinberg Law, gene pool and allele frequency.<br>4.2 Natural selection (concept of fitness, types of selection, kin selection).<br>4.3 Genetic Drift (mechanism, founder's effect, bottleneck phenomenon). | 8 |
| | **TOTAL** | 30 |

| MJC-11: Evolutionary Biology (Practical: 2 Credits) 20 hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours | | Full Marks-70 |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Study of types of fossils, Archaeopteryx. | 15 |
| 2 | Vestigial, Analogous and Homologous organs using suitable specimens<br>or<br>Sampling for discrete characteristics (dominant vs recessive) for discontinuous variations e.g. hitch-hiker's thumb, tongue rolling and ear lobe. | 15 |
| 3 | Calculation of genotypic, phenotypic and allelic frequencies from the data provided. | 20 |
| 4 | Practical records/ charts/ models | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books:**


- Ridley, M. (2004). Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Snustad. S Principles of Genetics.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell
- Savage, Evolution


**Major Course 12 (MJC-12)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| **Animal Behaviour** | **5** | **3** | **2** |

**Course Outcomes-** After the completion of the course, the student will be able:

**CO 1-** To understand various pattern of animal behaviours such as stereotyped, instinct, learnt, associative behaviour along with operant conditioning and habituation imprinting and to explain the concept of social and sexual behaviour.

**CO 2-** To provide the concept of biological rhythm, photoperiod and regulation of seasonal reproduction of vertebrates and role of melatonin.

**CO 3-** To understand the relevance of biological clock in terms of chronopharmacology, chronomedicine and chronotherapy.

**CO 4-** To develop the skill in this course by performing practical works such as studying nest and nesting habitat of birds and social insects and other significant experiments.

| MJC-12: Animal Behaviour (Theory: 3 credits) 30 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Introduction to Animal Behaviour:<br>1.1 Definition of behaviour.<br>1.2 Brief profile of modern ethologists (Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen).<br>1.3 Proximate and ultimate causes of behaviour. | 6 |
| 2 | 2. Patterns of behaviour and its Control:<br>2.1 Stereotyped Behaviour; Orientation and Reflex.<br>2.2 Innate and Learned behaviours. | 8 |
| 3 | 3. Biological Rhythm:<br>3.1 Biological clocks in animals, Adaptive significance of biological clocks<br>3.2 Types of biological rhythms- Tidal, Lunar, Circadian and Circannual<br>3.3 Role of melatonin | 8 |
| 4 | 4. Social and Sexual Behaviour:<br>4.1 Social behaviour of insects (Honey bee), Foraging and dances in honey bee.<br>4.2 Parental care in fishes and amphibians. | 8 |
| | **TOTAL** | **30** |

| MJC-12: Animal Behaviour (Practical: 2 Credits) 20 hrs | | |
|---|---|---|
| **End Semester Examination**<br>**Time – 3 hours** **Full Marks-70** | | |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Study of the pattern of Behaviour (any one of the followings)<br>a) Photo Tactile Response in Earthworms or *Paramecium*.<br>b) Geotactic Response of Earthworm or Pest. | 15 |
| 2 | Comment upon the given specimen with response to parental care – Ichthyophis, Alytes and Hippocampus etc. | 15 |
| 3 | Submit and write-up on any one of the given topic:<br>a) Courtship in Peacock /Pigeons<br>b) Maternal Behavior in Rats /Cats<br>c) Study of nests and nesting behavior of the birds and social insects<br>d) Study of honey bee hive | 20 |
| 4 | Practical records/ charts/ models | 10 |
| 5 | Viva- voce. | 10 |

Mayank.

**Suggested Books:**


- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge,University Press, UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.


**Semester VI**
**Minor Course 7 (MIC-7)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Evolution | 3 | 2 | 1 |

| MIC-7: Evolution (Theory: 2 Credits) 20 hours | | |
|---|---|---|
| Unit | Topics to be covered | No. of Lectures |
| 1 | Origin of Life: Chemogeny and Biogeny | 4 |
| 2 | Evolutionary concepts: A brief account of evolutionary theories: Lamarckism, Darwinism and Neo- Darwinism. | 8 |
| 3 | Evidences of Evolution, Evolution of man. | 6 |
| 4 | Population Genetics: Hardy-Weinberg Law | 2 |
| | TOTAL | 20 |

