FACULTY OF SCIENCE

SYLLABI

FOR

M.Sc. in Zoology (Semester System)
Under the Framework of Honours School System

Choice Based Credit System (CBCS)
1st to IVth Semester

Department of Zoology,
Panjab University, Chandigarh

EXAMINATIONS 2019-20
PREAMBLE

The Department of Zoology is one of the oldest and well-established departments in North India, which has completed more than 100 years of teaching and research. It was shifted from Hoshiarpur to present campus at Chandigarh in July 1960. The department has many landmarks as its teaching and research activities changed from classical to the most recent ones in Zoology, and remained at the forefront both nationally and internationally. Based on the performance of teaching and research potentials of the staff members, UGC had recognized the Department for Special Assistance Programme (SAP) in 1985 and extended it for two terms. Under the COSIST Programme, a grant of Rs. 42.5 lakhs was sanctioned for a five year term (1996-2001). 3rd Phase of SAP started from 2001-2006 with financial aid of Rs. 65.75 lakhs. On completion of the 3rd Phase of SAP, UGC review committee upgraded the department for CAS (Centre of Advance Study) in Biodiversity: Cell and Molecular Biology, with the financial assistance of Rs. 78.25 lakhs from 2007-2012. In 2013 the department was recognized by the DST under its FIST programme and sanctioned a grant of 1.10 crores for 5 years. In 2015 the department has received grant of Rs. 161.55 lacs + 2 Project Fellows under Phase II CAS Programme.

The Department is well equipped with teaching and research laboratories. There are three laboratories for under-graduate students and two for post-graduate students where course practicals are conducted. There are six specialized laboratories for research students (M.Sc., M.Phil. & Ph.D.) which are maintained as per the specific needs of the research areas including Cell and Animal Physiology, Aquatic Biology, Cytogenetics, Entomology & Parasitology. There is a central sophisticated instruments laboratory equipped with advanced instruments such as Real-time PCR, Flow Cytometer, 2D Gel Electrophoresis system, HPLC, Nanodrop etc along with other basic research instruments. The Department also has a well-equipped computer lab., which are open for use by students and staff. The Department has a seminar room with modern audio-visual facility and interactive class-room.

Library

The department library is well stocked with highly informative 10,000 textbooks and reference books having general information related to the subject of Zoology. The library also receives good scientific research journals of national and international repute for the benefit of research scholars and the faculty. New books and journals are regularly added and updated.

Museum

The department has two state of art museums with a wealth of 3000 specimens belonging to different animal phyla.
# TENTATIVE COURSE STRUCTURE

Choice Based Credit System (CBCS)

**M.Sc. ZOOLOGY**

**SEMESTER I - IV**

## SEMESTER I

(Total Credits = 20, Marks=500)

<table>
<thead>
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<th>Subject code</th>
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<tr>
<td>MZO-MC1</td>
<td>Advanced Cell Biology</td>
<td>4+1=5</td>
<td>MZO-MC3</td>
<td>Insect Ecology and Physiology</td>
<td>4+1=5</td>
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<tr>
<td>MZO-MC2</td>
<td>Aquaculture &amp; Fisheries</td>
<td>4+1=5</td>
<td>MZO-MC4</td>
<td>Biology of Parasites</td>
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## SEMESTER II

(Credits = 20, Marks = 500)

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<td>MZO-MC5</td>
<td>Biology of Vertebrate Immune System</td>
<td>4+1=5</td>
<td>MZO-MC7</td>
<td>Environmental and Quantitative Biology</td>
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<tr>
<td>MZO-MC6</td>
<td>Methods and applications of Molecular Biology</td>
<td>4+1=5</td>
<td>MZO-MC8</td>
<td>Methodology and Instrumentation</td>
<td>4+1=5</td>
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**M.Sc. (H.S.) 2**nd** year (3**rd** semester)**

<table>
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<th>Paper</th>
<th>Course/Paper</th>
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<tr>
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Total Credits: 5.6
Total Marks: 140

