

KURUKSHETRA UNIVERSITY KURUKSHETRA

**MASTER OF ZOOLOGY
FACULTY OF LIFE SCIENCES**

**SCHEME AND SYLLABUS
(Semester I to IV)**

**(For affiliated colleges of KUK)
(Effective from Session 2022-23)**



**DEPARTMENT OF ZOOLOGY
KURUKSHETRA UNIVERSITY, KURUKSHETRA
(SESSION 2022-23)**

Scheme of Examination of M.Sc. Zoology (Semester system) for affiliated colleges of KUK to be implemented w.e.f. session 2022-2023

Paper No.	Title of the Paper	Nature of paper	Contact hours per week T + S + P	Total Marks (T+IA)	Exam duration (Hours)
Semester I					
M-Z-101	Cell Biology	Core	4 + 0 + 0	80+20	3
M-Z-102	Biochemistry and Bio-techniques	Core	4 + 0 + 0	80+20	3
M-Z-103	Biosystematics and Biostatistics	Core	4 + 0 + 0	80+20	3
M-Z-104	Biology of Invertebrates	Core	4 + 0 + 0	80+20	3
M-Z-105	Practical (Based on Papers M-Z-101 & M-Z-102)	Core	0 + 0 + 8	80+20	4
M-Z-106	Practical (Based on Papers M-Z-103 & M-Z-104)	Core	0 + 0 + 8	80+20	4
Total			16 + 0 + 16	480+120=600	
Semester II					
M-Z-201	Population and Community Ecology	Core	4 + 0 + 0	80+20	3
M-Z-202	Comparative Physiology	Core	4 + 0 + 0	80+20	3
M-Z-203	Population Genetics & Evolution	Core	4 + 0 + 0	80+20	3
M-Z-204	Biology of Vertebrates	Core	4 + 0 + 0	80+20	3
M-Z-205	Seminar	Core	0 + 1 + 0	25	-
M-Z-206	Practical (Based on Papers M-Z-201 & M- Z-202)	Core	0 + 0 + 8	80+20	4
M-Z-207	Practical (Based on Papers M-Z-203 & M- Z-204)	Core	0 + 0 + 8	80+20	4
Total			16 + 1 + 16	505+120=625	

Scheme of Examination of M.Sc. Zoology (Semester system) for affiliated colleges of KUK to be implemented w.e.f. session 2022-2023

Semester III						
M-Z-301	Molecular Biology		Core	4 + 0 + 0	80+20	3
M-Z-302	Molecular Endocrinology		Core	4 + 0 + 0	80+20	3
M-Z-303	Applied Zoology		Core	4 + 0 + 0	80+20	3
M-Z-304	Molecular Reproduction-I	Any one from M-Z-304 to M-Z-306	Elective	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	0 + 1 + 0	25	-
M-Z-308	Practical (Based on Papers M-Z-301 to M-Z-303)		Core	0 + 0 + 8	80+20	4
M-Z-309	Practical (Based on Papers M-Z-304/M-Z-305/M-Z-306)		Elective	0 + 0 + 8	80+20	4
Total				16 + 1 + 16	505+120=625	
Semester IV						
M-Z-401	Developmental Biology		Core	4 + 0 + 0	80+20	3
M-Z-402	Vertebrate Immunology		Core	4 + 0 + 0	80+20	3
M-Z-403	Environmental Toxicology		Core	4 + 0 + 0	80+20	3
M-Z-404	Molecular Reproduction– II	Any one from M-Z-404 to M-Z-406	Elective	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	0 + 0 + 8	80+20	4
M-Z-408	Practical (Based on Papers M-Z-404 /M-Z-405/M-Z-406)		Elective	0 + 0 + 8	80+20	4
Total				16 + 2 + 16	480+120=600	
Grand Total					2450	

T – Theory; S– Seminar; P– Practical

SEMESTER – I

Paper: M-Z-101 (Core)

Cell Biology

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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.i

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

- 2.1 Introduction to cytoskeleton and its role
- 2.2 Molecular structure of Actin, myosin and their organisation
- 2.3 Structure and dynamic organizations of microtubules and microfilaments
- 2.4 Microtubule motors and movement
- 2.5 Intermediate filaments
- 2.6 Role of Centrioles and basal bodies
- 2.7 Structure and functions of Cilia and flagella

UNIT –II

3 The Extra Cellular Matrix and Cell interactions

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

4 Cell matrix adhesion

- 4.1 Integrins
- 4.2 Collagen
- 4.3 Non-collagen components
- 4.4 Auxin and cell expansion
- 4.5 Cellulose fibril synthesis and orientation

- 5 **Protein sorting and transport**
5.1 Protein uptake into the ER
5.2 Membrane proteins and Golgi sorting
5.3 Mechanism of vesicular transport
5.4 Lysosomes
5.5 Molecular mechanism of secretory pathway

