

M.Sc. Zoology Semester-III

MZO3T08 - Parasitology and Immunology

Course Outcomes (COs)

Students will be able to illustrate and differentiate life cycle, mode of transmission, infection and treatment of various bacterial infections and viral infections such as COVID-19, dengue and hepatitis. Describe, explain, classify and differentiate organs of immune system, innate immunity, adaptive immunity, antigen, antibodies, toxin, anti-toxin and their cellular target. Demonstrate antigen-antibody interaction with the help of ODD. Illustrate the maturation, activation, differentiation of T and B cells, inheritance of MHC molecules and various pathways of complement system. Classify, describe and differentiate various types of cytokines, hypersensitivity, autoimmunity and immunodeficiency diseases. Explain and describe activation and migration of leucocyte, mast cell, transplantation, tumor immunology, various infectious diseases and vaccines. Illustrate and differentiate working principle and significance of immunotechniques such as RIA and ELISA.

MZO3T08 - Parasitology and Immunology

UNIT-I

- 1.1 COVID-19 and H1N1 viruses – Life cycle, mode of transmission, infection, treatment and awareness programme.
- 1.2 Dengue and Hepatitis – Life cycle, mode of transmission, infection and treatment.
- 1.3 *Vibrio cholerae* and *Clostridium tetani* – Life cycle, mode of transmission, infection and treatment.
- 1.4 *Yersinia pestis* – Life cycle, mode of transmission, infection and treatment.

UNIT-II

- 2.1 *Trypanosoma* and *Entamoeba* – Life cycle, mode of transmission, infection and treatment.
- 2.2 *Leishmania* and Malaria – Life cycle, mode of transmission, infection and treatment.
- 2.3 *Wuchereria* and *Trichinella* – Life cycle, mode of transmission, infection and treatment.
- 2.4 Toxins and antitoxins – Types, cellular targets of toxins, application of toxin and antitoxin system.

UNIT-III

- 3.1 Immune system – Innate and adaptive immunity; antigens and antibodies and their interaction.
- 3.2 Cells and organs of immune system; T cells and B cells – maturation, activation and differentiation, T cell receptors.
- 3.3 Major Histocompatibility Complex (MHC) – General organization and inheritance of the MHC, MHC molecules and genes.
- 3.4 Complement system – Classical, alternative and lectin pathways, regulation of complement system, biological consequences of complement activation.

UNIT-IV

- 4.1 Cytokine – Properties, receptors and significance, leukocyte activation and migration.
- 4.2 Hypersensitivity reactions – Types, hypersensitivity reactions and its diseases; autoimmunity and its disease; immunodeficiency diseases.
- 4.3 Transplantation immunology – Blood antigens, transplantation or graft rejection, familial grafting, tissue typing, cross matching and immunosuppression.
- 4.4 Tumor immunology – Types and roles of tumor antigens, immune response to tumor; infectious diseases and vaccines. Immunotechniques – RIA and ELISA.

Suggested Readings

• Parasitology

1. Madigan M.T., Martinko J.M. and Parker J. *Brock Biology of Microorganisms* (9th Edition). Prentice Hall International Publication.
2. Youle W. and Maplestone. *The Nematode Parasite in Vertebrate*.
3. Dogiel V.A. *General Parasitology*.
4. Faust E.C. *Helminthology*.
5. Birt D.R. *Platyhelminthes and Parasitism*.
6. Aisen O.W. *Animal Parasite*.
7. Kreier J.P. and Baker J.R. *Parasitic Protozoa*. Allen and Unwin Press.
8. Kathering M.G., Paul A.J. and Zaman V. *Medical and Veterinary Protozoology*. Churchill Livingstone.

• Immunology

1. Kubly R.C. et al. *Immunology*.
2. Tizard. *Immunology*.
3. Roitt, Brostoff and Male D. *Immunology*.
4. Pelczar M.T. Jr., Chan E.C.S. and Krieg N.R. *Microbiology*. Tata McGraw-Hill.
5. Abbas. *Immunology*.

MZO3T09 - Wild Life and Avian Biology

Course Outcomes (COs)

Students will explain, describe and analyze importance of wildlife and its conservation, international conservation bodies, predator-prey relationship, population dynamics of ungulates and carnivores. They could also explain, describe and analyze morphology, morphometry of birds, bird diversity, techniques of bird counting, bird breeding population and breeding group maps, bird hotspots, bird sanctuaries and role of birds in ecosystem.

MZO3T09 - Wild Life and Avian Biology

UNIT-I - Wildlife Ecology and Behaviour

- 1.1 Definition, importance of wildlife, concept of conservation, conservation movement in India.
- 1.2 International conservation bodies: IUCN, UNDP, FAO, WWF, Red Data Book, rare and endangered animals of India.
- 1.3 Predator-prey relationship, predator dynamics, optimal foraging theory: patch choice, diet choice, prey selectivity, anti-predator defenses.
- 1.4 Social organization in carnivores and primates.

UNIT-II - Wildlife Population and Pest Management

- 2.1 Population estimation of ungulates and carnivores: Faecal samples, hair identification, pug marks and census method.
- 2.2 Management and identification of animals by natural marking, collars, tags, branding, rings etc. Dynamic marking: beta light, radio-tracking, collars.
- 2.3 Basic concept of forest soil dwelling arthropods, decomposer food web in forest soil, vertical distribution and aggregation of Collembola and mites.
- 2.4 Pests of Teak: Borers – *Alcterogystia cadambae* and defoliators – *Hyblaea puera*; pests of Sal: Borers – *Hoplocerambyx spinicornis* and defoliators – *Lymantria mathura*.