**M.Sc. (H.S.) 2**nd** year (4**th** semester)**

<table>
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<tr>
<td>XII [Special paper (either of these)]</td>
<td>i Limnology &amp; Fisheries</td>
<td>MZO 7201</td>
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<td>ii Entomology</td>
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<td></td>
<td>iii Concepts in Parasitology</td>
<td>MZO 7203</td>
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<tr>
<td></td>
<td>iv Genetics &amp; Molecular Cytogenetics</td>
<td>MZO 7204</td>
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<td></td>
<td>v Stress &amp; Reproductive Physiology</td>
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Total Credits: 18.4
Total Marks: 460
* Elective 1 will be selected from the options given below:

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<thead>
<tr>
<th>MZO-ME1.</th>
<th>Concepts of Parasitology</th>
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<tbody>
<tr>
<td>MZO-ME2.</td>
<td>Economic Entomology</td>
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<tr>
<td>MZO-ME3.</td>
<td>Molecular Cytogenetics</td>
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<tr>
<td>MZO-ME4.</td>
<td>Molecular Endocrinology and Reproductive Physiology</td>
<td>4</td>
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<tr>
<td>MZO-ME5.</td>
<td>Fish, Fisheries and Aquatic Biology</td>
<td>4</td>
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</tbody>
</table>

** Elective 2 will be selected from the options given below:

<table>
<thead>
<tr>
<th>MZO-ME6.</th>
<th>Animal Cell Culture and its Applications</th>
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<tbody>
<tr>
<td>MZO-ME7.</td>
<td>Biosystematics and Introduction to Bioinformatics</td>
<td>4</td>
</tr>
<tr>
<td>MZO-ME8.</td>
<td>Concepts in Human Genetics and Related Disorders</td>
<td>4</td>
</tr>
<tr>
<td>MZO-ME9.</td>
<td>Metabolic Disorders</td>
<td>4</td>
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<tr>
<td>MZO-ME10.</td>
<td>Biomaterials and Nanobiology</td>
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M.Sc. in Zoology (Semester System)
Under the Framework of Honours School System

Choice Based Credit System (CBCS)

SEMESTER I
OUTLINES OF TESTS

OBJECTIVE OF THE COURSE

To teach the various concepts of Zoology and their applications, the syllabus pertaining to M.Sc. (Honours) Zoology (2 Year course & 4 Semesters) in the subject of Zoology under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged UNIT wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills according to UGC.

Semester I

PAPERS

Theory Papers:

- MZO-MC1: Advanced Cell Biology 100 Marks (4 credits)
- MZO-MC2: Aquaculture and Fisheries 100 Marks (4 credits)
- MZO-MC3: Insect Ecology and Physiology 100 Marks (4 credits)
- MZO-MC4: Biology of Parasites 100 Marks (4 credits)

Practicals:

- MZO-MC1: Advanced Cell Biology 25 Marks (1 credit)
- MZO-MC2: Aquaculture and Fisheries 25 Marks (1 credit)
- MZO-MC3: Insect Ecology and Physiology 25 Marks (1 credit)
- MZO-MC4: Biology of Parasites 25 Marks (1 credit)

Total: 500 Total Marks (20 Total credits)

EVALUATION

1. There shall be one Mid Term Examination of 20% of the total marks (20 marks) in each semester.
2. End-semester examination will be of 80% of the total marks (80 marks).
3. There shall be continuous internal assessment for practicals of 20% marks (05 marks). The final examination will be of 80% marks (20 marks).

PATTERN OF END-SEMESTER QUESTION PAPER

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
(iii) The remaining eight questions will be in **Four UNITs**, each unit comprising of two questions.
(iv) Students will attempt one question from each UNIT and the compulsory question.

### Computation of Semester Grade Point Average (SGPA)

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<td>4+1=5</td>
<td>X= (Marks%/10)</td>
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SGPA= Total Credit point in the semester/total credits

### Grade and Grade Points:

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<tr>
<th>Letter Grade</th>
<th>O</th>
<th>A⁺</th>
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PAPERS-SEMESTER I
Semester I
MZU-MC1: Advanced Cell Biology
THEORY

Total lectures: 60 (45+15)  Credits: 4

Objectives:

☐ To enable the students to learn theoretical and practical aspects of cell biology. It will give an insight into the cell signaling mechanism, cell cycle, cell death, cancer and stem cell biology.