| MIC-7: Evolutionary Biology (Practical: 1 Credits) 10 hrs | | |
|---|---|---|
| End Semester Examination | | |
| Time – 3 hours | | Full Marks-70 |
| Sl. No. | Name of Practicals/Experiments | Marks |
| 1 | Study of types of fossils (Archaeopteryx- a connecting link) | 10 |
| 2 | Vestigial, Analogous and Homologous organs using suitable specimens. | 15 |
| 3 | Sampling for discrete characteristics (dominant vs recessive) for discontinuous variations e.g., tongue rolling, ear lobe. | 10 |
| 4 | Calculation of genotypic, phenotypic and allelic frequencies from the data provided | 15 |
| 5 | Practical records/ charts/ models | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**

- Ridley, M. (2004). Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell


## Minor Course 08 (MIC-08)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| **Developmental Biology** | **3** | **2** | **1** |

**Course Outcome:** After the completion of the course, the student will be able:

**CO 1-** To describe the mechanism of gametogenesis, fertilization.

**CO 2-** To explain early embryonic development in frog and chick.

**CO 3-** To understand the concepts of late embryonic development in model organisms.

**CO4** - To describe post embryonic development such as metamorphosis and regeneration with suitable examples and apply important experiments and project work.

| MIC-08 : Developmental Biology (Theory: 2 credits) 20 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | Introduction:<br>1. Basic concepts of reproduction and development. | 4 |
| 2 | Early and Late Embryonic Development:<br>2.1 Gametogenesis - Spermatogenesis, Oogenesis.<br>2.2 Types of eggs, Patterns of cleavage and Blastulation.<br>2.3 Early development of frog up to gastrulation,<br>2.4 Extra-embryonic membranes in birds. | 6 |
| 3 | Post Embryonic Development:<br>3.1 Metamorphosis: Changes, hormonal regulations in amphibians;<br>3.3 Ageing: Concepts and Theories | 5 |
| 4 | Implications of Developmental Biology:<br>4.1 Teratogenesis: Teratogenic agents and their effects on embryonic development.<br>4.2 In vitro fertilization. | 5 |
| | **TOTAL** | 20 |

| MIC-08: Developmental Biology (Practical: 1 Credit) 10 hrs | | |
|---|---|---|
| End Semester Examination<br>Time – 3 hours | | Full Marks-70 |
| Sl. No. | Name of Practicals/Experiments | Marks |
| 1 | Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula. | 20 |
| 2 | Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak 18, 24, 36, 48, 72, and 96 hours of incubation. | 20 |
| 3 | Study of different sections of placenta (Photomicropgraph/ slides) | 10 |
| 4 | Practical/Project report on chick embryo development. | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books:**


- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.
- Carlson, R. F. Patten's Foundations of Embryology.
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw Hill Publishers.
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.


**Semester VII**

**Major Course 13 (MJC-13)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| **Molecular Biology** | **5** | **3** | **2** |

**Course Outcome:** After the completion of the course, the student will be able:

**CO 1-** To understand Central dogma of molecular biology. Explain and distinguish mechanism of replication, transcription and translation in prokaryotes and eukaryotes.

**CO 2-** To understand and explain the post transcriptional modifications in eukaryotes.

**CO 3-** To explain and differentiate the mechanism of gene expression and regulation in prokaryotes and eukaryotes

**CO 4-** To describe the concept of regulatory RNAs, Ribo-switches and RNA interference and to enhance skill in molecular biology through relevant experiments.

| MJC-13: Molecular Biology (Theory: 3 credits) 30 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Basics of Nucleic Acid:<br>1.1 Central Dogma of Molecular Biology.<br>1.2 Structure of DNA, DNA forms, Repetitive DNA.<br>1.3 Structure and functions of mRNA, tRNA, and rRNA. | 8 |
| 2 | 2. DNA replication and repair:<br>2.1 DNA replication in prokaryotes.<br>2.2 DNA repair, mismatch repair, Base excision repair (BER), Nucleotide excision repair (NER).<br>2.3 Difference between prokaryotic and eukaryotic replication (A brief account) | 8 |
| 3 | 3. Transcription:<br>3.1 Mechanism of transcription in prokaryotes.<br>3.2 Difference between prokaryotic and eukaryotic transcription (A brief account). | 6 |
| 4 | 4. Translation:<br>4.1 Genetic code, degeneracy of genetic code and Wobble hypothesis.<br>4.2 Structure of ribosomes.<br>4.3 Mechanism of translation in prokaryotes.<br>4.4 Difference between prokaryotes and eukaryotes translation (A brief account). | 8 |
| | **TOTAL** | 30 |

