

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
Department of Zoology
Curriculum

The objective of the M.Sc. Zoology program is to produce graduates who:

1. Have a strong foundation in basic zoology and its applied branches with an ability to solve important problems in a modern technological society as valuable, productive taxonomists, ecologist, aquaculturists, sericulturist and entomologists.
2. Have a broad based background to practice M.Sc. Zoology in the areas of Animal physiology, Applied Parasitology, Fishery science, Molecular biology in industry and government settings meeting the growing expectations of stake holders and also gaining self employment.
3. Have an ability to pursue higher studies and succeed in academic and research careers in biotechnology and life sciences.
4. Have the ability to function and communicate effectively, both individually and within multidisciplinary teams using modern tools required for molecular biology.
5. Recognize the need for and possess the ability to engage in lifelong learning.
6. They will be sensitive to the consequence of their work, both ethically and professionally for productive professional careers.

Module

Program: M. Sc. (Zoology)

Discipline: Science

1	Domain knowledge: To apply knowledge of basic zoology and its applied branches for solution of animal interaction.
2	Problem analysis: To identify, formulate diversity survey of literature and analyze the problems in life science in particular zoology and its applied branches and undertake the relevant research to find out solutions.
3	Conduct investigations of complex problem: To design and conduct the research, experiments surveys and to analyze and interpret the resulting data for betterment.
4	Modern tool usage: To use the appropriate technologies, skills, modern tools necessary for molecular biology and also for detecting biodiversity(Taxonomy) animal cultures.
5	Citizenship and Society: The student will have the ethical and professional practice as taxonomist, ecologist, entrepreneur in context of global economic, environmental

	and societal realities.
6	Environment and sustainability: To understand the impact of applied zoology in a global, economic, environmental context and to prove it better for sustainable development.
7	Ethics: Applying ethical principles and commit to professional ethics and responsibilities and norms of the animal ethics, Nature's ethics.
8	Individual and team work : Function effectively as an individual , and as a member or leader in diverse teams and in multidisciplinary subjects like environmental science, botany and biochemistry.
9	Communication: Communicate effectively on complex knowledge of farmers, branches of applied zoology to farmers, community and society as a whole , to generate self employment and health awareness to avoid economical losses. Also to prepare the relevant data , reports , documents.
10	Lifelong learning : Recognize the needs of in particular zoology in present era and to have preparation and ability to do more work independently for achieving better opportunities in competitive world as a zoologist.

1. Course Title: ZOO401- Taxonomy and animal diversity

2. Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study fundamental aspects of taxonomy.				
2	To explain and communicate biodiversity importance to the public				
3	To assess the decline in biodiversity.				
4	To develop capacity building in the field of Taxonomy and Biodiversity				

2. Course Title: ZOO441- Practicals in Taxonomy and animal diversity

2. Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To assess the quality of wild life in given area				
2	To explain and communicate biodiversity importance to the public				
3	To assess the decline in biodiversity.				
4	Able to measure the biodiversity in a given area.				

Paper NO. ZOO- 401
Taxonomy and Animal diversity

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

Course objective:

1. To study fundamental aspects of taxonomy.
2. To study animal diversity.
3. To know the importance of taxonomy.
4. To know the importance animal diversity.

Unit I

Principles and methods of taxonomy:

1. Concepts of species-
 - 1.1. Essentialist, Nominalistic concepts and Current status.
 - 1.2. Sub species and other infra specific categories.
 - 1.3. Ring species
 - 1.4. Biological mechanism of genetic incompatibility
2. Hierarchical taxa,
3. Biological nomenclature, International code, Cladistics and its application.
4. Classical and quantitative methods of taxonomy of animals.

Unit II

Levels of structural organization:

1. Unicellular, Colonial and Multicellular forms;
2. Levels of organization of tissues, organs and systems;
3. Phylum wise study of
 - 3.1 **Protozoa** : Sexual and asexual reproduction, Symbiotic and parasitic protozoan. Locomotory organs, their structure, ultrastructure. Ciliary movements.
 - 3.2 **Porifera** : Skeleton, Canal system.
 - 3.3 **Coelenterata** : Polymorphism in Coelenterata, Coral reefs and their formation, Metagenesis, Nematocysts- Types, structure and functions.
 - 3.4 **Platyhelminthes** : Parasitic adaptations,
 - 3.5 **Aschelminthes** : Parasitic adaptations in round worms,
 - 3.6 **Annelida** : Advent of coelom, Metamerism in Annelida, Annelida diversity.
 - 3.7 **Arthropoda**: Metamerism in Arthropoda, Crustacean larvae, Feeding and mouth parts of insects, Efficiency of Insects.
 - 3.8 **Mollusca** : Shell in mollusca, Torsion and Detorsion in mollusca, Foot in mollusca.
 - 3.9 **Echinodermata** : Water vascular system

Unit III

Outline classification of animals :

1. Important criteria used for classification in each taxon;
2. Classification of animals
3. Evolutionary relationships among taxa.
4. Class wise study of
 - 4.1 **Fishes** : Scales in fishes, Respiration in fishes, Migration in fishes.
 - 4.2 **Amphibia** : Parental care in Amphibia, Paedomorphosis.
 - 4.3 **Reptiles** : Rhynchocephalia- the living fossil. Skull characteristics of reptiles.
 - 4.4 **Birds** : Flying adaptations, Types of feathers, Flight muscles, Migration in birds.
 - 4.5 **Mammals** : Dentition, Histology of mammalian tissues.

Unit IV

Comparative functional anatomy of various systems of vertebrates

1. Integument and its derivatives,
2. Digestive system,
3. Respiratory system,
4. Circulatory system including heart and aortic arches;
5. Urinogenital system,
6. Brain and Sense organs (eye and ear).

Natural history of Indian subcontinent:

1. Major habitat types of the subcontinent, Geographic origins and migrations of species;

2. Continental drift and distribution of animals.
3. Major terrestrial biomes;
4. Theory of island biogeography;
5. Biogeographical zones of India,
6. Wild life of India.

Unit V

Organisms of health and agricultural importance:

1. Concept of pest
2. Classification of pest
 - 2.1. Agricultural pests- Sugar cane leaf hopper (*Pyrilla perpusiella*), Caster semilooper (*Achaeajanata*), Rice weevil (*Sitophilus oryzae*).
 - 2.2. Animal husbandry pest (Ticks, Mites, Tabanus, Stomoxys).
 - 2.3. Organisms of Public health importance (Malaria, Filaria, Tuberculosis, Cholera and AIDS) their vectors, pathogens and prevention.
 - 2.4. Store grain pest
 - 2.5. Structural pest.

