

M.Sc. Zoology Semester-I

MZO1T01 Paper- Biology of Non- Chordata

Course Outcomes (COs)

Students will be able to identify, classify, describe, discuss and explain invertebrate specimen in the field as well as maintain and organize museum specimen. Develop a skill to demonstrate and explain different anatomical systems, physiological body processes and diversity of invertebrates, animal architecture and functions. Create the awareness of the economic importance, significance and explain structural and functional relationship between invertebrate phyla. Assess and evaluate a taxonomic status of primitive members of arthropods and molluscs. Describe and analyze the sea star's body plan, elucidate the origins and evolutionary significance of echinoderm larval forms, comprehend the mechanism of movements based on fluid filled cavities in invertebrates and identify and classify minor invertebrate specimen. Perform the whole mount preparations of given invertebrate material.

DSC MZO1T01 – Biology of Non- Chordata

Unit-I

- 1.1 Basic concepts of biosystematics, taxonomy and classification. Recent trends in biosystematics: Chemotaxonomy, Cytotaxonomy and Molecular taxonomy.
- 1.2 Ultra structure of locomotory organs and locomotion in Protozoa.
- 1.3 Origin of metazoan-colonial, syncytial and molecular theories.
- 1.4 Dermal cell and skeleton of Porifera. Canal system in sponges.

Unit-II

- 2.1 Comparative account of Coelenterata and Ctenophora: Structure and Reproduction.
- 2.2 Reproductive system and reproduction in Helminths.
- 2.3 Classification of coelomates based on coelom formation, metamerism and Symmetry.
- 2.4 Excretory system and excretion in Annelida.

Unit-III

- 3.1 Filter feeding mechanism in Invertebrates
- 3.2 Organs and Mechanism of respiration in Arthropoda and Mollusca
- 3.3 Affinities and taxonomic position of Peripatus and Neopilina.

3.4 Neuroanatomy in Gastropoda, Bivalvia and Cephalopoda.

Unit-IV

4.1 Water vascular system in Echinodermata: structure and functions.

4.2 Larval forms in Echinodermata: Metamorphosis and phylogenetic significance.

4.3 Principles of hydrostatic skeleton and Locomotion based on hydrostatic skeleton in Invertebrates

4.4 Systematic position, general organization and affinities of Bryozoa and Rotifera.

MZO1T02- Cell Biology and Genetics

Course Outcomes (COs)

Students will be able to describe and explain the structure and function of plasma membrane through fluid mosaic model, types of membrane proteins, transport and organization of cytoskeleton, cell organelles and endomembrane system. Differentiate and illustrate the mechanism of Cell division, cell cycle regulation, types of cell signalling, signal transduction pathways and various receptors involved in cell signalling. Describe and differentiate the types and functions of cellular communication, cell adherence molecule and extracellular matrix interaction. Differentiate Mendelian, non-Mendelian inheritance and solve the problems of inheritance based on probability. Explain, differentiate and compare codominance, incomplete dominance, gene interactions, linkage, crossing over, sex limited and sex influenced characters. Illustrate and differentiate the mode of inheritance of polygenic and monogenic traits, role of genetic and environmental factors of inheritance, inbreeding and its consequences and deduce coefficient of inbreeding and consanguinity. Explain, distinguish and describe the mutation and its types, structural and numerical alterations of chromosomes as well as the extra chromosomal inheritance, maternal inheritance, microbial genetics, genetic mapping and human genetics by 10 using pedigree analysis and types of genetic disorders. They could demonstrate metaphasic chromosomes, Barr body and Polytene chromosomes.

MZO1T02- Cell Biology and Genetics

Unit-I

1.1 Membrane structure and function Ultrastructure of Fluid Mosaic Model, Transport of substances through membrane- Osmosis, Diffusion, Facilitated diffusion, Active transport.

1.2 Structural organization and functions of cell organelles- Nucleus, Mitochondria, endomembrane system, Endoplasmic reticulum, Golgi complex, Lysosomes and Ribosome,

1.3 Organization of Cytoskeleton- Structure and function of microtubules, microfilaments and intermediate filaments.

1.4 Cell division and cell cycle - Phases of cell cycle, checkpoints of cell cycle, regulation of cell cycle, mitosis, meiosis.

Unit-II

2.1 Cell signaling - hormones and their receptors, signaling through G- protein coupled receptors, Receptor protein- tyrosine kinase and ion channel receptors.

2.2 Signal transduction pathways, primary and secondary messenger systems, regulation of signaling pathways.

2.3 Cellular communication – Cell-cell interaction. Cell adhesion molecules (Selectins, Immunoglobulin superfamily, Cadherins). Adherens junctions and desmosomes. Tight junctions. Gap junctions.

2.4 Cellular communication - Cell – Extracellular matrix interaction. Organization and components of extracellular matrix. Interaction of cell with extracellular matrix (Integrins, focal adhesions and hemidesmosomes).

