

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: General characteristics and classification (up to order) of the following Phyla: Protozoa, Porifera, Cnidaria, Ctenophora, Platyhelminthes and Nematelminths, Annelida, Arthropoda, Mollusca, Echinodermata.	8
2	2.1. Protozoa: Structure and Life cycle of Paramecium, Plasmodium, Entamoeba histolytica, Trypanosoma, L. donovani 2.2. Porifera: Spicules and Canal system in sponges; affinities of the Phylum	10
3	3.1. Cnidaria: Structure and Life Cycle: Obelia, Aurelia 3.2. Ctenophora: General organization of Hormiphora; affinities of the phylum. 3.3 Platyhelminthes and Nematelminths: Structure and Life cycle of <i>Fasciola hepatica</i> , <i>Taenia solium</i> , <i>Ascaris lumbricoides</i> .	10
4	4.1. Annelida: Earthworm, Leech: Structure, locomotion, alimentary canal Reproduction. 4.2. Arthropoda: Peripatus, Adaptive variations in insect mouth parts. 4.3. Mollusca: Structure and Life cycle: Unio, Pila. Torsion and Detorsion in Gastropoda 4.4. Echinodermata: Structure: Star fish; Larval forms in Echinoderms; Water Vascular System in Echinoderms	12
TOTAL		40

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MJC-1: Diversity of Non-Chordata (Practical: 2 credits) 20 hrs

Practical:

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

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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*.

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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 General characteristics and classification (upto Order): Cephalochordata, Urochordata, Pisces, Amphibia, Reptilia, Aves, Mammals, Cyclostomata.	8
2	2. Origin and Evolution of Chordata. 3. Cephalochordata: Amphioxus. 4. Urochordata: Herdmania (including retrogressive metamorphosis). 5. Cyclostomata: Petromyzon.	10
3	6. Pisces: Migration, Osmoregulation, and accessory respiration. 7. Amphibia: Origin and Evolution; Parental care, Neoteny. 8. Reptilia: Poison and nonpoisonous snakes; Poison apparatus; biting and feeding mechanism in snakes.	12
4	9. Aves: Origin of birds; Flight adaptations; Migration in birds. 10. Mammals: Characters, distribution and affinities of Prototheria, Metatheria, Eutheria.	10
TOTAL		40

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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*, *Erinaceus*, *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.

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

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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: 1.1 Digestion, Absorption and Assimilation of Carbohydrates, Protein and Lipid. 1.2 Digestive glands.	5
2	2. Neuromuscular Physiology: 2.1 Structure of neuron, Propagation of nerve impulse. 2.2 Structure of skeletal muscle, Mechanism of muscle contraction 2.3 Neuromuscular junction.	5
3	3. Respiratory Physiology: 3.1 Ventilation and Internal Respiration. 3.2 Respiratory pigments. 3.3 Transport of gases in blood.	4
4	4. Cardiovascular System: 4.1 Components of blood and their function, blood coagulation. 4.2 Coronary circulation and heart beat. 4.3 Cardiac cycle and ECG. 4.4 Nervous and chemical regulation of heart rate.	8

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

MJC-4: Physiology (Practical: 1 Credit) 10hrs		
End Semester Examination		
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. Hecourt Asia PTE Ltd/W.B. Saunders Company

Online Tools and Web Resources:

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

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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: 2.1 Various models of plasma membrane. 2.2 Transport across membranes (passive and active transport).	6
3	3. Cytoplasmic organelles: 3.1 Endoplasmic Reticulum – Structure, Signal hypothesis. 3.2 Golgi apparatus – Structure, Protein sorting. 3.3 Lysosomes and Peroxisomes. 3.4 Mitochondria – Structure, Respiratory chain and oxidative phosphorylation.	10

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

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MJC-5: Cell Biology (Practical: 2 Credits) 20hrs		
End Semester Examination		
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. or 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, ASM Press and Sinauer Associates.
- Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments, VI Edition, John Wiley & 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>