UNIT-III - Avian Systematics

- 3.1 Morphology and morphometry of birds, methods of identification and bird diversity.
- 3.2 Bird study techniques: equipment, area of study, field data recording, bird photography.
- 3.3 Bird counting technique: sampling, bird ringing techniques, use of hi-tech gadgets like GPS, CCTV, camera and high vision equipment.
- 3.4 Estimation of breeding population, breeding ground mapping.

UNIT-IV - Bird Diversity and Breeding

- 4.1 Bird biodiversity hotspots in India, bird sanctuaries in India.
- 4.2 Role of birds in ecosystem – pollination, seed dispersal, insect control, bird migratory routes.
- 4.3 Breeding biology, nesting territories, bird songs, courtship and mating.
- 4.4 Types of nest, nest building, nest defense and parental care.

Suggested Readings

• Wild Life and Avian Biology

1. Ali, S. and Ripley, S.D. (1983). *Handbook of the Birds of India and Pakistan* Compact Edition. Oxford University Press, New Delhi.
2. Anon. (1975). *Forest Pest Control*. National Academy of Science, NAS, Washington, D.C.
3. Bailey, J.A. (1984). *Principles of Wildlife Management*. John Wiley and Sons, New York.
4. Beeson, C.F.C. (1941). *The Ecology and Control of Forest Insects of India and Neighboring Countries*. Government of India Press.
5. Brockman, O.F. (1959). *Recreational Use of Wildlife*. McGraw Hill Book Company.
6. Daniel, J.C. (1983). *The Book of Indian Reptiles*. Bombay Natural History Society, Bombay.
7. Davis and Johnson. (1987). *Forest Management*. McGraw Hill Book Company.
8. Eisenbeis, G. and Wichard, W. (1991). *Atlas on the Biology of Soil Arthropods*. Springer-Verlag, London.
9. Elseth, B.D. and Baumgartner, K.M. (2003). *Population Biology*. Van Nostrand Co., New York.
10. Findley, W.P.K. (1967). *Timber Pests and Diseases*. Pergamon Press.
11. Graham, S.A. and Knight, F.B. (1965). *Principles of Forest Entomology*. McGraw Hill Book Company.
12. Harris, W.V. (1964). *Termites: Their Recognition and Control*. Longmans, London.
13. Krebs, J.R. and Davies, N.B. (1989). *An Introduction to Behavioural Ecology*. Blackwell Scientific Publications, Oxford.
14. Knight, P.V. (1980). *Principles of Forest Entomology*. McGraw Hill Publication.
15. Lenderen, D. (1991). *Modelling in Behavioural Ecology*. Chapman and Hall, London, U.K.
16. Rodgers, N.A. and Panwar, H.S. (2001). *Planning of Wildlife/Protected Area Network in India*. Wildlife Institute of India, Dehradun.
17. Snodgrass, R.E. (1995). *Principles of Insect Morphology*. USDA.
18. Staddon, J.E.R. (1983). *Foraging and Behavioural Ecology: Adaptive Behavior and Learning*. Cambridge University Press.
19. Stephens, D.W., Brown, J.S. and Ydenberg, R.C. (2007). *Foraging: Behavior and Ecology*. University of Chicago Press, Chicago.
20. Trippense, R.E. (1953). *Wildlife Management*. McGraw Hill Book Co.
21. Van Tyne, J. and Berger, A.J. (1976). *Fundamental Ornithology*. MacMillan Publishing Co. Inc., New York.
22. Wallace, G.J. and Mahan, H.D. (1975). *An Introduction to Ornithology*. MacMillan Publishing Co. Inc., New York.
23. West, D.C., Shugart, H.H. and Botkin, D.F. (1981). *Forest Succession: Concepts and Application*. Springer-Verlag, New York.
24. Witter, J.A. and Coulson, R.N. (1984). *Forest Entomology: Ecology and Management*. John Wiley and Sons, U.S.A.

MZO3T10 – Comparative Endocrinology

Course Outcomes (COs)

Students will be able to identify, classify, differentiate, describe and explain different types of cells and organs of neuroendocrine system of invertebrates. Illustrate the role of hormones in the regulation of various physiological processes in invertebrates such as metamorphosis, reproduction and colour change mechanisms. Describe, explain, and differentiate the hypothalamo-hypophyseal system, structure, hormones, functions and feedback mechanisms of pituitary, thyroid, parathyroid, pancreas, gastro-intestinal tract and adrenal gland. Comprehend the role of hormones in pharmaceuticals, including contraception, sex hormones, cancer, immune system and immune regulating hormones (IRH). Raise awareness about the significance of pharmaceutical applications. Students could demonstrate compare the preparation of histological slides of endocrine glands.

MZO3T10 – Comparative Endocrinology

Unit-I

- 1.1 Hormonal control of reproduction in Annelida.
- 1.2 Neuroendocrine system of Mollusca: Structure and function.
- 1.3 Neuroendocrine control of reproduction in Mollusca.
- 1.4 Neuroendocrine control of reproduction in Echinodermata.