Unit-III

3.1 Mendelian inheritance – Mendelian principles, Mono/dihybrid inheritance, Complete dominance, Exercises for solving genetics problems.

3.2 Extensions of Mendelian principles - codominance, incomplete dominance, gene interactions, multiple allelism, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

3.3 Quantitative Genetics - polygenic traits and mode of inheritance, genetic and environmental factors, heritability, inbreeding and consequences, coefficient of inbreeding and consanguinity.

3.4 Mutation - types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants.

Unit-IV

4.1 Structural and numerical alterations of chromosomes - deletion, duplication, inversion, transversion, translocation, ploidy and their genetic implications.

4.2 Extra chromosomal inheritance - cytoplasmic inheritance, inheritance of mitochondrial genes, maternal inheritance.

4.3 Microbial genetics - recombination in bacteria (transformation, conjugation, generalized transduction and specialized transduction), fine structure mapping of genes.

4.4 Human genetics- Pedigree analysis. Karyotypes. Genetic disorders (Huntington's disease, Phenylketonuria, Alkaptonuria, Albinism, Sickle cell anaemia, Thalassemia, Cystic fibrosis).

Semester I MZO1T03- Elective

Mammalian Reproductive Physiology - Male

Course Outcomes (COs)

Students will be able to describe and demonstrate the development processes and functions of different units of testis. Deduce the structure, functions, regulation, anomalies and disease of male reproductive and accessory reproductive organs and understand the mechanism of sperm capacitation. Explain and discuss the role of hormones in the regulation of reproductive behaviour and types of breeding systems. Recognize and identify structural and functional aspect of different types of pheromones. Illustrate and counsel about the factors responsible for infertility. Assess and describe reproductive health dysfunction affected by aging in males. They could able to demonstrate fructose, acid and alkaline phosphatase, sialic acid and sperm count analysis.

Semester-I MZO1T03-Elective

Mammalian Reproductive Physiology - Male

UNIT –I

- 1.1 Development, descent and structure of the testis.
- 1.2 Spermatogenesis: Molecular changes, hormonal regulation, and spermiogenesis.
- 1.3 Sertoli cells: Structure, functions, blood testes barrier.
- 1.4 Leydig cells: Structure, functions and interaction with peritubular and Sertoli cells.

UNIT II

- 2.1 Epididymis Structural organization and function.
- 2.2 Structure of spermatozoa, functions and anomalies.
- 2.3 Sperm capacitation: molecular and biochemical changes, decapacitation.
- 2.4 Vas deferens: Structure and function.

UNIT -III

- 3.1 Seminal Vesicle: Structure, function and regulation.
- 3.2 Prostate gland: Structural organization, function, endocrine regulation and prostatic cancer.
- 3.3 Cowper's gland: Structure, function and anomalies.

3.4 Penis: Structure and mechanism of erection and problems in ejaculation.

UNIT -IV

4.1 Male reproductive behaviour: Mating system, neural and hormonal control.

4.2 Pheromones: types, structure and function.

4.3 Infertility in male: causes, symptoms, diagnosis and remedy.

4.4 Andrology: reproductive health dysfunction in advanced age.

MZO1T04 - Research Methodology

Course Outcomes (COs)

Students will be able to learn, describe and imbibe animal ethics in research, as well as various guidelines provided by IAEC and CCSEA. Students will be able to compare the model organisms used in biological science. They will be able to discuss and determine the animal facilities to laboratories, transportation, hygiene, environment, maintenance, ethical, legal and policy issues. Encourage students to pursue their interests in research and to investigate selecting appropriate methodology of scientific research. Students could design the experiments properly. They will be able to write scientific reports, research proposals, patents, review articles, and will be aware of major funding agencies. Improve the knowledge of computer skills. They will be able to use basic computer programmes such as MS-Office, Coral Draw, and Photoshop. Students will analyse and use statistics to analyse data in biological research. They will be acquainted with AI and its use in Life Science as well as to apply various statistical tools like central tendency, dispersion, skewness, and kurtosis measures to analyze results in the research work. They also learn measures of relationship tests of hypothesis testing of significance and know about statistical software. Students will also be able to learn and be acquainted with IPR and Patent registration.

MZO1T4: Research Methodology

Unit-I

1.1 Introduction: IAEC and CPCSEA guidelines, guidelines for human and animals use.

1.2 Model organism used in biological research: Animal models (Rat, Fishes, Insects, Nematods etc).

1.3 Animal facilities to laboratories: Transportation, Hygiene, Environment, Maintenance, Tranquilizer and Disposal.

1.4 Legal ethical and policy related issues: Historical background to the A(SP)A, recent issues of public debate, regulations requiring the use of animals.