| MJC-13: Molecular Biology (Practical: 2 Credits) 20 hrs | | |
|---|---|---|
| **End Semester Examination** | | |
| **Time – 3 hours** | | **Full Marks-70** |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Demonstration of DNA by Feulgen reaction or RNA by Methyl Green Pyronin (MGP) method. | 20 |
| 2 | Isolation of plasmid/genomic DNA<br>or<br>Restriction digestion of DNA. | 15 |
| 3 | DNA gel electrophoresis<br>or<br>Preparation of nucleotide model by beads and sticks. | 15 |
| 4 | Practical/Project report on chick embryo development. | 10 |
| 5 | Viva- voce. | 10 |

**Suggested Books :**


- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell.* VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter:*Molecular Biology of the Cell*, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments.* VI Edition. John Wiley and Sons. Inc.


**Major Course 14 (MJC-14)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Research Methodology | 5 | 5 | 0 |

**Common Syllabus of MJC -14 for all the subjects of the Faculty of Sciences has been separately prepared.**

**Major Course 15 (MJC-15)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Immunology and Microbiology | 6 | 4 | 2 |

**Course Outcomes:** After the completion of the course, the student will be able:

**CO 1-** To explain cells and organs of the immune system, innate and adaptive immunity.

**CO 2-** To describe autoimmunity with reference to rheumatoid arthritis and tolerance and AIDS.

**CO 3-** To understand antigens and its type, structure and functions of immunoglobulins, antigen-antibody interactions and immunoassays (such as ELISA and RIA).

**CO 4-** To explain structure and functions major histocompatibility complex, know the concept of hypersensitivity and vaccines.

**CO 5-** To understand the microbial basis of diseases.

| MJC-15 : Immunology and Microbiology (Theory: 4 credits) 40 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Basic Concept of immunity:<br>1.1 Overview of Immune System, Cells and organs of Immune system. | 10 |

| | | |
|---|---|---|
| | 1.2 Innate and Adaptive Immunity - Anatomical barriers, Inflammation and Phagocytosis, Mechanism of cell and humoral mediated immunity, Active and Passive immunity. | |
| 2 | 2. Antigen and Immunoglobulin:<br>2.1 Antigens; Antigenicity vs immunogenicity, Factors influencing immunogenicity, Adjuvants and haptens.<br>2.2 Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions | 8 |
| 3 | 3. MHC and Cytokines:<br>3.1 Major Histocompatibility Complex: Structure and functions of MHC I and II, Antigen processing and presentation.<br>3.2 Cytokines – Types and function. | 6 |
| 4 | 4. Complement system and Vaccines:<br>4.1 Complement System: Components and pathways of complement activation.<br>4. 2 Vaccines: Various types of vaccines. | 6 |
| 5 | 5. Microbiology:<br>5.1 Bacteria; Structure, Classification, Growth, Culture and Pathogenicity.<br>5.2 Virus; Morphology and Pathogenicity.<br>5.3 A brief outline of endoparasitic diseases. | 10 |
| | **TOTAL** | **40** |

| **MJC-15 : Immunology and Microbiology (Practical: 2 Credits) 20 hrs** | | |
|---|---|---|
| **End Semester Examination**<br>**Time – 3 hours** | | **Full Marks-70** |
| **Sl. No.** | **Name of Practicals/Experiments** | **Marks** |
| 1 | Determination of ABO blood group using ABD antisera method. | 15 |
| 2 | Study of lymphoid organs:<br>(i) Kidney<br>(ii) Spleen<br>(iii) Bone marrow<br>(iv) Lymph node | 15 |
| 3 | Comment upon working principle of RIA, Flow Cytometry, ELISA. | 10 |
| 4 | Culture and Gram staining of Bacteria | 10 |
| 5 | Practical/Project report on chick embryo development. | 10 |
| 6 | Viva- voce. | 10 |

**Suggested Books:**


- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Publication.

- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Edition. Saunders Publication.
- Abbas, K.Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V
- Owen J A, Punt J, Stanford S A (2013). *Kuby Immunology* W H Freeman & Co;
- Wood P. (2007). Basic Immunology. Pearson publication
- Principles of Microbiology, Ronald M. Atlas, Wm. C. Brown Publishers.
- Microbiology by Pelczar, M. J. Pelczar.