Unit-II

- 2.1 Neuroendocrine system in crustacean; structure and hormones.
- 2.2 Endocrine control of metamorphosis, reproduction and colour change mechanisms in crustacea.
- 2.3 Cephalic neuroendocrine system in insects: structure and hormones.
- 2.4 Endocrine control of metamorphosis and reproduction in insects.

Unit-III

- 3.1 Pineal organ: Structure, hormones and functions.
- 3.2 Hypothalamo hypophyseal system: Structure, hypothalamic nuclei, hormones and function.
- 3.3 Pituitary: Cell types, hormones and functions.

3.4 Thyroid and Parathyroid gland: Structure, hormones and functions.

Unit-IV

4.1 Endocrine pancreas and gastro intestinal tract: endocrine cells, hormones and functions.

4.2 Adrenal gland: structure, hormones and functions in vertebrates.

4.3 Gonadal hormones in vertebrates and their hormonal action, feedback mechanisms.

4.4 Hormones as pharmaceuticals – Hormones in contraception, estrogen and cancer, Sex hormones and immune system and immune regulating hormone (IRH).

Suggested Readings

1. General and Comparative Endocrinology: E.J.W. Barrington. Oxford, Clarendon Press.
2. Text Book of Endocrinology: R.H. Williams. W.B. Saunders.
3. Endocrine Physiology: C.R. Martin. Oxford University Press.
4. Comparative Endocrinology: A. Gorbman et al. John Wiley and Sons.
5. Medical Physiology: W.F. Ganong (1981). 10th Edition. Lange Medical Publications.
6. Principles of Anatomy and Physiology: Tortora & Grabowski. 9th Edition. John Wiley and Sons.
7. Reproductive Physiology of Vertebrates: Van Tienhoven, A. (1983). 2nd Edition. Cornell University Press, New York.
8. The Pituitary Gland: Imura, H. (1994). 2nd Edition. Comprehensive Endocrinology Revised Series. Raven Press, New York.
9. Comparative Vertebrate Endocrinology: Bentley, P.J. (1976). Cambridge University Press, Cambridge.
10. General and Comparative Endocrinology: E.J.W. Barrington. Oxford, Clarendon Press.
11. Text Book of Endocrinology: R.H. Williams. W.B. Saunders.
12. Comparative Vertebrate Endocrinology: Bentley, P.J. (1976). Cambridge University Press, Cambridge.
13. Invertebrate Endocrinology: D.B. Tembhare (2012). Himalaya Publishing House.

MZO3T11 – Elective-I

Mammalian Reproductive Physiology – Female

Course Outcomes (COs)

Students will be able to understand and evaluate the different processes and hormonal control of ovarian cycle. Describe and specify the mechanism and hormonal control of uterine cycle in different mammalian species. Comprehend the structure, function, regulation, anomalies and disease of female reproductive tract. Discuss the physiological and hormonal reasons behind bodily changes at puberty, the importance of prostaglandins in reproduction. Recognize the anatomical structure and development of breasts, mechanism of synthesis, secretion and ejaculation of milk via hormonal influence. They could detect and confirm the pregnancy by using female urine sample.

Mammalian Reproductive Physiology – Female

UNIT-I

- 1.1 Differentiation of the ovary and female genital tract.
- 1.2 The process of folliculogenesis and its hormonal control.
- 1.3 Recruitment, selection, dominance of follicle and signaling for ovulation.
- 1.4 Follicle wall: Theca, differentiation, steroid hormone synthesis (2-gonadotropin, 2-cell concept).

UNIT-II

- 2.1 Estrous cycle in mammals.
- 2.2 Menstrual cycle and Menopause.
- 2.3 Mechanism and hormonal control of ovulation.
- 2.4 Corpus luteum: Histogenesis, function, maintenance and luteolysis.

UNIT-III

- 3.1 Oviduct: Structure, regional differentiation and function.
- 3.2 Uterus: Structure, function, types and abnormalities.
- 3.3 Cervix: Structure, function and cervical cancer.

3.4 Vagina: Structure, function, detection of various stages of estrous cycle by vaginal cytology, vaginal plug.

UNIT-IV

4.1 Onset of puberty and delayed puberty.

4.2 Prostaglandins: Structure, biosynthesis, mode of action and their role in reproduction.

4.3 Anatomy and growth of mammary glands.

4.4 Lactogenesis and galactopoiesis.

Semester-III MZO3P06

Skill Based Practical Course in M.Sc. Semester-III Zoology

Mammalian Reproductive Physiology

1. Demonstration of surgical operation in rat/mice with the help of ICT tools.

a. Male: Orchidectomy or Vasectomy or Epididymectomy

b. Female: Ovariectomy or Hysterectomy or Adrenalectomy

2. Anatomical observations, demonstration and detailed explanation of the male and female reproductive system of rat/mice with the help of ICT tools/models/charts/photographs etc.

3. Vaginal smear: Vaginal cytology with relation to estrous cycle with the help of already available permanent slides/ICT tools/charts/models/photographs etc.

4. Pregnancy detection test from urine.

5. Biochemical estimations of fructose/acid and alkaline phosphatase/sialic acid in reproductive tissue/semen using animal wastes from recognized slaughter houses/poultry farms/AIC etc.

6. Experimental studies (histological slides for identification) of the following with the help of already available permanent slides/ICT tools/models/charts/photographs etc.

a. Effects of anti-androgen on testis and sex accessory glands.

b. Effect of heavy metals on testis and sex accessory glands.

c. Effects of antifertility drugs on ovary and uterus.