Unit-II

2.1 Scientific Research- Methods, Design of experiments, Policies, Guidelines and regulations for using animals in research. Leading funding agencies in India (DBT, DSTSERB, RGSTC, UGC, ICIR, MOEF, ICMR, ICAR, PM-RUSA), International fellowships (Humboldt Research fellowship, Nehru-Fulbright fellowship, DAAD Fellowship)

2.2 Academic Scientific Writing- Preparation of scientific reports, Review Articles and Research articles, writing a research proposal. Thinking and planning, information, ideas, order of paragraph writing, proper use of nouns, pronouns and articles, tenses, spellings etc., Plagiarism.

2.3 Intellectual Property Rights (IPR): Significance of IPR, Types of IPR, IPR Laws in India.

2.4 Patent: Significance of Patent, Types of Patent (Utility, Design, Plant), Process of patent registration in India.

Unit-III

3.1 Basics of computer Software- MS-Office. Coral draw, Photoshop, Page maker.

3.2 Use of Encyclopedia, Handbooks, Academic Database for Animal Research

3.3 Reference management software (Mendley, Zottaro). Research Articles and Thesis Searching Web Sites (Shodhganga, Science Direct, Research Gate, Google Scholar etc.)

3.4 Importance of Artificial Intelligence (AI) in Life Sciences- Advantages and Disadvantages.

Unit-IV Biostatistics

4.1 Specific applications of measures of central tendency, dispersion, skewness and Kurtosis in research.

4.2 Measures of Relationship: Correlation and regression, ANOVA (one way and two way).

4.3 Non-parametric and Parametric Tests of hypothesis, introduction to statistical softwares.

4.4 Testing of significance with respect to proportion, variance and correlation.

Semester-I, MZO1P01 Skill based practical course in M. Sc. SEM-I Zoology, Biology of Non-Chordata

1 Study of museum specimens using already available specimens in the museum/ charts/ models/ photographs/ digital alternatives etc. Classification up to order and comments on the specimens representing all phyla.

2 Anatomical Observations Anatomical observations, demonstration and detailed explanation of a) Digestive system of Earthworm, Leech, Cockroach, Silkworm and Honey bee b) Nervous system of Prawn, Cockroach, Silkworm and Honey bee and c) Reproductive system of Earthworm, Leech, Cockroach and Honey bee with the help of ICT tools/ Models/ Charts/ Photographs etc.

3 Mounting - Whole mount preparation of plankton and/or study of permanent preparation of the following with the help of already available permanent slides/ ICT tools/ charts/ photograph etc.

- a. Earthworm – Nerve ring, ovary, spermatheca, nephridia.
- b. Leech – jaws, ciliated organ.
- c. Cockroach – Mouth parts, Salivary glands, trachea.
- d. Prawn – Appendages, Statocyst.
- e. Protozoans- Rhizopods, flagellates, ciliates (fresh water forms).
- f. Porifera – Spicules and gemmules of fresh water sponges.
- g. Crustaceans and rotifers - Planktonic copepods, cladoceran, ostracoderm and rotifers.
- h. Larval forms of the free-living invertebrates.
- i. Larval forms of parasitic invertebrates.

4 Study of permanent Invertebrates slides

- a. Porifera – T.S. and L.S. of Sycon, gemmules, spongian fibres, spicules
- b. Coelenterata – T.S. of Hydra, T.S. of Sea anemone, Ephyra larva
- c. Helminths – T.S. of Planaria, T.S. of Taenia, scolex W.M., Mature, gravid proglotids, T.S. of male and female Ascaris, W.M of Ankylostoma, Enterobius, Dracunculus, Wuchereria
- d. Annelida -T.S. of Nereis, T.S. of Earthworm passing through various organs, T. S. of Leech.
- e. Arthropod larvae – Nauplius, Zoea, Metazoea, Megalopa, Mysis.
- f. Mollusca – T.S. of foot, Veliger and Glochidium larva.

g. Echinodermata- Pedicellariae, T.S. of arm of star fish, Bipinnaria, Oricularialarva.

h. Hemichordata – T.S. through collar, proboscis, trunk and branchio-genital regions. Tornarialarva.

Distribution of Marks:	Marks
1. Anatomical observations (Major)	20
2. Anatomical observations (Minor)	10
3. Identification and comment on the spots(1-10)	30
4. Stained permanent preparation:	10
5. Submission of stained permanent slides	10
6. Class Record	10
7. Viva-voce	10
Total marks	100

MZO1P02 Skill based practical course in M. Sc. SEM-I Zoology, Cell Biology and Genetics and Research Methodology

1. Study of mitotic metaphasic chromosomes in plant material.
2. Preparation of human karyotypes by using photographs/pictures.
3. Demonstration of Barr body in human female leucocytes.
4. Demonstration of polytene chromosome in dipteran larvae with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5. Problems on genetics based on monohybrid/dihybrid ratios, sex linked inheritance and blood groups.
6. Study of various human genetic traits.
7. Study of different stages of spermatogenesis in grasshopper / rat with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
8. Demonstration of oogenesis in earthworm/ fish/ rat ovary with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.
9. Demonstration of monohybrid cross by using colored beads,
10. Demonstration of dihybrid cross by using colored beads
11. Study of characters and karyotypes of syndrome (Down, Klinefelter, Turner),
12. Study of Osmosis in Human RBCs. (Hypotonic, Hypertonic and Isotonic medium).
13. Demonstration of Mitochondria in Buccal Epithelium/ Lip Mucosa by Janus green B method
14. Demonstration of Coral draw/Photoshop/ Page maker
15. Demonstration of arrangement of reference using Mendley/ Zottaro
16. Problems based on measure of central tendency, correlation and regression and ANOVA (one way and two way)

