CHAUDHARY RANBIR SINGH UNIVERSITY, JIND

MASTER OF ZOOLOGY
IN THE FACULTY OF LIFE SCIENCES

SCHEME AND SYLLABUS
(Semester I to IV)
(Based on CBCS-LOCF Pattern)
(Effective from 2022-23 in phased manner)

DEPARTMENT OF ZOOLOGY
(September 2022)

VISION AND MISSION OF THE DEPARTMENT

Vision

To create an innovative atmosphere for teaching and learning to achieve excellence in biology education. The department promotes the discovery and broad knowledge about the biology of animals, evolution and their environments.

Mission

Our mission is to offer high quality education dedicated to building minds with social and moral responsibility. We are committed to educating the students beyond the confines of a class room to make them better individuals and develop their personalities, enabling them to face the challenges of the modern world. In addition, to conserve and propagate animals in consonance with human development imbibing the latest advances in the field of Zoology and enabling society to face the challenges of the modern world.

Programme Outcomes (POs) for PG courses of Faculty of Life Sciences

The PG Courses of Faculty of Life Sciences will be able:

PO1 To provide transformative, holistic and value-based immersive learning experiences to students.

PO2 To develop understanding of organismal, cellular, biochemical and environmental basis of life

PO3 To provide insight into ethical implications of biological research for environmental protection and good laboratory practices and biosafety

PO4 To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.

PO5 To understand application of biotic material in health, medicine, food security for human well-being and sustainable development.

PO6 To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self-reliance.

Programme-Specific Outcomes (PSOs) of the M.Sc. Zoology of the Department

PSO1 Students will have knowledge and skills and in-depth acquaintance of animal species, their life biology, evolution, interaction with the environment at organismal, cellular and molecular level

PSO2 Young students will understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Animal Behaviour, Cancer Biology, Microbiome and their roles in health and diseases, Bioremediation of pollutants and pesticides, etc.

PSO3 Youth will be trained to Identify, review, and analyse complex situations of living forms and commitment to professional ethics and responsibilities and norms of the work/research practice

PSO4 Youth will be capable of using research-based knowledge and research methods with problem solving expertise and robust communication skill with reference to animal life processes

PSO5 This programme will develop personnel who can function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings with deep understanding of Zoology and management principles

PSO6 This PG programme will develop youth with excellence in Zoology for career in teaching, research, industry and entrepreneurship in the line of self-reliant India.

PSO7 To provide quality education offering skill based programs and motivate the students for self-employment in applied branches of Zoology.

Scheme of Examination for M.Sc. Zoology (Semester system) as per Choice Based Credit System (CBCS) to be implemented w.e.f. session 2022-2023 in Phased Manner

Semester wise distribution of course and credits in Zoology

Paper No.	Title of the Paper	Nature of paper	Credits	Contact hours per week T + S + P	Total Marks (T+IA)	Exam duration (Hours)
Semester I						
M-Z 101	Cell Biology	Core	4	4 + 0 + 0	80+20	3
M-Z 102	Biochemistry and Bio-techniques	Core	4	4 + 0 + 0	80+20	3
M-Z 103	Biosystematics and Biostatistics	Core	4	4 + 0 + 0	80+20	3
M-Z 104	Biology of Invertebrates	Core	4	4 + 0 + 0	80+20	3
M-Z 105	Practical (Based on Papers M-Z 101 & M- Z 102)	Core	4	0 + 0 + 8	80+20	4
M-Z 106	Practical (Based on Papers M-Z 103 &M-Z 104)	Core	4	0 + 0 + 8	80+20	4
	Total		**24**	**16 + 0 + 16**	**480+120=600**	
Semester II						
M-Z 201	Population and Community Ecology	Core	4	4 + 0 + 0	80+20	3
M-Z 202	Comparative Physiology	Core	4	4 + 0 + 0	80+20	3
M-Z 203	Population Genetics & Evolution	Core	4	4 + 0 + 0	80+20	3
M-Z 204	Biology of Vertebrates	Core	4	4 + 0 + 0	80+20	3
M-Z 205	Seminar	Core	1	0 + 1 + 0	25	-
M-Z 206	Economic Zoology	Open elective	4	4 + 0 + 0	80+20	3
M-Z 207	Practical (Based on Papers M-Z 201 & M- Z 202)	Core	4	0 + 0 + 8	80+20	4
M-Z 208	Practical (Based on Papers M-Z 203 & M- Z 204)	Core	4	0 + 0 + 8	80+20	4
	Total		**29**	**20 + 1 + 16**	**585+140=725**	

Semester III							
M-Z 301	Molecular Biology		Core	4	4 + 0 + 0	80+20	3
M-Z 302	Molecular Endocrinology		Core	4	4 + 0 + 0	80+20	3
M-Z 303	Applied Zoology		Core	4	4 + 0 + 0	80+20	3
M-Z 304	Molecular Reproduction-I	Any one from M-Z 304 to M-Z 306	Elective	4	4 + 0 + 0	80+20	3
M-Z 305	Animal Behaviour & Wildlife Conservation – I						
M-Z 306	Fish, Fisheries and Aquaculture – I						
M-Z 307	Seminar		Core	1	0 + 1 + 0	25	-
M-Z 308	Animal Diversity & Conservation		Open Elective	4	4 + 0 + 0	80+20	3
M-Z 309	Practical (Based on Papers M-Z 301 to M-Z 303)		Core	4	0 + 0 + 8	80+20	4
M-Z 310	Practical (Based on Papers M-Z 304/Z 305/Z 306)		Elective	4	0 + 0 + 8	80+20	4
	Total			**29**	**20 + 1 + 16**	**585+140=725**	
Semester IV							
M-Z 401	Developmental Biology		Core	4	4 + 0 + 0	80+20	3
M-Z 402	Vertebrate Immunology		Core	4	4 + 0 + 0	80+20	3
M-Z 403	Environmental Toxicology		Core	4	4 + 0 + 0	80+20	3
M-Z404	Molecular Reproduction– II	Any one from M- Z 404 to M-Z 406	Elective	4	4 + 0 + 0	80+20	3
M-Z 405	Animal Behaviour & Wildlife Conservation – II						
M-Z 406	Fish, Fisheries and Aquaculture – II						
M-Z 407	Practical (Based on Papers M-Z 401 to M-Z 403)		Core	4	0 + 0 + 8	80+20	4
M-Z 408	Practical (Based on Papers M-Z 404 /Z 405/Z 406)		Elective	4	0 + 0 + 8	80+20	4
	Total			**24**	**16 + 2 + 16**	**480+120=600**	
					Grand Total	**2650**	

T – Theory; S– Seminar; P– Practical
Total Credits: Core 80 + Elective 16 + seminar 2 + open elective 8 = 106

SEMESTER – I

Paper: M-Z 101 (Core)
Cell Biology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To make students learn the deeper aspects of cell structure and function at molecular level.
2. To apprise students about likeness between the physiological processes at the cellular and organismic levels.

Course Outcomes:

CO1 This core course will make students able to understand how the cell functions as a unit of life.

CO2 Through this course, students will be able to appreciate the importance of various cell function and structures in the evolution of multicellular organisms.

CO3 The studies will make the students reveal elegance, dynamics and economy in the living cell and a gratifying unity in the principles by which a cell functions.

CO4 The students will know about the basic cellular and molecular approaches for cancer development and treatment

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT- I

1. Biomembranes

1.1 Molecular composition and arrangement, functional consequences
1.2 Cellular Transport – Recapitulation of the plasma membrane; diffusion, active transport and pumps, uniports, symports and antiports.
1.3 Donnan equilibrium; ion movements and cell function: acidification of cell organelles
1.4 Maintenance of cellular pH; cell excitation; bulk transport; Receptor mediated endocytosis
1.5 Transepithelial transport

2 Cytoskeleton and cell movement

Introduction to cytoskeleton and its role
Molecular structure of Actin, myosin and their organisation
Structure and dynamic organizations of microtubules and microfilaments
Microtubule motors and movement
Intermediate filaments
Role of Centrioles and basal bodies
Structure and functions of Cilia and flagella

UNIT –II

3 The Extra Cellular Matrix and Cell interactions

Cell walls
The ECM and cell-matrix interactions
Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata
Ca^{++} dependent and Ca^{++} independent Homophilic cell-cell adhesion

4 Cell matrix adhesion

Integrins
Collagen
Non-collagen components
Auxin and cell expansion
Cellulose fibril synthesis and orientation

5 Protein sorting and transport

Protein uptake into the ER
Membrane proteins and Golgi sorting
Mechanism of vesicular transport
Lysosomes
Molecular mechanism of secretory pathway

UNIT-III

6 Cell cycle

Eukaryotic cell cycle
Regulators of cell cycle progression
Role of Meiosis in Genetic Variation

7 Cell – Cell signaling

Signaling molecules and their receptors
Pathways of intracellular signal transduction

8 Biology of Cancer

The development and causes of cancer
Oncogenes
Tumor suppressor genes
Molecular approaches to cancer treatment

UNIT-IV

9 Genome organization

Chromosomal organization of genes
Transposons in prokaryotes and eukaryotes
Morphological and functional elements of eukaryotic chromosomes

10 Cell Death

Necrosis and Programmed cell death
Molecular Mechanism
Applications and Significance

11 Biology of Ageing

Morphological, Physiological and Functional changes during Ageing
Telomeres and Ageing
Theories of Ageing

Suggested Reading Material:

1. Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
3. Cell and molecular biology Phillip Sheeler, Donald E. Bianchi Wiley, 1987
4. Life: The Science of Biology by David Sadava
5. Cell and Molecular Biology by De Robertis
6. Cell Biology by A.K. Berry, EMKAY Publlications
7. Molecular Cell Biology, Lodishet al., W.H. Freeman and Company (8th Ed. 2016)
8. Molecular Biology, Weaver R. F., McGraw-Hill Education (5th Ed. 2011)

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – I

Paper: M-Z 102 (Core)
Biochemistry and Bio-techniques
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To develop understanding of biological processes at chemical, biochemical and molecular level to perform wide range of analytical techniques to explore biological activities.
2. To provide general overview of different biochemical experimental approaches to understand the structure and functions of cell and its components.

Course Outcomes:

CO1 It will provide the students a basic appreciation of the underlying principles and practical strategy of the analytical and preparative techniques that are fundamental to study and understanding of life processes.
CO2 It will make the students to understand the general reactions of various metabolic pathways.
CO3 Students will be able to explain the principle, working, materials used and applications of various biological techniques that are used to study the basic biological processes.
CO4 Students will be able to describe the structure and classification of biomolecules.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each unit (I to IV). The candidate will be required to attempt question No. 1 and four more selecting one question from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT – I

1.0 General Principles of Biochemistry and chemical composition of life

1.1 General Introduction to Biomolecules

2.0 Protein Biology:

2.1 Primary, Secondary, tertiary and quaternary structure of proteins: i)Domain, ii)Reverseturn of Ramachandran plot and its significance

3.0 Enzyme:

3.1 Classification and nomenclature,
3.2 Co-enzymes and Cofactors
3.3 Induced fit and Molecular Mechanism of Enzyme action,
3.4 Enzyme feedback mechanism, Isozymes.

4.0 Nucleic acids: Structure and Functions

4.1 DNA structure and functions
4.2 RNA structure and functions,
4.3 DNA choreography
4.4 Qualitative and quantitative estimation of DNA

UNIT - II

5.0 Metabolism:

5.1 Glycolysis, citric acid cycles its regulation and role as metabolic hub.
5.2 Hexose monophosphate pathway its regulation and significance.
5.3 Cholesterol biosynthesis, its metabolism and steroidogenesis.
5.4 Bile acids and their metabolism
5.5 Saturated and unsaturated fatty acid and their metabolism.

UNIT - III

6.0 Chemical and Biological assays (*in vitro* and *in vivo* assays).

7.0 Principles and uses of analytical instruments:

7.1 Microscopes and imaging
7.2 Spectrophotometers,
7.3 NMR spectrophotometer

8.0 Microbiological and cell culture Techniques

8.1Setting of microbiological laboratory,
8.2Sterilization and Media preparation techniques
8.3 Inoculation and growth monitoring (Standard plate count technique),
8.4Isolation of a microbial colony and slant preparation.
8.5Design and functioning of tissue culture laboratory,
8.6Basics of cell/tissue culture, Culture media preparation,
8.7Cell proliferation measurements
8.8Cell viability testing and Cell harvesting methods.
8.9 Biosafety and levels

9.0 Cryotechniques :

9.1Cryopreservation for cells, tissue, organisms,
9.2Cryotechniques for microscopy.