Recommended Books

1. Mayr and Ashock :Principles of systematic Zoology .
2. Simpson :Principle of animal taxonomy. Oxford IBH Pub. Company
3. M. Kato :The Biology of Biodiversity, Springer.
4. Biodiversity ,Academic press Washington – E.O.Wilson
5. Biodiversity Principles and conservation , Kumar and Aseja Agrobios Sidia
6. Biodiversity and Environment Agrawal Tiwari and Dubey
7. Principles of Environmental Biology PKJ Nair Himalaya Pub House Delhi.
8. E.O. Wilson: Biodiversity, Academic Press, Washington
9. Chatterjee K. D. (1969) –Parasitology (Protozoology and Helminthology)
10. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
11. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
13. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta
14. Applied Entomology 2nd edition, P. G Fenemore, Alka Prakash, Publisher : New Age International
15. “ Introduction to Insect Biology & Diversity” . Daly, H. V., J. T. Doyen & P.R. Ehrilch (1981) : International Student Edn. McGraw- Hill, Kogakusha, Japan.
16. Young, J.Z. :Life of Vertebrates. The Oxford University Press, London.
17. Parker and Haswell : Text book of Zoology vol. II
18. Goodrich.: Structure and Development of Vertebrates Vol.I and II.
19. Watermann, A.J. : Chordate Structure and Function, Mac Millan Co. New York.
20. Weichert C.K. : Anatomy of Chordates 4th edn. MC Graw Hill Books Co. New York.

3. Course Title: ZOO402- Ecology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To assess the quality of given ecosystems.				
2	To conserve and preserve ecosystems and biological diversity in given area				
3	Assess the importance of interactions among the species.				
4	Capacity building in the area of conservation of ecosystems.				
5	Be acquainted with current trends in conservation biology, wildlife biology and management.				

4. Course Title: ZOO442- Practicals based on Ecology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To assess the quantify and evaluate the given ecosystems.				
2	To assess the quality of ecosystems and biological diversity.				
3	Able to measure the of interactions among the species in terms of quality and quantity.				
4	To maintain and conserve ecosystems with different measures.				
5	To do environmental impact assesement of a given ecosystem				

Paper No. ZOO- 402

ECOLOGY

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

Course objective:

1. To study fundamental aspects of ecosystems.
2. To study different ecosystems and biological diversity.
3. To know the importance of interactions among the species.
4. To know the importance of maintenance, conservation of ecosystems.
5. To get acquainted current trends in conservation biology, wildlife biology and management.

Unit I Ecosystem:

1. Structure and function;
2. Energy flow and energy pyramids.
3. Mineral cycling (Carbon, Nitrogen, Phosphorus);
4. Primary production and decomposition;
5. Structure and function of some Indian ecosystems:
 - 5.1. Terrestrial (forest, and
 - 5.2. Aquatic (fresh water,).

Unit II Habitat and niche:

1. Concept of habitat and niche;
2. Niche width and overlap;
3. Fundamental and realized niche;
4. Resource partitioning;
5. Character displacement.

Ecological succession:

1. Types;
2. Mechanisms;
3. Changes involved in succession;
4. Concept of climax

Unit III .Species interactions:

1. Types of interactions-
 - 1.1 Interspecific Interactions –
 - 1.1.1 Commensalism,
 - 1.1.2 Mutualism,
 - 1.1.3 Parasitism,
 - 1.1.4 Amensalism,
 - 1.1.5 Symbiosis
 - 1.1.6 Competition
 - 1.2 Intraspecific Interactions –
 2. Herbivory,
 3. Carnivory,
 4. Pollination,

Community ecology:

1. Nature of communities;

2. Community structure and attributes;
3. Edges and ecotones.

Unit IV Population ecology:

1. Characteristics of a population;
2. Population growth curves;
3. Population regulation;
4. Life history strategies (*r* and *K* selection);
5. Concept of meta population – demes and dispersal,
6. Interdemic extinctions,
7. Age structured populations.

Unit V. Applied ecology:

1. Environmental pollution;
2. Global environmental change;
3. Biodiversity
 - a. Concept of Biodiversity;
 - b. Patterns of Biodiversity;
 - c. Importance of Biodiversity;
 - d. Loss of Biodiversity;
 - e. Biodiversity Hotspots,
 - f. Endangered organisms,
 - g. Extinction and Red Data Book,
 - h. Biosphere reserves, National parks and Sanctuaries.
4. Status, monitoring and documentation;
5. Major drivers of biodiversity change;

Conservation biology:

1. Principles of conservation,
2. Major approaches to management- *in situ* and *ex-situ* conservation,
3. Indian case studies on conservation/management strategy
 - 3.1. Project Tiger,
 - 3.2. Project Elephant,
 - 3.3. Project Rhino,
 - 3.4. Biosphere reserves, National park and Sanctuaries.
4. Other recent developments in wild life management.

Recommended Books

1. Ecology –E.P.Odum
2. Limnology –P.S.Welch
3. Environment and Man –R.H. Wagher
4. Man fresh water ecology –T.T. Macan
5. Biodiversity, Academic press Washington – E.O.Wilson
6. Biodiversity Principles and conservation, Kumar and Aseja Agrobios Sidia
7. Biodiversity and Environment Agrawal Tiwari and Dubey
8. Principles of Environmental Biology PKJ Nair Himalaya Pub House Delhi.
9. E.O. Wilson: Biodiversity, Academic Press, Washington

5. Course Title: ZOO403- Biochemistry

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study fundamental aspects of Biochemistry.				
2	To understand various biological reaction mechanism.				
3	To know the importance of metabolism.				
4	To explain the biochemical molecules and their interactions				

6. Course Title: ZOO443- Practicals based on Biochemistry

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To understand various biological reaction mechanism.				
2	To know the importance of metabolism.				
3	To use various biochemical reactions for quantification and quality assessment.				
4	Assess the quality of interaction among the various reactants.				

**Paper No. ZOO 403
BIOCHEMISTRY**

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

Course objective :

1. To study fundamental aspects of Biochemistry.
2. To study different biological reaction mechanism.
3. To know the importance of metabolism.