Distribution of Marks

Marks

1. Cytological Experiment	20
2. Problems on genetics (any two)	20
3. Spermatogenesis/oogenesis	10
4. Monohybrid/ Dihybrid experiment	10

5. Identification and comment on spots (1-5)	10
6. Use of Coral draw/Photoshop/ Page maker to draw diagram/edit photo/ Set text using page maker	10
7. Arrangement of given references using Mendley/Zottaro	05
8. Problems based on measure of central tencency/correlation and regression/ ANOVA (one way or two way, any one)	05
9. Class record	05
10. Viva-voce	05
Total Marks	100

Suggested Readings

• Biology of Non- Chordata

1. Hyman L.H. The Invertebrate Vol. I, Protozoa through Ctenophora. McGraw-Hill Co., New York.
2. Barrington E.J.W. Invertebrate Structure and Function. Thomas Nelson and Sons Ltd., London.
3. Jagerstein G. Evolution of Metazoan Life Cycle. Academic Press, New York and London.
4. Hyman L.H. The Invertebrate Vol. II. McGraw-Hill Co., New York.
5. Hyman L.H. The Invertebrate Vol. VIII. McGraw-Hill Co., New York.
6. Barnes R.D. Invertebrate Zoology. W.B. Saunders and Co., Philadelphia.
7. Russel Hunter W.D.D. Biology of Higher Invertebrate. The Macmillan Co. Ltd., London.
8. Hyman L.H. The Invertebrates: Smaller Coelomate Groups. Vol. V. McGraw-Hill Co., New York.
9. Read C.P. Animal Parasitism. Prentice Hall, New Jersey.
10. Kudo R.R. (1966). Protozoology. Charles C. Thomas, Springfield, Illinois.
11. Barradailes L.A. and Potts F.A. Invertebrates (1961). Eastham L.E.S., Saunders, Cambridge University Press, Cambridge.
12. Russel W.D. Hunter. Biology of Lower Invertebrates. McMillan, New York.
13. Marshall A.J. and Williams W.D. (1972). Zoology of Invertebrates. ELBS and McMillan, London.
14. Gtryyrt V. and Graham A. A Functional Anatomy of Invertebrates. Academic Press, New York.
15. Backlemiccher W.N. Principles of Comparative Anatomy of Invertebrates. Oliver and Boyed, Edinburgh.
16. Hadisi J. The Evolution of Metazoa. Pergamon Press, Oxford.
17. Dales R.P. Annelids. Hutchinson, London.
18. Green J. Biology of Crustacea. Witherby, London.
19. Morton J.E. Mollusca. Hutchinson, London.
20. Nichols D. Echinodermata. Hutchinson, London.

• Cell Biology and Genetics

1. Cell and Molecular Biology by De Robertis E.D.P., I.S.E. Publication.
2. Molecular Biology by Turner P.C. and McLennan. Viva Books Pvt. Ltd.
3. Advanced Molecular Biology by Twyman R.M. Viva Books Pvt. Ltd.
4. Molecular Biology by Freifelder D. Narosa Publication House.
5. Gene VI by Benjamin Lewin. Oxford Press.
6. Gene VIII by Benjamin Lewin. Oxford Press.
7. Molecular Biology of the Gene by Watson J.D. et al. Benjamin Publication.
8. Molecular Cell Biology by Darnell J. Scientific American Books, USA.
9. Molecular Biology of the Cell by Alberts B., Bray D., Lewis J. Garland Publishing Inc.

10. Genetics Vol. I & II by Pawar C.B. Himalaya Publication.
11. Essentials of Molecular Biology by Freifelder D. Narosa Publication House.
12. Molecular Cell Biology by Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D. and Darnell J. W.H. Freeman & Co.
13. The Cell: A Molecular Approach by Cooper G.M.
14. Molecular Biology by Upadhyay A. and Upadhyay K. Himalaya Publication.