## Minor Course 09

## (MIC-09)

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| **Animal Behaviour** | **3** | **2** | **1** |

**Course Outcomes:** After the completion of the course, the student will be able:

**CO 1-** To understand various pattern of animal behaviours such as stereotyped, instinct, learnt, associative behaviour along with operant conditioning and habituation imprinting and to explain the concept of social and sexual behaviour.

**CO 2-** To provide the concept of biological rhythm, photoperiod and regulation of seasonal reproduction of vertebrates and role of melatonin.

**CO 3-** To understand the relevance of biological clock in terms of chronopharmacology, chronomedicine and chronotherapy.

**CO 4-** To develop the skill in this course by performing practical works such as studying nest and nesting habitat of birds and social insects and other significant experiments.

| MIC-09 : Animal Behaviour (Theory: 2 credits) 20 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | Introduction to Animal Behaviour:<br>1.1 Definition and types of behaviour<br>1.2 Origin and history of ethology. | 5 |
| 2 | Patterns of Behaviour:<br>2.1 Instinct behaviours.<br>2.2 Learned behaviours. | 5 |
| 3 | Biological Rhythm:<br>3.1 Biological clocks in animals and its adaptive significance.<br>3.2 Types of biological rhythms- Tidal, Lunar, Circadian and Circannual. | 5 |
| 4 | Social Behaviour:<br>4.1 Social behaviour in insects (Honey bee).<br>4.2 Parental care in fishes. | 5 |
| | **TOTAL** | **20** |

**Semester VIII**

**Major Course 16 (MJC-16)**

| Course Title | Credit | Credit Distribution | |
|---|---|---|---|
| | | Theory | Practical |
| Instrumentation and Biometry | 4 | 4 | 0 |

**Course Outcomes:** After the completion of the course, the student will be able:

**CO1:** To understand the principles and working of various instruments used in biological experimentation.

**CO2:** Gain insight of relationship between mathematics and biology

**CO3:** To present their data in statistically reliable form

**CO4:** To test their hypothesis using different models

**CO5:** To correlate their data with different factors

| MJC-16: Instrumentation and Biometry (Theory: 4 credits) 40 hours | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Lectures** |
| 1 | 1. Instrumentation:<br>1.1 Principle and uses of: pH meter, Colorimeter, Spectrophotometer, Centrifuge.<br>1.2 Microscopy: Light microscope, Compound microscope, Phase contrast, Fluorescent and Electron Microscope. | 10 |
| 2. | 2. Biological Techniques:<br>2.1 Electrophoresis - Agarose gel, SDS-PAGE electrophoresis.<br>2.2 Chromatography - Column, GLC.<br>2.3 Cell separation by density gradient centrifugation.<br>2.4 Introduction to different culture medium and tools used.<br>2.5 PCR<br>2.6 Recombinant DNA Technology | 10 |
| 3 | 3. Introduction to Biometry:<br>3.1 Concept of data and graphical presentation of data.<br>3.2 Measures of central tendency: mean, mode and median.<br>3.3 Measures of dispersion, standard deviation, standard error.<br>3.4 Types of variables; Poisson, Binomial and Normal distribution.<br>3.5 Experimental design and hypothesis testing. | 10 |
| 4 | Tests of Significance:<br>4.1 Test of significance: t-test, F-test, chi square test<br>4.2 Multiple linear regression – ANOVA (One way and two-way ANOVA).<br>4.3 Correlation and simple linear regression<br>4.4 Karl-Pearson correlation coefficient and Ranks correlation coefficient | 10 |
| | **TOTAL** | 40 |

**Suggested Books :**


- AB Khanal (2016). Mahajan's Methods inBiostatistics for Medical Students and Research Workers. Jaypee Brothers Medical Publishers.

- Jerrold H. Zar (2009).Biostatistical analysis.Pearson publication.
- RC Elston and WD Johnson (2008). Basic Biostatistics for Geneticists and Epidemiologists. Wiley publication.
- Norman TJ Bailey (2000). Statistical Methods in Biology. Published by: Cambridge University Press
- Biological instrumentation and Methodology, P. K. Bajpai.
- Instrumentation: Theory and Application, S. Sheel.