UNIT - IV

10.0 Separation techniques in biology.

10.1 Molecular separations by chromatography, electrophoresis, precipitation etc.
10.2 Organelle separation by centrifugation. Density gradient centrifugation, Ultra Centrifugation, unit gravity centrifugation, affinity adsorption, anchorage based techniques etc.
10.3 Cell separation by flow cytometery and FACS

11.0 Radioisotope and mass isotope techniques in biology:

11.1 Sample preparation for radioactive counting

11.2 Autoradiography

11.3 Biosensors

12.0 DNA fingerprinting

Suggested Reading Materials:

1. Animal Cell Culture – A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Braun, McGraw Hill International editions
3. A Biologists guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K.H. Goulding, ELBS Edn.
4. Lehninger AL, Nelson DL & Cox MM (1993) Principles of Biochemistry, 2nd edn. New York: Worth.
5. Stryer L (1995) Biochemistry, 4th edn. New York: WH Freeman.
6. Voet D, Voet JG & Pratt CW (1999) Fundamentals of Biochemistry. New York: Wiley.

Teaching-Learning Process

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- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – I

Paper: M-Z 103 (Core)
Biosystematics and Biostatistics
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. This paper deals with nomenclature, taxonomy and preservation of organism, assigning names to organisms using nomenclature and classifying species into larger groups that have biological meaning.
2. It imparts understanding about fundamental concepts in statistics and their application in interpretation of biological data also demonstrate appropriate sampling scheme.

Course Outcomes:

CO1 Knowledge of Taxonomy helps in classifying and identifying biodiversity and biologist study the well understood relationships by making phylogenetic trees.
CO2 It will help to understand the overall biodiversity of the world and their application in all the fields of biological sciences.
CO3 Biostatistics helps to generate a hypothesis from a set of observation and then design experiment to test the hypothesis.
CO4 Able to acquire, analyse and understand the significance of data.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT – I

1.0 Biosystematics and taxonomy: Definition and perspectives,
2.0 Historical resume, Importance and applications of systematics in biology.
Concepts of newer aspects of biosystematics: Chemotaxonomy, Cytotaxonomy, Molecular taxonomy.

3.0 Dimensions of speciation and taxonomic characters:
3.1 Different Species concepts – species category,
3.2 Sub-species and other intra-specific categories.

4.0 Theories of biological classification, hierarchy of categories.
5.0 Taxonomic characters – different kinds, weighing of characters

UNIT - II

6.0 **Methodology:**

6.1 Taxonomic collections, preservation, curetting process and identification.
6.2 Taxonomic keys-different kinds of taxonomic keys, their merits and demerits.

7.0 **Systematic publications:**

7.1 Different kinds of publications.
7.2 International code of Zoological Nomenclature (ICZN): principles, objectives and rules: Stability, Priority, Concept of availability, formation of names, synonymy, homonymy, the type method, kinds of type specimen, type-designation.

8.0 Principles of Bioethics in Biodiversity

UNIT - III

9.0 **Measures of central value:**
11.1 Arithmetic mean, mode and median, Definition, calculation and its properties.

10.0 **Measures of Dispersion: Range,**
12.1 Interquartile range,
12.2 Quartile deviation.
12.3 Mean deviation and standard deviation,
12.4 Standard error

11.0 **Correlation:**
13.1 Types and Methods studying correlation – Scatter diagram method, Graphic method, Karl Pearson coefficient of correlation, Rank correlation.

12.0 Regression analysis (Regression lines and regression equation)

13.0 Chi-square analysis

UNIT - IV

14.0 **Concept of sampling and sampling methods:**
16.1 Definition and law of sampling,
16.2 Judgment sampling, Random sampling, stratified sampling, systematic sampling, multi-stages sampling and quota sampling.

15.0 Test of significance for large samples and small samples (student t-test, F- test; ANOVA).

16.0 Probability and law of probability, Theoretical probability distribution: Binomial distribution, Poison distribution, Normal distribution.

17.0 Components of computers, Basic functioning of computers, Use of Statistical Software in Biology

Suggested Reading Material:

1. M. Kato. The Biology of Biodiversity, Springer.
2. E.O. Wilson, Biodiversity, Academic Press, Washington.
3. G.G. Simpson, Principle of animal taxonomy, Oxford ISH Publishing Company.
4. E. Mayer, Elements of Taxonomy.
5. E.O. Wilson, The Diversity of Life (The College Edition), W.W. Northerm & Co.
6. S.K. Tikadar, Threatened Animals of India, ZSI Publication, Calcutta.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – I

Paper: M-Z 104 (Core)
Biology of Invertebrates
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. Make students to understand how life evolved from simple to complex organization by division of labour & enhancing efficiency in Invertebrates.
2. In depth knowledge of minor phyla and their organization and relationship with other invertebrates phyla

Course Outcomes:

CO1 The study of invertebrates reveals progressive evolutionary history and adaptations together which forms the basis of huge complex and diverse life forms.
CO2 Students will acquire a clear understanding about organization of minor phyla and their relationship with other animal phyla
CO3 Students will be able to know the structure and significance of various systems of Invertebrates
CO4 Will have detail understanding of adaptations and significance of Invertebrates

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT – I

1.1 Introduction to invertebrates with their general characters, Basic body plan, Concept of Invertebrata v/s Vertebrata and Non-Chordata v/s Chordata

2.0 Organization of coelom

2.1 Concept and structure of Acoelomate, Pseudocoelomates and Coelomates.
2.2 Protostomia and Deuterostomia
2.3 Metamerism in Annelida, Pseudometamerism.

3.0 Minor Phyla:

3.1 Concept and significance

3.2 Organization and general characters of Acoelomate, Pseudocoelomates and Coelomates minor phyla (with special emphasis on Ctenophora, Rotifera, Endoprocta, Ectoprocta, Phoronida, Sipunculida and Echiuroidea).

UNIT-II

4.0 Locomotion

4.1 Flagella and ciliary movement in Protozoa

4.2 Hydrostatic movement in Coelenterata, Annelida and Echinodermata

5.0 Nutrition and Digestion

5.1 Patterns of feeding and digestion in lower metazoa

5.2 Filter-feeding in Polychaeta, Mollusca and Echinodermata

6.0 Respiration

6.1 Organs of respiration : Gills, lungs, trachea,skin,Cloacal chamber, Buccopharyangeal area etc.

6.2 Respiratory pigments

6.3 Mechanism of respiration

UNIT-III

7.0 Excretion

7.1 Organs of excretion: Coelom, coelomoducts, Nephridia and Malpighian tubules.

7.2 Mechanism of excretion and osmoregulation

8.0 Nervous system

8.1 Primitive nervous system: Coelenterata and Echinodermata

8.2 Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda).

8.3 Trends in neural evolution.

9.0 Social life in insects, Social life in Isoptera and Hymenoptera

UNIT-IV

10.0 Invertebrate larvae

10.1 Larval forms of free living invertebrates

10.2 Strategies and Evolutionary significance of larval forms

10.3 Conservation of invertebrates.

11.0 Introduction to insects

11.1 Mouthparts of Insects

11.2 Mechanism of insect flight and hovering

11.3 Metamorphosis in insects

11.4 Hormonal control of moulting.

12.0 Economic importance of Invertebrates; Various Adaptations in Invertebrates

Suggested Reading Materials:

1. Hyman, L.H. The invertebrates, Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J. London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol.2. McGraw Hill Co., New York.

5. Hyman, L.H. The Invertebrates. Vol.8. McGraw Hill. Co., New York.
6. Barnes, R.D. Invertebrate Zoology, IIIrd edition. W.B. Saundrs Co., Philadelphia.
7. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London.
8. Hyman, L.H. the Invertebrates smaller coelomate groups, Vol. V. McGraw Hill Co., New York
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student text book of Zoology. Vol. I, II and III Central Book Depot, Allahabad
11. Parker, T.J., Haswell, W.A. Text book of Zoology, McMillan Co., London.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – I

Paper: M-Z 105 (Core)
Practical (Based on Papers M-Z 101 & M-Z 102)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objectives: To understand the fundamental chemical principles of biochemistry based
techniques and their application in biological science.

Course Outcomes:

CO1 Students will develop skills in basic laboratory techniques and understand the principles in Biology.

CO2 Able to apply the scientific method to the process of experimentation.

CO3 This course will make students able to understand the regulation of chemical reactions in living cells.

CO4 Students will be able to conduct the morphomatric analysis of chromosomes and demonstrate cell division

Course Contents:

1. Preparation of mitotic chromosomes from onion root tips
2. Preparation of meiotic chromosomes from grasshopper testes.
3. Preparation of karyotypes from micrographs.
4. Calculation of morphometric data and preparations of idiogram.
5. Determination of chiasma frequency and terminalization coefficient.
6. Study of permanent slides of different stages of meiosis and mitosis.
7. Preparation of polytene chromosomes (*Chironomous*/mosquito) and mapping.
8. Preparation of Solutions- Standard solution, Molar, Molal and Normal solution.
9. Proteins: Quantitative estimation of proteins by Biuret method and Lowry's method.
10. Carbohydrates: quantitative estimation of total carbohydrates and glucose
11. **Analysis of Fats/ Oils:** iodine number, saponification value, acid value quantitative estimation of total lipids.
12. Preparation of Standard curve for the estimation andextraction of nucleic acids (DNA and RNA).
13. Paper chromatography: amino acids and carbohydrates.
14. Thin layer chromatography: neutral and phospholipids.
15. Tools: demonstration of parts and working of the following tools: PCR, GLC, Spectrophotometers, various kinds of microscopes, pH meter, Electrophoresis, Centrifuges, Tissue culture unit, Incubators
16. Microbiological media preparation, sterilization, dilution, inoculation and standard plate count.

SEMESTER – I

Paper: M-Z 106 (Core)
Practical (Based on Papers M-Z 103 & M-Z 104)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objectives: Providing the students with the ability to recognize the major groups of invertebratesand to identify the specimens of invertebrate phyla.

Course Outcomes:

CO1 Students will able to understand the processes involved in the recognition of key groups of invertebrates

CO2 Students will be able to prepare permanent mounts of different mouthparts of insects to study the details of their structure.

CO3 Students will able to identify and classify the specimens of available invertebrate phyla.

CO4 Able to elaborate the different systems of invertebrates such as Earthworm, Cockroach, Prawn, Starfish etc.

Course Contents:

1. Slides and Museum specimens of following phyla:
   - (a) PROTOZOA
   - (b) PORIFERA
   - (c) CNIDARIA
   - (d) ANNELIDA
   - (e) ARTHROPODA
   - (f) MOLLUSCA
   - (f) ECHINODERMATA
   - (h) HEMICHORDATA
2. Study of mouth parts of Cockroach, Honey Bee, Red cotton bug and House fly
3. Mounting: Obelia, Tubularia, Bougainvillea, Trachea of Cockroach, Crustacean Larva, *Cyclops, Nauplius, Daphnia*
4. Demonstration of Digestive system, reproductive system and nervous system of Earthworm, Cockroach, Prawn, Loligo and Star fish.
5. Preparation and use of different types of taxonomic keys.
6. Statistical analysis of data using manual and computer software methods
   a. Mean, mode & Median
   b. Standard deviation and S.E.
   c. Coefficient of correlation
   d. Diversity Indices
   e. Test of Significance (Student's t - test)

SEMESTER – II

Paper: M-Z 201 (Core)
Population and Community Ecology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objective:

1. To expose the students in understanding various types of interactions between biotic and abiotic components of environment.
2. To describe how the biogeochemistry, energy flow, or biodiversity of ecosystems responds to climate change or another disturbance.

Course Outcomes:

CO1 Students will be able to understand and explain the need for intra- and interdisciplinary cooperation in researching different ecosystems.

CO2 Students will understand the all biotic and abiotic factors that are related to individual, population, community and ecosystem and defines the relationships between them.