• **Mammalian Reproductive Physiology – Male**

1. A Textbook of In Vitro Fertilization and Assisted Reproduction. Edited by P.R. Brinsden and P.A. Rainsbury. Jaypee Brothers, 1992.
2. Advances in Reproductive Physiology, Vol. 1–6. McLaren (1968). Logos Press Ltd., London.
3. Advances in Reproductive Toxicology. Eds. S.C. Joshi and A.S. Ansari. Pointer Publishers.
4. Andrology (2nd Edition): Male Reproductive Health and Dysfunction. Eds. E. Nieschlag & H.M. Behre, 2000.
5. Zanzveld L.J.D. & Chatterton R.T. (1982). Biochemistry of Mammalian Reproduction. John Wiley & Sons, New York.
6. Assalye N.S. (1968). Biology of Gestation. Academic Press, London.
7. Guraya S.S. (1985). Biology of Ovarian Follicles in Mammals. Springer-Verlag.
8. Guraya S.S. (2001). Comparative Cellular and Molecular Biology of Testis in Vertebrates. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar. Narosa Publishing House, 1998.
10. Das R.P. (1989). Contraceptive Technology: Past, Present and Future. N.I.H.F.W., New Delhi.
11. Crighton D.B., Haynes N.B., Foxcroft G.R. & Lamming G.E. (1978). Control of Ovulation. Butterworths, London.
12. Encyclopedia of Reproduction, Vol. I–IV. Eds. Ernst Knobil and J.D. Neill, 1998.
13. Cowie A.T., Forsyth I.A. & Hart I. (1980). Hormonal Control of Lactation. Springer-Verlag, Berlin & New York.
14. Hafez E.S. & Blandau R.J. Mammalian Oviduct. The University of Chicago Press, Chicago & London.
15. Marshall's Physiology of Reproduction, 4th Edition, Vol. III (Pregnancy and Lactation, Parts I–III). Edited by G.E. Lamming. Chapman & Hall.
16. Asdell S.A. (1964). Patterns of Reproduction. Constable & Co., London.
17. Choudhary S.K. Practice of Fertility Control. Churchill & Livingstone.
18. Reiter R.J. Progress in Reproductive Biology, Vol. IV: The Pineal and Reproduction. Karger, Basel, Paris & London.

19. Austin C.R. & Short R.V. (1984 & 1994). Reproduction in Mammals (Series 1–6). Cambridge University Press, Cambridge.
20. Shaw's Textbook of Gynaecology. Eds. V.G. Padubidri & S.N. Daftary. 2000.
21. Blandau R.J. (1971). The Biology of Blastocyst. The University of Chicago Press, Chicago & London.
22. Ramwell P.W. (1974). The Prostaglandins, Vol. I & II. Plenum Press, New York & London.
23. Johnson A.D. & Gomes W.R. The Testis, Vol. I–IV.
24. Mossman H.W. (1989). Vertebrate Foetal Membranes. Rutgers Press Ltd.
25. WHO Laboratory Manual for the Examination of Human Semen and Sperm–Cervical Mucus Interaction. 4th Edition. Cambridge University Press, 2000.

• Research Methodology

1. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983).
2. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).
3. Biostatistics-Arora and Malhan
4. Biostatistics- Jasraj and Gurudeep Raj
5. Biostatistics- P. Ramkrishan
6. Methods in Biostatistics-Mahajan
7. https://cpcsea.nic.in/WriteReadData/userfiles/file/SOP_CPCSEA_inner_page.pdf

M.Sc. Zoology Semester II

MZO2T05 - Biology of Chordata

Course Outcomes (COs)

Students will be able to describe and recognize unique characters, life functions, connecting link between non-chordates and chordates and the diversity of urochordates, cephalochordates, cyclostomes and fish. Describe the structural, physiological and evolutionary correlation of different vertebrates; elaborate how kidneys represented successful evolutionary responses to the surrounding environmental pressures. List some migratory bird species, conduct bird tracking and watching activity. Facilitate students to explore the world of cetaceans and the marine environment. Gain a better understanding of the forces that drive evolution, speciation and the diversity of life on our planet. Identify, describe and differentiate the basic structure and functions of the central and peripheral nervous systems and define learning and memory. Compare and contrast the organization and evolution of the vertebrate circulatory system and heart. Describe specialized sensory organs of vertebrates and relate their role to their habitat. Comprehend the gradual development and evolutionary history of man. Identify, classify, describe and explain vertebrate specimen in the field as well as maintain and organize museum specimen. Develop a skill to demonstrate and explain different anatomical systems of vertebrate, and perform whole mount preparations of given vertebrate materials, different steps of microtomy and staining procedure. They could use, handle and maintain the instruments like microtome and oven. Students will able to identify, demonstrate, explain and compare the histological structure and functions of internal organs of vertebrates.

MZO2T05 - Biology of Chordata

UNIT-I

- 1.1 Origin and ancestry of Chordata.
- 1.2 Characteristic features and affinities of the Urochordata and Cephalochordata.
- 1.3 Characteristic features of Agnatha and development of Ammocoetes larva.
- 1.4 General characters and affinities of Dipnoi.

UNIT-II

- 2.1 Organs and mechanism of respiration in Pisces and Amphibia.
- 2.2 Vertebrate integument and its derivatives.
- 2.3 Jaw suspension in vertebrates.
- 2.4 General body organization and classification in Chelonia.