4. To study the biochemical molecules and their interactions

Unit I. Structure of atoms, molecules and chemical bonds and forces. Stabilizing interactions

1. Van der Waals,
2. Electrostatic,
3. Hydrogen bonding (ex. Water)
4. Hydrophobic interaction.

Unit II. Composition, structure and function of biomolecules

1. Carbohydrates,
2. Lipids,
3. Proteins,
4. Nucleic acids and
5. Vitamins.

Principles of biophysical chemistry

1. pH and pKa
2. buffer, (Henderson and Hasselbalch equation)
3. Reaction kinetics,
4. Colligative properties

Unit III Principles of Bioenergetics

1. Oxidative phosphorylation,
2. Coupled reaction,
3. Phosphoryl group transfer,
4. Biological energy transducers.

Principles of catalysis,

1. Enzymes and Enzyme kinetics (Michaelis and Menten equation, Competitive, Uncompetitive, non-competitive inhibition, Allosteric enzymes)
2. Enzyme regulation,
3. Mechanism of enzyme catalysis ((Mechanism of enzyme action – binding of substrate and lowering of activation energy, ex. Chymotrypsin),
4. Isozymes.

Unit IV Conformation of proteins

1. Ramachandran plot,
2. Secondary (α and β sheet), tertiary and quaternary structure of proteins
3. Domains, motif and folds.

Conformation of nucleic acids

1. A- DNA,
2. B- DNA,
3. Z-DNA,
4. t-RNA,
5. micro-RNA.

Stability of protein and nucleic acid structure

- 1.1. Denaturation and renaturation of protein and DNA ,
- 1.2. Cot curve.

Unit V. Metabolism of

1. Carbohydrates (Anaerobic and Aerobic-Glycolysis, TCA Cycle Gluconeogenesis, PPP Pathway, Glycogen metabolism and its control
2. Lipids (Fatty acid and triacylglycerol breakdown, β oxidation, Cholesterol

synthesis,Lipoproteins),

3. Amino acids(Transamination,Oxidative deamination of glutamate)

4. Nucleotides and

5. Vitamins.

List of Books for Paper I : Biochemistry

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Vogt and Vogt.
3. Biochemistry by Zubey
4. Biochemistry by Stryer
5. Outline of biochemistry By Cohn and Stump
6. Physiological biochemistry By Harper

7. Course Title: ZOO411- Animal Physiology**Program: MSc (Zoology)****Discipline: Science**

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	The study of this course is essential to understand the physiological processes important in medical, Non- medical and veterinary sciences..				
2	To study different biological reaction mechanism.				
3	To know the importance of metabolism.				
4					

8. Course Title: ZOO451- Practicals based on Animal Physiology**Program: MSc (Zoology)****Discipline: Science**

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	The study of this course is essential to understand the physiological processes important in medical, Non- medical and veterinary sciences..				
2	Able to understand different biological reaction mechanism.				
3	Impart the knowledge of the importance of metabolism.				

**Paper No. ZOO-411
General Animal Physiology****Total no. of credits- 4****No. of periods per credit- 15****Total No. of periods -60****Evaluation: External-80%, Internal-20%****Objectives :-**

The study of this course is essential to understand the physiological processes important in medical, Non-medical and veterinary sciences.

Unit I a) Digestive system:

1. Digestion
 - 1.1. Ingestion,
 - 1.2. Mechanical and Chemical breakdown of Food,(Digestion of Carbohydrates, Proteins and Fats, Enzymes involved)
 - 1.3. Absorption(Molecular basis absorption of Carbohydrate, Proteins and Fats) and
 - 1.4. Egestion,
 - 1.5. Hormones involved in Digestion
 - 1.6. Deviation in the animal world to above processes.(ex.Coprohagy,Cellulose digestion,Wax digestion)
2. Energy balance,
3. BMR.

b)Blood and circulation:

1. Blood corpuscles,
2. Haemopoiesis and formed elements,
3. Plasma function,
4. Blood volume and blood volume regulation,
5. Blood groups,
6. Haemoglobin,
7. Haemostasis.

Unit II

a)Cardiovascular System:

1. Comparative anatomy of heart structure,
2. Myogenic heart and Neurogenic heart
3. Cardiac cycle,
4. Heart as a pump.
5. ECG – its principle and significance,
6. Blood pressure,
7. Neural and chemical regulation of all above.
8. Heart ailments-Atherosclerosis, CHD

b) Respiratory system:

1. Comparison of respiration in different species, anatomical considerations,
2. Transport of gases –
 - 2.1. Oxygen-Hb dissociation curve
 - 2.2. Factors affecting the std dissociation curve,
 - 2.3. Bohr effect
3. Exchange of gases in lungs and transport of CO₂,
4. Neural and chemical regulation of respiration.

Unit III. a) Nervous system:

1. Gross neuroanatomy of the brain and spinal cord,
2. Central and Peripheral nervous system,
3. Neuron Structure, Resting membrane potential.
4. Synaptic structure, Molecular mechanism of Synaptic transmission,
5. Neurotransmitters

b)Sense organs: Vision, hearing and tactile response.

c)Muscle physiology

1. Structure of Striated Muscle fiber and Sarcomere
2. Muscle contraction mechanism – at molecular level
3. Effects of exercise on muscles.

Unit IV a) Excretory system:

1. Comparative physiology of excretion.
2. Kidney.-Comparative Structure
3. Urine formation (Ammonotelic,Ureotelic and Uricotelic organisms),
4. Urine concentration (Countercurrent multiplier system)
5. Micturition,
6. Regulation of water balance,
7. Blood volume and blood pressure (Renin-Angiotensin system),
8. Electrolyte balance,
9. Acid-base balance.

b)Thermoregulation:

1. Comfort zone,
2. body temperature –
 - 1.1.Physical,
 - 1.2.Chemical,
 - 1.3.Neural regulation,
 - 1.4.Acclimatization.

c)Stress and adaptation-

1. High altitude physiology ,-
2. Space physiology
3. Underwater physiology

Unit V a) Endocrinology and reproduction:

1. Endocrine glands – Hypothalamus, Pituitary, Adrenal, Thyroid, Endocrine pancreas.
2. Basic mechanism of hormone action-
 - 2.1.Molecular mechanism of Peptide hormone action
 - 2.2.Molecular mechanism of Steroid hormone action
3. Reproductive processes and Glands involved in Reproduction.
4. Neuroendocrine regulation.
 - 4.1. Hypothalamo hypophyseal axis
 - 4.2. Hypothalamo hypophyseal gonadal axis.
5. Hormones and diseases;

Books Recommended :

1. Comparative Animal Physiology by Prosser C.L.
2. General and Comparative Physiology by Floren W.A.
3. General and Comparative Physiology by Hoar W. B.
4. Animal Physiology by Neilsen K.S.
5. General Physiology by Giese A.C.
6. Principles of Animal Physiology by Wilson J.A.
7. Animal Physiology by Gordon G.L.
8. Modern Physiology by Strang F.L.
9. Animal Physiology by Mohan and Arora
10. General Physiology by Guyton
11. Animal Physiology by William and Hoar
12. Molecular biology of the cell By Albert et al
13. Molecular biology of the Gene by Watson et al

14. Genes By Lewin

15: General Endocrinology by C. D. Turner

16 Endocrinology by Hadley , M. E.

9. Course Title: ZOO412 – Genetics

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To know the hereditary biology				
2	Understand the mechanism involved in hereditary diseases and disorders.				
3	To understand fundamental processes of life.				