CO3 Information provided will give an insight about the benefits of ecosystem and can be used in the management of natural resources for sustainable development in ways that leave the environment healthy.

CO4 Many specialties within ecology such as marine, vegetation and statistical ecology provides students information to better understand the environment around them.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT - I

1.0 Basic Concepts: Definition, Scope and Significance of Ecology, Concept of biosphere, atmosphere, litho sphere and hydrosphere.

2.0 Organizational level of ecological systems, Ecological aspects of abiotic, biotic and edaphic factors, limiting factors

3.0 **Ecosystem:** Concept, Kinds and components

4.0 **Ecological energetic and energy flow:** Food chains, food webs, trophic structure; concept of productivity: primary, secondary, gross and net, Energy flow models.

UNIT - II

5.0 **Restoration Ecology**

Ecology of Disturbed Ecosystems: disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems.

6.0 **Population characteristics**

- 6.1 Introduction and concepts of population ecology
- 6.2 Attributes of populations
- 6.3 Population density, methods of population density measurement
- 6.4 Growth rate and growth forms
- 6.5 Natality, mortality, survivorship curves and life tables
- 6.6 Biotic potential – Generation time, net reproductive rate reproductive values
- 6.7 Population and distribution.
- 6.8 Population dispersion

UNIT - III

7.0 **Population regulation and Interactions**

- 7.1 Extrinsic and intrinsic mechanisms
- 7.2 Concept of density dependent and density independent factors in population regulation.
- 7.3 Concept of intra specific and inter specific population interactions
- 7.4 Protocooperation, mutualism and commensalisms
- 7.5 Host-parasite interactions, Life history strategies – r and k selection.

8.0**Competition and niche theory**

- 8.1 Intraspecific and inter specific interactions
- 8.2 History of niche concepts
- 8.3 Gause's theory of niche

UNIT - IV

9.0 **Predation**

- 9.1 Theory; predator-prey oscillations
- 9.2 Model of prey – predatory dynamics
- 9.3 Role of predation in nature
- 9.4 Parasitism

10.0 **Community characteristics**

- 10.1 Species diversity; Biodiversity indices: Diversity, dominance, Similarity & dissimilarity Index
- 10.2 Ecological Succession
- 10.3 Ecological dominance
- 10.4 Ecotones and Edge effect

11.0 Ecological Impact Assessment

Suggested Reading Materials:

1. Understanding Evolution by Earl. D. Hanson, Oxford University Press, Oxford, New York.
2. Oxford Surveys in Evolutionary Biology Vol. I – Vol. VI, Oxford University Press, Walton, Street, Oxford.
3. Evolution by Theodose H. Eaton (Jr.) Thomes – Nolson & Sona Limited, London.
4. Evolutionary Theory: (The unfinished synthesis) by Robert G.B. Reid: Croom Helm: London & Sydney.
5. Dobzhansky, Th. Genetics and Origin of species. Columbia University Press.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – II

Paper: M-Z 202 (Core)
Comparative Physiology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. The aim of this paper is to impart advanced knowledge about the principles of physiology, of both cells and organisms and also with respect to the principal Phyla and Classes of animals.
2. This core course will make students understand how animal works at all levels and also a comparison of mechanism of working

Course Outcomes:

CO1 An appropriate understanding of functioning of each system of different groups of animals with their comparison will be acquainted.
CO2 The students will able to explore all reasoning and queries that how animals work
CO3 The students will be able to learn that how the physiology of different groups of organismsis influenced by the different environments of their niches
CO4 Since this course also have some important practical component where interesting exercises will be conducted to perform experiment and answer various queries of animal physiology

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise

UNIT - I

UNIT - I

1.0 **Digestion**
1.1 Feeding mechanisms and regulation,
1.2 Comparative physiology of digestion and absorption in different animal groups
2.0 **Respiration**
2.1 Respiratory organs, Types of respiration, mechanism of breathing
2.2 Transport of respiratory gases
2.3 Respiratory pigments through different phylogenetic groups.
2.4 Physiological response to oxygen deficient stress.
3.0 **Excretion**
3.1 Patterns of nitrogen excretion among different animal groups
3.2 Functional anatomy of renal unit; mechanisms of ultrafiltration, Counter Current mechanism, Dialysis

4.0 **Osmoregulation** in different animal groups

4.1 Definition and basic classification of organisms on the basis of osmoregulation

4.2 Osmotic challenges of different environments

4.3 Mechanism of Osmoregulation in fresh water, Estaurine and Marine animals

4.4 Osmoregulation in migratory organisms, Control and regulation of osmoregulation

UNIT - II

5.0 **Thermoregulation**

5.1 Homeothermic animals, Poikilotherms, Hibernation and Aestivation,

5.2 Physical, chemical, neural regulation,

5.3 Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature

6.0 **Circulation** of body fluids and their regulation among different animal groups

6.1 Systems of circulation, heart beat and blood pressure,

6.2 Cardiac cycle, Cardiac output and its regulation,

6.3 Lymphatic system

7.0 **Receptor physiology** – a comparative study of Mechanoreception, Photoreception, Chemoreception and Equilibrium reception

8.0 **Muscle and Contractile physiology**

8.1 Contractile elements, cells and tissues among different phylogenic groups; Muscle structure and function-correlation;

8.2 Electric organs and tissues

UNIT- III

9.0 **Comparative testicular physiology** in animals

9.1 Morphology, Differentiation, Function and its regulation

10.0 **Comparative ovarian physiology** and differentiation in vertebrates

10.1 Morphology, Endocrinolgy, Oogensis vitellogensis

11.0 **Neuronal physiology**

11.1 Structure and classification of neurons and glial cells.

11.2 Synaptic action, dendritic properties and functional operation of spinal cord, Brain stem

11.3 Autonomic nervous system.

UNIT - IV

12.0 **Principles of synaptic transmission**

12.1.Ca2+ and transmitter release; post synaptic transmission mechanism;

12.2.diversity of neurotransmitters: acetylcholine, catecholamine, serotonin, GABA, glycine, histamine, peptides, NO, and opiods.

13.0 **Physiological adaptations** to different environments

13.1 Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature,

13.2 Physiological adaptation at high altitude and in deep sea environment.

14.0 **Stress Physiology** Concept of Stress and Strain, Stress hormones and stress regulatory mechanisms.

Suggested Reading Material

1. C.L. Prosser. Comparative Animal Physiology. W.B. Saunders & Company.
2. R. Eckert. Animal Physiology: Mechanisms and Adaptation. W.H. Freeman & Company.
3. W.S. Hoar. General and Comparative Animal Physiology
4. Schiemdt-Nielsen. Animal Physiology: Adaptation and Environment. Cambridge.
5. C.L. Prosser. Environment and Metabolic Physiology. Wiley-Liss, New York.
6. David Randall, Warren Burggren, Kathleen French: Eckert Animal Physiology
7. Guyton, A.X., Text Book of Medical Physiology, 7th edition, Saunders Company (1986).

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – II

Paper: M-Z 203 (Core)
Population Genetics and Evolution
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To understand the origin and progression of life on earth with conventional and novel evidences and techniques.
2. In depth knowledge of process of speciation with concept of ecology & evolution

Course Outcomes:

CO1 To provide students the basic insight about the mechanism of evolution and to make them able to relate different forms of life on our planet earth. It will also provide them in-depth knowledge about the changing frequency and distribution of alleles within the population.
CO2 Acquire a clear understanding about genetic equilibrium in natural populations
CO3 To know about genetics of quantitative traits in populations
CO4 Detail understanding of molecular phylogenetics and methods of construction of phylogenetic tree

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise

UNIT-I

1.0 Concepts of evolution and theories of organic evolution with an emphasis on Darwinism.
2.0 Emergence of Neo-Darwinism-Neutral Hypothesis
3.0 **Neo Darwinism**
- 3.1 Hardy-Weinberg law of genetic equilibrium
- 3.2 A detailed account of destabilizing forces:
  - (i) Natural selection
  - (ii) Mutation
  - (iii) Genetic drift
  - (iv) Migration
  - (v) Meiotic drive

UNIT-II

4.0 **Quantifying genetic variability**
- 4.1 Genetic structure of natural populations
- 4.2 Phenotypic variations
- 4.3 Models explaining changes in genetic structure of populations
- 4.4 Factors affecting human disease frequency

5.0 **Molecular population genetics**
- 5.1 Patterns of change in nucleotide and amino acid sequences
- 5.2 Ecological significance of molecular variations

6.0 **Genetics of quantitative traits in populations**
- 6.1 Analysis of quantitative traits
- 6.2 Estimation of heritability
- 6.3 Genotype-environment interactions
- 6.4 Inbreeding depression and heterosis
- 6.5 Molecular analysis of quantitative traits
- 6.6 Phenotypic plasticity

UNIT-III

7.0 **Genetics of speciation**
- 7.1 Concept of species
- 7.2 Patterns and mechanisms of reproductive isolation
- 7.3 Modes of speciation (Allopatric, Sympatric, Parapatric, Peripatric)

8.0 **Molecular Evolution**
- 8.1 Gene Evolution
- 8.2 Evolution of gene families, Molecular drive
- 8.3 Assessment of molecular variations

9.0 **Origin of higher categories**
- 9.1 Phylogenetic gradualism and punctuated equilibrium
- 9.2 Major trends in 'the origin of higher categories
- 9.3 Micro-and Macro-evolution

UNIT-IV

10.0 **Molecular phylogenetics**
- 10.1 Concept of phylogenetic trees.
- 10.2 Methods of construction of Phylogenetic trees.

11.0 **Population genetics and ecology**
- 11.1 Metapopulations
- 11.2 Monitoring Natural Populations
- 11.3 Populations size and extinction
- 11.4 Loss of genetic variations
- 11.5 Conservation of genetic resources in diverse texa

Suggested Reading Material

1. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
2. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
3. Hartl, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
4. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
5. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.
6. Merrel, D.J. Evolution and Genetics. Holt, Rinehart and Winston, Inc.
7. Smith, J.M. Evolutinary Gentics. Oxford University Press, New York.
8. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston London.
9. Sherwood

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – II

Paper: M-Z 204 (Core)
Biology of Vertebrates
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. This paper deals with the comparative and evolutionary trends in structure and function of the organ systems of the vertebrate series.
2. To understand what are the general characters and different categories of chordates animal.
3. To understands the level of organization in chordate subphylum.
4. To understand the origin and evolutionary relationship in different subphylum of chordates.

Course Outcomes:

CO1 Students will be able to understand various biological functions, the evolution of life from most primitive to most advanced form with respect to their habit and habitat.

CO2 Students will have acquaintance with the basic concepts, external morphology and sexual dimorphism in chordates and understand the various systems, adaptation and dentition in chordates.

CO3 Students will also Understand the Classification various classes of phylum Chordate i.e., Pisces, Reptiles, Aves and Mammals.

CO4 This core course will make students familarise with the vertebrate diversity around them

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise

UNIT - I

1.0 **Introduction to Chordates with their general characters.**
- 1.1 Origin of Chordates
- 1.2 Concept of Protochordata or pre-vertebrates
- 1.3 Classification of Vertebrates upto orders

2.0 **Integument and its derivatives**
- 2.1 Development, general structure and functions of skin and its derivatives
- 2.2 Glands, scales, horns, claws, nails, hoofs, feathers and hair

UNIT - II

3.0 **Skeletal system**

3.1 Form, function, body size and skeletal elements of the body
3.2 Comparative account of jaw suspensorium, Vertebral column
3.3 Limbs and girdles

4.0 **Digestive system**

4.1 Dentition, Stomach, Digestive Glands
4.2 Anatomy of gut in relation of to feeding habits- herbivores, carnivores and omnivores.