UNIT-III

- 3.1 Evolution of kidney and excretion in vertebrates.
- 3.2 Origin of birds. Migration in birds.
- 3.3 Cetacea: General characters and adaptations.
- 3.4 Adaptive radiation in vertebrates: Aquatic, Terrestrial, Aerial, Arboreal and Fossorial.

UNIT-IV

- 4.1 Autonomic nervous system in vertebrates: Structure and functions.
- 4.2 Evolution of circulatory system and heart in vertebrates.
- 4.3 Sense organs in vertebrates: Echolocation, Electoreception and Lateral line system in fishes.
- 4.4 Evolution of Man: Oligocene, Miocene, Pliocene primate ancestors of human, Pleistocene hominids: Evolutionary trends in man.

MZO2T06 - Advanced Developmental Biology

Course Outcomes (COs)

Students will be able to differentiate and explain the basic developmental concept of insects, caste differentiation in insects, amphibian metamorphosis and aves with its hormonal control and regeneration process in vertebrates. Illustrate and classify the type, structure, function and hormones of the placenta, analyse the cell differentiation, organ formation, cell death, and multiple physiological levels of aging. They will be able to analyse the process of advanced cattle breeding with the help of MOET, cloning techniques, acquire knowledge about embryonic sexing to diagnose the genetic disorder, the economic and clinical significance of embryonic stem cells. Comprehend birth control method that uses the body's immune response and classical contraceptive techniques to prevent pregnancy. Explain different anti-androgen and anti-spermiogenic compounds and also discuss transgenic animals that elevated the potential of biological research for human welfare. They will able to demonstrate the development of *Lymnaea* and mounting of chick embryo.

MZO2T06 - Advanced Developmental Biology

UNIT-I

- 1.1 Basic concepts of Developmental Biology: Model system – *Drosophila*.
- 1.2 Basic concepts of Developmental Biology: Model system – Chick.
- 1.3 Metamorphosis in Amphibia: Morphogenetic and biochemical mechanism, hormonal control.
- 1.4 Placenta – Types, structure, functions. Hormones of placenta and their functions.

UNIT-II

- 2.1 Concept of growth, differential cell proliferation, shaping of organ primordia and programmed morphogenetic cell death.
- 2.2 Ageing – Mechanism, concepts and models.
- 2.3 Polymorphism (caste differentiation) in insects (Termites, Honey bees and Ants).
- 2.4 Regeneration in vertebrates: Tail, limb, lens and retina.

UNIT-III

- 3.1 Multiple ovulation and embryo transfer technology (MOET).
- 3.2 Application of embryonic stem cells, clinical and economic significance.
- 3.3 Embryonic sexing, cloning, screening for genetic disorder diagnosis (ICSI, GIFT etc.).
- 3.4 Cloning of animals by nuclear transfer.

UNIT-IV

- 4.1 Immunocontraception – Fertilization inhibition and pregnancy termination.
- 4.2 Classical contraceptive techniques: Physical, chemical, surgical and IUCD devices.
- 4.3 Anti-androgen and anti-spermiogenic compounds (LDH-CY and SP-10).
- 4.4 Role of mutants and transgenic animals in human welfare.

MZO2T07 - Elective

1. Mammalian Reproductive Endocrinology

Course Outcomes (COs)

Students will be able to comprehend the structural and functional aspect of hypothalamus. Illustrate regulations and feedback mechanism of various neurohormones, neurotransmitters and neural signals, structural and physiological role of pituitary. Elucidate the histological organization of endocrine glands, gonads and correlate it with the health issues. Describe and explain the non-steroidal regulators of reproduction, the hypothalamic-pituitary axis with the help of gonads, adrenal and thyroid gland, the mechanism of biosynthesis, mode of action and function of reproductive hormones such as estrogen, progesterone, androgen and inhibin that are involved in sexuality and fertility. Prepare, identify, differentiate and explain the histological slides of endocrine gland.

Mammalian Reproductive Endocrinology

UNIT-I

- 1.1 Hypothalamus – Anatomy, cytoarchitecture.
- 1.2 Releasing and release inhibiting hormones.
- 1.3 Feedback regulatory mechanism.
- 1.4 Neurotransmitters and neural signals.

UNIT-II

- 2.1 Adenohypophysis and Neurohypophysis – Anatomy, cytology and hormones.
- 2.2 Non-steroidal regulators of reproduction – Activin and Inhibin, Follistatin, AMH.
- 2.3 Gonadotrophic hormones: Structure, mechanism of secretion and function.
- 2.4 Oxytocin: Structure, regulation and its role in reproduction.

UNIT-III

- 3.1 Hypothalamo–hypophyseal testis axis.
- 3.2 Hypothalamo–hypophyseal ovarian axis.
- 3.3 Hypothalamo–hypophyseal adrenal-gonad axis.
- 3.4 Hypothalamo–hypophyseal thyroid-gonad axis.

UNIT-IV

- 4.1 The Androgen: Biosynthesis, mode of action, transport and functions of testosterone.
- 4.2 The Oestrogen: Biosynthesis, mode of action, transport and functions.
- 4.3 The Progesterone: Biosynthesis, mode of action, transport and function.
- 4.4 Physiology of Inhibin: Biosynthesis, mode of action and functions.