7. Histology: Preparation of permanent slide of reproductive organs using animal wastes from recognized slaughter houses/poultry farms.

a. Male: Testis, epididymis (caput, corpus and cauda), seminal vesicle and prostate.

b. Female: Ovary, oviduct, uterus, vagina and cervix.

8. Study of following endocrine glands with the help of already available permanent slides/ICT tools/models/charts/photographs etc.

a. Pituitary gland: Anatomy, cell types and identification of cell types.

b. Thyroid gland: Histology of active and inactive glands, effects of anti-thyroid drugs.

c. Adrenal gland: Normal histology and effects of anti-adrenal drugs.

9. Embryology: Study of various stages of development of mammalian egg, development of foetal membranes, different types of placenta, progestational changes in uterus with the help of already available permanent slides/ICT tools/charts/models/photographs etc.

10. To study the prenatal stages of human development with the help of already available permanent slides/ICT tools/charts/models/photographs etc.

11. Field Work:

- Visit to Artificial Insemination Centre.
- Visit to laboratory for embryo transfer.
- Visit to family planning clinics.

Distribution of Marks

Particulars	Marks
1. Surgical operation	15
2. Anatomical observation	15
3. Minor experiment	10
4. Biochemical estimation	20
5. Identification and comments on spots (1–5)	15
6. Submission of permanent slides	05
7. Practical record	10
8. Viva-voce	10
Total Marks	100

Suggested Readings

Mammalian Reproductive Physiology – Female

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. I–VI. McLaren (1968). Logos Press Ltd., London.
3. **Advances in Reproductive Toxicology**, edited by S.C. Joshi and A.S. Ansari. Pointer Publishers.
4. **Andrology**, 2nd Edition: *Male Reproductive Health and Dysfunction*, edited by E. Nieschlag and H.M. Behre (2000).
5. **Biochemistry of Mammalian Reproduction**: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & Sons, New York.
6. **The Ovary**, Vol. I, II & III: Zuckerman, S. (1962). Academic Press, London.
7. **Biology of Gestation**: Assalye, N.S. (1968). Academic Press, London.
8. **Biology of Ovarian Follicles in Mammals** (1985). S.S. Guraya. Springer-Verlag.
9. **Comparative Cellular and Molecular Biology of Testis in Vertebrates** (*Trends in Endocrine, Paracrine and Autocrine Regulation of Structure and Functions*). S.S. Guraya (2001). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
10. **Comparative Endocrinology and Reproduction**, edited by K.P. Joy, A. Krishna and C. Haldar. Narosa Publishing House (1998).
11. **Contraceptive Technology: Past, Present and Future**: Das, R.P. (1989). N.I.H.F.W., New Delhi.
12. **Control of Ovulation**: Crighton, D.B., Haynes, N.B., Foxcroft, G.R. & G.E. Lamming (1978). Butterworths, London.
13. **Encyclopedia of Reproduction**, Vol. I–IV, edited by Ernst Knobil and J.D. Neill (1998).
14. **Endocrinology and Metabolism**, 4th Edition (2001). Philip Felig & Lawrence A. Frohman. McGraw-Hill Inc., Medical Publishing Division.
15. **Endocrinology**, Vol. I–III: L.J. DeGroot et al. (1989). W.B. Saunders Co., Philadelphia.
16. **General Endocrinology**: Turner, C.D. & J.T. Bagnara (1990). W.B. Saunders Co. & Toppan Co., Philadelphia, London & Tokyo.
17. **Hormonal Control of Lactation**: Cowie, A.T., Forsyth, I.A. & I. Hart (1980). Springer-Verlag, Berlin & New York.
18. **Mammalian Oviduct**: Hafez, E.S.E. & R.J. Blandau. The University of Chicago Press, Chicago & London.

MZO3P07, Research Project (RP) Minor Work

Course Outcomes (COs)

After completion of minor research project, the student will be able to search research articles online and offline. Draft scientific writeup and submit in the form of report. They will be able to check the script for plagiarism. Discuss particular topic and could arrange it in a proper manner. Learn and write bibliography by various styles.

MZO3P07, Research Project (RP) Minor Work

In this minor research project, the student shall be required to carry out exhaustive literature survey and prepare a review covering a literature survey of last 20 years in the area specific to students/supervisors chosen research area and prepared review has to be checked for plagiarism with the plagiarism policy of University. The evaluation of this minor project will be done at departmental level by the approved internal and external examiners.

M.Sc. Zoology Semester-IV

MZO4T12 - Biotechniques, Biostatistics, Toxicology and Bioinformatics

Course Outcomes (COs)

Students will be able to elaborate, discuss and describe sterilization, animal cells, tissue culture, primary culture, cell lines, cell quantification, and growth kinetics and cryopreservation technique. Describe, demonstrate and explain the principle and working mechanism of sedimentation, centrifugation, TLC, gas chromatography and electrophoretic technique. Illustrate and explain the biostatistical measures such as central tendency, dispersion, probability, sampling types, methods and significance test. Describe and explain neuronal genetics, environmental components in the development of animal behaviour, organization and functions of animal ethics. Illustrate and explain about the significance of toxicity test in the projects and research. Describe and explain the importance and scope of bioinformatics, various biological databases such as BLAST and FASTA, PSI-BLAST etc. and various program runs for the construction of phylogenetic tree like MEGA. Students could construct, analyze and interpret phylogenetic tree.