UNIT – I

Cell Signaling
Signalling molecules and cell surface receptors, pathways of intracellular signal transduction.

Sorting and maturation of proteins

UNIT – II

Cell cycle
Cell Cycle regulation & progression: Cyclins and Cyclins dependent kinases, Maturation promoting factors (MPF), Cell cycle promoting and inhibitory factors, Forces of cell division.

Cell death
Necrosis, Autophagy and Programmed Cell Death (Events of apoptosis, Caspases and their activation, Cell Death Receptors, Signaling pathways regulating apoptosis, Inhibition of apoptosis)

UNIT – III

Cancer Biology
Development of cancer, characteristics of cancer cells, causes of cancer: chemicals, viruses and radiations, human tumour viruses. Genetic pathways of cancer, Oncogenes and their proteins (characteristics and classification), tumour suppressor genes and functions of their proteins; therapeutic interventions in cancer.

UNIT – IV: Stem Cell Biology
Introduction, properties and classification of stem cells, types of stem cells: Embryonic Stem Cells (ESC), adult stem cells and induced pluripotent stem cells (iPSC), characterization and differentiation of stem cells, role of Yamanaka factors in iPSC, role of stem cells in organ regeneration, Therapeutic applications of stem cells, advantages, disadvantages and ethical issues in stem cell therapy.
MZO-MC1: Advanced Cell Biology
PRACTICALS

Credit : 1

1. Preparation of permanent histological slides for demonstration of extracellular matrix proteins.
2. Study of cell organelles from electron micrographs.
3. Abnormalities of mitotic/meiotic divisions (through micrographs/karyotypes/micronucleation).
4. Preparation of temporary stained squash preparation of onion root tip to study various stages of mitosis.
5. Demonstration of animal cell culture.
6. Demonstration of apoptosis/cell cycle by propidium iodide.
7. Preparation of mice chromosomes by air drying technique.
8. Preparation of polytene chromosomes from *Chironomus* larvae.

SUGGESTED READINGS


ADDITIONAL READINGS

1. Research journals and review articles as suitable and applicable.
Objectives

- To acquaint the students with different kinds of aquaculture practices used in India.
- To enable the students with desirable traits for fish culture and induced breeding of fish.
- To enhance the skills required for undertaking aquaculture of fish at a professional level.

UNIT – I:

Classification of lakes
On the basis of trophic status, temperature and turnover (Forel’s and Yoshimura’s classifications of lakes), Hutchinson’s classification of lakes – Amictic, cold monomictic, dimictic, warm monomictic, oligomictic and polymictic lakes. Special lakes – salt lakes, polar and alpine lakes.

Productivity
Concepts of productivity – Primary and secondary productivity, yield, biomass, biotic potential, standing crop and carrying capacity, estimation of primary productivity by different methods - Harvest method, oxygen production method, carbon dioxide assimilation method, radioisotope method, chlorophyll method, disappearance of raw materials and pH method.

Eutrophication
Types of eutrophication, causes and impacts of eutrophication, control of eutrophication – mechanical, chemical and biological control.

UNIT – II:

Ecological classifications of freshwater organisms other than fishes
On the basis of trophic status, on the basis of mode of life – Benthos, Periphyton, Plankton, Nekton and Neuston, on the basis of zonation in lentic and lotic habitats.

Estuarine habitat
Characteristics of estuarine habitat, classification of estuaries, estuarine fauna – temporary and permanent and adaptations of estuarine fauna.

Pearl culture in India
Species involved in pearl culture, implantation procedure, water quality, pearl composition, kinds of pearls, economics and enemies of oysters.

