

SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM



M.Sc. ZOOLOGY – 2021

DEPARTMENT OF ZOOLOGY, BMT, HG and WLB & C

University School of Sciences
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M.Sc. in ZOOLOGY
SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM
SEMESTER – I
SYLLABUS EFFECTIVE FROM JUNE 2021

Sl. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1.	ZOO-401	CELL BIOLOGY & ANIMAL CELL CULTURE	3+1	30	70	100	04
2.	ZOO-402	ANIMAL PHYSIOLOGY & BIOCHEMISTRY	3+1	30	70	100	04
3.	ZOO-403	GENERAL INSTRUMENTATION & TECHNIQUES	3+1	30	70	100	04
4.	ZOO-404	ANIMAL SYSTEMATICS AND FUNCTIONAL ANATOMY	3+1	30	70	100	04
5.	ZOO-405PR	PRACTICAL -1	06	30	70	100	04
6.	ZOO-406PR	PRACTICAL - 2	06	30	70	100	04
		TOTAL	28	180	420	600	24

M.Sc. In Zoology

PROGRAMME OUTCOMES:

The programme of Master's in Zoology focuses in-depth the study of animals and human beings by imparting classical and modern knowledge and skill sets to the students which makes them competent to thrive in research and industries pertaining to pharmaceuticals, research centres, medical centres, pathological centres etc. Students will also be imparted knowledge of intellectual property rights and bioethics.

COURSE OUTCOMES:

Semester 1:

ZOO 401: The students would be able to learn the structure and functions of normal cells in animal including human beings. The students would be able to explain with examples various types of cells with normal functions and abnormal cancerous cells, etc.

ZOO 402: The students would be able to know metabolism and energy generating pathways and metabolism associated diseases in human and animals. They will be also taught about physiological process, various regulatory processes and adaptation to the environment.

ZOO 403: The students would be able to learn various techniques like microscopy, electrophoresis, chromatography, spectrophotometry, various separation techniques, centrifugation, etc.

ZOO 404: The students would be able to learn systematic and diversity of various animal classes and their interaction with environment.

ZOO 405 PR & 406 PR. The students will attain on hand practical experiences of various various topics covered in the theory papers.

M.Sc in ZOOLOGY

SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM

SEMESTER – 1 JUNE 2021 ONWARDS

ZOO-401: CELL BIOLOGY & ANIMAL CELL CULTURE

UNIT I: Cell Organelles:

Membranes of cells and transport across membranes, Energy generation in mitochondria and chloroplast, Cytoskeleton, General organization of protein transport within and outside the cell, Protein sorting and secretion, Mechanism of intracellular digestion, Structure and function of peroxisome, Nucleus, Nucleolus and biogenesis of ribosome

UNIT II: Cell Junctions, Cell Cycle, Cell Death, Cancer and Stem Cells:

Cell adhesions, adherence, tight and gap junctions; Extracellular matrix and its association with cells; Cell cycle and its regulation; Cell death, apoptosis, necrosis, terminal differentiation and cell aging; Cancer, metastasis and angiogenesis; Stem cells, its types and application.

UNIT III: DNA, Chromatin and Chromosome:

Structure, properties, types of DNA and its isolation; Types and properties of histone and non-histone proteins; Nucleosome, Solenoid structure, Loop and domain, Organization of DNA in the chromosome; Types of chromosomes; Types and properties of heterochromatin; Lyon hypothesis; X-chromosome inactivation; Sex chromatin and its importance.

UNIT IV: Cell, Histotypic and Organotypic Culture of Animal cells:

Basics of cell culture; Culture environment, Sterilization techniques; Factors affecting cell culture, Contamination and its remedies; Serum and serum-free media; Primary and secondary cultures; Cell lines; Cell strains; Techniques for creation of cell strains or cell cloning Monolayer cultures; Suspension cultures; Cell synchronization and characterization; Measurement of cell growth and multiplication; Scaling-up of animal cells in culture; Cryopreservation, Histotypic and organotypic cultures; 3-D cell culture.

ZOO-402: ANIMAL PHYSIOLOGY & BIOCHEMISTRY

Unit-I: Enzymology:

Significance of Enzymes in Biological systems; Nomenclature and Enzyme Classification; Enzyme structure and function; Properties of Enzymes; Mechanism of Action of Enzymes; Enzyme Kinetics: Unisubstrate enzyme kinetics, K_m , V_{max} ; Linear Plots; Factors affecting Enzyme Activity; Reversible and Irreversible Enzyme Inhibition; Types of Inhibition; Allosteric enzymes; Immobilization and Industrial uses of enzymes; Ribozymes; DNAzymes; Metalloenzymes; Isoenzymes; Clinical Role of Enzymes.

Unit-II: Energy Generation and Associated Diseases:

Reactions, regulation and genetic disorders of glycolysis, Krebs' cycle, Pentose phosphate pathway, Fatty acid oxidation and Glycogen metabolism, Glucose transporters, Diabetes and its effects on the body.

Unit-III: Circulatory, Respiratory and Excretory System:

Cardio-vascular physiology; Functions & Disorders of Circulatory System; Respiratory physiology; Lung volumes and capacities; Control of respiration; disorders of the respiratory system; Role of body fluids; Homeostasis; Structure and function of kidneys; Concentration of urine; Control of urine formation; Disorders of the urinary system.

Unit-IV: Digestive, Nervous and Muscle System:

Physiology of food intake; Digestion and absorption of Carbohydrates; Proteins and Fats. Control and components of secretions in the oral cavity, stomach and intestine; Gastric motility and emptying; Cells and organization of the Nervous system, Nerve impulse transmission; EPSP and IPSP; Neurotransmitters, Cells and organization of the Muscular system; Physiology of Skeletal, Smooth and Cardiac Muscles; Neuromuscular junctions; Muscle contraction and energetic; Neuromuscular Disorders.

ZOO-403: GENERAL INSTRUMENTATION & TECHNIQUES

Unit-I: Microscopy:

Principle, working and types of light microscope: Bright-field, Dark-field, Phase-contrast, Fluorescence, Confocal, Atomic Force Microscopy; Principle and working of electron microscope – SEM and TEM; Freeze-etch and Freeze fracture technique for EM; Image analysis for microscopy.

Unit-II: Electrophoresis and Centrifugation:

Principle of Electrophoresis; Types of electrophoresis: Agarose gel electrophoresis, Polyacrylamide gel electrophoresis, Isoelectric focusing and 2D-PAGE, Pulse field gel electrophoresis, Tube gel electrophoresis, Capillary gel electrophoresis; Factors affecting electrophoresis.

Principle of centrifugation; Types of rotors; Types of centrifuges; Types of centrifugation techniques: Differential, Density gradient and Analytical ultracentrifugation.

Unit-III: Chromatography and Photometry

History and introduction of separation techniques; Fundamentals of chromatographic separation, Chromatographic techniques; Methods of separation and detection; Hyphenated techniques - HPLC, HPTLC, FPLC, UPLC, etc.,

Principle and applications of spectroscopic techniques – UV-Vis; IR; NMR; MS; MALDI-ToF etc.

Unit-IV: Histological and Histochemical Techniques (For light and Electron microscope)

Tissue fixation; Embedding; Staining; Basic and Acid Dyes; Mordants; Amphophilic and Neutrophilic tissues; Metachromatic histochemical and immunohistochemical techniques.

ZOO-404: ANIMAL SYSTEMATICS AND FUNCTIONAL ANATOMY

UNIT I: ANIMAL SYSTEMATICS:

Introduction – Systematics; Taxonomy; Identification; Classification; Nomenclature and Phylogenetics; Classification systems introduced by Carl Linnaeus, Ernst Haeckel, Robert Whittaker, Carl Woese and Thomas Cavalier-Smith; Aims, tasks, stages and importance of taxonomy; Taxonomic characters and character states. Concepts of conventional and newer aspects of taxonomy – Ecotaxonomy, Behavioral taxonomy, Cytotaxonomy Numerical taxonomy, Cladistics, Evolutionary taxonomy, Chemotaxonomy and Molecular phylogeny; Recent developments in taxonomy – DNA barcode and Phylocode.