**Virtual Labs:**

1. http://www.vlab.co.in
2. http://zoologygysan.blogpost.com
3. www.onlinelabs.in
4. www.labinapp.com
5. www.uwlax.edu
6. info@premierreducationaltechnologyies.com

## Syllabus for 4 Year Undergraduate Programme under CBCS System

## RESEARCH METHODOLOGY FOR FACULTY OF SCIENCE

### SEMESTER-VII: MAJOR COURSE-14 (MJC-14)

**Credits: Theory-05** **Full Marks:ESE-70 + CIA-30 = 100**

**Objective of the Course**

- To introduce fundamental of research process including problem identification. hypothesis concept and to draw conclusion.

**Learning outcome:**

After completion of this course the students will be able to

- Develop the skill of contextualization of knowledge and critical thinking
- Choose appropriate methods of research aims and objectives.
- Apply ethical principle in research work.
- Understand the philosophy of research integrity and publication ethics.

| MJC-XIV :Research Methodology (Credit: 5) | | |
|---|---|---|
| **Unit** | **Topics to be covered** | **No. of Hours (50)** |
| 1 | **Fundamental of Research** | |
| | 1.1 Philosophy, concept, aims, objectives, purpose and scope of research. | 04 |
| | 1.2 Types of Research : Descriptive *vs* Analytical, Pure *vs* Applied, Conceptual *vs* Empirical, Qualitative *vs* Quantitative,Scientific *vs*Technical. | 03 |
| | 1.3 Good Laboratory Practices and safety measures. | 02 |
| 2 | **Concept of Research Problem and Research Designing** | |
| | 2.1 Identifying the Research Problem: meaning; importance; sources; selecting, stating and evaluating a research problem | 03 |
| | 2.2 Hypothesis: Designing and Testing | 03 |
| | 2.3 Experimental Research and Design: Approximation of data, simulation and modelling | 02 |
| | 2.4Sampling: Types of sampling, Questionnaire and observational methods of data collection. | 03 |

19/9/23 19/09/23 19/09/2023

| | | |
|---|---|---|
| 3 | **Use of Tools and Techniques in Research**<br>3.1 Use of Search engines for reviewing of literature and data retrieving(Google scholar, PubMed, ResearchGate and ShodhGanga)<br>3.2 Use of Software: Microsoft Word, Microsoft Excel, Latex,SPSS/R/MATLAB/SCILAB/EndNote<br>3.3 Basic Statistical Methods and Techniques: Descriptive Statistics, Test of Significance, ANOVA, Regression Analysis.<br>3.4 Electronic submission of paper in different journals, Transferring big files through software | 02<br>03<br>03<br>03 |
| 4 | **Scientific Communication**<br>4.1 Steps of Research Paper writing: Title, Abstract and Keywords, Introduction, Material and Methods, Results and Discussion, Conclusion, Conflict of Interest, Acknowledgment, Table and Graphs, Appendices.<br>4.2 Research Proposal: Writing and Submission<br>4.3 Funding Agencies: BCST, UGC, CSIR, ICMR,DST, DBT, ICAR<br>4.4Seminar/Conference/Webinar presentation: Abstract writing and oral (PPT)and poster presentation.<br>4.5Journal: Types, Indexing, Concept of Impact factor and Citation. | 04<br>03<br>02<br>02<br>02 |
| 5 | **Research Publication and Ethics**<br>5.1 Ethical issues in Research<br>5.2 Plagiarism : Meaning, Types and Implications, Checking Software<br>5.3 IPR: Patent, Copyright and Trademark<br>5.4 UGC guidelines on Research Ethics | 02<br>02<br>01<br>01 |
| | **TOTAL** | **50** |

**Recommended Books:**


1. Research Methodology- C.R. Kothari
2. Research Methodology :Methods & Technique (2023) – VimalSagar, AGPH, Bhopal
3. Research Methodology for PhD Coursework (2023)- D.N. Pandit, Hindustan Publishing Corporation, New Delhi
4. Statistics: A modern approach (2022) - D.N. Pandit, Hindustan Publishing
5. Essays on Research Methodology (2015)-Hegde D.S. Springer
6. Research Methodology Step by Step Guide for Beginners (2019)-Kumar R. Sage Publication.
7. Research Methodology for Science: Michael P. Marden Cambridge Univ. Press
8. Fundamentals of Research Methodology and Statistics (2006): Singh Y.K. New Edge Publication


19/9/23 19/09/23 19/09/2023