5.0 **Respiratory system**

5.1 Characters of respiratory tissue, Internal and External Respiration
5.2 Comparative account of respiratory organs

UNIT –III

6.0 **General plan of circulation in various groups**

6.1 Components of Blood
6.2 General plan of circulation in reptiles, birds and mammals
6.3 Evolution of heart, aortic arches and Portal systems

7.0 **Evolution of Urinogenital system in vertebrate series**

7.1 Structure and functions of different types of kidney
7.2 Urino-genital ducts

Flight adaptation in birds, Migration in fish and Birds

UNIT– IV

8.0 **Nervous system**

8.1 Comparative anatomy of the brain in relation to its functions
8.2 Comparative anatomy of spinal cord
8.3 Nerves-Cranial, Peripheral and Autonomous nervous systems

9.0 **Sense organs**

9.1 Simple receptors
9.2 Organs of Olfaction and taste
9.3 Lateral line system
9.4 Electroreception

Suggested Reading Material

1. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinbourgh.
2. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
3. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
4. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates. Central Book Depot, Allahabad.
5. Kent, C.G. Comparative anatomy of vertebrates.
6. Milton Hilderbrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
7. Sedgwick, A. A Students Text Book of Zoology, Vol. II.
8. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York and London.
10. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – II
Paper: M-Z 205
Seminar
Credits: 01

Total Marks: 25

Course Objective:

1. **To develop speaking skills in the students**
2. **To have ability to prepare and present on any topic assigned to them**

Course Outcomes:

CO1. Students will be able to speak on the topic assigned to them after going through related Literature
CO2. Students will be able to prepare power point presentations
CO3. Students will have knowledge of different topics of Zoology especially current topics
CO4. Students will be able to comprehend vast topic in limited sphere

SEMESTER – II

Paper: M-Z 206 (Open Elective)
Economic Zoology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. It is an open elective paper. It provide zoological knowledge for the benefit of mankind
2. It includes culturing of animals for human use and their economic values and control animals that are injurious to man directly or indirectly.

Course Outcomes:

CO1 Students will be aware of applications of applied biology to meet the challenge of food storage during recent times.
CO2 It increases socio-economic status and self employment with rural development.
CO3 Will provide awareness about the strategies used for the culture of economically important animals and their applications for human as well as animal welfare.
CO4 Further studies will help in improving product and by-products of cultured animals both quantitative and qualitatively.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise two questions from each unit (I- IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT -I

1.0 Integrated pest management: cultural-control, chemical control, biological control, herbal control, legal control.

2.0 Rodent and birds as Pest and their management

UNIT-II

3.0 Sericulture : Types of silk, species of silk moth (scientific names), Silkworms and their host plants, mulberry silk worm culture, natural enemies and diseases of silkworm and their control

4.0 Apiculture : Species of honey bees in India, life history of *Apis ceranaindica*, agriculture techniques, bee products and their uses, natural enemies and diseases of honey bee and their control.

5.0 Lac culture: lac insect (Scientific name), composition of lac, strains of lac insect, cultivation of lac host plants (in brief) processing of lac and uses of lac.

UNIT- III

6.0 Vermiculture: species of vermiculture, culture methods, significance of vermicomposting Economic status of Vermiculture.

7.0 Economic status and products of Poultry keeping and Dairy industry in Haryana.
8.0 Pearl culture

UNIT– IV

8.0 Aquaculture (Fresh water fishes and Prawn culture).
9.0 leather industry: processing and enemies of skin.
10.0 Economic importance of mammals
11.0 Pond management for pisciculture

Suggested Reading Material:

1. Insect Pest Management by Dent, D.
2. Agricultural Entomology by Hill, D.S., Timber Press.
3. Entomology and Pest Management by Pedigo L. P. Prentice Hall, India
4. Agricultural Pests: Biology and Control Measures by B. M. Deoray and T. B.Nikam, Nirali Publication, Pune.
5. Concepts of Insect Control by Ghosh M. R. Wiley Eastern Ltd. New Delhi.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – II

Paper: M-Z 207 (Core)
Practical (Based on Papers M-Z 201 & M-Z 202)
Credits: 4
Objective:

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

1. To acquire practical knowledge of histological studies and water analysis which will help further in research studies.

Course Outcomes:

CO1 Provide significant knowledge of biological research with safe lab practices.
CO2 Students will understand application of histological studies in clinical and medical sciences and will be able to prepare these slides
CO3 Students will be able to identify biodiversity around them and spread awareness about biodiversity conservation
CO4 This course will help the students to understand research based knowledge methods for the welfare of human.

Course Contents:

1. Study of various components of pond and grassland ecosystem.
2. Determination of Water quality characteristics viz: Dissolved oxygen, pH, free carbon dioxide, salinity, transparency, alkalinity and hardness.
3. Methods of population density measurements.
4. Estimation of biodiversity indices.
5. Field Visit to Aquatic, Forest and other ecosystems for identification of biota.
6. Preparation of tissues for microtomy and demonstration of cryo techniques
7. Histochemistry: Methods of fixation of different tissues.
8. **Histochemical test:**
   (a) Haemotoxylin-eosin
   (b) Toluidine Blue
   (c) Sudan Block-B
   (d) Mercury bromophenol blue
   (e) Methyl green-pyronin-Y
   (f) Periodic acid Schiff's
   (g) Acid phosphatase
   (h) Alkaline phosphatase
9. Demonstration of live gametes and their staining procedure.
10. Determination of optimum pH, temperature and concentration for optimum activityof salivary amylase,
11. To demonstrate that the optimum activity of trypsin enzyme is pH temperaturedependent.
12. Qualitative test of vitamins and Quantification of vitamin A and C.
13. Total RBC, WBC and Different WBC count
14. Estimation of Blood plasma

SEMESTER – II
Paper: M-Z 208 (Core)
Practical (Based on Papers M-Z 203 & M-Z 204)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objective: Providing the students with the ability to recognize the major groups of vertebrates and toidentify the specimens of different classes.

Course outcomes:

CO1: Students will able to understand the processes involved in the recognition of key groups of vertebrates

CO2: Students will be able to identify and classify the available specimens of vertebrate classes.

CO3: Students will have ability to prepare permanent mounts of different types of scales and hair to studythe details of their structure and their role in the identification of specimens.

CO4: Will be able to elaborate the different systems of vertebrates such as fish, frog rat and pigeon.

Course Contents:

1. Demonstration of cranial nerves and aortic arches of *Scoliodon*, Degestive system, Nervous system, Arterial and venous system of frog, Lizard, Pigeon and rabbit.
2. Museum specimens and slides :
   - (i) Protochordates
   - (ii) Fishes
   - (iii) Amphibians
   - (iv) Reptiles
   - (v) Birds
   - (vi) Mammals
3. Comparative Osteology
   - (i) Skull and lower jaw
   - (ii) Vertebrae
   - (iii) Girdles
   - (iv) Limb bones
4. Temporary/Permanent mounts of Hair & Scales
5. Different types of Feathers, Scales & Hair
6. Construction of Phylogenetic tree

SEMESTER – III

Paper: M-Z 301 (Core)
Molecular Biology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To make students understand the complex molecular mechanisms occurring in cell and the applications of molecular technologies.
2. In depth knowledge of central dogma processes inside the cell

Course Outcomes:

CO1 Learn the necessary information about the chemistry of life to allow the students to understand the basis of molecules of life.
CO2 Acquire a clear understanding about protein sorting and their mechanisms
CO3 To know about Recombination and repair mechanism in DNA
CO4 Detail understanding of molecular techniques of genomes analysis

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1.0 DNA Replication

1.1 Prokaryotic and Eukaryotic DNA replication
1.2 Mechanics of DNA replication
1.3 Enzymes and accessory proteins involved in DNA replication

2.0 Transcription

2.1 Prokaryotic and Eukaryotic transcription
2.2 General and specific transcription factors
2.3 Regulatory elements and mechanisms of transcription regulation
2.4 Transcriptional and post-transcriptional gene silencing.
2.5 Post-transcriptional Modifications in RNA
2.6 5'-Cap formation, 3'-end processing and polyadenylation
2.7 Splicing, Editing, Nuclear export of mRNA, mRNA stability

UNIT-II

3.0 Translation

- 3.1 Genetic code and deciphering of genetic code
- 3.2 Prokaryotic and Eukaryotic translation
- 3.3 The translational machinery
- 3.4 Adaptor hypothesis, Kozak rule
- 3.5 Mechanisms of initiation, elongation and termination
- 3.6 Regulation of translation

4.0 Transport of Protein

- 4.1 Co- and Post-translational transport of proteins
- 4.2 Co- and Post-translational modifications of proteins
- 4.3 Protein trafficking/sorting

UNIT-III

5.0 Recombination and Repair

- 5.1 Holiday junction, gene targeting, gene disruption
- 5.2 Cre/lox recombination
- 5.3 RecA and other recombinases
- 5.4 DNA repair mechanisms

6.0 Antisense and Ribozyme technology

- 6.1 Molecular mechanisms of antisense molecules
- 6.2 Inhibition of splicing, polyadenylation and translation
- 6.3 Disruption of RNA structure and capping
- 6.4 Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes
- 6.5 Strategies for designing ribozymes
- 6.6 Application of antisense and ribozyme technologies

UNIT-IV

7.0 Molecular mapping of genome

- 7.1 Genetic and physical maps
- 7.2 Physical mapping and map-based cloning
- 7.3 Southern and fluorescence *in situ* hybridization for genome analysis
- 7.4 Chromosome micro-dissection and micro-cloning
- 7.5 Molecular markers in genome analysis RFLP, RAPD and AFLP analysis and their applications
- 7.6 Molecular markers linked to disease resistance genes

8.0 **rDNA Technology:**

- 8.1 Gene-cloning
- 8.2 Vectors
- 8.3 cDNA and genomic liberaries
- 8.4 Blotting techniques
- 8.5 Chromosome walking
- 8.6 Application of rDNA technology

Suggested Reading Materials

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA
3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J,D. Watson. Garland Publishing Inc., New York.
4. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
5. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A Meyers (Ed.), VCH Publishers, Inc., New York.
6. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
7. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
8. Molecular Biology LabFax, T.A Brown (Ed.), Bios Scientific Publishers Ltd., Oxford.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 302 (Core)
Molecular Endocrinology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives: To explore the molecular approaches to study the mechanism of action of hormonesand related molecules involved in various physiological processes.

Course Outcomes:

CO1 It helps in explaining hormonal synergism and antagonism at the molecular level

CO2 Students will be able to identify the organs involved in the endocrine function and an understanding of appropriate key human endocrine disorder will also be developed

CO3 Develop an in-depth comprehensive knowledge of endocrinology from a physiological, cellular, and molecular perspective.

CO4 This course will make students understand the basic structure and chemical organization of hormones and various signaling molecules.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1. Basic concept of endocrinology, its scope and role in molecular biology.
2. **Chemical nature of hormones;**
   - 2.1 Amino-acid derived hormones
   - 2.2 Peptide hormones
   - 2.3 Glyco-protein hormones,
   - 2.4 Steroid hormones and
   - 2.5 Prostaglandin
3. Biosynthesis of peptide hormones, transcriptional and post-transcriptional modifications
4. Biosynthesis and secretion of thyroid hormones. Thyroid hormone disorders.

UNIT-II

5. Prostaglandin structure, type, synthesis and biological activities.
6. Mechanism of action of peptide hormones; concept of second messengers, cAMP, cGMP, Ca^{++}, IP_3, DAG, NO, signal transduction mechanisms.
7. Mechanism of action of steroid hormones; Cross talk concept, Heat shock proteins.

UNIT-III

8. **Hormonal regulation of Metabolism:**
   - 8.1 Role of Insulin & Glucagon in regulation of Carbohydrate metabolism
   - 8.2 Metabolic regulatory hormones in Lipid & Protein metabolism

9. Gastrointestinal hormones and their role in regulation of metabolic activity.

10. Endocrine regulation of calcium and phosphate homeostasis in mammals.

UNIT-IV

11. Genetic basis of hormonal disorders.
    - 11.1 General principle and classification of hormonal disorders
    - 11.2 Genetic basis of growth hormone disorder
    - 11.3 Genetic basis of PCOS

12. Sequence-specific DNA binding receptor proteins
    - 12.1 Nuclear receptor proteins
    - 12.2 Cytosolic receptor proteins
    - 12.3 Cell surface receptor proteins
    - 12.4 Their role in gene transcription, cell differentiation and cell proliferation.

Regulatory substances –Eicosanoids, Growth factors, Thymus gland & Kinins.