MZO4T12 - Biotechniques, Biostatistics, Toxicology and Bioinformatics

UNIT – I

1.1 Sterilization techniques, media for microbial culture, inoculation methods.

1.2 Animal cell & tissue culture – primary culture, cell lines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells.

1.3 Basic principle of sedimentation and centrifugation; Radioactive isotopes.

1.4 Chromatographic separation – Thin layer and gas chromatography; Electrophoretic separation techniques.

UNIT – II

2.1 Central tendency and dispersion – mean, mode and median with examples; Dispersion and variance.

2.2 Probability and probability distribution – Basic theory and type of probability and probability distribution with examples (binomial, Poisson and normal distribution).

2.3 Sampling – types, standard error (SE), standard deviation (SD), significance tests – t-test, z-test, Chi-square test – assumption, importance and examples.

2.4 Representation of data in the form of tables, histograms, pie diagrams; use of SPSS and GraphPad.

UNIT – III

3.1 Introduction and scope of toxicology.

3.2 Environmental toxicology – Classification of environmental toxicants; Pesticides, fertilizers, heavy and trace metals, radioactive substances, food additives, automobile emissions.

3.3 Translocation of toxicants – absorption, distribution, biotransformation and excretion of toxicants.

3.4 Toxicity tests – Types (Acute and Chronic), calculation of LC_{50} and LD_{50} ; Antidotal therapy – antidotes, types of antidotes and antidotal procedure.

UNIT – IV

4.1 Introduction and scope of bioinformatics – history, scope of bioinformatics in research, business and employment opportunities; Bioinformatics in India.

4.2 Sequence alignment – Pairwise sequence alignment and multiple sequence alignment programs CLUSTAL Ω and CLUSTAL W.

4.3 Biological databases – History of Basic Local Alignment Search Tool (BLAST) and FASTA; Variants of BLAST, PSI-BLAST.

4.4 Phylogenetic analysis – Tree styles (Monophyletic, Paraphyletic and Polyphyletic), tree-building algorithms (Neighbor Joining, Maximum Likelihood and Maximum Parsimony), phylogenetic tree construction using MEGA.

Suggested Reading

Biotechniques

1. Animal Cell Culture – A Practical Approach (III Edition), Ed. John R. W. Masters. IRL Press.
2. *In Vitro Cultivation of Animal Cell*, Biotechnology by Open Learning (BIOTOL), Butterworth Heinemann Ltd., Linacre House, Jordan Hill, Oxford.
3. *Introduction to Instrumental Analysis*, Robert Broun, McGraw Hill International Edition.

4. *A Biologist's Guide to Principles and Techniques of Practical Biochemistry*, K. Wilson and K. H. Goulding, ELBS Edition.
5. *Molecular Cell Biology*, J. Darnell, H. Lodish and D. Baltimore, W. H. Freeman and Company, New York.
6. *DNA Techniques*, Alcamo.
7. *Insect Cell Culturing Engineering*, Ed. M. F. A. Goosen, A. J. Daugulis and P. Faulkner.
8. *Biotechnology*, B. D. Singh.
9. *Biophysical Chemistry*, Upadhyay, Upadhyay and Nath.

Biostatistics

1. *Biostatistics* – Arora and Malhan.
2. *Biostatistics* – Jasraj and Gurudeep Raj.
3. *Biostatistics* – P. Ramkrishan.
4. *Methods in Biostatistics* – Mahajan.

Toxicology

1. *Animal Clinical Chemistry: A Primer for Toxicologists*, G. O. Evans (Ed.), Taylor & Francis, 1996.
2. *Animal Models in Toxicology*, S. C. Gad & C. P. Chengelis (Eds.), Marcel Dekker, 1992.
3. *Annual Reviews of Pharmacology & Toxicology*, 1997.
4. *Basic Toxicology: Fundamentals, Target Organ & Risk Assessment*, F. C. Lu, Taylor & Francis, 1996.
5. *Casarett & Doull's Toxicology: The Basic Science of Poisons*, C. D. Klaassen (Ed.), McGraw-Hill, 1996.
6. *Comprehensive Toxicology*, I. Sipes, C. A. McQueen & A. Gandolfi (Eds.), Elsevier Science, 1997.
7. *General & Applied Toxicology*, B. Ballantyne, T. Marrs & P. Turner (Eds.), Vol. I & II, Macmillan/Stockton Press, 1993.
8. *Loomis's Essentials of Toxicology*, T. A. Loomis & A. W. Hayes, Academic Press, 1996.
9. *Encyclopaedia of Toxicology: Chemical and Concepts*, P. Wexler, Academic Press, 1998.
10. *Dictionary of Toxicology*, E. Hodgson, J. E. Chambers & R. B. Mailman, Groves Inc., 1997.

Bioinformatics

1. Mount, W. (2004). *Bioinformatics and Sequence Genome Analysis* (2nd Edition). CBS Publishers, New Delhi.
2. Bergman, N. H. (2007). *Comparative Genomics*. Humana Press Inc., Springer Science+Business Media.