UNIT – III:

General information about the fishes of Punjab, Haryana and Himachal Pradesh:
Brief account of the following orders with ecological notes on the fishes mentioned below: Clupeiformes - Notopterus notopterus and Chitala chitala.
Cypriniformes: *Cyprinus carpio, Ctenopharyngodon idellus, Hypophthalmichthys molitrix, Labeo rohita, Catla catla, Cirrhinus mrigla, Salmo trutta fario* and *Salmo gairdneri gairdneri*,
Siluriformes: *Sperata seenghala, Heteropneustes fossilis, Clarias batrachus*
Channiformes: *Channa punctatus*
Perciformes: *Anabas anabas*
Mastacembeliformes: *Mastacembelus armatus*

**Culturable fishes**
Desirable traits for culturable fish, endemic fish culture, exotic fish culture, culture of Indian major carps, salt water fishes and air breathing fish

**Types of fish culture**
Integrated fish culture (Paddy/Duck/Piggery/Dairy/Plants), monoculture and polyculture (composite) and sewage fish farming

**UNIT – IV:**

**Induced breeding**
Natural and bundh breeding, fish seed collection from natural sources, breeding hapas, technique of induced breeding, hatcheries (Chinese and glass jar), use of synthetic chemicals for induced breeding

**Fish diseases and their control**
Protozoan, viral, bacterial, fungal, crustacean, helminthes nematodes and environmental stress (temperature, light, DO, pH, ammonia, bicarbonates, acidity, nutritional deficiency diseases).

**Fish preservation**
Chilling, freezing, salting, fermentation, drying and dehydration, smoking, pickling and spicing, and canning; rigor mortis
MSc. Zoology CBCS

MZO-MC2: AQUACULTURE AND FISHERIES
PRACTICALS

Credit: 1

1. Quantitative and qualitative analysis of phytoplankton and zooplankton from natural resources
2. Estimation of DO by Winkler’s method.
3. Estimation of BOD of the given water sample.
4. Estimation of free carbon dioxide content in water sample.
5. Determination of total hardness in the given water sample.
6. Determination of total alkalinity in the given water sample.
7. Estimation of Nitrates and Phosphates in water.
8. Determination of Primary productivity in an aquatic habitat.
9. Identification of the following fishes up to species level of Punjab, Haryana and Himachal Pradesh using already prepared field keys: *Notopterus notopterus*, *Chitala chitala*, *Cyprinus carpio*, *Ctenopharyngodon idellus*, *Hypophthalmichthys molitrix*, *Labeo rohita*, *Catla catla*, *Cirrhinus mrigla*, *Salmo trutta fario*, *Salmo gairdneri gairdnerii*, *Sperata seenghala*, *Heteropneustes fossilis*, *Clarias batrachus*, *Channa punctatus*, *Anabas anabas* and *Mastacembelus armatus*
10. Study of various culturable fish species.
11. Study of different bivalves involved in pearl culture.
12. Identification of spawn, fry, fingerling of male and female adult of Zebrafish.
13. Visit to a fish farm/lake/fish market/hatchery and report.

SUGGESTED READINGS

MZ0-MC3: INSECT ECOLOGY AND PHYSIOLOGY
THEORY

Total lectures:60(45+15) Credits: 4

Objectives

- To impart knowledge to students on ecological and physiological aspects of Insects, which dominate in number among all living organisms.
- To make the students understand the adaptations of these animals to their environment and the concept of insect societies.

UNIT – I

Salient features of different orders of insects, Preservation techniques.

Insect and its environment: Interrelations with living and non-living environment.

Extreme environments and insects: Desert insects, cave insects, high altitude insects, insects of torrential streams.

Insect - Plant Interactions: Mechanism of host plant selection, receptors systems and sensory perception in phytophagous insects, resistance of host plants to insect attack, Insect – pollinator interactions, Insect – Plant Gall Interactions.

UNIT–II

Insect Societies: Origin of sociality in insects, Ant society with reference to general habits including
- caste system
- nest construction
- communication
- brood care
- thermoregulation
- swarming
- feeding and foraging
- defense

UNIT – III

Physiology of digestion in insects including digestion of various types of food.

Gaseous exchange in terrestrial insects.

Physiology of excretion, salt and water metabolism and conservation of water in insects.