UNIT II: FUNCTIONAL ANATOMY OF INVERTEBRATES:

Metamerism, Coelom and Symmetry; Feeding and digestion in Protozoa and lower metazoa; Filter feeding; Amoeboid, flagellary and ciliary movement, Hydrostatic skeleton and movement; Respiratory organs and pigments; Osmoregulation; Neuro-endocrine mechanisms; Patterns of reproduction, larval forms and metamorphosis.

UNIT III: ZOOGEOGRAPHY

History of zoogeography and zoogeography regions; Distribution of animals in respect of the regions; Factors affecting animal distribution; Extinction of species; Exotic animals and their introduction and its effects; Endemic species; Anthropological pressure on zoogeography.

UNIT IV: FUNCTIONAL ANATOMY OF VERTEBRATES:

Movement and Locomotion – Aerial, Water and Land; Comparative functional anatomy of Digestive, Circulatory, Excretory, Nervous, Endocrine and Reproductive Systems of Vertebrates; Respiratory organs of vertebrates.

ZOO – 405 PR:

Practicals based on the theory papers ZOO-401 and ZOO-402. Field/Industrial/ Laboratory visits

ZOO – 406 PR:

Practicals based on the theory papers ZOO-403 and ZOO-404. Field/Industrial/ Laboratory visits

LIST OF REFERENCE BOOKS

1. Becker's World of the cell.- Jeff Hardin and Gregory Bertoni.
2. Karp's Cell and Molecular Biology Concepts and Experiments.- Gerald Karp, Janet Iwasa and Wallace Marshall.
3. Cell and Molecular Biology.- E.D.P. DeRobertis and EMP De Robertis Geoffrey Cooper.
4. Molecular Biology of the Cell.- Bruce Alberts et al.,
5. Animal cell culture: Essential methods.- John M. Davis(Ed).
6. Culture of Animal cells:A manual of basic technique and specialized applications.- R. Freshney.
7. Animal cell culture and Technology.- Michael Butler.
8. Animal cell culture.- Mohd. Al-Rubeai(Ed).
9. Animal cell culture.- John R.W. Masters(Ed).
10. Textbook of Physiology.- George Howard Bell, Donald Emslie-Smith, Colin Ralston Paterson.(Eds).
11. Human Physiology, Biochemistry and Basic Medicine.- Laurence cole , Kramer, Peter.
12. Physiology and Biochemistry in modern medicine.- John Macleod.
13. Principles of Biochemistry.- Albert L. Lehninger, David L. Nelson and Michael M. Cox.
14. Textbook of Medical Physiology.- John E. Hall and C. Guyton.
15. Tortora's Principles of Anatomy and Physiology.- Gerard J Tortora.
16. Fundamentals of Enzyme kinetics.-
17. Understanding the control of metabolism.- David Fell.
18. Fundamentals of Enzymology.- Nicholas C. Price and Lewis Stevens.
19. Wilson & Walker's Principles and Technique of Biochemistry and Molecular Biology.
20. Instrumental Analysis in the Biological Sciences.- Gordon M.H.
21. Systematic Zoology.- Ernst Mayr and Peter D Ashlock.
22. Principles of Animal Taxonomy.- George Gayloard Simpson.
23. Invertebrate Structure and Function.- Barrington E J W.

24. Functional anatomy of the vertebrates an evolutionary perspective.- Warren Walker, Karel Liem, William Bemis and Lance Grande.
25. A Functional Anatomy of Invertebrates.- Vera Fretter and Alistair Graham.
26. Fundamentals of Enzymology-The Cell and Molecular Biology of Catalytic Proteins.- Price, N. C. and Stevans, L.
27. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry.-Bonner, P.L. and Palmer, T.
28. Enzymes: Catalysis, Kinetics and Mechanisms.- Puneekar, N. S.
29. Harper's Illustrated Biochemistry Thirty-First Edition.- Rodwell, V.W., Bender, D. Botham, K.M. et al.
30. Biochemistry - Satyanarayana, U. and Chakrapani, U.
31. Biochemistry & Metabolism..- Davison, A., Milan, A. Phillips, S. and Ranganath, L.
32. Molecular cell biology.- Harvey Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M. & Amon, A
33. Techniques in microscopy and cell biology.- Sharma, V. K.
34. A manual of laboratory experiences in cell biology.- Gasque, C.E.
35. Wilson and Walker's principles and techniques of biochemistry and molecular biology.- Wilson, K., Hofmann, A., Walker, J. M., & Clokie, S. (Eds.).
36. Electrophoresis in practice: A guide to methods and applications of DNA and protein separations.- Westermeier, R.
37. Electrophoresis: theory, methods, and applications.- Bier, M. (Ed.).
38. Centrifugal separations in biotechnology.- Leung, W. W. F.
39. Centrifugal Separations in Molecular and Cell Biology.- Birnie, G. D. and Rickwood, D. (Eds.).
40. Encyclopedia of Separation Science.- Smith, R. M.

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M.Sc. in ZOOLOGY
SYLLABUS FOR CREDIT BASED SEMESTER SYSTEM
SEMESTER – II
SYLLABUS EFFECTIVE FROM JUNE 2021

SR. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1.	ZOO-407	GENETICS & IMMUNOLOGY	3+1	30	70	100	04
2.	ZOO-408	GENETIC ENGINEERING & ADVANCE MOLECULAR TECHNIQUES	3+1	30	70	100	04
3.	ZOO-409	ECOLOGY & ETHOLOGY	3+1	30	70	100	04
4.	ZOO-410	EVOLUTION & RADIATION BIOLOGY	3+1	30	70	100	04
5.	ZOO-411PR	PRACTICAL -1	06	30	70	100	04
6.	ZOO-412PR	PRACTICAL – 2	06	30	70	100	04
		TOTAL	28	180	420	600	24

M.Sc. In Zoology

PROGRAMME OUTCOME:

The program and syllabus designed for the Masters degree in Zoology has been framed to equip the post graduate student with knowledge and practical expertise of the both, basic foundational elements in the field as well as, the recent advances and developments. This would enable a student to comprehend the basic tenets in this subject and use the information to generate innovative research ideas to meet current challenges, using advanced knowledge and technology. A student so trained would be ready for futuristic career opportunities with clear basic concepts.

COURSE OUTCOME: Semester II

ZOO 407: The module includes topics in Genetics and Immunology. The student would gain information on the molecular organization and complexity of Genomes, fundamental molecular processes and gene regulatory mechanisms. In addition, the student would understand the principles of monogenic and multifactorial inheritance and further gain insight into Clinical Genetics, with the study of chromosomal analysis, Genetic anomalies and syndromes. This would make a student extremely relevant in this era of Genomics. Topics in Immunology would help the student to learn about the immune system, its functions and the deficiencies and disorders related to immune function, pertinent in an age where innumerable diseases confront the immune function. Knowledge and practical experience in Immunotechnology, immunodiagnostics and immunotherapies, are essential prerequisites in this field, since a vast number of clinical conditions are yet to be explained and require in-depth awareness.

ZOO 408:

Industry, Biomedicine and Research today have grown with an increased dependence on Biotechnology and Advanced Molecular Technologies. This course provides a platform for a student to shape her/his career in Industry or at Advanced Biological Research Institutes by giving the student a comprehensive understanding of the working principles and hands-on skill development in Molecular Analytical tools, such as Recombinant DNA technology, Next generation sequencing, CRISPER etc., which are now the need of the hour in a developing country.

ZOO 409

The focus of this revised curriculum is to enable a student to appreciate the significance of basic Environmental issues and yet keep pace with current trends, to resolve environmental conflicts with a Global perspective. Ecosystem dynamics, Climate change, Environmental degradation, Pollution, Biome destruction, Population studies, are pivotal in helping a student to understand present day Ecological problems and carry out the much needed impact assessment. The units in Ecology have been set to give the student essential theoretical and practical concepts, to work towards achieving a healthy, sustainable planet. A student of this field should have inclusive knowledge of Animal Behavior under natural conditions, animal responses and adaptations, which are extremely significant in understanding threats to existing species and building working strategies for animal conservation.