3. Baxevanis, A. D. & Ouellette, B. F. F. (2009). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. John Wiley & Sons, New York.
4. Campbell, A. M. & Heyer, L. J. (2007). *Discovering Genomics, Proteomics and Bioinformatics* (2nd Edition). Benjamin Cummings.
5. Higgins, D. & Taylor, W. (2000). *Bioinformatics: Sequence, Structure and Databanks*. Oxford University Press.
6. Rashidi, H. H. & Buehler (2002). *Bioinformatics Basics: Applications in Biological Science and Medicine*. CRC Press, London.
7. Gibas, C. & Jambeck, P. (2001). *Developing Bioinformatics Computer Skills*. Shroff Publishers and Distributors Pvt. Ltd. (O'Reilly), Mumbai.

MZO4T13 – Radiation and Chronobiology

Course Outcomes (COs)

The students will be able to define and explain the scope and significance of radiobiology in human welfare. Identify ionizing radiation, linear energy transfer, radiation dose and units, and conceptualize the different types of radiation. Describe, explain and analyze the applications of radiology and the beneficial and harmful effects of radiation. Comprehend the concept of circadian rhythm, central clock system and peripheral clock system. Students will describe, explain and analyze the centers of the biological clock, the relevance of the biological clock in human welfare, the mechanism of regulation of the biological clock, and the effects of irregularity of the biological clock along with its remedies.

MZO4T13 – Radiation and Chronobiology

UNIT – I: Radiation Biology

1.1 Definition, scope and significance of radiation biology.

1.2 General classification of radiation. Ionizing radiation, linear energy transfer, radiation dose and units.

1.3 Principles of radiation dosimetry, direct and indirect effects. Radiation lesions in DNA, radiobiological effects on cells.

1.4 Radiation sensitizers and protectors.

UNIT – II: Effect of Radiation on Human Health

- 2.1 Health consequences after total body irradiation from radiation accidents.
- 2.2 Long-term radiation risks from low radiation doses.
- 2.3 Radiation-induced cancer.
- 2.4 Radiation effects in the developing embryo and fetus; radiation-induced heritable diseases.

UNIT – III: Circadian Cycle

- 3.1 Organization of the circadian system in multicellular animals.
- 3.2 Concept of central and peripheral clock system.
- 3.3 Circadian pacemaker system in invertebrates with particular reference to *Drosophila*.
- 3.4 Circadian pacemaker system with particular reference to rodents.

UNIT – IV: Biological Clock

- 4.1 Chronobiology – Introduction; Centers of biological clock – Suprachiasmatic nuclei, pineal gland and optic lobes.
- 4.2 The relevance of biological clock for human welfare – Clock function and dysfunction.
- 4.3 Depression and sleep disorders.
- 4.4 Chronopharmacology, chronomedicine and chronotherapy.

Suggested Readings

1. Kumar, V. (2002). *Biological Rhythms*. Narosa Publishing House, Delhi / Springer-Verlag, Germany.
2. Dunlap, J. C., Loros, J. J. & DeCoursey, P. J. (2004). *Chronobiology: Biological Timekeeping*. Sinauer Associates Inc., Sunderland, MA, USA.
3. Fliedner, T. M., Friesecke, I. & Beyrer, K. (2001). *Medical Management of Radiation Accidents – Manual on the Acute Radiation Syndrome*. British Institute of Radiology Supplement.
4. Kramer, K. & Mellow, M. (2013). *Handbook of Experimental Pharmacology: Circadian Clocks*. Springer, London.

5. Hall, E. J. & Giaccia, A. J. (2006). *Radiobiology for the Radiologist*. Lippincott Williams & Wilkins, Philadelphia.
6. Saunders, D. S., Steel, C. G. H., Afopoulou, X. & Lewis, R. D. (2002). *Insect Clocks*. Barnes and Noble Inc., New York, USA.
7. International Commission on Radiological Protection (2003). *Biological Effects after Prenatal Irradiation (Embryo and Foetus)*. ICRP Publication.
8. International Commission on Radiological Protection (2006). *Low Dose Extrapolation of Radiation-Related Cancer Risk*. ICRP Publication.
9. Foster, R. & Kreitzman, L. (2014). *Rhythms of Life: The Biological Clocks that Control the Daily Lives of Every Living Thing*. Profile Books Ltd.

MZO4T14 – Molecular Biology and Biotechnology

Course Outcomes (COs)

Students will be able to analyse the basics of cellular genome, organization of genetic material, and the fundamental process of duplication of genetic material in prokaryotes and eukaryotes important for cell division. Evaluate the different types of DNA damage and repair mechanisms. Illustrate the fundamentals of various mobile DNA elements useful in horizontal gene transfer, evolutionary processes and gene expression in prokaryotes and eukaryotes. Explain the mechanisms and regulation of operon models significant in the regulation of gene expression in prokaryotes. Illustrate the fundamental process of protein synthesis with explanation of antisense and ribozyme technology. They could differentiate and distinguish DNA sequencing and gene amplification methods, cloning by different cloning vectors for recombinant DNA technology. Explain and describe the applications of molecular biology and biotechnology. They could demonstrate and estimate DNA, RNA, protein and carbohydrates.

MZO4T14 – Molecular Biology and Biotechnology

UNIT – I

1.1 Structure and organization of cellular genome – C-value paradox and $Cot^{1/2}$ value. Structure of chromosome. Organization of chromatin fiber (Nucleosome, Solenoid model, histones and non-histones). Forms of DNA.