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MJC-6: Endocrinology (Practical: 2 Credits) 20 hrs		
End Semester Examination		
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 Or 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, and analyse 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: 1.1 Biotic factors. 1.2 Abiotic factors. 1.3 Laws of limiting factors.	2
2	2. Ecosystem: 2.1 Definition, structure, and function of different types of ecosystems including wetland ecosystem. 2.2 Food chain and Food web. 2.3 Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies. 2.4 Biogeochemical cycles.	10
3	3. Population ecology: 3.1 Study of population attributes (Natality, Mortality, Density). 3.2 Life tables; Exponential and logistic growth, equation and patterns, r and k strategies. 3.3 Population interactions; Lotka-Volterra model.	6
4	4. Community Ecology: 4.1 Community characteristics: species richness, dominance, diversity, abundance, Ecotone and Edge effect. 4.2 Ecological succession with examples and types.	4
5	5. Applied Ecology: 5.1 Biodiversity - Importance and threats. 5.2 Wildlife conservation and management; National Parks, Bioreserves and Sanctuaries. 5.3 Pollution and its hazards.	8
Total		30

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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 Or 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 quadrat 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

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MIC- 4: Ecology (Practical: 1 Credit)		10hrs
End Semester Examination		
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 quadrat 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 & 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.

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

MJC 8 : Biochemistry (Practical: 2 credits) 20 hrs		
End Semester Examination		
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: 1.1 Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis and Pleiotropy. 1.2 Linkage and crossing over; its cytological basis and molecular mechanisms, Recombination frequency, Interference and coincidence.	8
2	2. Mutations: 2.1 Gene mutation - Chemical and Physical mutagenesis. 2.2 Chromosomal aberrations – Structural and Numerical. 2.3 Detection of mutations in <i>Drosophila</i> - CLB method and attached X method.	8
3	3. Sex Determination: 3.1 Chromosomal mechanisms of sex determination. 3.2 Genetic and molecular basis of sex determination in <i>Drosophila</i> . 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. 4.2 Antibiotic resistance in <i>Chlamydomonas</i> , Kappa particles in <i>Paramecium</i> and Maternal effects (Shell spiralling in <i>snail</i>). 4.3 Polygenic inheritance.	
	TOTAL	30

MJC-9 : Genetics (Practical: 2 credits) 20 hrs		
End Semester Examination		
Time – 3 hours		Full Marks-70
Sl. No.	Name of Practicals/Experiments	Marks
1	Identification of various mutants of <i>Drosophila</i> in the given photograph/specimen. Practical Records / charts / models. 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 <i>Drosophila</i> 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 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. GS, Taylor and Francis Group, New York and London.

MIC-06 : Genetics (Practical: 1 Credit) 10 hrs		
End Semester Examination		
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: 1.1 Principles and Basic concepts of development biology - Phases of development, Cell-Cell interaction, Differentiation and growth 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: 2.1 Early development of frog and chick up to gastrulation. 2.2 Late Embryonic Development: Fate of Germ Layers, Extra-embryonic membranes in birds, Placentation.	8
3	3. Post Embryonic Development: 3.1 Metamorphosis: Changes, hormonal regulations in amphibians. 3.2 Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each).	6
4	4. Implications of Developmental Biology: 4.1 Teratogenesis: Teratogenic agents and their effects on embryonic development. 4.2 In vitro fertilization, Stem cell, Amniocentesis. 4.3 Basic concept of Aging and senescence.	6
	TOTAL	30

MJC-10: Developmental Biology (Practical: 1 Credit) 10 hrs		
End Semester Examination		
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 Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

Major Course 11 (MJC-11)

Course Title	Credit	Credit Distribution
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Handwritten signatures and notes:
 Ansin, J.K. = 3hr, Platin, Bliska, 23, Banik, 41, Jyoti