ZOO 410

A student is therefore offered a foray into advanced molecular sequence based theories, such as the genetic basis of speciation, to encourage a student to identify evolutionary patterns, trends and impacts in the light of molecular alterations. The course includes important topics in Radiation Biology to provide the candidate with an intrinsic and holistic approach to this relatively young and dynamic Science. The rampant use, exposure and threats from radiation warrants an in-depth study of Radiation from all dimensions, including the sources, dosimetry, exposure consequences and precautions, features which have been emphasized in this syllabus.

ZOO 411 PR & 412 PR. The students will attain hands-on practical experiences of various topics covered in the theory papers.

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SEMESTER –II JUNE 2021 ONWARDS

ZOO-407: Genetics & Immunology

Unit-I: Genetics-I

DNA replication, transcription & splicing, Regulation of gene expression in prokaryotes – negative and positive control of lac operon, trp operon and its attenuation, Extra nuclear inheritance and maternal effect, Mutation & mutagenesis, C value, complexity of genomes, Split genes, non-coding genes, overlapping genes, multi-gene families, pseudogenes, overlapping sequences, Unique sequences, Repetitive sequences - satellite DNAs and interspersed repeated DNAs, LINES, SINES, Alu family, Transposons.

Unit-II: Genetics-II

Mendelian inheritance and its extension, epistasis, pleiotropy, incomplete dominance, codominance, multiple alleles, penetrance & expressivity, phenocopy. Linkage & crossing over. Mechanism of sex determination, sex linked inheritance, Y specific genes. Chromosome aberrations, Chromosome syndromes caused by aneuploidy, mosaicism, and structural anomalies, Chromosomal anomalies in malignancy. Polygenic inheritance, Inborn errors of metabolism, Multifactorial disorders

Unit-III: Immunology-I

An Introduction to the Immune System, Immune response, Antigen, Antibodies, Major Histocompatibility Complex, Primary and secondary immunodeficiencies, Allergy and Hypersensitivity, Autoimmunity, Immunosenescence, Cancer immunology

Unit-IV: Immunology-II

Immunological diagnostic techniques/Immunochemical techniques, Immunoassays, Immunoelectrophoresis, Future of Diagnostic Immunology, Immunocapture Polymerase Chain Reaction, Immunotherapy, Immunosuppressive therapy, Transplantation, Environmental Allergy and Allergotoxicology, Immunotoxicity Testing

ZOO-408: Genetic Engineering & Advance Molecular Techniques

Unit-I: Genetic Engineering - I

Expression and interaction-based screening of colonies, Principles of hybridization and hybridization-based techniques, CRISPR/Cas9, Recombination-based cloning, Molecular interaction assays including two hybrid assays, Transformation and Transfection methods, Promoter characterization and mutagenesis

Unit-II: Recombinant DNA Technology

Enzymes used in DNA technology – nucleases, Polymerases, Ligase, kinases and phosphatases, Vectors – Plasmids, Phages, Cosmids, Artificial chromosomes, Shuttle vectors, Expression vectors, Construction of genomic and cDNA libraries, Applications of Recombinant DNA Technology, GMOs,

Unit-III: Advance Molecular Biology Techniques - I

Isolation of DNA, RNA and Plasmid; Polymerase chain reaction and its general applications; Dye and Probe based detection in Real Time PCR; Gene expression study and data analysis in qPCR; DNA fingerprinting; DNA foot-printing.

Unit-IV: Advance Molecular Biology Techniques – II

RFLP and Restriction Mapping; Southern blotting, Northern blotting, Western blotting, Dot Blot technique; DNA sequencing by chain termination method and chemical degradation method, Capillary sequencing technique; Gene transfer techniques.

ZOO-409: ECOLOGY & ETHOLOGY

Unit-I: Ecology

Productivity in ecosystems, Ecological succession and niches, Indian biomes, Aquatic and wetland ecology, Environmental degradation and pollution, Bioremediation, Ecological footprints, Carbon footprints, Environment impact assessment, Solid waste management

Unit-II: Population Ecology

Population density - Absolute and Relative density and its measurements, Population Demographic units; Life Tables and Survivorship curves, Age distribution, Population growth - Exponential and Logistic growth, Population dispersion, dispersal, and fluctuations, Population selection - Life history strategies, r and K selection, Clutch size and sex ratios in populations, Biotic Interactions-Positive and Negative Interactions

Unit-III: Remote sensing and other ecological sampling methods

Basics of remote sensing, active and passive remote sensing, Concept of electromagnetic spectrum (EMR), Interaction of EMR and earth's surface Atmospheric windows, Types of platforms and scanning systems, Base and thematic maps, Elements of a good map, Sources of thematic maps, Fundamentals of photogrammetry, types of Aerial Cameras, Types of Aerial photographs, scale and their correction (swing, tilt, pitch, yaw), Depth perception and stereoscopic viewing, Concept of digital photogrammetry, Image Interpretation, Sensors and image characteristics of LANDSAT, SPOT, NOAA and IRS series of satellites Spatial, spectral and temporal resolutions

Unit-IV: Animal Behavior

Learning, Memory, Territorial behavior, Reproductive behavior and parental care, Social behavior in invertebrate and vertebrates, Tool use in animals, Behavioral types and patterns, Genetic basis of animal behavior, Communication, navigation, Migration.

ZOO-410: Evolution & Radiation Biology

Unit I: Basic and applied evolution

Concept of species Origin of life on earth, Geological time scales, Animal plant coevolution, Animal microbial coevolution, Trends and patterns in evolution, Evolution of man, Adaptations and mimicry.

Unit II: Molecular evolution

Genetic variation and mutation, HW law, Gene flow and genetic drift Molecules and evolution Macro and micro evolution, Molecular phylogeny.

Unit-III: Radiation Biology - I

Radioactive isotopes, types, properties and application in nuclear medicine and research; Radioactivity, Specific activity, Radioactive decay, half-life; Modes of radioactive decay; Sources of Exposure; Types and properties - Electromagnetic and Particulate forms (α , β , η , protons, positrons); Radiation dosimetry, Measurement modalities and Units of Radiation; Ionising radiation: Types, uses and properties of X-rays; Varied Diagnostic applications of X-rays; Properties of Gamma rays. Interaction of radiation with matter; Non-Ionizing radiation: Types, sources, uses, properties and biological effects of Ultraviolet radiation, Infrared radiation, microwaves and radiofrequency radiation.

Unit-IV: Radiation Biology - II

Law of Radiosensitivity; Differential radiosensitivity; By-stander effect; Effects of Ionizing radiation: Effects on Biomolecules, Cell and Cell organelles; Effects on various organs and organ systems; Radiation Genetics; Radiation syndromes; Radiation and Cancer, Radiotherapy, External Beam radiotherapy and Brachytherapy; Radioprotective agents, radiosensitizing agents, Radiation hormesis; Precautions and ICRP safety rules in handling radiation/radioactive isotopes.

ZOO – 411 PR:

Practicals based on the theory papers ZOO-407 and ZOO-408. Field/Industrial/ Laboratory visits.

ZOO – 412 PR:

Practicals based on the theory papers ZOO-409 and ZOO-410. Field/Industrial/ Laboratory visits.