Suggested Reading Materials

1. Benjamin Lewin, Genes VII, Oxford University Press.
2. Lodish et al. Molecular Cell Biology.
3. Ethan Bier. The Coiled Spring, Cold Spring Harbor Press.
4. L.P. Freedman. Molecular Biology of Steroid and Nuclear Hormone Receptors, Birkhauser.
5. G. Litwack. Biochemical Actions of Hormones, Academic Press.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 303 (Core)
Applied Zoology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives: To create acquaintance about economic and therapeutic importance of animals for humans *vis-à-vis* animal welfare.

Course Outcomes:

CO1 Awareness about use of certain animals and their products for human welfare *vis-à-vis* animal welfare will be created.

CO2 Information regarding the animals that are responsible for economic losses will also be acquainted.

CO3 Students will ableto explain the basic concepts of sericulture, apiculture, lac culture and other animal industries along with economics of pest management techniques.

CO4 Students will able to justify the animals in pharmaceutical research.

CO5 Students will gain knowledge about various disease vectors and their impact on human.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT- I

1.0 Vertebrate and non vertebrate pests (Wheat, Rice, Sugarcane and cotton) their harmful status and economic importance.

1.1. Integrated pest management. Cultural control, Physical control, Mechanical control, Chemical control, Biological control, Herbal control and legal control andPheromones involved in pest management.

2.0 Insects of medical and veterinary importance.

UNIT- II

3.0 Zoonosis:

3.1 Viral-Rabies,
3.2 Japaneses encephalitis;
3.3 Bacterial- Brucellosis, Plague;
3.4 Ricketsial- Ricketsial zoonosis, Q fever, Scrub typhus.
3.5 Protozoan *Entamoeba histolytica, Plasmodium vivax and Trypanosoma gambiense*), Helminth and Nematode diseases in humans (Schistosomiasis, Cestodiasis, Termatodasis, Filariasis and Ascariasis).

UNIT - III

Sericulture, Apiculture and Lac culture

4.0 Sericulture : Types of silk, species of silk moth (scientific names), Silkworms and their host plants, mulberry silk worm culture, agricultural aspects of mulberry plant cultivation, extraction and reeling of silk, natural enemies and diseases of silkworm and their control.

5.0 Apiculture : Species of honey bees in India, life history of *Apis cerana indica,* agriculture techniques, bee products and their uses, natural enemies and diseases of honey bee and their control.

6.0 Lac culture: lac insect (Scientific name), composition of lac, strains of lac insect, cultivation of lac host plants (in brief) processing of lac and uses of lac.

7.0 Wool and fur industry, leather industry.

UNIT- IV

8.0 Vermiculture, Poultry keeping and Dairy industry.

9.0 Prawn culture, Pearl culture.

10.0 Edible fresh water fishes and their diseases, Snakes (Haryana) and its Economic importance of snake venom

11.0 Pharmaceuticals from animals and role of animals in stem cell therapy. How to harvesthe technology from animals for human welfare

Animal welfare and ethics, CPCSEA guidelines and maintenance of experimental animals

Suggested Reading Materials

1. Insect Pest Management by Dent, D.
2. Agricultural Entomology by Hill, D.S., Timber Press.
3. General and Applied Entomology by David, B. V. & Ananthakrishnan, T. N., Tata McGraw-Hill Publishing.
4. Entomology and Pest Management by Pedigo L. P. Prentice Hall, India.
5. General and Applied Entomology by Nayar K. K. and T. N. Ananthkrishnan and B. V. Davis, Tata McGrew Hill Publications. New Delhi.
6. Agricultural Pests: Biology and Control Measures by B. M. Deoray and T. B. Nikam, Nirali Publication, Pune.
7. Concepts of Insect Control by Ghosh M. R. Wiley Eastern Ltd. New Delhi.
8. Economic Zoology. Shukla Upadhyay, Rastogi Publication, Meerut, India, 1998.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 304 (Elective)
Molecular Reproduction-I
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To introduce students to the essential and unifying concepts of physiology, reproduction, and development in animals which are central to modern Biology.
2. To address the basic biological mechanisms that underlie male and female reproduction that pertain to reproductive health issues, such as contraception, infertility, sexually transmitted diseases, and reproductive aging.

Course Outcomes: Students will be able to understand:

CO1 The cellular, molecular and biochemical changes in reproductive physiology
CO2 The basic and molecular concepts of spermatogenesis folliculogenesis, ovulation, follicular atresia and germ line- soma interaction.
CO3 The importance of diet, exercise, stress and yoga during ageing
CO4 Various problems of male sterility and female infertility.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1. **Male Reproductive system:** Cytology of testis and spermatozoon, physiology of spermatogenesis, molecular bases of testicular steroidogenesis, endocrine regulation of steroidogenesis, role of male accessory sex structures.
2. **Female Reproductive System:** Structural and histochemical aspects of ovary and primordial follicles.
3. **Folliculogenesis:** Dynamics of follicular growth and maturation, intracellular dynamics of cholesterol synthesis-two cell theory, endocrine regulation of folliculogenesis.

UNIT–II

4. **Oocyte Maturation-** Nuclear, epigenetic and cytoplasmic; oocyte granulosa interactions
5. **Ovulation-** Mechanism, Induced and spontaneous ovulators.
6. **Corpus Luteum-** Structure and functions, molecular mechanism and endocrine regulation of luteinization, luteal steroidogenesis, corpus luteum of pregnancy.

UNIT-III

7. **Follicular atresia:** Causes, regulation and significance, factors affecting atresia, role of granulosa cells apoptosis in atresia.
8. **Male sterility-** Azoospermia, Oligozoospermia, Asthenozoospermia, Varicocele, Genetic basis for male infertility.
9. **Female infertility-** genetic and endocrinal factors, PCOD, atresia.

UNIT-IV

10. **Female reproductive aging:** epidemiology, theories, markers, significance, implications, fertility preservation.
11. **Age-Related Reproductive disorders-** perimenopause, premenopause, post menopausal disorders, osteoporosis.
12. Effect of diet, nutrition, stress, disease, exercise and yoga on reproductive ageing.

Suggested Reading Materials:

1. Guraya S.S. (1998). Cellular and Molecular Biology of General development and Maturation in mammals Narosa Publishing House, New Delhi.
2. Hafez E.S.E.(1994). "Reproduction in farm animals". Lea Febighiese.
3. Gurays S.S. (2000). Comparative Cellular and Molecular Biology of Ovary in mammals. I.B.H., New Delhi.
4. The Physiology of Reproduction, second edition, Vol 1 and 2, edited by Ernst Knobil and Jimmy D. Neil. *Raven Press*, 2014.
5. Male Reproductive Function, edited by Christina Wang. Kluwer *Academic Publishers*, 1999.
6. The ovary, edited by Solly Zuckerman Baron Zuckerman, Barbara J. Weir, T. G. Baker. *Academic Press*.
7. The ovary, edited by Peter C.K. Leung and Eli Y. Adashi, Elsevier (Academic Press), 2004.
8. Cell and Molecular Biology of Testis, edited by Claude Desjardins and Larry L. Ewing. *Oxford University Press US*.
9. Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, edited by Samuel S. C. Yen, Robert B. Jaffe, Robert L. Barbieri. *Saunders publisher*.
10. Regulation of Implantation and Establishment of Pregnancy in Mammals, Editors: Rodney D Geisert, Fuller W. Bazer, ISBN 978-3-319-15856-3, Springer International Publishing, 2015.
11. Implantation and early development, Editors: Hilary Critchley, Ian Cameron and Stephan Smith, ISBN 9781107784680, Cambridge University press, 2014.
12. Implantation, Biological and Clinical Aspects, Editors: Michael G. Chapman, J. Gedis Grudzinskas, Tim Chard, ISBN 978-1-4471-3531-9, Springer-Verlag, 1988.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 305 (Elective)
Animal Behaviour and Wildlife Conservation – I
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To know the important concept of animal behavior
2. In depth knowledge of Theory and practice of wildlife conservation

Course Outcomes:

CO1 It will boost students for betterment of diversified resources and life forms for better conservational measures with keen understanding.
CO2 Acquire a clear understanding about behavior patterns in animals
CO3 Students will be aware and understand the concept of protected area system
CO4 Detail understanding of conservational approaches and organizations

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1. Concept of Animal behaviour; Mile-Stones in the history of animal behaviour and scope.
2. Stereotyped and acquired behaviour patterns: Tropisms, Taxes, Reflexes, Instincts, learning & reasoning; Change in major modes of adaptive behaviour in phylogeny.
3. Perception of the environment : Mechanical, Electrical, chemical, olfactory, auditory, visual
4. Biological rhythms and concept of biological clock.

UNIT-II

5. Motivation: Introduction, goal oriented behaviour, biological drives – Primary and Secondary drives.
6. Concept of learning: law of learning, types of learning – Habitation, trial & error learning, latent learning, Insight, Imprinting, Classical conditioning & Instrumental learning.
7. Concept of Migratory behaviour

UNIT-III

8. Wildlife: Definition, significance and Biogeographic/wildlife zones of India, Bio-diversity of the Indian Subcontinent and World.
9. Protected Area Systems: Concept, Historical background, categories and management objectives of protected areas, world growth of protected areas, and Present status of National PA-Systems.

10. Theory and Practice of Biosphere Reserves of the world: Biosphere Reserves of India, Wildlife conservation techniques.

UNIT-IV

11. Natural Heritage Sites of the world, Natural Heritage sites in India. Important National Park and Wildlife Sanctuaries of India

12. Wildlife and livelihood; Wildlife and illegal trade & control;

13. Role of WWF, IUCN, UNEP,

14. Red Data Book; Categories of Endangered Wildlife Species.

Suggested Reading Materials:

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand
3. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
6. E.P. Gee, The Wildlife of India.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 306 (Elective)
Fish, Fisheries and Aquaculture – I
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To acquaint the students about the huge diversity of fishes
2. To acquaint about biology of fish and methods of aquaculture, which are important contributors to food security.

Course Outcomes:

CO1 Through this core elective paper student/s will learn identification of fish species using classical morphological methods

CO2 This core elective paper will generate knowledge about various methods and significance of aquaculture

CO3 It will create awareness about food security, significance of protein in diet and importance of fish in fighting protein deficiency

CO4 It will also be helpful in acquainting with methods of conserving fish diversity.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting two questions from each Unit I to IV. The candidate will be required to attempt question No. 1 and four more selecting one questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT - I

1.0 Definition of Fish, Fisheries and aquaculture; Types of Aquaculture

2.0 Classification of fishes with distinguishing characters and examples of each group.

3.0 Estuarine, Marine, Riverine and wetland fisheries: characteristic species and their exploitation.

4.0 Culture fisheries

4.1 Cultivable organisms for aquaculture.
4.2 Criteria of selection of cultivable fishes

UNIT - II

5.0 Design, construction and maintenance of fish culture ponds.

6.0 Ecology of fish pond ecosystem

6.1 Physico chemical conditions of ponds water and soil
6.2 Biological conditions of waters
6.3 Weeds and their control
6.4 Productivity of fish pond
6.5 Classification of water bodies on the basis of productivity.

7.0 **Aquatic pollution**: Sources of water Pollution, Impact of pollution on aquatic organisms, Impact of exotic fish species onaquatic biodiversity, Fishes and their relationships with abiotic and biotic factors.

8.0 Aquaculture Ranching and Rational fishery.

UNIT -III

9.0 Fish integument: Exoskeleton and colouration

10.0 Fins: origin, types and functions

11.0 Food and feeding habits of fishes, Digestion in fishes

12.0 Respiratory system Gill structure and functions, Accessory respiratory organs swim bladder and webberian ossicles

13.0 Osmoregulation in fishes

UNIT - IV

14.0 Receptors in fishes
- 14.1Chemoreceptors
- 14.2 Lateral line organs
- 14.3 Eye Ear
- 14.4 Pineal organ

15.0 Hormones and reproduction: Induced breeding in carps and catfishes.

16.0 Identification of different maturity stages of fishes.

17.0 Migration in fishes

18.0 Age and growth studies

Suggested Literature:

1. Encyclopedia of Fish Physiology. 2011. Anthony P. Farrell, E.D. Stevens, J.J. Cech& J.G. Richards (Eds). Academic Press, UK.
2. APHA (1995) Standard Methods of Examination of Water and Wastewater. American PublicHealth Association, AWWA, WCPF, Washington DC.
3. Bardach, JE, Ryther & McLarney, Wo (1972) Aquaculture, New York: Wiley-Interscience.896pp.