MIC-08: Developmental Biology (Practical: 1 Credit) 10 hrs		
End Semester Examination		
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 (Photomicrograph/ 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: 1.1 Central Dogma of Molecular Biology. 1.2 Structure of DNA, DNA forms, Repetitive DNA. 1.3 Structure and functions of mRNA, tRNA, and rRNA.	8
2	2. DNA replication and repair: 2.1 DNA replication in prokaryotes. 2.2 DNA repair, mismatch repair, Base excision repair (BER), Nucleotide excision repair (NER). 2.3 Difference between prokaryotic and eukaryotic replication (A brief account)	8
3	3. Transcription: 3.1 Mechanism of transcription in prokaryotes. 3.2 Difference between prokaryotic and eukaryotic transcription (A brief account).	6
4	4. Translation: 4.1 Genetic code, degeneracy of genetic code and Wobble hypothesis. 4.2 Structure of ribosomes. 4.3 Mechanism of translation in prokaryotes. 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 70		Full Marks-
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 or Restriction digestion of DNA.	15
3	DNA gel electrophoresis or Preparation of nucleotide model by beads and sticks.	15
4	Practical/Project report on chick embryo development.	10
5	Viva- voce.	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: 2.1 Antigens; Antigenicity vs immunogenicity, Factors influencing immunogenicity, Adjuvants and haptens. 2.2 Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions	8
3	3. MHC and Cytokines: 3.1 Major Histocompatibility Complex: Structure and functions of MHC I and II, Antigen processing and presentation. 3.2 Cytokines – Types and function.	6
4	4. Complement system and Vaccines: 4.1 Complement System: Components and pathways of complement activation. 4.2 Vaccines: Various types of vaccines.	6
5	5. Microbiology: 5.1 Bacteria; Structure, Classification, Growth, Culture and Pathogenicity. 5.2 Virus; Morphology and Pathogenicity. 5.3 A brief outline of endoparasitic diseases.	10
	TOTAL	40

MJC-15 : Immunology and Microbiology (Practical: 2 Credits) 20 hrs		
End Semester Examination		
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: (i) Kidney (ii) Spleen (iii) Bone marrow (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 Lichtman 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: 1.1 Definition and types of behaviour 1.2 Origin and history of ethology.	5
2	Patterns of Behaviour: 2.1 Instinct behaviours. 2.2 Learned behaviours.	5
3	Biological Rhythm: 3.1 Biological clocks in animals and its adaptive significance. 3.2 Types of biological rhythms- Tidal, Lunar, Circadian and Circannual.	5
4	Social Behaviour: 4.1 Social behaviour in insects (Honey bee). 4.2 Parental care in fishes.	5
TOTAL		20

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Dr. Shri. Shikha Mishra
Dr. Shikha

Dr. Anil

Dr. Anil
Dr. Anil

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: 1.1 Principle and uses of: pH meter, Colorimeter, Spectrophotometer, Centrifuge. 1.2 Microscopy: Light microscope, Compound microscope, Phase contrast, Fluorescent and Electron Microscope.	10
2.	2. Biological Techniques: 2.1 Electrophoresis - Agarose gel, SDS-PAGE electrophoresis. 2.2 Chromatography - Column, GLC. 2.3 Cell separation by density gradient centrifugation. 2.4 Introduction to different culture medium and tools used. 2.5 PCR 2.6 Recombinant DNA Technology	10
3	3. Introduction to Biometry: 3.1 Concept of data and graphical presentation of data. 3.2 Measures of central tendency: mean, mode and median. 3.3 Measures of dispersion, standard deviation, standard error. 3.4 Types of variables; Poisson, Binomial and Normal distribution. 3.5 Experimental design and hypothesis testing.	10
4	Tests of Significance: 4.1 Test of significance: t-test, F-test, chi square test 4.2 Multiple linear regression – ANOVA (One way and two-way ANOVA). 4.3 Correlation and simple linear regression 4.4 Karl-Pearson correlation coefficient and Ranks correlation coefficient	10
TOTAL		40

Suggested Books :

- AB Khanal (2016). Mahajan's Methods in Biostatistics 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@premiereducationaltechnologyies.com

Mayank

Anam
Jal

Dr. K. Keshri

Dr. Rakesh
Rakesh

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Dr. Rakesh

Dr. Rakesh
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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
	2.4 Sampling: Types of sampling, Questionnaire and observational methods of data collection.	03

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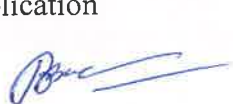
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3	<p>Use of Tools and Techniques in Research</p> <p>3.1 Use of Search engines for reviewing of literature and data retrieving(Google scholar, PubMed, ResearchGate and ShodhGanga)</p> <p>3.2 Use of Software: Microsoft Word, Microsoft Excel, Latex,SPSS/R/MATLAB/SCILAB/EndNote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





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