UNIT-IV

Neuro-endocrine organs, hormones and their role in development and metamorphosis.

Parthenogenesis and other atypical methods of reproduction in insects viz:

Paedogenesis, polyembryony, viviparity.

Effect of temperature and photoperiod, details of onset, termination and significance of diapause.
MZO-MC3: INSECT ECOLOGY AND PHYSIOLOGY
PRACTICALS
Credit: 1

1. Study of representatives from different insect orders in order to understand the salient features and diversity in insect groups.
2. Killing, pinning and stretching technique of insects.
3. Demonstration of dissection of various insects to study the alimentary canal and glands associated with the digestion of different types of food through charts/models/video clipping.
4. Demonstration of dissection of insect tracheation and spiracles through charts/models/video clipping.
5. Demonstration of dissection of various insects to demonstrate number, arrangement and associations of malpighian tubules through charts/models/video clipping.
6. Demonstration of dissection of an insect (cockroach/grasshopper) to expose neuroendocrine organs through charts/models/video clipping.
7. To study the effect of temperature and photoperiod on the development of insects.
8. To study of nest, castes and life stages of ants.
9. Project work

SUGGESTED READINGS
MZO-MC4: BIOLOGY OF PARASITES
THEORY

Total lectures: 60 (45+15)  
Credits : 4

Objective:

To enable the students to classify and study the variation in morphology, life cycle and pathogenesis of important parasites causing diseases in animals and human beings.

UNIT-I

Introduction to Parasitology: Establishment of infection: Active and Passive entry, site selection in their host, entry into specific organs and cells.
Parasite induced modifications of the host: Effect on behaviour, growth, parasitic, modifications of the host cell by microsporidians, piroplasms and Plasmodium.

UNIT-II

Classification and detailed account of medically parasitic protozoans: Plasmodium, Leishmania, Trypanosoma, Entamoeba, Trichomonas, Toxoplasma, Balantidium, Cryptosporidium, Sarcocystis, Isospora, Microsporidium
In vitro culture of parasites: Plasmodium, Entamoeba, Giardia, Leishmania, Trichomonas, Trypanosoma

UNIT-III

Classification and detailed account of medically important cestodes and their life cycle patterns: Taenia saginata, Echinococcus granulosus, Hymenolepis nana, H. diminuta, Diphyllobothrium latum.
Role of tegument in the digestion and uptake of nutrients.
Classification and detailed account of medically important trematodes and their life cycle:
Fasciola hepatica, Fasciolopsis buski, Schistosoma spp, Opisthorchis, Clonorchis sinensis.

UNIT-IV

Classification and detailed account of medically important nematodes and their life cycle patterns: Ascaris lumbricoides, Dracunculus medinensis, Filarial worms, Trichinella spiralis, Toxocara spp, Strongyloides stercoralis, Ancylostoma duodenale, Necator americanus, Enterobius vermicularis.
Ultrastructure of Sense Organs of parasitic nematodes.
MZO-MC4: BIOLOGY OF PARASITES
PRACTICALS
Credit: 1

Practical -1 Study of cestodes belonging to the family Anoplocephalida: Collection, stretching, fixation and preservation of permanent stained mounts of cestodes (Moniezia/Stilesia) collected from the small intestine of sheep/goat. Study of permanent slides - Taenia scolex, mature proglottids, cysticercus larva. T.S. of mature proglottid to demonstrate tegument, Echinococcus granulosus W.M., Hydatid cyst, Diphylobothrium latum mature proglottid, Dipylidium caninum scolex, mature proglottids.

Practical- 2 Study of trematodes belonging to the family Paramphistomidae: Collection, stretching, fixation and preservation of trematode (Gastrothylax/ Paramphistomum) from the small intestine of sheep/goat. Permanent stained preparation of trematodes (Gastrothylax, Paramphistomum, Fasciola). Study of permanent slides - Fasciola hepatica W.M., Clonorchissinensis W.M., Echinostoma W.M., Fasciolopsis buski W.M., Gastrothylax W.M., Paramphistomum W.M., T.S of Fasciola to demonstrate tegument, larval forms of Fasciola- sporocyst, redia, cercaria.