5. Boulenger, GA & Bridge, TW (1910) Fishes (Vol. VII of the Cambridge Natural History)Cambridge Univ. Press, London.
6. Das, P, Verma, SR, Dhaje, RJ & Malik DS (2002) Coldwater Fish Genetic Resources and theirConservation. National Conservators publication, 7, 325pp.
7. Datta Munshi, JS & Srivastava, MP (1998) Natural History of Fishes and Systematics ofFreshwater Fishes of Infia. Narendra Publishing house, Delhi, 403pp.
8. Jayram, KC (2013) The Freshwater Fishes of the Indian Region (Corrected 2nd Edition) NarendraPublishing house, Delhi, 616pp, XXXIX plates.
9. Lagler, KF, Bardach, JE, Miller, RR & Passino, DRM (1977) Ichthyology, 21nd Edition, NewYork, Wiley, 506 pp.
10. Nikolsky, GV (1963) The Ecology of Fishes, Academic Press, London.
11. Pillay, TVR (1990) Aquaculture, principles and practices. Fishing New Books. 575pp2. Fish Physiology. (Series) W.S.Hoar and D.J. Randall (Series Eds). Academic Press, UK.
12. The Physiology of Fishes. 2013. Evans, D. H. and Claiborne, J. D., Taylor and FrancisGroup, CRC Press, UK.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 307 (Core)
Seminar
Credits: 1
Total Marks: 25

Course Objective:

1. **To develop speaking skills in the students**
2. **To have ability to prepare and present on any topic assigned to them**

Course Outcomes:

CO1. Students will be able to speak on the topic assigned to them after going through related Literature
CO2. Students will be able to prepare power point presentations
CO3. Students will have knowledge of different topics of Zoology especially current topics
CO4. Students will be able to comprehend vast topic in limited sphere

SEMESTER – III

Paper: M-Z 308 (Open Elective)
Animal Diversity & Conservation
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. Aim of conservation of biodiversity is to protect, preserve and manage natural resources
2. To expose students to the basic understanding of animal diversity, its significance in our life and environment.

Course Outcomes:

CO1 Biological diversity provides immediate benefits to society such as recreation and tourism
CO2 It will generate initiative among students for conservation of our rich natural resources and diversified life forms.
CO3 It gives jobs opportunities for people by establish training research programmes that have been launched for conservation and sustainable use of bio diversity.
CO4 Expand the knowledge of researchers to explore diversity of animal, its protection from extinction and their habitat from destruction

Note:

1. Nine questions will be set in all. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise two questions from each unit (I- IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
2. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1.0 Wildlife: Definition, significance; Wildlife of India, Endemic and Exotic species

2.0 Techniques of animal counts (Examples of Tiger count)

3.0 Various census techniques

UNIT- II

4.0 Wildlife zones of the India

5.0 Wildlife Tourism

6.0 Illegal trade of wildlife

UNIT- III

7.0 Biodiversity: Concept, threats to biodiversity, poaching and anti-poaching operations

8.0 Conservation (objectives and strategies), biodiversity indices

9.0 Natural Heritage sites

UNIT - IV

7.0 Concept and objectives of Protected areas:

8.0 Important Protected Areas of India (Biosphere reserve, National Park & Wildlife sanctuaries)

9.0 Red Data Book, IUCN Categories of wildlife species

Suggested Reading Materials:

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand
3. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
4. Wildlife in India by V.B. Saharia. Natraj Publishers, Dehradun.
5. E.P. Gee, The Wildlife of India.

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – III

Paper: M-Z 309 (Core)
Practical (Based on Papers M-Z 301 to M-Z 303)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objective:

1. To develop understanding of biological and analytical techniques to explain biological activities.

Course Outcomes:

CO1 Students will be able to explain the basic principle, procedures and applications of various biological techniques that are used to study the basic biological processes.
CO2 Will understand the basic concepts of applied Zoology in human welfare.
CO3 Will be able to perform electrophoresis for scope in research field.
CO4 Study of endocrinology will help the student to identify the organs involved in the endocrine function and which help in understanding human endocrine disorder.

Course Contents:

1. Non-protein nitrogenous substances: qualitative estimation of serum Bilirubin serum and urine creatintine.
2. Estimation of Acid and alkaline phosphates.
3. Barr body examination from Buccal smear.
4. Sex chromatin from blood sample.
5. *In-vitro* study of effect of hormones.
6. Study of **histological slides** and endocrine glands of vertebrates.
7. **Blood smear preparation**, Blood groups, hematin crystals, haemoglobin count, DLC, TLC etc.
8. Demonstration of SDS-PAGE
9. Demonstration of Agarose gel electrophoresis and prepration of gel
10. **Collection of different larva of**mosquitoes:-*Culex*; *Anopheles*; *Aedes*, marking out the basic **morphological** differences at larval level.
11. **Preparation of permanent mounts of adult mosquitoes:** *Culex* and *Aedes* and *Anopheles* - highlight differences, if any, between basic these important vectors.
12. Study of life cycle of honey bee, Lac insect, Silk worm, Cabbage butterfly.
13. Study on common household and agriculture pest.

SEMESTER – III

Paper: M-Z 310 (i) (Elective)
Practical (Based on Papers M-Z 304)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objectives

1. To provide students the opportunity to gain a first-hand laboratory experience of the structure, function, and development of the reproductive organs.
2. To gain experience in experimental design, cutting-edge research techniques, data analysis, and scientific report writing and will be introduced to the practicalities of reproductive manipulation and assisted reproductive technologies.

Course Outcomes: Students will be able-

CO1 To develop the scientific attitude that makes the students open minded, critical observations, curiosity thinking etc.
CO2 To acquire the specialized knowledge relevant to reproductive biology and biochemistry.
CO3 To understand the basic and molecular laboratory techniques in both physiology and biochemistry.
CO4 To acquire the knowledge about various male and female infertility problems

Course Contents:

1. Demonstration of male and female reproductive systems of earthworm, grass hopper, and rat.
2. Processing of reproductive tissues for microanatomy and histochemistry.
3. Study of permanent slides on mammalian reproductive tissues.
4. Study of folliculogenesis and atresia in rat ovary.
5. Study of apoptosis in gonads.
6. Extraction and estimation of macromolecules such as proteins, carbohydrates, lipids, and nucleic acids.
7. Isolation of testicular cells and ovarian follicular cells.
8. Oocyte collection; aspiration and slicing method.
9. Sperm morphology, capacitation, sperm count, and sperm motility.
10. Vaginal smear preparation to examine estrous cycle and pregnancy.
11. Oocyte maturation *in vitro*.
12. *In vitro* fertilization

SEMESTER – III

Paper: M-Z 310 (ii) (Elective)
Practical (Based on Papers M-Z 305)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objectives:

1. Practical knowledge of important concept and types of animal behavior
2. In depth knowledge of Theory and practice of ornithology

Course Outcomes:

CO1 It will boost students for keen understanding various behavioral activity of animal world
CO2 Students will acquire a clear practical understanding about behavior patterns in animals
CO3 Students will know about the practical approaches of protected area system in India
CO4 Detail understanding of residential and migratory nature of avian fauna

Course Contents (Animal Behaviour and Wildlife Conservation – I)

1. Designing of experiments, observations, techniques of data analysis, presentation of results and writing of laboratory report.
2. To demonstrate locomotive, explorative withdrawal and habituation behaviours in animals.
3. To demonstrate response of animals to light.
4. To demonstrate antennal grooming behaviour in cockroach.
5. Demonstration of food preferences in insects/pests
6. Investigation of habituation of diving response of mosquito larvae.
7. To study the effect of temperature on heartbeat of cockroach/ Gill movements in Fishes.
8. Field study of nesting behaviour of common available avian fauna of the region.
9. Study of Migratory Birds
10. To study mobbing response of birds.
11. Study of animal behavior patterns using repertoire sheets.
12. To prepare charts of wildlife zones of India and the world.
13. Field visits to local areas/Project Report

SEMESTER – III

Paper: Z 310 (iii) (Elective)
Practical (Based on Papers M-Z 306)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objectives:

1. To develop capability of identifying different species of fishes, their taxonomic status, their anatomy and ostelogy
2. To train students for analysis of physic chemical and biological conditions of water

Course Outcomes:

CO1 Student/s will be able to identify of fish species using classical morphological methods
CO2 Students will be able to analyse physico- chemical status of water of lotic and lentic Components
CO3 Students will be able to conduct qualitative and quantitative analysis of phyto and Zooplanktons
CO4 This practical course will also be helpful to develop personnel to develop career in organizations where water quality analysis and fish diversity studies are carried out

Course Contents (Fish, Fisheries and Aquaculture – I):

1. Study of Anatomy and Morphology of important group of fishes.
2. Taxonomic study of common families, genera and species of fishes
3. Survey and Collection of fishes of Haryana
4. Examination of skeleton of cartilaginous and bony fishes
5. Study of histological and microscopic structure in fishes
6. Analysis of physical and chemical properties of water: Temperature, pH, turbidity, salinity, total solids, Dissolved oxygen, Free carbon-di-oxide, hardness, chlorides, orthophosphates, nitrates, ammonia
7. Qualitative and quantitative examination of Phyto and zooplanktons in a water body.
8. Determination of percent composition of different groups of phyto and zoo planktons
9. Determination of species diversity of phyto and zooplanktons
10. Study of Aquatic weeds and aquatic insects

SEMESTER – IV

Paper: M-Z 401 (Core)
Developmental Biology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objective: To explain how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult, or more generally throughout a life cycle.

Course Outcomes:

CO1 Based on learning contents of embryology, students can have a systematic and organised learning about the knowledge and concepts of growth and development.

CO2 Developmental biology displays a rich array of material and conceptual practices that can be analysed to better understand the scientific reasoning exhibited in experimental life sciences

CO3 To understand biological processes that takes place in and between cells and in and between organisms in nature.

CO4 This understanding will make the students capable of describing and explaining both biological processes and their importance for living organisms.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting four questions from each unit (I - IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT - I

1. Introduction to animal development:
   1.1 Problems of developmental biology
   1.2 Developmental patterns in metazoans
   1.3 Development in unicellular eukaryotes
   1.4 Development in Dictyostelium

2. Creating multicellularity:
   2.1 Cleavage types and significance, Blastula, Fate maps, cell lineages
   2.2 Comparative account of gastrulation

3. Early vertebrate development:
   3.1 Neurulation and ectoderm
   3.2 Mesoderm and endoderm

UNIT - II

4. Cytoplasmic determinants and autonomous cell specification:
   - 4.1 Cell commitment and differentiation
   - 4.2 Germ cell determinants
   - 4.3 Germ cell migration
   - 4.4 Progressive cell - Cell interaction and cell specification fate
   - 4.5 Cell specification in nematodes

5. Body pattern formation:
   - 5.1 Establishment of Body axis in mammals and birds
   - 5.2 Proximate tissue interactions
   - 5.3 Genetics of axis specification in *Drosophila*

UNIT- III

6. Hormones as mediators of development:
   - 6.1 Amphibian metamorphosis
   - 6.2 Insect metamorphosis

7. Biology of sex determination:
   - 7.1 Chromosomal sex determination – Mammals, Drosophila and Nematodes
   - 7.2 Testis determining genes
   - 7.3 Secondary sex determination in mammals
   - 7.4 Environmental sex determination.

8. Cell death and cell renewal
   - 8.1 Programmed cell death
   - 8.2 Stem cells and the maintenance of adult tissues
   - 8.3 Embryonic stem cells and therapeutic cloning

UNIT - IV

9 Environmental evolution and animal development
   - 9.1 Environmental cues and effects
   - 9.2 Malformations and disruptions
   - 9.3 Changing evolution through development modularity
   - 9.4 Developmental constraints

10. Homeobox concept in different phylogenetic groups
   - 10.1 Cell diversification in early animal embryo
   - 10.2 Tetrapod limb development
   - 10.3 Skeletal muscle regeneration
   - 10.4 Connective tissue cell family
   - 10.5 Blood cells formation

Suggested Reading Material:

1. S.F. Gilbert. Developmental Biology. Sinauer Associates Inc., Massachusetts. Ethan Bier. 'The Cold Spring'. Cold Spring Harbor Laboratory Press, New York.
2. Essentials of Developmental Biology: JMW Slack [Latest edition] .
3. Principles of Development: Louis Wolpert [Latest edition].
4. An Introduction to Embryology by B.I. Balinsky, Saunders, Philadelphia (1981).
5. Major Problems in Developmental Biology by H. Urspaung, Academic Press, New York, (1972).
6. The Control of Gene Expression in Animal Development by J.B. Gurdon, Harvard University, Press, Oxford (1974).
7. Gene activity in Early Development by Davdson, E.H. Academic Press, London (1977).
8. Development Biology (Vol.II) by Browder, L.W, Saunders (1984).