REFERENCE BOOKS

- Darwin, C. 1859. On the Origin of Species. London: John Murray (always seek out the first edition, facsimile version, and avoid later editions).
- Dobzhansky, T. 1937. Genetics and the Origin of Species. New York: Columbia Univ. Press (there are several later editions, and the title changed in the last).
- Fisher, R. A. 1930. The Genetical Theory of Natural Selection. Oxford: Oxford Univ. Press (there is a later edition).
- Hennig, W. 1966. Phylogenetic Systematics. Urbana: Univ. Illinois Press (an English translation of a book published earlier in German).
- Mayr, E. 1942. Systematics and the Origin of Species. New York: Columbia Univ. Press (there is a later edition, with a different title).
- Schmalhausen, I. I. 1949. Factors of Evolution. Philadelphia: Blakiston (publication of this book, written in the early 1940's, was delayed because of war, and then the translation from Russian to English was also delayed; it has been reprinted by Univ. Chicago Press).
- Simpson, G. G. 1944. Tempo and Mode of Evolution. New York: Columbia Univ. Press (again, there is a later edition, with a different title).
- Bonner, J. T. 1988. The Evolution of Complexity. Princeton: Princeton Univ. Press.
- Williams, G. C. 1966. Adaptation and Natural Selection. Princeton: Princeton Univ. Press
- Crow, J. F. 1991. Basic Concepts in Population, Quantitative, and Evolutionary Genetics. New York: W. H. Freeman.
- Falconer, D. S. 1981. Introduction to Quantitative Genetics, second ed. London: Longman.
- Hartl, D. L. And A. G. Clark. 1989. Principles of Population Genetics, second, ed. Sunderland, MA: Sinauer.
- Real, L. A. (ed.). 1994. Ecological Genetics. Princeton: Princeton Univ. Press
- Meyers, Wiley – Blackwell Lewin's Genes XII by Krebs, Goldstein and Kilpatrick by Jones and Bartlett Learning Synthetic Biology
- Mishra and Alok, Educreation Publication, A handbook of research methodology
- Arumugam, Saras publication, Research Methodology for life Sciences
- Ahmad, S. (2011). Remote sensing and gis for environmental management, World Education.
- Cooley, M. (2013). Remote Sensing, Gis And Wetland Management, Random Exports.
- Reddy; A. (2010). Textbook of Remote Sensing and Geographical Information, BS Publications.
- Dowman, I. (2018). Fundamentals of Remote Sensing. By George Joseph and C. Jeganathan. Universities Press (India) Private Limited.
- Panda, B. C. & Panda, B. C. (2005). Remote sensing principles and applications. Viva Books Pvt.Limited.
- Campbell, J. B. & Wynne, R. H. (2011). Introduction to remote sensing. Guilford Press.
- Punt, J.; Jones, P.; Owen, J. A. & Stranford, S. (2018). Kuby Immunology. United Kingdom: Macmillan Learning.
- Wilson, K.; Hofmann, A.; Walker, J.; Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. United Kingdom: Cambridge University Press.
- Paul, W. E. (2013). Fundamental immunology. Philadelphia: Lippincott Williams et Wilkins.
- Murphy, K. M. & Weaver, C. (2017). Janeway's Immunobiology. United Kingdom: Garland

Science.

- Latha, P. M. (2012). A Textbook of Immunology. India: S. Chand & Company.
- Casarett, A.P. 1968. Radiation Biology. Prentice Hall Publications.
- Chadwick, K.H. Understanding Radiation Biology. CRC Press. 1998.
- Shah, V. C. 1985. Elements of Radiation Biology. Globe Books and Periodicals.
- Radiation Biology. Publications by P. Uma Devi.
- De Robertis, E. D. P. and De Rebartis, E. M. F. 1987. Cell and Molecular Biology. Eighth Edition. Lea and Febiger, Philadelphia.
- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, D. 1983. Molecular Biology of The Cell. Garland Publishing, New York.
- Lodish, H., Baltimore, D., Berk, A., Zipursky, S. L., Matsudaira, P. and Darhell, J. 1995. Molecular Cell Biology. Third Edition. Academic Press, New York.
- Karp, G. 1999. Cell and Molecular Biology. John Wiley, London.
- Russel, P. J. 1998. Genetics. Beryamin / Cummaings Publishing Company.
- Strickberger, M. W. 1985. Genetics. MacMillan Pub. Co., Philadelphia.
- Gardner, E. J. 1999. Genetics, John wiley & Sons, New York.
- Benjamin, L. 2000. Genes VII. John Wiley & Sons, New York.
- Benjamin L. 2003. Genetics: A Conceptual Approach. Freeman.
- Odum, E. P., 1990. Fundamentyls of Ecology. W. B. Saunders Company.
- Krebs, C. J. 1985, Scology, 3rd Edition, Harper& Row , New York.
- Sharma, P. D. 1996. Ecology and Environment. Seventh Edition. Rastogi Publication. Meerut.
- Kormondy, E. J. 1996. Concepts of Ecology. Fourth Edition. Prantice Hall of India Pvt. Ltd., New Delhi.
- Sambrook and Russell. 2001. Molecular Cloning. Coldspring Harbour
- Pasternak. 2000. An introduction to molecular human genetics. Fitzgerald.
- Wilson and Walker. 2000. Practical biochemistry. Principle and techniques. Cambridge.
- Griffith's et al., 2004. An introduction to genetic analysis. Freeman.
- Brown. 2001. Essential Molecular biology (Volume I & II). Oxford University Press.
- Glick and Pasternak. 1990. Molecular biotechnology. ASM press.
- Miesfield. 1999. Applied Molecular Genetics. Willey.
- Griffith et al. An introduction to Genetic analysis. Published by Freeman
- Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Lewin's GENES XII. Published by Jones and Bartlett learning.
- D. Peter Snustad, Michael J. Simmons. Principles of Genetics.
- W S Klug & M R Cummings. Concepts of Genetics.

**ZOOLOGY – SYLLABUS - SEMESTER III - JUNE 2022 ONWARDS, GUJARAT
UNIVERSITY, AHMEDABAD – 380 009, GUJARAT, INDIA.**

**M.Sc. Zoology, Semester-III
June, 2022 Onwards**

SR. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1	ZOO – 501	BIostatistics, Bioinformatics AND RESEARCH METHODOLOGY	3+1	30	70	100	04
2	ZOO - 502	DEVELOPMENTAL BIOLOGY & MOLECULAR MEDICINE	3+1	30	70	100	04
3	ZOO – 503EA	CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY-I	3+1	30	70	100	04
4	ZOO – 503EB	ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY – I					
5	ZOO – 503EC	ECOTOXICOLOGY AND WILDLIFE FORENSIC – I					
6	ZOO – 503ED	FISH BIOLOGY AND FISHERY SCIENCES – I					
7	ZOO – 503EE	GENETIC COUNSELING – I					
8	ZOO – 503EF	TOXICOLOGY-I					
9	ZOO - 503EG	ENTOMOLOGY-I					
10	ZOO – 504EA	CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY-II					
11	ZOO – 504EB	ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY – II					
12	ZOO – 504EC	ECOTOXICOLOGY AND WILDLIFE FORENSIC - II					
13	ZOO – 504ED	FISH BIOLOGY AND FISHERY SCIENCES – II					
14	ZOO – 504EE	GENETIC COUNSELING – II					
15	ZOO – 504EF	TOXICOLOGY-II					
16	ZOO - 504EG	ENTOMOLOGY-II					
17	ZOO - 505PR	PRACTICAL – I	6	30	70	100	04
18	ZOO - 506PR	PRACTICAL - II	6	30	70	100	04
		Total	28	180	420	600	24

PROGRAMME OUTCOME

The program and syllabus designed for the third semester for the Master's degree in Zoology has been framed to provide the student with the essential pre-requisites for the next step in research, for carrying out a dissertation or for pursuing Doctoral research. This would equip a student with the required knowledge of all aspects related to carrying out intrinsic experimental research and analyze and process the data as per current standards. The syllabus designed for the third semester for the Master's degree has been formulated to offer the student an elective paper with promise for future career opportunities. This would enable a student to obtain theoretical and practical knowledge in an area which would have wide applicability in securing a good career option and help the student fulfill their career goals.