MZO2P03 – On Job Training

Course Outcomes (COs)

Students will gain hands-on training of any activity associated with Zoology.

Semester-II MZO2P04

Skill Based Practical Course in M.Sc. Semester-II

Zoology – Biology of Chordata

1. Study of museum specimens using already available specimens in the museum/charts/models/photographs/digital alternatives etc. Classification of vertebrates up to order and comments on the specimens representing all phyla.

2. **Anatomical Observations**

Anatomical observations, demonstration and detailed explanation of the following with the help of ICT tools/models/charts/photographs etc.

- a) Brain and cranial nerves – Fish/Rat.
- b) Arterial and venous systems – Fish/Rat.
- c) Urinogenital system – Fish/Rat.
- d) Reproductive systems – Fish/Rat.
- e) Internal ear in fish, Weberian ossicles in fish, accessory respiratory organs in fish.

3. **Mounting**

Study of stained permanent preparation of scales, ampullae of Lorenzini, otolith, striated muscles and cartilage of fish using animal wastes from local recognized fish markets or with the help of already available permanent slides/ICT tools/charts/photographs etc.

4. **Histology and Skeleton**

- a) Study of slides of internal organs of vertebrates with the help of already available permanent slides/ICT tools/models/charts/photographs etc.
- b) Axial and appendicular skeleton of fowl and rabbit using already available skeleton/ICT tools/models/charts/photographs etc.

5. **Microtomy**

Fixation, embedding, sectioning and staining of the endocrine gland (Source of tissue: Animal wastes from local recognized slaughter houses/poultry farms/fish markets etc.).

6. Preparation of Histological Slides

- a) Histological slide of endocrine glands and gonadal endocrine components, EM structure of endocrine gland.
- b) Identification of pituitary cell type.
- c) Identification of α , β , γ cells of Islets of Langerhans with the help of already available permanent slides/ICT tools/charts/photographs etc.

7. Anatomical Observations

Anatomical observations, demonstration and detailed explanation of the endocrine glands – pituitary, thyroid, parathyroid and adrenal in fish/rat with the help of ICT tools/models/charts/photographs etc.

Distribution of Marks

Particulars	Marks
1. Anatomical observations of Fish/Rat	15
2. Stained permanent preparation	10
3. Identification and comment on spots (1–10)	30
4. Submission of stained permanent slides	05
5. Anatomical observations of endocrine glands	10
6. Histological staining of endocrine gland	10
7. Class Record	10
8. Viva-Voce	10
Total Marks	100

Semester-II MZO2P05

Skill Based Practical Course in M.Sc. Semester-II

Zoology – Advanced Developmental Biology

1. Study of the reproductive system in mammals with the help of ICT tools/models/charts/photographs etc.
2. Study of different types of eggs on the basis of their yolk content.

3. Study of developmental stages of live eggs of *Lymnaea* or any gastropod with the help of already available permanent slides/ICT tools/models/charts/photographs etc.
4. Study of developmental stages of insects/fishes with the help of already available permanent slides/ICT tools/models/charts/photographs etc.
5. Study of developmental stages of frog with the help of already available permanent slides/ICT tools/models/charts/photographs etc.
6. Chick embryo mounting by window method.
7. Study of developmental stages of chick through slides and whole mounts.
8. Morphological study of different types of placenta with the help of already available permanent slides/ICT tools/models/charts/photographs etc.
9. Histological study of placenta with the help of already available permanent slides/ICT tools/models/charts/photographs etc.
10. Sperm count from any domestic animal (Source of semen: Government Artificial Insemination Centre).
11. Semen analysis: Physical viscosity, pH, liquefaction time, agglutination test and motility (Source of semen: Government Artificial Insemination Centre).
12. Sperm vitality study using suitable stains (Source of semen: Government Artificial Insemination Centre).
13. Hypo-osmotic swelling (HOS) test for the assessment of normal semen.
14. Study of vaginal smear in rat by temporary mounting (Methylene blue) or by permanent staining (Haematoxylin–Eosin) with the help of already available permanent slides/ICT tools/charts/photographs etc.
15. Histology of male and female reproductive organs and accessory reproductive glands with the help of already available permanent slides/ICT tools/charts/photographs etc.