1.2 DNA replication – Molecular mechanisms of prokaryotic and eukaryotic DNA replication. Structure and role of prokaryotic and eukaryotic DNA polymerases. Regulation of replication.

1.3 DNA damage – Types of DNA damage, causes and various causative agents. Repair of DNA damage – Mismatch repair, excision repair, recombination repair, double-strand break repair and transcription-coupled repair.

1.4 Mobile DNA elements – Transposable elements in bacteria, IS elements, composite transposons, bacteriophage Mu transposition, Tn10 transposition, SINEs and LINEs, retroviruses and retroposons.

UNIT – II

2.1 Transcription – Prokaryotic and eukaryotic transcription, RNA polymerases, transcriptional unit, initiation, elongation, termination, transcription factors and post-transcriptional modifications.

2.2 Regulation of gene expression – Regulatory proteins (Helix-turn-helix, Zinc finger, Homeodomain, Leucine zipper). Regulation of gene expression in prokaryotes – Lac operon model, positive and negative control, Tryptophan operon model and Tryptophan attenuator.

2.3 Regulation of gene expression in eukaryotes – Transcriptional activators, transcriptional repressors, direct and indirect repression, post-transcriptional gene regulation by RNA interference.

2.4 Translation – Prokaryotic and eukaryotic translation, altered code in elongation, termination factors, fidelity of translation and post-translational modifications.

UNIT – III

3.1 Antisense and ribozyme technology – Inhibition of splicing, polyadenylation, molecular mechanisms of antisense molecules, miRNA, siRNA and gene silencing.

3.2 Isolation and sequencing techniques – Isolation and sequencing of DNA, gene amplification, PCR, RAPD, RFLP, Maxam–Gilbert method and Sanger's dideoxy method.

3.3 Splicing and cloning – Cloning vectors for recombinant DNA technology: plasmids, cosmids, phagemids, YACs, gene replacement and restriction enzymes.

3.4 Hybridization techniques – Southern hybridization, Northern hybridization and Microarray.

UNIT – IV

4.1 Medical biotechnology – Application of Restriction Fragment Length Polymorphism (RFLP) in forensic science, disease prognosis and genetic counselling.

4.2 Agricultural biotechnology – Biofertilizers, bioinsecticides, biogas and genetically modified (GM) crops.

4.3 Immunobiotechnology – Hybridoma technology, Fluorescent In Situ Hybridization (FISH) and Genome In Situ Hybridization (GISH).

4.4 Industrial and Environmental biotechnology – Microbial production of fermentation products, enzymes, antibiotics, single-cell proteins and biosensors.

Suggested Readings

1. *Harper's Review of Biochemistry*. Prentice Hall.
2. Lehninger, A. L. & Nelson, D. L. *Principles of Biochemistry*. CBS Publications and Distributors.
3. Allen J. Scism. *The Biochemistry: Student's Companion*. Prentice Hall.
4. Jain, J. L. *Fundamentals of Biochemistry*. S. Chand Publications.
5. Zubay, G. L. *Principles of Biochemistry*. Wm. C. Brown Publishers.
6. Horton, H. R. *Principles of Biochemistry*. Prentice Hall.
7. Boyer, R. *Concept of Biochemistry*. Cole Publication Co.
8. Murray, R. K. P. & Granner, D. K. (Eds.). *Harper's Biochemistry*. Prentice Hall.
9. Mathews, C. K. & Van Holde, K. E. *Biochemistry*. Benjamin C. Publishing Co.
10. Garrett, R. H. & Grisham, C. M. *Biochemistry*. Saunders College Publications.
11. De Robertis, E. D. P. *Cell and Molecular Biology*. ISE Publication.
12. Turner, P. C. & McLennan. *Molecular Biology*. Viva Books Pvt. Ltd.
13. Twyman, R. M. *Advanced Molecular Biology*. Viva Books Pvt. Ltd.
14. Freifelder, D. *Molecular Biology*. Narosa Publishing House.
15. Lewin, B. *Gene VI*. Oxford University Press.
16. Lewin, B. *Gene VIII*. Oxford University Press.
17. Watson, J. D. et al. *Molecular Biology of the Gene*. Benjamin Publications.
18. Darnell, J. *Molecular Cell Biology*. Scientific American Books, USA.
19. Alberts, B., Bray, D. & Lewis, J. *Molecular Biology of the Cell*. Garland Publishing Inc.
20. Pawar, C. B. *Genetics* (Vol. I & II). Himalaya Publications.
21. Freifelder, D. *Essentials of Molecular Biology*. Narosa Publishing House.
22. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D. & Darnell, J. *Molecular Cell Biology*. W. H. Freeman & Co.
23. Cooper, G. M. *The Cell: A Molecular Approach*.
24. Upadhyay, A. & Upadhyay, K. *Molecular Biology*. Himalaya Publications.

1. Mammalian Reproductive Toxicology and Fertility

Course Outcomes (COs)

Students will be able to distinguish and describe the prevalence and risk in the male and female reproductive systems with respect to chemical and environmental toxicants including radiations, heavy metals and pesticides. Analyse the complex but highly organized physiological and molecular processes of preimplantation, foetal programming and prenatal development up to the time of labour with respect to endocrine regulators. Comprehend the information regarding traditional and advanced contraceptives, sterilization techniques and pregnancy vaccines used to prevent unintended pregnancies, thereby reducing maternal ill health and pregnancy-related deaths. Differentiate various contraceptive mechanisms in males that create physical and chemical barriers preventing sperm from reaching the oocyte through surgical techniques, antagonists, antibodies, anti-androgenic and anti-spermiogenic compounds. Prepare, identify, differentiate and explain histological slides of female and male reproductive organs affected by antifertility drugs, heavy metals and pesticides, including ovary, uterus, thyroid gland, stages of mammalian egg development, foetal membranes, types of placenta and progestational changes in the uterus.