UNIT-III

- 6 **Cell cycle**
6.1 Eukaryotic cell cycle
6.2 Regulators of cell cycle progression
6.3 Role of Meiosis in Genetic Variation
- 7 **Cell – Cell signaling**
7.1 Signaling molecules and their receptors
7.2 Pathways of intracellular signal transduction
- 8 **Biology of Cancer**
8.1 The development and causes of cancer
8.2 Oncogenes
8.3 Tumor suppressor genes
8.4 Molecular approaches to cancer treatment

UNIT-IV

- 9 **Genome organization**
9.1 Chromosomal organization of genes
9.2 Transposons in prokaryotes and eukaryotes
9.3 Morphological and functional elements of eukaryotic chromosomes
- 10 **Cell Death**
10.1 Necrosis and Programmed cell death
10.2 Molecular Mechanism
10.3 Applications and Significance
- 11 **Biology of Ageing**
11.1 Morphological, Physiological and Functional changes during Ageing
11.2 Telomeres and Ageing
11.3 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 Publications
7. Molecular Cell Biology, Lodish et al., W.H. Freeman and Company (8th Ed. 2016)
8. Molecular Biology, Weaver R. F., McGraw-Hill Education (5th Ed. 2011)

SEMESTER – I

Paper: M-Z-102 (Core)

Biochemistry and Bio-techniques

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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) Reverse turn 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 (*invitro* 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

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

9.0. **Cryotechniques :**

- 9.1 Cryopreservation for cells, tissue, organisms,
- 9.2 Cryotechniques 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
- 10.3 Cell separation by flow cytometry 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.

SEMESTER – I

Paper: M-Z-103 (Core)

Biosystematics and Biostatistics

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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, curation 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:

14.1 Definition and law of sampling,

14.2 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.

SEMESTER – I

Paper: M-Z-104 (Core)

Biology of Invertebrates

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 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, Buccopharyngeal 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. Saunders 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.

SEMESTER – I

Paper: M-Z-105 (Core)

Practical (Based on Papers M-Z-101 &M-Z-102)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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 and extraction 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)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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.

SEMESTER – II

Paper: M-Z-202 (Core)

Comparative Physiology

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 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, Estuarine 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, Endocrinology, Oogenesis vitellogenesis

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 opioids.

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).

SEMESTER – II

Paper: M-Z-203 (Core)

Population Genetics and Evolution

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 taxa

Suggested Reading Material

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

SEMESTER – II

Paper: M-Z-204 (Core)

Biology of Vertebrates

Total Marks: 100

Theory Examination: 80

Internal Assessment: 20

Time: 3 Hours

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

4.1 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,Edinburgh.
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.

SEMESTER – II

Paper: M-Z-205 (Core)

Seminar

Total Marks: 25

Report and Presentation: 20

Attendance: 5

SEMESTER – II

Paper: M-Z-206 (Core)

Practical (Based on Papers M-Z-201 & M-Z-202)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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) Haematoxylin-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 activity of salivary amylase.
11. To demonstrate that the optimum activity of trypsin enzyme is pH temperature dependent.
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-207 (Core)

Practical (Based on Papers M-Z-203 & M-Z-204)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

Course Contents:

1. Demonstration of cranial nerves and aortic arches of *Scoliodon*, Digestive 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

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 libraries
- 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.

SEMESTER – III

Paper: M-Z-302 (Core)

Molecular Endocrinology

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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.

13.0 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.

SEMESTER – III

Paper: M-Z-303 (Core)

Applied Zoology

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 and Pheromones involved in pest management.
- 2.0 Insects of medical and veterinary importance.

UNIT- II

3.0 Zoonosis:

- 3.1 Viral-Rabies,
- 3.2 Japanese encephalitis;
- 3.3 Bacterial- Brucellosis, Plague;
- 3.4 Rickettsial- Rickettsial 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 harvest the technology from animals for human welfare

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

Suggested Readings:

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. & Ananthkrishnan, 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 McGraw 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.

SEMESTER – III

Paper: M-Z-304 (Elective)

Molecular Reproduction-I

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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. GeddisGrudzinskas, Tim Chard, ISBN 978-1-4471-3531-9, Springer-Verlag, 1988.

SEMESTER – III

Paper: M-Z-305 (Elective)

Animal Behaviour and Wildlife Conservation – I

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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.

SEMESTER – III

Paper: M-Z-306 (Elective)

Fish, Fisheries and Aquaculture – I

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 on aquatic 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
 - 14.1 Chemoreceptors
 - 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:

Encyclopedia of Fish Physiology. 2011. Anthony P. Farrell, E.D. Stevens, J.J. Cech & J.G. Richards (Eds). Academic Press, UK.

APHA (1995) Standard Methods of Examination of Water and Wastewater. American Public Health Association, AWWA, WCPF, Washington DC.