ZOOLOGY COURSE OUTCOME

ZOO – 501 & 502

This Unit includes topics in Biostatistics. It is well-accepted that no research is accepted or can be validated without substantiation by correctly used Statistical methods. A student equipped with the theory and practical aspects of this curriculum would have a good foundation in precise Sampling and Data Collection, have the ability to represent data effectively and carry out the requisite Descriptive as well as Analytical Statistics to ensure accurate Scientific standards. A student would be able to carry out the Statistical Analysis for both parametric and non-parametric data. A firm foundation in Biostatistics would thus prepare a student for research associated with Industry or Medical or Biological fields.

This Paper also provides a student with the basic concepts in Bioinformatics. basic concepts of biological databases, Resources and Tools. A student would thus be familiar with the use of related software, various Tools for Bioinformatics, Sequence alignment, exploring Sequence & Structure Databases and the applications of Bioinformatics. This knowledge would extremely useful vocations in any Organization or Institution dealing with Molecular Analysis, which is currently ubiquitous in Medical, Forensic Sciences, Pharmaceutical, Biotechnological and several other fields.

The inclusion of Research Methodology is specifically with the forethought of moulding a student for future research. With the discontinuation of the M.Phil. degree, it is now imperative to add this module in the Master's degree syllabus. With this unit a student will comprehend and accurately carry out Experimental design in Research, Measurements and Experimentation with Scientific logic, setting hypothesis with proper rationale and data interpretation with analytical reasoning. This curriculum will also guide a student in the workings for development of pre-proposal and full proposal, Scientific writing and documentation, Ethics in Science and all regulatory processes for Laboratory accreditation.

Students will learn about different aspects of Developmental Biology such as gene expression during development, stem cells in development as well as cytological, genetical and chemical basis of development. It also covers importance of adopting a multidisciplinary approach for understanding the nature of growth and regeneration. Students will learn about types, dynamics and physiological mechanisms of growth and regeneration which will help them to understand the concepts deeper for the research work. Students will also have great exposure on topic such as Molecular Medicine. Understanding of fundamentals, approaches and future of molecular medicine will help students advancing their career in research field.

CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY - 503 & 504

There have been unprecedented technical advancement in genetics and molecular biology which is continuing and holds a lot of promise. Hence, this course has been designed to include all the basic as well as new emerging techniques in this field. Conventional tools such as pedigree analysis, chromosome identification, Banding techniques etc. have been included which still remain a powerful starting tool. Emphasis has also been given to Cancer Biology and toxicology. Furthermore, students will be taught other important topics of genetics including Human Genome Project, DNA repair, Toxicity and toxicity testing, cell signalling and communication etc. Students will also become proficient in new areas such as Nanotechnology and stem cell biology. In this module, the students will be familiar with the science of toxicology, including hazard identification, exposure assessment, dose-response assessment, and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. They will also learn technical aspects and experimental approaches in toxicological research, testing, and risk assessment. Students will also learn about molecular techniques such as PCR, sequencing, gene silencing, gene expression analysis using microarray. Our goal is to provide students a broad understanding of all these recent techniques which are important for advanced biological research. We will also be giving students the comprehensive idea of gene therapy to cure the disease which will help them in future career development.

ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY 503 & 504

The course covers details of embryonic development of the Endocrine and Reproductive system and its regulation, as well as anatomical, biochemical, molecular and functional details of the Endocrine organs, male and female reproductive systems. These topics give a student the background and foundation needed for pursuing a research or investigation (diagnostic) career in Endocrinology, Fertility regulation, control and management.

The curriculum of the specialization on Endocrinology and Reproductive Technology is designed to provide students with in-depth knowledge of various aspects of Endocrinology and Reproductive Technology. This paper also confers knowledge and practical skill related to Endocrine and Reproductive Technologies, which includes Molecular technologies, Bioassays, Immunoassays and specific laboratory based *in-vitro* technologies. With the growing focus on fertility regulation and management, this is a major thrust area for research and diagnosis.

Genetic Counselling 503 & 504

Genetic counselling is progressing as a subject of great significance today due to rapid and revolutionary advancements in Human Genetics. Hence, these two papers have been designed in a manner to develop a comprehensive knowledge and proficiency apt for Genetic Counselling. Also, care is taken to further hone the practice-based competencies in the students to manage a genetic counselling case before, during, and after the clinic visit. The syllabus includes detailed aspects of pedigree analysis, risk assessment, prenatal diagnosis, genetic testing and interpretation etc. The ethical, legal and social issues arising from developments in Human genetics and the influences on Genetic counselling are also included.

TOXICOLOGY 503&504

In this module, the students will be familiar with the science of toxicology, including hazard identification, exposure assessment, dose-response assessment, and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. They will also learn technical aspects and experimental approaches in toxicological research, testing, and risk assessment. They will also get the understanding of how the toxic chemicals harms the specific organs, the kinetics of those hazardous toxicants and how they create certain diseases after getting digested in the body. This course will also provide the platform for those students who want to build their future in pharmaceuticals by understanding the basics of guidelines for animal house facilities and its formation. In this module, the students will be familiar with the science of toxicology, including hazard identification, exposure assessment, dose-response assessment, and an understanding of the mechanisms of action and effects of toxic chemicals at multiple levels of biological organization. They will also learn technical aspects and experimental approaches in toxicological research, testing, and risk assessment. They will get to learn the important toxicological aspect which is ecological or environmental toxicology in which they will understand how the aquatic and terrestrial nature is getting harmed by toxicants and the tests to assess it. This course will also provide the platform for those students who want to build their future in pharmaceuticals by understanding the basics of guidelines and quality standards for animal house facilities and animal experimentation along with applications of Toxicology.

ENTOMOLOGY 503 & 504

The curriculum in Entomology has specifically designed keeping in mind the vast Economic importance of Insects and the immense career opportunities associated with the study of Entomology. Details related to the Insect anatomy, physiology, taxonomy, ecology and toxicology have been included to equip the student with the essential knowledge in Entomology. The second elective paper in Entomology has been framed with emphasis on the commercial and applied aspects of the study of entomology, particularly the Economically important insects since they play a key role in Agriculture and Production. Special importance has been given to the study and applications of Biotechnology in control of insect crop pests. Of key commercial value is Sericulture and Apiculture, which contribute immensely to the commercial value and success of insect species. Medical, Veterinary and Forensic Entomology has been included owing to the vast number of insect related diseases, Insect parasites, insect associated pathology of humans and animals and specifically the control of House pests. This elective also trains a student with the practical expertise in various techniques for entomology such as Inset collection, identification and Preservation. This study has vital significance in today's world and provide good scope for a student to take up a career in Entomology. Government agencies, NGOs, Medical and Research Institutions have recently shown and increased demand to employ study with specialized knowledge and expertise in Entomology.

FISH BIOLOGY AND FISHERY 503& 504

There is an urgent need to step up and revive the Fishery Industry in the State of Gujarat in order to increase the commercial value and earning potential of this Industry. This Elective paper has been formulated with all the key elements required to train and equip a student to fulfill the requirements for a career in this vital Industry. The Paper helps the student to derive practical and theoretical knowledge in the classification, morphological features, identification, taxonomy, fish physiology, endocrinology, genetics and toxicology. In addition, special attention has been paid to including fundamentals regarding Commercially important freshwater and marine fishes, economically important Crustacea and Mollusca. The second Elective in this paper gives a student practical field knowledge in the Capture methods and processing of fishery products and byproducts. Special emphasis has laid on Fishing crafts and gears, Fishing equipment and accessories, GPS navigation and modern technology so that a student is familiar with the current technology. Specifically, this course trains a student in Fisheries management and economics with information regarding of the Administrative and organizational authorities, Fishery institutes and industries to prepare the student with holistic knowledge to evolve as an entrepreneur in this area.