1. Mammalian Reproductive Toxicology and Fertility

UNIT – I

1.1 Chemical toxicants and testicular toxicity.

1.2 Impact of environmental and occupational factors on reproductive health.

1.3 Infertility – Radiation, heavy metals and pesticides.

1.4 Genotoxicity on reproduction.

UNIT – II

2.1 Preimplantation development of mammalian embryo and its regulation.

2.2 Placental role in foetal programming.

2.3 Major developmental events during the foetal period in mammals (e.g., Human).

2.4 Onset and endocrine control of parturition.

UNIT – III

3.1 Intrauterine and intracervical devices (IUDs and IUCDs), medicated and non-medicated IUDs, long-acting steroidal contraceptives.

3.2 Surgical sterilization and Medical Termination of Pregnancy (MTP).

3.3 Pregnancy vaccines (Anti-HCG, Antizona vaccine, immunization with FSH).

3.4 Recent advances in female contraception – Inhibin, prostaglandins, hormone analogues and subdermal implants.

UNIT – IV

4.1 Vasectomy and reversible vas occlusion.

4.2 LH-RH antagonist, estrogen antagonist and GnRH antagonist.

4.3 Anti-androgen and anti-spermiogenic compounds (LDH-C₄ and SP-10), Inhibin.

4.4 Antibodies for acrosomal enzymes and sperm surface proteins.

Suggested Readings

1. *A Textbook of In Vitro Fertilization and Assisted Reproduction*. Edited by P. R. Brinsden and P. A. Rainsbury. Jaypee Brothers, 1992.
2. McLaren, A. (1968). *Advances in Reproductive Physiology* (Vol. 1–6). Logos Press Ltd., London.
3. Joshi, S. C. & Ansari, A. S. (Eds.). *Advances in Reproductive Toxicology*. Pointer Publishers.
4. Nieschlag, E. & Behre, H. M. (Eds.) (2000). *Andrology* (2nd Edition): Male Reproductive Health and Dysfunction.
5. Zanzveld, L. J. D. & Chatterton, R. T. (1982). *Biochemistry of Mammalian Reproduction*. John Wiley & Sons, New York.

6. Assali, 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: Trends in Endocrine, Paracrine and Autocrine Regulation of Structure and Functions*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Joy, K. P., Krishna, A. & Haldar, C. (Eds.) (1998). *Comparative Endocrinology and Reproduction*. Narosa Publishing House.
10. Das, R. P. (1989). *Contraceptive Technology: Past, Present and Future*. N.I.H.F.W., New Delhi.
11. Crichton, D. B., Haynes, N. B., Foxcroft, G. R. & Lamming, G. E. (1978). *Control of Ovulation*. Butterworths, London.
12. Knobil, E. & Neill, J. D. (Eds.) (1998). *Encyclopedia of Reproduction* (Vol. I–IV).
13. Felig, P. & Frohman, L. A. (2001). *Endocrinology and Metabolism* (4th Edition). McGraw-Hill Medical Publishing Division.
14. DeGroot, L. J. et al. (1989). *Endocrinology* (Vol. I–III). W. B. Saunders Co., Philadelphia.
15. Turner, C. D. & Bagnara, J. T. (1990). *General Endocrinology*. W. B. Saunders Co., Philadelphia, London & Tokyo.
16. Cowie, A. T., Forsyth, I. A. & Hart, I. (1980). *Hormonal Control of Lactation*. Springer-Verlag, Berlin & New York.
17. Hafez, E. S. E. & Blandau, R. J. *Mammalian Oviduct*. The University of Chicago Press, Chicago & London.
18. Lamming, G. E. (Ed.). *Marshall's Physiology of Reproduction* (4th Edition, Vol. III: Pregnancy and Lactation, Parts I–III). Chapman & Hall.
19. Perry, J. S. *Ovarian Cycle of Mammals*. Oliver and Boyd, Edinburgh.
20. Asdell, S. A. (1964). *Patterns of Reproduction*. Constable & Co., London.
21. Smith, V. *Physiology of Lactation*. Vearch, Constable & Co., London.
22. Rajan, R. (1997). *Postgraduate Reproductive Endocrinology* (4th Edition). Jaypee Brothers Medical Publishers (P) Ltd.
23. Choudhary, S. K. *Practice of Fertility Control*. Churchill Livingstone.

MZO4P08 – Research Project (RP) Major Work

Course Outcomes (COs)

After completion of the major research project, the student will be able to select an appropriate research problem (title), plan and develop the experimental design for the project, select and use appropriate methods and materials for research work, analyse and interpret the results, draft a scientific write-up and submit it in the form of a thesis, and prepare bibliography using various referencing styles.

MZO4P08 – Research Project (RP) Major Work

In this major research project, the topic will be based on the elective opted by the student. The project will include laboratory-based work. The project report shall be submitted and presented, followed by a viva-voce examination. The evaluation of the major project will be conducted at the departmental level by the approved internal and external examiners.