10. Course Title: ZOO452 – Practicals based on Genetics

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study the hereditary biology				
2	To understand the mechanism involved in hereditary diseases and disorders.				
3	Assess the hereditary characters in the population				
4					

Paper No. ZOO-412 Genetics

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

Course Objective :

1. To study the hereditary biology
2. To study the mechanism involved in hereditary diseases and disorders.
3. To study the fundamental processes of life.

Unit I Mendelian principles:

1. Law of Dominance and its significance
2. Law of Segregation,

3. Law of Independent assortment,

Concept of gene:

1. Multiple alleles,
2. Pseudoallele,
3. Complementation tests.

Extensions of Mendelian principles:

1. Codominance,
2. Incomplete dominance,
3. Gene interactions (ex.Epistasis)
4. Pleiotropy,
5. Genomic imprinting,
6. Penetrance and expressivity,
7. Phenocopy,
8. Linkage and crossing over,
9. Sex linkage,
10. Sex limited and sex influenced characters.

Unit II Gene mapping methods:

1. Linkage maps,
2. Tetrad analysis,
3. Mapping with molecular markers,
4. Mapping by using somatic cell hybrids, Development of mapping population in plants.

Extra chromosomal inheritance:

1. Mitochondrial inheritance
2. Kappa particles.

Microbial genetics:

1. Methods of genetic transfers –
 - 1.1. Transformation,
 - 1.2. Conjugation,
 - 1.3. Transduction and
 - 1.4. Sex-duction,
2. Mapping genes by interrupted mating,
3. Fine structure analysis of genes.

Unit III Human genetics:

1. Pedigree analysis,
2. Lod score for linkage testing,
3. Karyotypes,
4. Genetic disorders.- Causes , Symptoms and treatment
 - 4.1. Sickle cell anemia
 - 4.2. Cystic fibrosis
 - 4.3. Phenylketoneuria
 - 4.4. Albinism
 - 4.5. Alkaptonuria
 - 4.6. Huntington's disease

Quantitative genetics:

1. Polygenic inheritance,
2. heritability and its measurements,
3. QTL mapping.

Unit IV Mutation:

1. Types of Mutation
2. Causes and detection,
3. Mutant types –
 - 3.1. Lethal,
 - 3.2. Conditional,
 - 3.3. Biochemical,
 - 3.4. Loss of function and gain of function,
 - 3.5. Germinal versus somatic mutants,
 - 3.6. Insertional mutagenesis.

Unit V Structural and numerical alterations of chromosomes:

1. Deletion,
2. Duplication,
3. Inversion,
4. Translocation,
5. Ploidy and their genetic implications.
6. Syndromes
 - 6.1 Turner's syndrome
 - 6.2. Klinefilter syndrome
 - 6.3 Down syndrome

Recombination:

1. Homologous and non-homologous recombination,
2. Transposition,
3. Site-specific recombination.

Books recommended :

1. Hartman and Surkind – Gene action
2. Hexter and Yost – The science of Genetics
3. Sinnot, Dunn and Dobzhansky- Principles of Genetics
4. Alberts B., Bray D., Lewis J., Rabt M., Robert K. and J. D.Watson. Molecular Biology of the Cell, Garland Publishing Inc. London.
5. Simmon, S. and Snustad: Principles of Genetics, 8th Edition, John Wiley and Sons Inc. N.Y.
6. Hartl D.L. and Jones E.W. Genetics: Analysis of gene and genome. Jones and Bartlett publishers . Boston

7. Tamarin R.H. Principles of Genetics. Wadsworth Publishing company ,Belmont, California.
8. Lewin Benjamin Genes VII Oxford University Press.
9. Winchester A.M. Genetics Oxford and IBH Publishing co New Delhi.
10. Genetics By Strichberger
11. Dobzhansky, Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
12. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
13. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
14. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
15. Varma and Agrawal – Evolution

11. Course Title: ZOO413 – Cell biology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To impart knowledge in evolving biological science at cellular level.				
2	To impart understanding of the fundamental process governing life and information flow in cell				
3	To inculcate interest in molecular cell biology research and creating human expertise.				
4					

12. Course Title: ZOO453 – Practicals based on Cell biology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To impart knowledge in evolving biological science at cellular level.				
2	To impart understanding of the fundamental process governing life and information flow in cell				
3	To inculcate interest in molecular cell biology research and creating human expertise.				
4					

**Paper No. ZOO-413
Cell Biology**

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

OBJECTIVE:

1. To impart knowledge in evolving biological science at cellular level.
2. To impart understanding of the fundamental process governing life and information flow in cell
3. To inculcate interest in molecular cell biology research and creating human expertise.