WILDLIFE FORENSIC AND ECOTOXICOLOGY 503 & 504

The course contains topics on rules for conservation and ecotoxicology. It is of utmost important that students are aware of the recent rules of India for the conservation of wildlife. Student will also learn about the general ecotoxicology such as toxicity in the laboratory and toxicity in the nature such as aquatic and terrestrial environment. The course will also enable students with the effect of toxicants to various parts of wild organisms and cases of wildlife poisoning. The course contains topics related to wildlife forensic. Students will acquire knowledge pertaining to the modern aspects of wildlife forensic. They will learn about wildlife crime scene, its recording, analysis and collection of evidence. Students will learn how insects help in decomposing the body of wild organisms and how it can be used for the detection of time since death. They will also acquire knowledge about the use of skin products such as hair, nail, claws, scales, feathers and biomolecules such as DNA for the identification of wild organism.

ZOO – 501: Biostatistics, Bioinformatics and Research Methodology

UNIT-I: Biostatistics-I

Data Collection, Representation and Sampling:

Types of Data: Qualitative, Quantitative Data: Discrete and Continuous. Understanding of Population, Sampling and Sampling methods, Methods Data Collection, Grouping of data, Frequencies: Frequency Distributions, Relative Frequencies. Tabulation, Graphical Presentation

Descriptive Statistics:

Measures of Central Tendency-concept; Mean, mode, median for ungrouped and grouped data, Measures of Dispersion: Absolute and Relative measures; Range, Interquartile Range, Variance, Standard Deviation, Standard Error and Coefficient of Variation, Probability: Basic concepts of Probability, Empirical, Theoretical Probability. Addition Rule, Product law. Applications of Probability, Probability Distributions: Binomial, Normal Distribution, Measures of Skewness and Kurtosis

UNIT-II: Biostatistics-II

Tests of Hypotheses:

Parametric, Non-Parametric data, Statistical hypotheses: Null and Alternative hypotheses. Simple and Composite hypotheses. Statistical Tests: Acceptance and Rejection Norms. Sampling Distributions - t, chi-square and F distributions. Significance Tests for Normal Distribution: One sample test (unmatched) – z test and t-test and scores; Confidence Intervals. Bivariate and Multivariate Analysis: Correlation: Methods for Correlation analysis, Pearson's Correlation Coefficient 'r', Rank Correlation, Regression: Linear regressions. Chi Square Analysis, two sample tests for normal distributions: Tests for Means when variances are known or unknown. Paired t-test for equality of means. Student's t test; Analysis of Variance: One-way, Two-way (parametric) ANOVA. Tukey's test for two-way ANOVA, Mann-Whitney U test, Wilcoxon matched pairs tests

UNIT- III: Bioinformatics

Introduction to Bioinformatics, Basic concepts of biological databases, Gene and Protein Databases and Resources (NCBI, EBI, ExPasy, Entrez, RCSB) - NCBI Databases and Tools for Bioinformatics, Sequence alignment - BLAST, FASTA, PSI-BLAST algorithms, Primary & Secondary Sequence & Structure Databases (Genbank, SwissPort/Uniport, EMBL, MMDB & KEGG) and its application, Primer designing.

UNIT -IV: Research Methodology and regulation

Scientific Logic, Biological Thoughts, Methods of Reasoning in Research, Principles of measurements and experiment, Impact assessment and Management, Role of criticism in sciences, Conceptualization and development of research plan, Development of pre-proposal and full proposal, Writing of scientific and popular articles, Case studies, Ethics in Science, Good laboratory techniques, Intellectual property rights, Laboratory accreditations

ZOO-502: Developmental Biology & Molecular Medicine

UNIT – I: Developmental Biology - I

Patterns and process of development (Fate maps and Gradients)
Differential gene expression during development
Major model organisms
Stem cells in development

UNIT – II: Developmental Biology - II

Building with Ectoderm, Mesoderm and Endoderm
Cytological, genetical and chemical basis of development
Cell-cell communication during development

UNIT – III Growth and Regeneration

Growth patterns; Dynamics of growth; Types of growth; Physiological mechanisms of growth. Regeneration in non-chordates and chordates; Factors affecting regeneration; Regeneration fields; Physiological gradients and polarity concerned with regeneration, Cellular and Genetic basis of regeneration

UNIT – IV: Molecular medicine

Introduction to molecular medicine, Molecular pathological epidemiology, Molecular pathology, Approaches and methods in molecular medicine, Future of molecular medicine

ELECTIVE PAPER - I
CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY

ZOO-503EA - Cell Biology, Cytogenetics And Molecular Biology-I

Unit-I: Human cytogenetics

Pedigree construction - inheritance patterns and risk assessment, Types and structure of chromosomes, Chromosome identification, ISCN, Banding techniques and karyotyping, FISH and mFISH, Spectral karyotyping, CGH, Chromosomes & diseases, chromosomes and cancer, Chromosomes and evolution, Prenatal diagnosis

Unit-II: Gene Expressions & Regulations

DNA modification & restriction, DNA repair mechanism, DNA repair genes and genetic instability, hereditary diseases caused by defective DNA repair, Regulation of gene expression in eukaryotes, Isolation of gene, Understanding Human Genome Project – organization, gene families

Unit-III: Cancer Biology

Hallmarks of cancer, Mutagens, Carcinogens, Oncogenes and Tumor suppressor genes, Cell transformation and tumorigenesis, Cell cycle checkpoint and cancer, Telomerase and cancer, Angiogenesis and Metastasis, Familial cancers, Chromosomal aberrations in cancer, Genetic predisposition to sporadic cancer, Tumor specific markers, Applications of new technologies in diagnostics, treatment and prevention of cancer.

Unit-IV: General Toxicology and Toxicity Testing:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - I
CELL BIOLOGY, CYTOGENETICS AND MOLECULAR BIOLOGY

ZOO-504EA - Cell Biology, Cytogenetics And Molecular Biology-II

Unit-I: Cell Signaling and communication

Cell signaling, Types of signal molecules, Secondary messengers, Types of receptors, Signal transduction, Component of signaling system, Hormone mechanism of action, KEGG pathway, Scatchard plot, Cell signaling technology

Unit-II: Nanotechnology

Introduction to nanotechnology, Nanotechnology: origin, history and principles, Approaches of nanotechnology in biology, Nanoscale advances, Nanoparticles, Nanodevices, Nanomedicine

Unit-III: Stem Cell Biology

Molecular Basis of stem cells; Different types of stem cells; Stem cells isolation and characterization, Recent advances in stem cell research and regenerative medicine; Application of stem cell therapy in diabetes, skin, dental, bone, heart, reproductive, muscles, neuronal disease.

Unit-IV: Molecular Biology

Variants in PCR and its specific applications; Second and third generation sequencing; Chromosome walking and jumping; Somatic and germ line gene therapy, Criteria for effective gene therapy, General gene therapy strategies; Gene silencing; Transgenic animals; DNA vaccines; Microarray types and applications; Flow cytometry; Recent advances in molecular biology.

ELECTIVE PAPER - II
ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY

ZOO-503EB: ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY - I

UNIT – I: General Endocrinology

Origin, Evolution and Classification of Endocrine system. Feedback Mechanisms, Regulation by Signal transduction and Hormones, Nerves' metabolites, Hormones Mechanism of action, Hormone receptors mechanism and metabolism

UNIT – II: Endocrine Glands

Endocrine glands – Hormone synthesis, release, regulation and its pathology. Hormones of extra endocrine sites – GI tract, Kidney, Liver, Heart, Lungs

UNIT – III: Hormonal Control

Hormonal control of carbohydrate, lipid, protein and nucleic acid and mineral metabolism. Hormonal control of growth and development, Endocrine role of adipose Tissues, Hormonal control of Reproductive behavior, Endocrine basis of communication in reproduction and aggression Pheromones, Vitamin D as a Hormone

Unit-IV: General Toxicology and Toxicity Testing:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - II
ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY

ZOO-504-EB: ENDOCRINOLOGY AND REPRODUCTIVE TECHNOLOGY - II

UNIT – I: Gonadal Development

Development of Gonads, Accessory sex organ and external genitalia, Factors affecting sex determination, Genetic Control of sex determination, Disorders of gonadal differentiation, Endocrinology of the foetal gonads, Prenatal diagnostic techniques

UNIT – II: Female Reproductive Organs

Structure and functions of Female reproductive organs. Folliculogenesis, Ovulation, Corpus luteum, atrecia, Implantation, Placenta, Pregnancy and its control Foetoplacental unit as an endocrine entity. Menopause and hormone replacement therapy, reproductive cycles, non-steroidal regulators of ovarian function. Gamete and zygote transport. Mammary glands, Lactation and its hormonal control

UNIT – III: Male Reproductive Organs

Structure and function of the Male Reproductive Organs. Spermatogenesis and its hormonal control. Ultrastructure functions of the Sertoli cells and Leydig Cells. Semen formation and its biochemistry. Sperm structure function and sperm function tests. Testis Anomalies, Senescence, Puberty

UNIT – IV: IVF and General Techniques.