Practical -3 Study of nematodes infecting sheep and goat: Collection, stretching, fixation and preservation of nematodes (Trichuris globulosa, Oesophagostomum spp., Haemonchus contortus) from the large intestine of sheep/goat. Study of lactophenol cleared nematodes (Trichuris globulosa, Oesophagostomum spp., Haemonchus contortus, Oxyuris), study of permanent slide- Ancylostoma male & female, Wuchereria female.

Practical-4 Detailed morphological and histological studies of Ascaris: Dissect and expose the digestive, male and female reproductive system of Ascaris suum, study of mature eggs. Permanent slides - T. S. Ascaris male, T.S. Ascaris female.


Practical -6 Study of in vitro culture of Leishmania: Preparation of culture media, study of promastigotes grown cultured in NNN medium.

SUGGESTED READINGS


**ADDITIONAL READINGS**


M.Sc. in Zoology (Semester System)
Under the Framework of Honours School System

Choice Based Credit System (CBCS)

SEMESTER II
PAPERS - SEMESTER II
Semester II

PAPERS

Theory Papers:

MZO-MC5: Biology of Vertebrate Immune System 100 Marks (4 credits)
MZO-MC6: Methods and Applications of Molecular Biology 100 Marks (4 credits)
MZO-MC7: Environmental and Quantitative Biology 100 Marks (4 credits)
MZO-MC8: Methodology and Instrumentation 100 Marks (4 credits)

Practicals:

MZO-MC5: Biology of Vertebrate Immune System. 25 Marks (1 credit)
MZO-MC6: Methods and Applications of Molecular Biology 25 Marks (1 credit)
MZO-MC7: Environmental and Quantitative Biology 25 Marks (1 credit)
MZO-MC8: Methodology and Instrumentation 25 Marks (1 credit)

Total: 500 Total Marks (20 Total credits)

EVALUATION

1. There shall be one Mid Term Examination of 20% of the total marks (20 marks) in each semester.
2. End-semester examination will be of 80% of the total marks (80 marks).
3. There shall be continuous internal assessment for practicals of 20% marks (05 marks). The final examination will be of 80% marks (20 marks).

PATTERN OF END-SEMESTER QUESTION PAPER

(i) Nine questions in all with equal weightage (16 marks). The candidate will be asked to attempt five questions.
(ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
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Computation of Semester Grade Point Average (SGPA)

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Semester II

MZO-MC5: BIOLOGY OF VERTEBRATE IMMUNE SYSTEM THEORY

Total lectures: 60(45+15)  Credits: 4

Objectives:
□ To acquaint the students with the basic concepts of immunology and immune effector mechanisms.
□ To enable the students to learn the immune systems with emphasis on its clinical relevance.

UNIT-I

Historical Perspective and way to modern immunology: components of the immune system, principles of innate immunity (anatomical barriers, inflammation, soluble and membrane associated receptors, toll-like receptors, TLR signaling) and adaptive immunity.

Cells and Organs of the Immune System: Haematopoiesis, stem cells-clinical uses and potential, structure and function of primary and secondary lymphoid organs.


UNIT-II

Immunoglobulins: Fine structure of antibody, classes, effector functions.

Monoclonal antibodies: Basic steps in production, uses and clinical applications.

TCR: Organization and rearrangement of TCR genes, TCR-CD3 complex, T-cell maturation, activation and differentiation, TCR-mediated signaling.

B-cell generation, activation and differentiation, BCR, Signal transduction pathways activated by BCR

Cell mediated Cytotoxic Responses-CTLs & NK cells

UNIT-III

Immunity to parasites: Brief account of immunity to protozoan parasites (Plasmodium, Leishmania, Trypanosoma) and helminth parasites (Schistosoma)

Hypersensitivity: Mechanism and causes of anaphylactic shock, Arthus-type and cell mediated delayed hypersensitivity.

Cytokines: Properties, structure, receptors, antagonists, Th1 and Th2 specific cytokines, cytokine-related diseases and therapies.