Unit I Membrane structure and function:

1. Structure of membrane (Unit Membrane & Fluid Mosaic Model)
2. Membrane protein types.
3. Functions of membrane
 - 3.1. Diffusion and Osmosis,
 - 3.2. Passive transport
 - 3.3. Active transport : Primary and Secondary
 - 3.4. Exocytosis
 - 3.5. Endocytosis (Phagocytosis, Pinocytosis and Receptor mediated endocytosis.)
4. Mechanism of Protein sorting
 - 1.1. For Secretory protein
 - 1.2. For Mitochondrial protein
5. Regulation of intracellular transport,
6. Electrical properties of membranes.
 - 5.1. General organization of neuron
 - 5.2. Molecular aspect of development of action potential and conduction

Unit II Structural organization and function of intracellular organelles:

- 1 Cell wall (Gram positive and Gram negative)
- 2 Nucleus:
- 3 Ribosomes (Subunits in prokaryotes & eukaryotes)
- 4 Mitochondria: (Oxidative phosphorylation and Chemiosmotic theory)
- 5 Golgi bodies,
- 6 Lysosomes,
- 7 Endoplasmic reticulum
- 8 Peroxisomes,
- 9 Structure & function of cytoskeleton and its role in motility. (Microfilaments, Microtubules, Intermediate filaments)

Organization of genes and chromosomes:

1. Structure of chromatin and chromosomes
 - 1.1. Nucleosome model
 - 1.2. Special type of Chromosomes
 - 1.2.1 Polytene chromosome
 - 1.2.2 Lampbrush chromosome
2. Unique and repetitive DNA
3. Heterochromatin
 - 3.1 Lyon hypothesis (X Chromosome inactivation)
 - 3.2 C Value paradox
4. Euchromatin,

Unit III Cellular communication:

1. General principles of cell communication,
2. Cell adhesion and roles of different adhesion molecules,
3. Gap junctions,
4. Extracellular matrix,
5. Integrins.

Cell signaling:

1. Hormones and their receptors-
 - 1.1. Nuclear receptors
 - 1.2. Membrane receptors (Enzyme linked receptors, Ion channel receptors),

- 1.3. Miscellaneous receptors (Toll like receptors-TLR)
2. Signal Transduction
 - 2.1. G-protein mediated signaling pathway
 - 2.2. Cytokine receptor-STAT mediated signaling pathway
3. Regulation of signaling pathways.

Unit IV Cell division and cell cycle:

1. Mitosis and meiosis their regulation,
2. Steps in cell cycle (G0, G1, S, G2 & M phases)
3. Control of cell cycle.(Regulation of CDK-cyclin activities and Molecular basis of cellular check points)

Cancer:

1. Cancer and the cell cycle,
2. Genetic rearrangements in progenitor cells,
3. Cancer causing genes-
 - 3.1 . Oncogenes,
 - 3.2 Tumor suppressor genes,
4. Virus-induced cancer,
5. Metastasis,
6. Interaction of cancer cells with normal cells,
7. Anticancer therapy and mechanism ;
8. Recent developments in anticancer treatments.

Unit V Innate and adaptive immune system:

1. Innate immune system

- 1.1. Overview, Features, Epithelial barrier. Neutrophil and Macrophage function.
- 1.2. Inflammation.
- 1.3. NK cell.
- 1.4. Cross-talk with Adaptive Immune system
2. Antigen Presentation
 - 2.1 Antigen ,Antigenicity and Epitopes
 - 2.2 APCs
 - 2.3 Dendritic cell
 - 2.4 MHC
3. Antigen Recognition
 - 3.1 T and B cell receptor
 - 3.2 Antibody molecules-Structure, types and functions
 - 3.3 Generation of Antibody diversity (Antigen Receptor Diversity)
 - 3.4 Clonal selection and Expansion
4. Humoral and cell-mediated immune responses
5. Memory cells

Text Books recommended:

1. Molecular Cell Biology : Lodish et al
2. Molecular Cell Biology : J Darnell and others. Fifth Edition
3. Molecular biology of the cell -B. Alberts et al. Gartand publishing Inc. New York
4. Cell and Molecular Biology De robertis and De robertis :
5. Gene VIII -Benjamin Lewin
6. Cell Physiology - Giese A.C. :
7. Molecular biology of the Gene -Watson et al

13. Course Title: ZOO501 – Evolution and Animal behavior

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	Understand the Origin of various animal groups.				
2	Understand the mechanism involved in evolution.				
3	Understand the significance and pattern of evolution.				
4	Able to understand the behavioral mechanisms				

14. Course Title: ZOO541 –Practicals based on Evolution and Animal behaviour

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	identify various behavioural mechanisms and its interpretation.				
2	To understand the mechanism involved in evolution.				
3	To understand significance and pattern of evolution.				
4	To study the behavioral mechanisms				

**Paper No. ZOO 511
Evolution, Animal behaviour**

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

Course Objective :

1. To study the Origin of various animal groups.
2. To study the mechanism involved in evolution.
3. To study the significance and pattern of evolution.
4. To study the behavioral mechanisms.

Unit I Emergence of evolutionary thoughts:

1. Lamarck's theory of evolution;
2. Darwin's theory of evolution –
 - 2.1. Concepts of variation
 - 2.2. Adaptation
 - 2.3. Struggle for existence
 - 2.4. Fitness and
 - 2.5. Natural selection;
3. Spontaneity of mutations;
4. The modern evolutionary synthesis.

Unit II Origin of cells and unicellular evolution:

1. Origin of basic biological molecules;
2. Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane;
3. Experiment of Miller (1953);
4. The first cell and Evolution of prokaryotes;
5. Origin of eukaryotic cells;
6. Evolution of
 - 7.1 Unicellular eukaryotes;
 - 7.2 Anaerobic metabolism,
 - 7.3 Photosynthesis and
 - 7.4 Aerobic metabolism.

Unit III Paleontology and evolutionary history:

1. The evolutionary time scale (eras, periods and epoch)
2. Major events in the evolutionary time scale
3. Origins of
 - 3.1. Unicellular and multicellular organisms and sex ;
 - 3.2. Major groups of animals (Amphibia, Reptilia, Birds and Mammals)
 - 3.3. Stages in primate evolution including Homo.

Molecular Evolution:

1. Concepts of natural evolution,
2. Molecular divergence and molecular clocks;
3. Origin of new genes and proteins; 4. Gene duplication and divergence.

Unit IV The Mechanisms:

1. Population genetics –
 - 1.1. Populations,
 - 1.2. Gene pool,
 - 1.3. Gene frequency;
2. Hardy-Weinberg law
3. Concepts and rate of change in gene frequency through
 - 3.1. Natural selection,
 - 3.2. Migration and
 - 3.3. Random genetic drift;
4. Adaptive radiation and modifications;
5. Isolating mechanisms;
6. Speciation – Allopatric, Sympatric and Parapatric ;
7. Convergent evolution;
8. Sexual selection;
9. Co-evolution.