Principles of Fertility Regulation in males and females, *In-Vitro* Fertilization, ET and AR technologies, PGS and PGD, Mitochondrial Replacement therapy, Collection and preservation of Gametes, Cryopreservation assay, Research methodologies; RIA, PCR, EIA, IRMA, Radioreceptors, Sequencing methods, Chemiluminescence, ECL, Polyclonal and Monoclonal antibodies, Hybridoma technology.

ELECTIVE PAPER - III
ECOTOXICOLOGY AND WILDLIFE FORENSIC

ZOO-503EC - ECOTOXICOLOGY AND WILDLIFE FORENSIC - I

Unit-I: Rules for Wildlife Conservation in India

Government body for wildlife and forest managements at forest, taluka, district, state and national level, National policy governing wildlife protection in India, Historical perspective evolution of policies during different eras, Current policy, National Wildlife action plan and its detailed review, Broad policy framework for wildlife protection at national and state level Organizational structure, Role of Indian Board of Wildlife and State wildlife advisory board, power and function, An overview of different acts related to Wildlife protection and conservation, Wildlife Protection Act (1972) and its detailed structure, recent amendments in WPA 1972 and their role in Wildlife protection and Conservation, Nation and International treaties, Treaties for wildlife conservation

Unit-II: Pathology and toxicology

Introduction
Wound Analysis
Wildlife Poisoning by Insecticides
Wildlife Poisoning by Rodenticides

Unit-III: Ecotoxicology – I

Environmental toxicology
Agricultural pesticides and their effects
Pesticides and effect on biodiversity and ecosystem
Impact of anthropogenic pollution on biology of terrestrial and aquatic system
Global perspectives and emerging issues
Ecological risk assessment
Cases of ecotoxicology at world and India level

Unit-IV: General Toxicology and Toxicity Testing:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - III
ECOTOXICOLOGY AND WILDLIFE FORENSIC

ZOO-504EC - ECOTOXICOLOGY AND WILDLIFE FORENSIC - II

Unit-I: Crime Scene and Physical Evidence Collection

Introduction, Definition of a Crime Scene, Questions to Be Asked, Scene Priority, Responding Officer, Securing the Scene, Chain of Custody, Processing the Scene, Initial Documentation, Scene Documentation, Remains in an Aquatic Environment, Collection of Evidence, Review of Scene Processing, Final Inspection, Recovering Evidence at Poaching Scenes, Locating the Burial: Anomalies on the Surface.

Unit-II: Forensic Entomology

Application of Forensic Entomology to Wildlife Crimes
Arthropods Commonly Encountered
Diptera
Coleoptera
Sampling
Conclusion

Unit-III: Use of Hair, bones and skin products

Types of Hair, Hair Structure, Bone identification, Skin products, Techniques for Studying Hair Structure, International Trade in Reptile Skins, Challenges to Species Identification of Reptile Skin Products, Species and Products Represented in the Reptile Skin Trade Reptile Scale Morphology Basics and Current Limitations, Identifying Features of Major Reptile Groups

Unit-IV: Forensic DNA analysis

Introduction, DNA Isolation and Handling, Sample Speciation, Minisatellites (VNTRs) Mitochondrial Markers (mtDNA), Additional Genetic Speciation Methods, Limitations of Genetic Speciation, Sample Sexing, Sample Individualization, Sample Localization, Validation of Wildlife Forensic Techniques, Court admissibility

ELECTIVE PAPER - IV
FISH BIOLOGY AND FISHERY SCIENCE

ZOO-503ED: FISH BIOLOGY AND FISHERY SCIENCES - I

Unit-I: Classification of fishes and shellfishes

Morphological, morphometric and meristic criteria for taxonomy
Major taxa of inland and marine fishes
Commercially important freshwater and marine fishes and their identification
Classification of economically important crustacea and Mollusca

Unit-II: Fish nutrition, digestion and feed technology

Fish nutrition for adult fishes, larvae and juveniles
Digestive system of fishes and prawns
Live feeds
Feed additives
On farm and commercial feed manufacture
Fish food storage

Unit-III: Fish physiology and endocrinology

Neuroendocrinology, hormones and behavior
Fish migration
Fish reproduction, spermatogenesis, oogenesis and development
Fish stress physiology and adaptations
Fish respiratory and circulatory system
Fish integument and immune system

Unit-IV: Principle of Toxicology and Basics of Toxicity Testing Methods:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute, Subacute, Subchronic and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment, Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - IV
FISH BIOLOGY AND FISHERY SCIENCE

ZOO-504ED: FISH BIOLOGY AND FISHERY SCIENCES - II

Unit-I: Inland and marine fisheries

Candidate species of phytoplankton and zooplankton as live food,

Culture of fish food organisms

Green algae, blue green algae, spirulina, diatoms, infusoria, rotifers, cladocerans, tubifex, brine shrimp, chironomids culture and maintenance

Cultivable inland and marine fishes and shell fishes

Pearl oyster culture

Ornamental fishes, their culture and maintenance

Infectious diseases of fishes and shell fishes and their treatments

Aquaculture wastewater management

Unit-II: Capture and processing of fishery products and byproducts

Fishing crafts and gears

Fishing equipment and accessories

GPS navigation

Sonar, net sonde and other monitoring equipment

Fish refrigeration and freezing technology

Handling of fresh catch and processing

Canning, thermal processing and packaging

Fish byproducts

Unit-III: Fisheries management and economics

Fisheries departments of state and country

Organization of fishery administration

Fishery institutes and industries of national and state importance

Cooperative movements in fishers and related community

Marketing of fish products

Aquatic pollution and its effect on fisheries

Unit-IV: Advances in fish genetics

Inheritance of qualitative and quantitative traits

Chromosomal polymorphism, chromosome manipulation

Gynogenesis and androgenesis

Super males and transgenic fishes

Genotoxicity

Chromosome study techniques

ELECTIVE PAPER - V
GENETIC COUNSELING

ZOO-503EE: Genetic Counseling – I

Unit-I: Practice of Genetic counseling & Pedigrees

Concept and purpose, Historical overview of genetic counseling, goals, Philosophy and ethos of genetic services and counseling, Providers of genetic counseling, Practice based competencies for genetic counselors, Indications and purpose, Past medical, social & family history, construction of pedigrees & Patterns of inheritance, Incidental detection of other genetic disorders on pedigree evaluation, establishing carriers.

Unit-II: Interviewing, Case preparation & Management

Basic communication skills, interviewing techniques, verbal & non-verbal communication, inter cultural communication, case preparation & management, Psychotherapeutic counseling & decision-making concepts, Medical Genetic evaluation, Physical examination, Documentation.

Unit-III: Risk assessment

Risk assessment and counseling in: common Variants, Mendelian and multifactorial Disorders, genetic case pathway and preventive management guidelines, bioinformatics resources and their use in informing genetic testing methodologies and reporting.

Unit-IV: Principles of Genetic Toxicology & Toxicity Testing

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - V

GENETIC COUNSELING

ZOO-504EE: Genetic Counseling – II

Unit-I: Prenatal diagnosis & Newborn screening

Ethical and legal issues in Prenatal diagnosis, Indications of prenatal diagnosis, prenatal diagnosis in late onset disorders, Techniques: invasive, non-invasive methods – Amniocentesis, Chorion Villus sampling, NIPT, ultrasound, maternal blood screening, PGD, Screening of genetic disorders in newborn.