UNIT-IV

Major Histocompatibility Complex: Distinguishing features of MHC, H2 complex, HLA complex, transplantation, T cell receptor.

Autoimmunity: Immunological tolerance and autoimmunity, major autoimmune diseases and immunosurveillance.

Vaccines: Types – subunit, conjugate and recombinant vector vaccines.
MZC-MC5: BIOLOGY OF VERTEBRATE IMMUNE SYSTEM PRACTICALS

Credit: 1

1. To study the histology of lymphoid organs through permanent slides.
2. Identification of different types of white blood cells from human blood.
3. To perform agglutination reaction using blood group typing kit.
4. To perform antigen-antibody interaction by Ouchterlony method.
5. To perform antigen-antibody reaction by ELISA.
6. To perform DOT-ELISA by using kit.

SUGGESTED READINGS


ADDITIONAL READINGS

MZO-MC6: METHODS AND APPLICATIONS OF MOLECULAR BIOLOGY THEORY

Objectives:

To enable the students to learn theoretical aspects and applications of molecular biology in various fields.

Unit-I

Basic recombinant DNA techniques: cutting and joining DNA molecules, restriction modification systems, various enzymes used in recombinant DNA technology, restriction maps and mapping techniques; nucleic acid probes, blotting techniques, DNA fingerprinting, footprinting, methyl interference assay.

Unit-II

Basic biology of cloning vectors: plasmids, phages, single stranded DNA vectors, high capacity vectors, retroviral vectors, expression vectors and other advanced vectors in use. Gene cloning strategies: methods of transforming \textit{E. coli} and other cells with rDNA; methods of selection and screening of transformed cells; construction of genomic and cDNA libraries.

Unit-III

Polymerase chain reaction– method, types and applications, LCR, Principles of DNA sequencing, automated sequencing methods, Next gen. sequencing; synthesis of oligonucleotides, primer design; micro-arrays; Site directed mutagenesis.

Unit-IV

Manipulating genes in animals: gene transfer to animal cells; genetically modified organisms: gene knockouts, mouse disease models; gene therapy: somatic and germ-line therapy, applications of recombinant DNA technology.
MZO-MC6: METHODS AND APPLICATIONS OF MOLECULAR BIOLOGY PRACTICALS

Credit: 1

1. Plasmid DNA isolation.
2. Genomic DNA isolation.
3. Agarose gel electrophoresis of DNA/RNA.
4. DNA quantization and purity of DNA.
5. Restriction enzyme digestion of DNA.
6. Purification of DNA from an agarose gel.
7. Demonstration of Polymerase Chain Reaction.
8. Isolation of proteins and separation on SDS-PAGE.
9. Micronucleus assay

SUGGESTED READINGS


ADDITIONAL READINGS

Research journals and review articles as suitable and applicable.
MZo-MC7: ENVIRONMENTAL & QUANTITATIVE BIOLOGY THEORY

Credits: 4

Objectives

☐ To impart students with quantitative methods for analysing the effect of toxicants on fish.
☐ To make them learn the various structural indices being used for estimation of fish age and growth parameters.
☐ To make them learn the statistical parameters for analysis of biological data sets.

UNIT – I:

Toxicity bioassays
Uses of toxicity assays, terminology, types of toxicity assays, test organism (fish), fish selection and culture procedures, test procedures and analyzing results of toxicity assays

Length-weight index and determination of age & growth in fish
Length-weight relationship, condition factor, length-frequency analysis, conventions for age designations, use of hard parts (choice and techniques), back calculation of annular growth (Le-Cren and Fraser-Lee method) and validation and verification of marks on hard parts

Quantitative description of the diet
Sampling strategies, removal, fixation and preservation of gut contents, identification of diet components, quantitative description of diet and data analysis

UNIT – II:

Epidemiology: Definition, meaning, history, concept and scope, descriptive and analytical epidemiology, epidemiological triad – Person, Place and Time Factors: Physical factors biological factors and socio-economic factors

Detection of Epidemics: Verification, confirmation, identification of cases, data analysis and Hypothesis