Unit V Brain, Behavior and Evolution:

1. Kinship
2. Altruism and Kin selection
3. Reciprocal altruism;
4. Neural basis of -
 - 4.1. Learning,
 - 4.2. Memory,
 - 4.3. Cognition,
 - 4.4. Sleep and
 - 4.5. Arousal;
5. Biological rhythms, biological clock, tidal, seasonal and circadian rhythms
6. Development of behavior
7. Social communication;
8. Social dominance;
9. Parental care
10. Aggressive behavior;
11. Habitat selection and optimality in foraging;
12. Migration, Orientation and Navigation;

Books recommended :

1. Varma and Agrawal - Genetics and Evolution
2. Dobzhansky, Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press.
Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
3. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
4. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
5. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
6. Varma and Agrawal - Evolution
7. Animal behavior and Evolutionary Approach by Alcock
8. Perspectives in animal behavior Goodenough , Wiley 1993
9. An introduction to animal behavior 5 th ed. Cambridge Univ Press. By Manning Dawkins.

15. Course Title: ZOO502 – Quantitative biology**Program: MSc (Zoology)****Discipline: Science**

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	Mathematical and statistical approaches have played a fundamental role in understanding Biological concepts.				
2	To be empowered to use such tools of greater significance.				
3	To understand computing and data mining is now a prerequisite for literacy in modern sciences..				
4					

16. Course Title: ZOO542 – Practicals based on Quantitative biology**Program: MSc (Zoology)****Discipline: Science**

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	Mathematical and statistical approaches have played a fundamental role in understanding biological concepts.				
2	It will enable students to be empowered to use such tools of greater significance.				
3	The knowledge of computing and data mining is now a prerequisite for literacy in modern sciences..				

Paper No. ZOO-502

Quantitative Biology

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, **Internal-**20%

Objective:

1. Mathematical and statistical approaches have played a fundamental role in understanding biological concepts.
2. It will enable students to be empowered to use such tools of greater significance.
3. The knowledge of computing and data mining is now a prerequisite for literacy in modern sciences.

Unit I Statistical Methods

1. Classification of Data,
2. Measures of central tendency
 - 2.1. Mean , Mode and Median, Geometric mean, Harmonic mean,
 - 2.2. Sample mean verses population mean
3. Measures of Dispersion,
 - 3.1. Absolute and Relative measures,
 - 3.2. Range and Interquartile range
 - 3.3. Absolute deviation and mean absolute deviation,
 - 3.4. Variance,

Unit II Statistical Methods

- 1. Standard deviation-** Sample std deviation and Population std deviation
 - 1.1. Coefficient of range and interquartile range,
 - 1.2. Coefficient of Mean deviation ,
 - 1.3. Coefficient of Std deviation and Coefficient of Variation
5. Frequency distribution
 - 1.4. Normal curve
 - 1.5. Standard deviation and standard error
 - 1.6. Sampling and t-test ,
 - 1.7. Student t-test,
 - 1.8. Chi Square test, Their importance and uses.
 - 1.9. Levels of significance;
 - 1.10. Regression and Correlation;

Unit III Probability theory

1. Probability distributions, and their properties.
2. Sampling distribution,
3. F-test (one-way & two-way F test).
4. Analysis of variance: One way and Two way.
5. Basic introduction to Multivariate statistics.

Unit IV Computational methods

1. Bioinformatics scope,
2. Tools and resources in bioinformatics.
3. Database,
4. Biological databases,
5. Data bases, types and information,
6. Nucleic acid and protein sequence databases;
7. Data mining methods for sequence analysis,
8. Web-based tools for sequence searches

Unit V Computational methods

9. Sequence retrieval,
10. Basic concepts and operational aspects
11. Phylogentic analysis,
12. Clustal W and Blast application,
13. Construction of phylogenetic trees using molecular data.(Cytochrome, myoglobin etc.).
14. Predictive methods based on sequence data,
15. Genome information
16. Motif analysis and presentation.

Recommended books:

1. Introduction to mathematics for life scientists By Batschetelet , E. ,Springer –Verlag. Berlin
 2. Fundamentals of Ecological modeling by Jorgensen, S.E. , Elsevier, New York
 3. Ecological simulation primer by Swartzman, G.L., and S. P . Kalunzy, Macmillen , New York.
 4. Modeling in behavioral Ecology by Lendern, Chapman and Hal , London K.
 5. Biometry , by Sokal, R.R. and R.J.Rolf , Freeman, San Francisco
- Tentative Zoology Syllabus for PG Page 3
6. Statistical methods by Snedecor, G.W. and W.G. Cochran. Affiliated East West Press. New Delhi. (India Ed.)
 7. Sampling design and statistical methods for environmental biologist by Green , R.H. , John Wiley and Sons, New York.
 8. Mathematical Biology by Murray , J.D., Springer Verlag, Berlin.
 9. The Interpretation of Ecological Data. A Primer on classification and Ordination by Pielou, E.C.
 10. Introduction to Bioinformatics: A Theoretical and Practical Approach by Stephen A. Krawetz
 11. Bioinformatics and Genomes by Andrade

17. Course Title: ZOO503 – Fundamental processes

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To impart knowledge in evolving biological science at molecular level.				
2	To impart understanding of the fundamental process governing life and information flow in cell.				
3	To inculcate interest in molecular biology research and capacity building..				

18. Course Title: ZOO543 – Practicals based on Fundamental processes

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To impart knowledge in evolving biological science at molecular level.				
2	Understanding the processes involved in the process governing life and information flow in cell.				
3	To inculcate interest in molecular biology research and capacity building..				

**Paper No. ZOO-503
Fundamental Processes**

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

OBJECTIVE:

1. To impart knowledge in evolving biological science at molecular level.
2. To impart understanding of the fundamental process governing life and information flow in cell.
3. To inculcate interest in molecular biology research and capacity building.

Unit I Prokaryotic and Eukaryotic DNA replication, repair and recombination:

1. Unit of replication, enzymes involved,
2. Replication origin and replication fork,
3. Fidelity of replication,
4. Extrachromosomal replicons,
5. DNA damage and repair mechanisms.

Unit II Transcription (RNA synthesis and processing)

1. Transcription regulation in Prokaryotes:
 - 1.1. RNA Pol subunit composition and
 - 1.2. DNA motif,
 - 1.3. Operon- Operons - inducible, repressible operons.
2. Transcription in Eukaryotes:
 - 2.1. RNA Pols subunit composition and
 - 2.2. DNA motif,
 - 2.3. Transcription factor and chain terminator.
 - 2.4. Promoters; enhancers, silencers.
3. Post transcriptional events:
 - 3.1. Splicing;
 - 3.2. Capping &
 - 3.3. Polyadenylation;
 - 3.4. Co-ordination of mRNA processing,
 - 3.5. rRNA & tRNA Processing;
 - 3.6. RNA editing,
4. Post-transcriptional control of gene regulation.