Bardach, JE, Ryther & McLarney, Wo (1972) Aquaculture, New York: Wiley-Interscience. 896pp.

Boulenger, GA & Bridge, TW (1910) Fishes (Vol. VII of the Cambridge Natural History) Cambridge Univ. Press, London.

Das, P, Verma, SR, Dhaje, RJ & Malik DS (2002) Coldwater Fish Genetic Resources and their Conservation. National Conservators publication, 7, 325pp.

Datta Munshi, JS & Srivastava, MP (1998) Natural History of Fishes and Systematics of Freshwater Fishes of India. Narendra Publishing house, Delhi, 403pp.

Jayram, KC (2013) The Freshwater Fishes of the Indian Region (Corrected 2nd Edition) Narendra Publishing house, Delhi, 616pp, XXXIX plates.

Lagler, KF, Bardach, JE, Miller, RR & Passino, DRM (1977) Ichthyology, 21st Edition, New York, Wiley, 506 pp.

Nikolsky, GV (1963) The Ecology of Fishes, Academic Press, London.

Pillay, TVR (1990) Aquaculture, principles and practices. Fishing News Books. 575pp. Fish Physiology. (Series) W.S.Hoar and D.J. Randall (Series Eds). Academic Press, UK.

The Physiology of Fishes. 2013. Evans, D. H. and Claiborne, J. D., Taylor and Francis Group, CRC Press, UK.

SEMESTER – III

Paper: M-Z 307 (Core)

Seminar

Total Marks: 25

Report and Presentation: 20

Attendance: 5

SEMESTER – III

Paper: M-Z-308 (Core)

Practical (Based on Papers M-Z-301 to M-Z-303)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

Course Contents:

1. Non-protein nitrogenous substances: qualitative estimation of serum Bilirubin serum and urine creatinine.
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 preparation 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-309 (Elective)

Practical (Based on Papers M-Z-304)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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-309 (Elective)

Practical (Based on Papers M-Z-305)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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: M-Z-309 (Elective)

Practical (Based on Papers M-Z-306)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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. Ursprung, 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 Davidson, E.H. Academic Press, London (1977).
8. Development Biology (Vol.II) by Browder, L.W, Saunders (1984).

SEMESTER – IV

Paper: M-Z-402 (Core)

Vertebrate Immunology

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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-CD3 complex
 - 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 vector vaccines.

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].

SEMESTER – IV

Paper: M-Z-403 (Core)

Environmental Toxicology

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 Publishing Co., Columbs, Toronto, London.
3. Bioremediation Technology by Fulekar, M.H.
4. Biotransformation: 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, NDJ 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.

SEMESTER – IV

Paper: M-Z-404 (Elective)

Molecular Reproduction-II

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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. GeddisGrudzinskas, Tim Chard, ISBN 978-1-4471-3531-9, Springer-Verlag, 1988.

SEMESTER – IV

Paper: M-Z-405 (Elective)

Animal Behaviour and Wildlife Conservation – II

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majumuria; 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.

SEMESTER – IV

Paper: M-Z-406 (Elective)

Fish, Fisheries and Aquaculture – II

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 3 Hours

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 four questions 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:

Ponniah, AG, Das, P & Verma SR (Ed.) (1998) Fish Genetics and Biodiversity Conservation. Nature Conservators, Muzaffarnagar, India 474pp.

Bardach, JE, Ryther, JH & Mclarnely, OW (1972) Aquaculture. Wiley Interscience

Boyd, CE (1988) Water quality management for pond fish culture. Developments in Aquaculture and Fisheries Sciences. I. Elsevier Scientific Publishing Company, Amsterdam.

Delince, G (1992) The Ecology of the fish pond system. Kluwer Academic Publishers, Netherlands, 230 pp.

Hepher, B (1975) Supplementary feeding in fish culture. In: Nutrition and Production of Fishes. Vol. 3 S. Karger, Basel : 183-198

Hoar, WS, Randall, DJ & Donaldson, ME (1983) Fish Physiology. Vol. IXA & IXB. Reproduction. Academic Press, London.

Jhingran, VG (1983) Fish and Fisheries of India. Hindustan Publishing Corporation (India) 954 pp

Tandon, KK & Johal, MS (2006) Age and Growth in Indian Freshwater Fishes. Narendra Publishing House Delhi, 232 pp.

Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, New Delhi. 755 pp.

SEMESTER – IV

Paper: M-Z-407 (Core)

Practical (Based on Papers M-Z 401 to M-Z 403)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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 (Elective)

Practical (Based on Papers M-Z-404)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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 (Elective)

Practical (Based on Papers M-Z-405)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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 (Elective)

Practical (Based on Papers M-Z-406)

Total Marks: 100

External Examination: 80

Internal Assessment: 20

Time: 4 Hours

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