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – IV

Paper: M-Z 402 (Core)
Vertebrate Immunology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives: To provide an understanding of fundamental immunology and the immunologicalbasis of treatment of some common diseases.

Course Outcomes: The students will have understanding about

CO1 How the immune system can fight infection and other diseases
CO2 The strategies to improve existing vaccines and how to approach these
CO3 Cellular and molecular basis of inflammatory response
CO4 Mechanisms involved in control of immune response

Note:
1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting four questions from each unit (I - IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1.0 Phylogeny and Ontogeny of immune system
- 1.1 Innate and Acquired Immunity
- 1.2 Organization and structure of lymphoid organs
- 1.3 Cells of the immune system and their differentiation

2.0 Nature of antigens and superantigens
- 2.1 Antigenicity and immunogenicity
- 2.2 Factors influencing immunogenicity
- 2.3 Epitopes and haptens

3.0 Structure and Functions of Antibodies
- 3.1 Classes and subclasses
- 3.2 Gross and Fine structure
- 3.3 Antibody mediated effector functions

4.0 Antigen-Ab interactions: Principles and Applications
- 4.1 Cross Reactivity, Precipitation reactions, Agglutination reactions
- 4.2 Radioimmunoassay, ELISA, Immunoprecipitation, Immunofluorescence

UNIT-II

5.0 Nature of immune response
- 5.1 Humoral Immune Response
- 5.2 Cellular Immune Response

6.0 Cytokines
- 6.1 Cytokine Properties
- 6.2 Cytokine receptors
- 6.3 Cytokines and Immune response
- 6.4 Cytokine Antagonists
- 6.5 Cytokine Related Diseases

7.0 Cell-mediated effector functions
- 7.1 Cell adhesion molecules
- 7.2 Effector cells and molecules
- 7.3 CTLs –Mechanism of action
- 7.4 NK cells-mechanisms of action

8.0 Hypersensitivity-Types and Mechanism.

UNIT-III

9.0 Complement System
- 9.1 Components and functions of Complement system
- 9.2 Pathways of complement system
- 9.3 Regulation and biological consequences.

10.0 Major Histocompatibility Complex in mouse and HLA system in human
- 10.1 Class I and class II molecules
- 10.2 Expression and diversity
- 10.3 Disease susceptibility and MHC/HLA

11.0 Organization and expression of Ig genes
- 11.1 Multigene organization of Ig genes
- 11.2 DNA rearrangements and mechanisms
- 11.3 Generation of antibody diversity
- 11.4 Differential expression of Ig genes.

UNIT-IV

12.0 T-Cell Maturation, Activation and Differentiation
- 12.1 T-Cell Receptors- Organization and rearrangement of TCR genes, TCR-CD3complex
- 12.2 T-cell maturation and thymus
- 12.3 T -cell activation and differentiation
- 12.4 Cell death and T-cell population

13.0 B-cell generation, activation and differentiation
- 13.1 B-cell receptors
- 13.2 B-cell maturation, activation and proliferation
- 13.3 T H-B-Cell interactions

14.0 Auto-immunity and Vaccines- Types – subunit, conjugate and recombinant vectorvaccines.

Suggested Reading Material:

1. Kuby. Immunology, W.H. Freeman, USA.
2. W. Paul. Fundamentals of Immunology.
3. I.M. Roitt. Essential of Immunology, ELBS Edition.
4. Immuno Biology- The immune system in health and disease, Janeway, Travers, Walport and Shlomchik, Garland Science Publishing [Latest edition].
5. Fundamentals of Immunology by William E. Paul, Lippincott Williams & Wilkins Publishing [Latest edition].
6. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Elsevier Publishing [Latest edition].

Teaching-Learning Process

- **Lectures :** Supported by power point presentations and related videos
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SEMESTER – IV

Paper: M-Z 403 (Core)
Environmental Toxicology
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To apprise the students about the toxicants and their effects on human health
2. To identify relationships between chemical exposure and effects on physiological systems

Course Outcomes:

CO1 The awareness about toxic agents, their different routes of exposure and their effects on humans and their livestock will be apprised.
CO2 The students will have the knowledge about mode of transformation of toxicants
CO3 It will help in creating skilled personnel in the field of environment protection and research.
CO4 Students will have an understanding of ill-health and diseases that are related to exposure to chemicals in human everyday life

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting four questions from each unit (I - IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT - I

1.0 **Introduction to Environmental Toxicology:**
- 1.1 Emergence of toxicity in the environment
- 1.2 Classical toxicology, ecotoxicology and environmental toxicology.
- 1.3 Classification of toxicants.

2.0 Toxic agents: Pesticides, metals, solvents radiation, carcinogens, poisons, bio-toxins, petrochemicals.

UNIT - II

3.0 **Toxicant uptake:**
- 3.1 Route of toxicant uptake/Absorption of toxicant at tissue and cellular level
- 3.2 Distribution and storage of toxicant.
- 3.3 Biotransformation and elimination of toxicant.

4.0 Xenobiotics: Definition, types and significance Target organ toxicity:
- 4.1 Hematotoxicity
- 4.2 Hepatotoxicity
- 4.3 Nephrotoxicity
- 4.4 Neurotoxicity

UNIT - III

5.0 Environmental Toxicology: Food additives, air, water and soil pollutants and Bioindicators.

6.0 Effect of pollutant on ecosystem with case study of important Organo-phosphorous and Organo-chlorine pesticides and Nitrates

7.0 Solid waste management: Primary waste products-Solid waste, toxic biological and hospital landfills, incineration, source reduction and recycling.

UNIT - IV

8.0 Bioremediation, its role and significance.

9.0 Toxicological risk assessment and management with reference to relevant case study.

10.0 Principles and significance of systematic toxicology.

11.0 Genotoxicology: Definition, Effects, molecular mechanisms and prevention.

12.0 Applications of toxicology anthropogenic activities and environment.

13.0 Human toxicology and medicinal ethics.

Suggested Reading Material:

1. Handbook of Solid Waste Management by Wilson, Van Nostrand, Reinhold.
2. Environmental Studies by D.B. Botkin, & E.A. Keller, Martill Publising Co., Columbs, Toronto, London.
3. Bioremediation Technology by Fulekar, M.H.
4. Biotranformation: Bioremediation Technology for Health & Environmental Protection by R. D. Stapleton Jr. and V.P. Singh (Ed), Elsevier.
5. Casarett & Doull's Toxicology: The Basic Science of Poisons by Curtis Klaassen.
6. Ecotoxicology: The study of pollutants in ecosystems. 3rd Ed. Elsevier by Moriarty, F.
7. Environment concerns and strategies. Ashish Pub. House, NDL by T.N. Khushoo.
8. Environmental biology. Akashdeep Pub. House by R.R. Trevedi Gurdeep Raj.
9. Textbook: A Textbook of Modern Toxicology. Third Edition by E. Hodgson (Ed.). John Wiley & Sons, Inc. (Posted on the D2L content page.)
10. Environmental Health by Monroe T. Morgan
11. Handbook of Environmental Health and Safety – principle and practices by H. Koren; Lewis Publishers
12. Principles of Environmental Toxicology by I. C. Shaw and J. Chadwick; Taylor & Francis ltd.
13. Introduction to Toxicology, 3rd Ed. Taylor & Francis, London by Timbrell, J.

Teaching-Learning Process

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SEMESTER – IV

Paper: M-Z 404 (Elective)
Molecular Reproduction-II
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To introduce students to the essential and unifying concepts of physiology, reproduction, and development in animals which are central to modern biology to specify the targets for fertility regulation.
2. To address the basic biological mechanisms that underlies male and female reproduction that pertains to reproductive health issues, such as contraception, congenital malformations and infertility,

Course Outcomes: The students will have knowledge about the:

CO1 Basic and molecular concepts of reproductive physiology.
CO2 Cellular and molecular mechanisms of fertilization, implantation, pregnancy and lactation
CO3 The biological principles underlying contraceptive technology, and compare and contrast the various options for control of fertility, methods for assisted reproductive technologies to circumvent infertility.
CO4 The origin and characteristics of common congenital malformations, the maternal responses and complications of pregnancy.

Note

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting four questions from each unit (I - IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1. **Sex Determination:** Chromosomal sex determination in mammals, Autosomal testis determining genes, Hormonal regulation of sex determination. Androgen insensitivity syndrome
2. **Reproductive cycles:** Menstrual cycle and its regulation in humans, Estrous cycle in rat, Estrous behaviour in cycling animals.
3. **Molecular bases of Fertilization in mammals:** Gamete transport, fertilization competence by gametes, capacitation, acrosome reaction, oocyte-sperm interaction, oocyte activation, gamete fusion.

UNIT – II

4. **Hormonal regulation:** Implantation, pregnancy, parturition, oxytocin- synthesis, secretion and its role in parturition, placenta and its hormones.
5. **Mammary glands-** Structure, development and physiology of lactation, milk synthesis and secretion; regulation and ejection of milk.

UNIT-III

6. **Apoptosis:** Molecular mechanism, regulation, and significance; Apoptosis in reproductive aging.
7. **Assisted reproductive techniques-** IVF, IUI, ICSI, GIFT, ZIFT, Surrogacy, negative aspects and recent trends in ART.
8. **Contraception:** Natural method (Fertility awareness), Surgical, Physical/Barrier methods, Chemical methods, Immunocontraception.

UNIT-IV

9. **Reproductive failure in females-**Ovarian dysfunction, estrus abnormalities, fertilization failure, Pregnancy wastage- embryonic mortality, fetal mortality, infectious and non-infectious causes, prenatal and neonatal mortality.
10. **Reproductive failure in males-**Congenital malformations-cryptorchidism, testicular hypoplasia, ejaculatory disturbances, sperm defects, fertilization failure.

Suggested Reading Materials:

1. Guraya S.S. (1998). Cellular and Molecular Biology of General development and Maturation in mammals Narosa Publishing House, New Delhi.
2. Hafez E.S.E.(1994)."Reproduction in farm animals". Lea Febighiese.
3. Gurays S.S. (2000). Comparative Cellular and Molecular Biology of Ovary in mammals. I.B.H., New Delhi.
4. The Physiology of Reproduction, second edition, Vol 1 and 2, edited by Ernst Knobil and Jimmy D. Neil. *Raven Press*, 2014.
5. Male Reproductive Function, edited by Christina Wang. Kluwer *Academic Publishers*, 1999.
6. The ovary, edited by Solly Zuckerman Baron Zuckerman, Barbara J. Weir, T. G. Baker. *Academic Press*.
7. The ovary, edited by Peter C.K. Leung and Eli Y. Adashi, Elsevier (Academic Press), 2004.
8. Cell and Molecular Biology of Testis, edited by Claude Desjardins and Larry L. Ewing. *Oxford University Press US*.
9. Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, edited by Samuel S. C. Yen, Robert B. Jaffe, Robert L. Barbieri. *Saunders publisher*.
10. Regulation of Implantation and Establishment of Pregnancy in Mammals, Editors: Rodney D Geisert, Fuller W. Bazer, ISBN 978-3-319-15856-3, Springer International Publishing, 2015.

11. Implantation and early development, Editors: Hilary Critchley, Ian Cameron and Stephan Smith, ISBN 9781107784680, Cambridge University press, 2014.
12. Implantation, Biological and Clinical Aspects, Editors: Michael G. Chapman, J. Gedis Grudzinskas, Tim Chard, ISBN 978-1-4471-3531-9, Springer-Verlag, 1988.