Unit III Translation (Protein synthesis) and processing

1. Genetic code,
2. Aminoacylation of tRNA,
3. tRNA-identity,
4. Aminoacyl tRNA synthetase,

Prokaryotic Translation

1. Initiation,
2. Elongation&
3. Termination.

Unit IV Eukaryotic translation

- 1.1. Ribosome,
- 1.2. Formation of initiation complex,
- 1.3. Initiation factors and their regulation,
- 1.4. Elongation and elongation factors,
- 1.5. Termination,

2. Translational proof-reading,
3. Translational inhibitors,
4. Co and post- translational modification of proteins.

Unit V Control of gene expression at transcription and translation level

1. Prokaryotic gene expression
 - 1.1. Operons and regulons, repression and activation of *Lac* operon.
2. Eukaryotic gene expression
3. Role of chromatin in regulating gene expression and gene silencing.

Books recommended

1. Hartman and Surkind – Gene action
2. Hexter and Yost – The science of Genetics
3. Sinnot, Dunn and Dobzhansky- Principles of Genetics
4. Alberts B., Bray D., Lewis J., Rabt M., Robert K. and J. D.Watson. Molecular Biology of the Cell, Garland Publishing Inc. London.
5. Simmon, S. and Snustad: Principles of Genetics, 8th Edition, John Wiley and Sons Inc. N.Y.
6. Hartl D.L. and Jones E.W. Genetics: Analysis of gene and genome. Jones and Bartlett publishers . Boston
7. Tamarin R.H. Principles of Genetics. Wadsworth Publishing company ,Belmont, California.
8. Lewin Benjamin Genes VII Oxford University Press.
9. Winchester A.M. Genetics Oxford and IBH Publishing co New Delhi.
10. Genetics By Strichberger
11. Dobzhansky, Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
12. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
13. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
14. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
15. Varma and Agrawal – Evolution

19. Course Title: ZOO511 – Developmental biology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To impart knowledge in evolving biological science with respect to Developmental biology.				
2	To impart understanding of the fundamental process governing development of life.				
3	To inculcate interest research in developmental biology and creating manpower for this region.				

20. Course Title: ZOO551 – Practicals based on Developmental biology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To impart knowledge in evolving biological science with respect to Developmental biology.				
2	To impart understanding of the fundamental process governing development of life.				
3	To inculcate interest research in developmental biology and creating manpower for this region.				

Developmental Biology

Total no. of credits- 4

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

OBJECTIVE:

1. To impart knowledge in evolving biological science with respect to Developmental biology.
2. To impart understanding of the fundamental process governing development of life.
3. To inculcate interest research in developmental biology and creating manpower for this region.

Unit I.Gametogenesis, fertilization and early development:

1. Production of gametes-
 - 1.1. Spermatogenesis in mammals, structure of sperm,
 - 1.2. Oogenesis in mammals, Structure of egg and types.
2. Cell surface molecules in sperm-egg recognition in animals;

Unit II Zygote formation

- 1.1.Capacitation
- 1.2.Prevention to polyspermy (Fast block and slow block)
- 1.3.Acrosome reaction
- 1.4.Activation of Egg metabolism
2. Cleavage and patterns of embryonic cleavage
3. Blastula formation and fate map of blastula
4. Gastrulation and formation of 3 germ layers in animals (Ex. Frog and Chick)

Unit III Basic concepts of development:

1. Potency,
2. Commitment,
3. Specification,
4. Induction,
5. Competence,
6. Determination and differentiation;
7. Morphogenetic gradients;
8. Cell fate and cell lineages;
9. Stem cells;
10. Genomic equivalence and the Cytoplasmic determinants;
11. Imprinting; mutants and transgenics in analysis of development.

Unit IV Morphogenesis and organogenesis in animals:

1. Cell aggregation and differentiation in *Dictyostelium*;
2. Axes and pattern formation in *Drosophila*,
 - 2.1. Segmentation genes,
 - 2.2. Homeotic genes
3. Amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*;
4. Axis formation in Amphibians
 - 4.1. Spemann's Organizer experiment(Primary embryonic induction)
 - 4.2. Functions of organizer
5. Nuclear transplantation experiments of Briggs and King and Gurdon in the frog.
6. Nuclear transplantation and cloning in mammals.
7. The concept of totipotency Embryonic stem cells
8. Eye lens induction, limb development and regeneration in vertebrates;
9. Differentiation of neurons,
10. Post embryonic development-
 - 10.1. Larval formation,

- 10.2. Metamorphosis;
- 10.3. Environmental regulation of normal development;
- 11. Sex determination.

Unit V Programmed cell death, aging and senescence.

- 1. Apoptosis
- 2. Senescence
- 3. Theories of aging-
 - 3.1. Programmed theories (ex. Programmed senescence theory, Telomeric theory,) and
 - 3.2. Error theories (ex. Free radical theory)

Text books

- 1. Developmental Biology by Gilbert Scott
- 2. Molecular biology of the cell By Albert et al
- 3. Molecular biology of the Gene by Watson et al
- 4. Principle of Development by Wolpert
- 5. Genes VIII/ IX By Benjamin Lewin
- 6. Developmental Biology by Balinsky
- 7. Developmental Biology by Berril
- 8. Developmental Biology by Waddington
- 9. Readings are also assigned from journals and from Internet resources such as Medline([Http://www.ncbi.nlm.nih.gov/entrez/quey.fcgi](http://www.ncbi.nlm.nih.gov/entrez/quey.fcgi)) and bio Med Net (<http://www.bmn.com/>) Wikipedia etc.

21. Course Title: ZOO512 – Methods in biology**Program: MSc (Zoology)****Discipline: Science**

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study the biochemical molecules and their interactions				
2	To study the principle of instruments used for biological study.				
3	To study the functioning of instruments used in biology.				

22. Course Title: ZOO552 – Practicals based on Methods in biology**Program: MSc (Zoology)****Discipline: Science**

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study the biochemical molecules and their interactions				
2	To study the working principle of instruments and create expertise in the area.				
3	To study the functioning of instruments used in biology.				