Unit-II: Genetic testing & interpretation

understanding genetic testing: Interpretation of new genome testing techniques, DNA testing – Direct testing (Known and unknown mutations) and Indirect testing (gene tracking), DNA profiling: establishing identity and relationships Population screening - ethics, organization and advantages. Pre-symptomatic testing for late onset diseases.

Unit-III: Contexts of Genetic counseling

Reproductive issues: Technologies in reproductive assistance, pre-conceptional counseling, Medico-legal Issues: Surrogacy, Paternity testing. Congenital anomalies and rare medical disorders: risk factors, Rare disorders – why not treatable? pre-pregnancy evaluation and intervention strategies, Social and cultural issues, support groups for rare medical disorders. Impact of disorders of sexual development (DSDs) and genetic counselling. Genetic counseling for late onset diseases (example neuro-genetic disorders, Myotonic dystrophy and Inherited cancers, breast and ovarian cancer): Predictive counseling & Principles, management in follow-up sessions. Testing of vulnerable populations, ethical issues in testing of minors & incapacitated individuals.

Unit-IV: Ethical, legal and social issues in Human genetics

Influences on Genetic counseling, Bioethics in research & experimentation, Implications of New Technologies: embryonic stem cells, animal cloning, genetic engineering, gene therapy & clinical trials, Supervision and strategies for providing support & guidance to new counselor, Dilemmas faced by counselors, Medical ethics in India, Informed consent and confidentiality, Right of choice, Impact of genetic disease on patients and families, social practices and health cost issues. Case studies, interaction with parents & families to increase empathy.

ELECTIVE PAPER - VI
TOXICOLOGY

ZOO-503EF - TOXICOLOGY-I

Unit-I: Animal House and Maintenance

Design and construction of animal housing facilities; Caging and housing system; Important factors in animal housing: Illumination, Noise, Ventilation, Temperature, Humidity, Bedding, Water, Food; Health monitoring; Sanitation; Waste disposal; IAC and CPCSEA

Unit-II: Target Organ Toxicity

Toxic responses of Blood, Liver, Kidney, Skin, Immune system, Respiratory system, Nervous system, Ocular and visual system, Heart and vascular system, Reproductive system, Endocrine system

Unit-III: Toxic Agents and Toxicokinetics

Classification of toxicants; Metals; Pesticides; Xenobiotics; Teratogens; Food additives and contaminants; Toxins of animal and plant origin; Radiation types, detection and effects. Absorption; Digestion; Metabolism; Excretion; Mutagenicity; Carcinogenicity; Teratogenicity; Biotransformation; Bioactivation; Mechanism of Toxicity

Unit-IV: Guidelines, Quality Standards and Applications of Toxicology:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD₅₀, LC₅₀, IC₅₀, EC₅₀; Route of administration; Dose response relationship and its evaluation, Risk assessment, Introduction and Principle of Free radical toxicity, Cytotoxicity and Genotoxicity testing methods

ELECTIVE PAPER - VI TOXICOLOGY

ZOO-504EF- TOXICOLOGY-II

Unit-I: Cytotoxicity, Genotoxicity and Free Radical Toxicity Testing

Cell viability and cytotoxicity: Trypan blue dye exclusion assay, MTT assay, LDH and Neutral red uptake assay, WST assay, SRB assay; Genotoxicity: Ames test, TK, HPRT and XPRT mutation test, SCE, Chromosomal aberration assay, Comet assay, Micronucleus assay; Free radical toxicity: Total ROS, LPO, SOD, Catalase, GSH, GPx, Grd, GST; Carcinogenicity testing; Teratogenicity testing, (OECD 473 and 490) Cell lines for toxicity testing: L5178Y, CHO, AS52, V79, TK6, CACO II

Unit-II: Ecotoxicology

Principle of ecotoxicology; Terrestrial model and ecotoxicity testing: Earthworm, Honey bee, Birds, Plants; Aquatic models and ecotoxicity testing: Algae, Daphnia, Brine shrimp, Fish. Route of exposure: Water, Soil, Food; Ecotoxicogenomics: Estrogen receptor, Aryl hydrocarbon receptor, Protein damage, DNA damage

Unit-III: Environmental Toxicology

Environmental risk assessment; Environmental health and hazards; Air pollutants: Past disasters and current condition, Outdoor pollutants, Photochemical oxidants, Indoor air pollutants; Water and soil pollutants: Synthetic persistent chemicals, Inorganic ions, Cyanotoxins

Unit-IV: Guidelines, Quality Standards and Applications of Toxicology

National regulatory guidelines: DCGI / CDSCO, FSSAI, GOTS, CPCB / GPCB; International regulatory guidelines: US FDA, OECD, US EPA, ICH, Food safety, TTC; National and international quality standards: NABL, OECD, GLP, ISO; Application of Toxicology: Food toxicology and food residues; Analytic/Forensic toxicology; Clinical toxicology; Occupational toxicology

ELECTIVE PAPER - VII
ENTOMOLOGY

ZOO-503EG: ENTOMOLOGY-I

Unit-I: General entomology

Insect morphology

Insect anatomy, excretion, circulation, reproduction and life cycle

Insect digestion and nutrition

Insect nervous system and sense organs

Insect behavior

Pheromones and toxins

Insect genetics

Unit-II: Taxonomy and types

Evolutionary, parataxonomy, numerical, phylogenetic taxonomy

Classification of insects up to orders and their characters

Biodiversity, threats and conservation

Unit-III: Insect ecology

Ground dwelling insects

Aquatic insects

Social insects

Aerial and plant inhabiting insects

Unit-IV: Principle of Toxicology and Basics of Toxicity Testing Methods:

General principles and terminology; Types of toxicity; Factors affecting toxicity; Acute and Chronic toxicity; LD50, LC50, IC50, EC50; Route of administration; Dose response relationship and its evaluation, Risk assessment, Introduction and Principle of Free radical toxicity testing methods, Cytotoxicity testing methods and Genotoxicity testing methods.

ELECTIVE PAPER - VII
ENTOMOLOGY

ZOO-504EG: ENTOMOLOGY-II

Unit-I: Commercial and applied entomology

Economically important insects

Insects and plants

Insect as a crop pest

Biotechnology in control of insect crop pests

Predators and parasitoids for insect pests

Sericulture

Apiculture

Unit-II: Medical and Veterinary entomology

Insect associated pathology of humans and animals

Insect vectors

House pests and their control

Animal parasites

Unit-III: Forensic entomology

Application of Forensic Entomology to Wildlife Crimes

Arthropods Commonly Encountered

Diptera

Coleoptera

Sampling

Unit-IV: Techniques for entomology

Insect collection

Insect identification

Preservation and dry mount

Liquid preservation

Storage and handling

Insect repositories

Indian national biodiversity guidelines

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ZOO – 505 PR:

Practicals based on the theory papers ZOO-501 and ZOO-502. Field/Industrial/ Laboratory visits.

ZOO – 506 PR:

Practicals based on the theory papers ZOO-503 and ZOO-504. Field/Industrial/ Laboratory visits.

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**ZOOLOGY – SYLLABUS - SEMESTER IV - JUNE 2022 ONWARDS, GUJARAT
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M.Sc. Zoology Semester – IV

SR. No.	Course Code	Name of the Course	Hours per Week	Internal Marks	External Marks	Total Marks	Credits
1	ZOO – 507PT	Dissertation and Viva-voce	20	120	280	400	16
2	ZOO – 508S	Assignments / group discussions.	4	30	70	100	04
3	ZOO – 509M	Seminars and Industrial Visits during the Semester.	4	30	70	100	04
		Total	28	180	420	600	24

ZOO-507PT : Dissertation and Viva-voce

ZOO-508S : Assignments / Group Discussions.

ZOO-509M : Seminars and Industrial Visits during the Semester.