Teaching-Learning Process

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SEMESTER – IV

Paper: M-Z 405 (Elective)
Animal Behaviour and Wildlife Conservation – II
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Course Objectives:

1. To know the important concept of animal behavior
2. In depth knowledge of Theory and practice of wildlife conservation

Course Outcomes:

CO1 It will boost students for betterment of diversified resources and life forms for better conservational measures with keen understanding and new approaches.
CO2 Acquire a clear understanding about social behavior patterns in animals
CO3 To know about the concept of wildlife census techniques
CO4 Detail understanding of conservational approaches in wild

Note

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set unit wise selecting four questions from each unit (I - IV). The candidate will be required to attempt question No. 1 and four more selecting two questions from each unit.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT-I

1.0 Social behaviour:
- 1.1 Aggregations and society;
- 1.2 Advantages of group living;
- 1.3 Types of social organization in animals
- 1.4 Group selection, kin selection, altruism, reciprocal altruism.
- 1.5 Territoriality and parental care
- 1.6 Behaviour Ecology: Habitat selection

2.0 Social behaviour of termites, ants and primates.
3.0 Various means of communication in animals: Chemical, Visual, auditory, touch etc.

UNIT-II

4.0 Hormones and animal Behaviour: Hormones important to behavioural regulation; Genetic basis of behaviour
5.0 Aggressive behaviour; sexual attraction and sexual behaviour.
6.0 Pheromones and animal behaviour: types of pheromones, role of pheromones in animal behaviour; pheromones of social insects, Human Ethology

UNIT-III

7.0 Wildlife Census: Planning a wildlife census, understanding sample counts, Block counts, Road side counts, Dung counts, Pugmark census, Water-hole census.
8.0 Study of signs and symptoms: A practice of recording field observations, Bio-telemetry, Ageing and Sexing techniques.

9.0 Wildlife Tourism: Definition scope and range; Popular Wildlife Tourist Sports of the world, Popular Wildlife spots in India, Sustainable use of wildlife spots.

UNIT-IV

10.0 Wildlife Damage, its nature and definition, electric fences for wildlife damage control, Basic electric fence design, Trench design, live trapping, Mist netting, Rocket netting Chemical capture: Equipment, Drugs, Plan of operation.

11.0 Poaching: Its definition and implications, conducting anti-poaching operations, evidence in poaching cases.

12.0 National Projects: Project Tiger, Project elephant, Project Rhinoceros, Project Crocodiles, Project Hangul, Manipur Brow Antlered Deer.

Suggested Reading Materials:

1. Techniques for wildlife Census in India by W.A. Rogers (A field mannual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand
3. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
5. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
6. E.P. Gee, The Wildlife of India.

Teaching-Learning Process

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- **Assignments and exercises**
- **Test:** Knowledge of the students is tested through surprise tests, quiz & session tests.

SEMESTER – IV

Paper: M-Z 406 (Elective)
Fish, Fisheries and Aquaculture – II
Credits: 4

Total Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 Hours

Objectives:

1. To generate knowledge about the recent methods of fish stock improvement and intensive culture techniques of important fin-fish and shell-fish species.
2. To develop ability for different type of aquaculture practices.

Outcomes:

CO1 The students will learn the techniques using biotechnological approach to improve fish stock and will also understand ethics involved in it.
CO2 This core elective paper will help in learning culture techniques of aquatic organisms
CO3 This will help in developing skilled personnel in techniques of improving the fish Stock and yield of aquaculturally important aquatic organisms.
CO4 The study of culture techniques of various aquatic organisms helps in the production of healthy food for human consumption in a sustainable manner and also in employment generation.

Note:

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section wise selecting fourquestions from each section (I & II). The candidate will be required to attempt question No. 1 and four more selecting two questions from each section.
3. As far as possible the questions should be divided into sub-parts and marks indicated part wise.

UNIT - I

1.0 Introduction to fish biotechnology

2.0 Selection and hybridization

3.0 Androgenesis and Gynogenesis – natural and induced

4.0 Polyploidy techniques

5.0 Sex reversal and sterility

UNIT - II

6.0 Transgenesis, transgenes and application

7.0 Cryopreservation of gametes and embryo

8.0 Fish-by products

9.0 Fish preservation process

10.0 Nutritive aspect of fish meat and oil.

UNIT - III

11.0 Different systems for aquaculture: pond culture, cage culture, raceway culture.

12.0 Culture of important fish species (Major carps, common carps, Chinese carps, cat fish culture and Tilapia culture).

13.0 Integrated Aquaculture and waste water aquaculture

14.0 Pearl Culture

15.0 Frog culture

UNIT - IV

16.0 Prawn culture-Fresh and brackish water

17.0 Impact of Aquaculture on Environment

18.0 Methods of Fishing : Crafts and gear technology

19.0 Fish diseases and their control

20.0 Nutrition in Aquaculture

- 20.1 Nutrient and non-nutrient diet components
- 20.2 Preparation and processing of feed, feed formulae,
- 20.3 Natural and supplementary feed and their utilization

Suggested Reading Materials:

1. Ponniah, AG, Das, P & Verma SR (Ed.) (1998) Fish Genetics and Biodiversity Conservation.Nature Conservators, Muzaffarnagar, India 474pp.
2. Bardach, JE, Ryther, JH & Mclarnely, OW (1972) Aquaculture. Wiley Interscience
3. Boyd, CE (1988) Water quality management for pond fish culture. Developments in Aquacultureand Fisheries Sciences. I. Elsevier Scientific Publishing Company, Amsterdam.
4. Delince, G (1992) The Ecology of the fish pond system. Kluwer Academic Publishers, Netherlands, 230 pp.
5. Hepher, B (1975) Supplementary feeding in fish culture. In: Nutrition and Production of Fishes.Vol. 3 S. Karger, Basel : 183-198
6. Hoar, WS, Randall, DJ & Donaldson, ME (1983) Fish Physiology. Vol. IXA & IXB. Reproduction. Academic Press, London.
7. Jhingran, VG (1983) Fish and Fisheries of India. Hindustan Publishing Corporation (India) 954 pp
8. Tandon, KK & Johal, MS (2006) Age and Growth in Indian Freshwater Fishes.Narendra Publishing House Delhi, 232 pp.

Teaching-Learning Process

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- **Assignments and exercises**
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SEMESTER – IV

Paper: M-Z 407 (Core)
Practical (Based on Papers M-Z 401 to M-Z 403)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objective: To provide the students with the knowledge about the developmental stages, comparativestructures of tissues, analysis of genotoxicity and principles of sediment chemistry.

Course Outcomes:
CO1: Students will know the principle and various techniques of embryology.
CO2: Students will be able to identify the various stages involved in the developing embryo of chick.
CO3: They will able to demonstrate basic principles in sediment chemistry and qualitative analysis ofgenotoxicity.
CO4: Students will able to prepare the histological slides of different tissues for clinical studies and forresearch purpose.

Course Contents:

1. Permanent preparation of chick embryo developmental stages.
2. Studies of different types of eggs with reference to their yolk contents
3. To study internal morphology of chick egg
4. Study of development in Dictyostelium
5. Determination of various parameters of chick egg
6. To study the permanent slides of frog embryo developmental stages
7. Antigen-antibody interaction in vitro.
8. ELISA (Demonstration).
9. Phagocytosis *in vitro*.
10. Immunological diagnosis of pregnancy/infection/cancer.
11. To study permanent slides of Lymphoid and endocrine glands
12. Studies on vaginal smears during different stages of estrous cycle.
13. Bioassay to demonstrate toxicological effect : Micronuclei Assay and demonstration of Single Cell Gel electrophoresis to elucidate toxicological effect
14. Determination of sediment chemistry
    a. Moisture
    b. Carbonate
    c. Nitrate
    d. pH
    e. Phosphate
    f. Texture

SEMESTER – IV

Paper: M-Z 408(i) (Elective)
Practical (Based on Papers M-Z 404)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objectives

1. To provide students the opportunity to gain a first-hand laboratory experience of the structure, function, and development of the reproductive organs.
2. To gain experience in experimental design, cutting-edge research techniques, data analysis, and scientific report writing and will be introduced to the practicalities of reproductive manipulation and assisted reproductive technologies.

Course Outcomes: Students will be able-

CO1 To develop the scientific attitude that makes the students open minded, critical observations, curiosity thinking etc.
CO2 To acquire the specialized knowledge relevant to reproductive biology and biochemistry.
CO3 To understand the basic and molecular laboratory techniques in both physiology and biochemistry.
CO4 To acquire the knowledge about various male and female infertility problems

Course Contents (Molecular Reproduction-II):

1. Effects of pesticides, drugs, and xenobiotics on granulosa cells *in vitro*.
2. Effects of pesticides, oxidants, and free radicals on testicular tissue *in vitro*.
3. Morphological changes during spermatogenesis.
4. Effects of environmental endocrine disruptors on the fertility after exposure in vitro.
5. Estimation of catalase from reproductive tissues
6. Determination of Glutathione peroxides, glutathione reductase from reproductive tissues.
7. Lipid peroxidation by MDA method.
8. Impact of Vitamin C & E and other antioxidants on pesticides induced cytotoxicity on reproductive tissues *in vitro*.
9. Isolation of genomic DNA
10. Agarose Gel Electrophoresis: Practical demonstration
11. Age related changes in sperm characteristics.
12. Demonstration of Single Cell Gel electrophoresis/COMET Assay to elucidate toxicological effect.

SEMESTER – IV

Paper: M-Z 408(ii) (Elective)
Practical (Based on Papers M-Z 405)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objective:

1. Practical knowledge of important concept and types of behavior patterns
2. In depth knowledge of Theory and practice of avian fauna

Course Outcomes:

CO1 It will boost students for keen understanding various population estimation methods in animal world.
CO2 Students will acquire a clear practical understanding about behavior repertoire sheets
CO3 Students will understand the practical approaches of diversity indices
CO4 Will have detail understanding of reported avifaunal status in the field

Course Contents (Animal Behaviour and Wildlife Conservation – II):

1 To study the effect of temperature on gill movement in fishes.

2 To study nesting behaviour of squirrels in different habitats vis., urban environment, grain-market-area, roadside plantations, orchards gardens etc.

3 Field study of burrowing behaviour of common available rodent fauna of the region.

4 Study of morphological changes in common avian species during breeding season.

5 Preparation of charts of endangered amphibians, reptiles and mammals with ecological remarks.

6 Animal behaviour patterns using Photostat sheets/ repertoire sheets

7 Analysis of standard pug marks of large sized wild mammals.

8 Study of Migratory Birds

9 Study of Diversity indices : use of software in calculating diversity indices

10 Study of beaks and claws of different bird species.

11 Field visit to a zoo or wildlife part/sanctuary and preparation of field report

12 Preparation of field diary on the basis of observations regarding habitat, habits of common available avian and rodent fauna of the region.

SEMESTER – IV

Paper: M-Z 408(iii) (Elective)
Practical (Based on Papers M-Z 406)
Credits: 4

Total Marks: 100
External Examination: 80
Internal Assessment: 20
Time: 4 Hours

Course Objective:

1. To generate knowledge about the recent methods fish feed formulation and processing
2. To apprise students about induced breeding identification of different stages of fish development and use of craft and gears

Course Outcomes:

CO1 The students will be able to formulate and process fish feed using different ingredients for sustainable fish culture

CO2 This practical paper will make students capable of quantifying proximate composition of fish feed

CO3 This will develop skilled personnel in techniques of making pituitary extract and estimating primary productivity

CO4 This will develop students capable of using different fish nets and gears for capturing fishes and also of conducting small projects

Course Contents (Fish, Fisheries and Aquaculture – II):

1. Fish Feed formulation and processing.
2. Proximate analysis of fish feed (Determination of moisture, protein, fat, ash carbohydrate, fiber and energy).
3. Taking out of pituitary gland, preservation and preparation of extract.
4. Estimation of primary productivity
5. Study of benthic macroinvertebrates in natural water bodies.
6. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
7. Determination of length weight relationship.
8. Determination of age of fish using hard parts
9. Analysis of fecundity, Gonado somatic index (GSI), Hepatosomatic index (HIS) in some fishes.
10. Study of crafts and gear and method of operation (Models can also be used)
11. Visit to fish farm and fish market and preparation of report
12. A small experimental project