Distribution of Marks

Particulars	Marks
1. Sperm count / Semen analysis	15
2. Study of vaginal smear in rat / Sperm vitality study	10
3. Whole mount preparation of chick embryo	15
4. Preparation of developmental stages of live eggs of <i>Lymnaea</i>	10
5. Identification and comment on spots (1–10)	30
6. Class Record	10
7. Viva-Voce	10
Total Marks	100

Suggested Readings

• Biology of Chordata

1. Alexander R.N. *The Chordata*. Cambridge University Press, London.
2. Barrington E.J.W. *The Biology of Hemichordates and Protochordates*. Oliver and Boyd, Edinburgh.
3. Bourne G.H. *The Structure and Function of Nervous Tissue*. Academic Press, New York.
4. Kingsley J.S. *Outlines of Comparative Anatomy of Vertebrates*. Central Book Depot, Allahabad.
5. Honeywill A.R. *The Chordates*. Cambridge University Press, London.
6. Smith H.S. *Evolution of Chordate Structure*. Holt, Rinehart and Winston Inc., New York.
7. Walter H.A. and Sayles L.D. *Biology of Vertebrates*. Macmillan & Co., New York.
8. Romer A.S. *Vertebrate Body*. W.B. Saunders Co., Philadelphia.
9. Young J.Z. *Life of Vertebrates*. Oxford University Press, London.
10. Young J.Z. *Life of Mammals*. Oxford University Press, London.
11. Colbert E.H. *Evolution of Vertebrates*. John Wiley & Sons Inc., New York.
12. Kent G.C. *Comparative Anatomy of Vertebrates*.
13. Waterman A.J. *Chordate Structure and Functions*. Macmillan Co., New York.
14. Montagna W. *Comparative Anatomy*. Clarendon Press, Oxford.
15. Weichert C.K. and Presch W. *Elements of Chordate Anatomy*. McGraw-Hill Book Co., New York.
16. Lovtrup S. *The Phylogeny of Vertebrates*. John Wiley & Sons Inc., London.
17. Joysey K.A. and Kemp T.S. *Vertebrate Evolution*. Oliver and Boyd, Edinburgh.
18. Romer A.S. *Vertebrate Paleontology*. University of Chicago Press, Chicago.
19. Newman. *Phylum Chordata*.
20. Goodrich E.S. *Structure and Development of Vertebrates*. Dover Publications Inc., New York.
21. Hardisty M.W. and Potter I.C. *Biology of Lampreys*. Academic Press, New York.
22. Parker and Haswell W.A. *Textbook of Zoology*. Macmillan Co. Ltd., London.
23. Noble G.K. *The Biology of Amphibia*. Dover Publications Inc., New York.

• Advanced Developmental Biology

1. *Developmental Biology*. 2nd Edition. Leon W. Browder. Saunders College Publishing.
2. *Current Topics in Developmental Biology*. Eds. R.A. Pedersen and G.P. Schatten.
3. Goel S.C. *Principles of Animal Developmental Biology*. Himalaya Publishing House.
4. Gilbert S.F. *Developmental Biology*. 4th Edition. Sinauer Associates Inc. Publishers.
5. Ede D.A. *An Introduction to Developmental Biology*.
6. *Principles of Development*. Paul Weiss. Hafner Publishing Company, New York.
7. *Cells into Organs: The Forces that Shape the Embryo*. 2nd Edition. John Philip Trinkaus and Tom Aloisi.

8. Wolpert L. et al. *Principles of Development*. Oxford University Press, 1998.
9. Patten B.M. and Carlson B.M. *Foundations of Embryology*. Tata McGraw-Hill Publishing Company Ltd., New Delhi.
10. Balinsky B.I. (1981). *An Introduction to Embryology*. 5th Edition. CBS College Publishing.
11. Austin C.R. and Short R.V. *Embryonic and Foetal Development*. Cambridge University Press, 2nd Edition, 1982 & 1994.
12. Lamming G.E. *Marshall's Physiology of Reproduction*. Vol. I & II. Longman Green & Co., London. 1984, 2000.

• Mammalian Reproductive Endocrinology

1. *Comparative Endocrinology and Reproduction*. Eds. K.P. Joy, A. Krishna and C. Haldar. Narosa Publishing House (1998).
2. Das R.P. (1989). *Contraceptive Technology: Past, Present and Future*. N.I.H.F.W., New Delhi.
3. Crighton D.B., Haynes N.B., Foxcroft G.R. & Lamming G.E. (1978). *Control of Ovulation*. Butterworths, London.
4. *Encyclopedia of Reproduction*, Vol. I–IV. Eds. Ernst Knobil and J.D. Neill (1998).
5. Felig P. & Frohman L.A. *Endocrinology and Metabolism*. 4th Edition. McGraw-Hill Inc. Medical Publishing Division, 2001.
6. DeGroot L.J. et al. *Endocrinology*, Vol. I–III. W.B. Saunders Co., Philadelphia, 1989.
7. Turner C.D. & Bagnara J.T. (1990). *General Endocrinology*. W.B. Saunders Co. & Toppan Co., Philadelphia, London & Tokyo.
8. Cowie A.T., Forsyth I.A. & Hart I. (1980). *Hormonal Control of Lactation*. Springer-Verlag, Berlin & New York.
9. *Reproductive Endocrinology*, Ref. No. 1, Vol. III: *Hormones in Reproduction*.
10. Ramwell P.W. (1974). *The Prostaglandins*, Vol. I & II. Plenum Press, New York & London.