**Paper No. ZOO-512
Methods in Biology**

Total no. of credits- 4**No. of periods per credit- 16****Total No. of periods -60****Evaluation:** External-80%, Internal-20%**Course objective :**

1. To study the biochemical molecules and their interactions
2. To study the principle and functioning of instruments used for biological study

Unit I Microscopic techniques:

1. Visualization of cells and subcellular components by light microscopy,
2. Resolving powers of different microscopes,
3. Microscopy of living cells,
4. Scanning and transmission microscopes,

5. Different fixation and staining techniques for EM

Unit II Histochemical and immunotechniques:

1. Antibody generation,
2. Detection of molecules using ELISA, RIA,
3. Western blot,
4. Immunoprecipitation,
5. Flowcytometry and immunofluorescence microscopy, Detection of molecules in living cells,
6. *in situ* localization by techniques such as FISH and GISH.
7. Chromosome painting.

Biophysical methods:

1. Analysis of biomolecules using
 - 1.1. UV/visible,
 - 1.2. Fluorescence,
 - 1.3. Circular dichroism,
 - 1.4. NMR and
 - 1.5. ESR spectroscopy,
2. Structure determination using
 - 2.1. X-ray diffraction and
 - 2.2. NMR;

Radiolabeling techniques:

- 1.1. Properties of different types of radioisotopes normally used in biology,
- 1.2. Their detection and measurement
- 1.3. Incorporation of radioisotopes in biological tissues and cells,

Unit III Recombinant DNA methods:

1. Isolation and purification of RNA , DNA (genomic and plasmid) and proteins,
2. Different separation methods;
3. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis,
4. Isoelectric focusing gels;
5. Molecular cloning of DNA or RNA fragments in eukaryotic systems;
6. Expression of recombinant proteins using bacterial, animal and plant vectors;
7. Isolation of specific nucleic acid sequences;
8. Generation of genomic and cDNA libraries in plasmid, phage, cosmid
9. In vitro mutagenesis and deletion techniques,
10. Gene knock out in eukaryotic organisms;

Unit IV Molecular biology methods:

1. DNA sequencing methods,
2. Protein sequencing methods,
3. Detection of post-translation modification of proteins;
4. RFLP,
5. RAPD and
6. AFLP techniques

Unit V Electrophysiological methods:

1. Single neuron recording,
2. Patch-clamp recording,
3. Brain activity recording,
4. Lesion and stimulation of brain,
5. Pharmacological testing,
6. PET,
7. MRI,
8. fMRI,
9. CAT

Methods in field biology: Methods of estimating population density of animals

List of Books :

1. Instrumentation and Techniques by Chatwal and Chatwal
2. Biophysical chemistry by Upadhyaya and Upadhyaya.
3. Principles of Biochemistry by Lehninger
4. Harper's Biochemistry.
5. Molecular biology of Gene. By Watson.
6. Molecular cell biology by Lodish.
7. Biochemistry by Voets and Voets
8. Hand book of molecular and cellular methods in biology by Leland J Cseke et al.

23. Course Title: ZOO513 – Applied Zoology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study the applied aspects of zoology.				
2	To study the principle and functioning of new technologies used in Zoology.				
3	Impart knowledge about various new technologies coming in the zoology.				

24. Course Title: ZOO553 – Practicals based on Applied Zoology

Program: MSc (Zoology)

Discipline: Science

Sr.No.	Course Outcomes	Check 1	Check 2	Check 3	Check 4
1	To study the applied aspects of zoology.				
2	To study the principle and functioning of new technologies used in Zoology.				
3	Study various new technologies in the zoology.				

Paper No. ZOO 513
Applied Zoology

Total no. of credits- 4

No. of periods per credit- 16

Total No. of periods -60

Evaluation: External-80%, Internal-20%

Course objective :

1. To study the applied aspects of zoology.
2. To study the principle and functioning of new technologies used in Zoology.

Unit I . Microbial fermentation and production of small and macro molecules.

Application of immunological principles (vaccines, diagnostics).

Edible vaccines

Tissue and cell culture methods for plants and animals.

Tissue engineering

1. Principle
2. Objective
3. Method –
 - 3.1. Scaffold properties
 - 3.2. Scaffold guided tissue regeneration

Unit II Recombinant DNA technology;

1. Plasmid, cosmid, artificial chromosomes as vectors,
2. DNA cloning and whole animal cloning (Principles and methods).
3. Animal Cloning.

Stem cells:

3. Sources and types
4. Induced pluripotent stem cells (iPSCs)
5. Use of stem cells in human welfare,

Assisted reproductive technologies

6. In vitro fertilization and embryo transfer,
7. ICSI
8. GIFT

Unit III Transgenics

1. Transgenic animals-Methodology and applications.
2. Transgenic plants - Methodology and applications.
3. Health and ethical considerations for transgenic organisms.
4. Molecular approaches to diagnosis and Strain identification.

Unit IV Advanced Technologies

1. Ribozyme display technology
2. Human genome project,
3. Genomics and Proteomics.
4. Its application in Health (Gene therapy) and Agriculture

Unit V Bioresources and uses of biodiversity.

1. Biodiversity and food security
2. Biodiversity and pharmacy research
3. Breeding in plants and animals, including marker – assisted selection.
4. Bioremediation and phytoremediation.
5. Bio-nano technology- Principles and applications.
6. Biosensors and Biomimetics

Books recommended

1. Biomimicry By Dora Lee, Margot Thompson
2. Bionics by Judith Jango-Cohen
3. Biometrics by Yoseph Bar-Cohen.
4. Biometrics by Mohmet Sarikaya et al.
5. Design in Nature by C. Matteck.
6. Bionanotechnology :Lessons from Nature.by David S. Goodsell
7. Bionanotechnology : A revolution in food,biomedical and health sciences by Debashish Bagchi and others. John Wiley Publications.
8. Bioresources and Human environment by Reena Mehanka
9. Tissue engineering : Principles and practices by John P. Fisher et al.
10. Tissue engineering : From cell biology to artificial organs by Will W. Minuth.
11. Molecular biotechnology by Bernard R. Glick.
12. Technology, Transgenics and Practical Moral code by Dennis Cooley, Springerpublications.
13. Assisted Reproductive technology : Accomplishment and new Horizon edited by Christopher J De Jonge and Christopher L.R. Barret by Cambridge University Press.
14. Stem Cells by Eapen Cherian Jaypee brothers medical publishers.

27	III	Zoo543											
28	IV	Zoo511											
29	IV	Zoo512											
30	IV	Zoo513											
31	IV	Zoo551											
32	IV	Zoo552											
33	IV	Zoo553											
34	IV	Zoo561											

Write three observations about your program:

- 1.
- 2.
- 3.