Demographic Studies: Fertility, mortality, population size and population pyramid

UNIT – III:

Sample and sampling
Collection and presentation of data, construction of graph when different types of biological data

Distribution patterns
Normal distribution: Normal distribution curve; and its properties, Z-score, skewness and kurtosis

Test of significance
Hypothesis testing; Type I and Type II Errors; p value and power t-test and chi-square test.
UNIT – IV:

**Measures**
Measures of central tendency (mean mode and median), measures of dispersion (range, standard deviation and variance)

**Correlation coefficient**
Types – positive/negative, partial/linear, methods of estimating correlation coefficient – scatter diagrams, Karl Pearson’s coefficient of correlation, Spearman’s rank correlation and concurrent correlation

**Regression analysis**
Independent and dependent variables, linear regression analysis, regression equation, regression coefficient
MZO-MC7: ENVIRONMENTAL & QUANTITATIVE BIOLOGY PRACTICALS

Credit: 1

1. Recording of morphometric and meristic data from fish.
2. Estimation of the gut contents of the commercial fish species.
3. To study the composition of microbiota of fish gut by plate count method or spread plate method.
4. Study of different kinds of hard parts used for age determination in fish.
5. Study of circuli and annuli on the scale or any other part on the scale reader.
6. Calculation of length-weight equation from the data recorded from the set of fish given.
7. Calculation of Karl Pearson’s correlation coefficient from the recorded data sets.
8. Calculation of Spearman’s ranking correlation from the given data set.
9. Calculation of mean, mode, median of the given data sets.
10. Construction of different kinds of graphs from the morphometric and meristic data recorded.
11. Determination of the regression equation from the data sets

SUGGESTED READINGS

MZO-MC8: METHODOLOGY AND INSTRUMENTATION THEORY

Objectives

To acquaint the students with various instruments used in scientific laboratories and to make them understand the basic principles involved in the important techniques used in scientific research.

UNIT – I

Microscopy: Principle, structural parts and applications of compound microscope, phase-contrast microscope, differences of phase contrast and interference microscope, fluorescent microscope, confocal microscope, scanning and transmission electron microscope, differences between SEM and TEM

Cell fractionation method: Different mechanical and chemical procedures, different types of centrifugal machines, principle of centrifugation, methods of ultra-centrifugations and their applications, different kinds of rotors and structural parts of an analytical ultracentrifuge.

UNIT – II

Chromatography: Principles of chromatography, paper chromatography, thin layer chromatography, gas chromatography, gel permeation chromatography, ion exchange chromatography, high pressure liquid chromatography and affinity chromatography.

Flow cytometry: Principles and its applications, cell sorting. Enzyme linked Immunosorbent Assay

UNIT – III

Electrophoresis: Principle of electrophoresis, polyacrylamide gel electrophoresis and SDS-PAGE, agarose gel electrophoresis, isoelectric focusing, applications of electrophoresis - distinguishing of Phage DNA, detection of plasmids, separation of DNA molecules.

Tissue culture techniques: Aseptic and sterilization techniques, factors effecting cell growth in vitro; specialized cell culture techniques.

UNIT – IV

Spectroscopy: Principle, instrumentation and applications of UV-Visible and Fluorescence spectroscopy
Radioisotopes: Radioactive isotopes, half life of isotopes, detection and measurement of radioactivity (Gas ionization, scintillation and autoradiography), applications of radioisotopes in biological sciences.

MZO-MC8: METHODOLOGY AND INSTRUMENTATION

PRACTICALS

Credit: 1

1. To study the parts of the compound microscope, fluorescent microscope and phase-contrast microscope and their maintenance.
2. To study the living material under the phase contrast microscope.
3. To find out the diameter, area and circumference with the help of stage micrometer and occulometer.
4. To sketch the diagram of any tissue with the help of camera lucida and to draw its magnification line.
5. Demonstration of section cutting and mounting of sections on the grid for SEM and TEM. Demonstration of SEM & TEM in the CIL lab.
6. Demonstration of working of ultracentrifuge.
7. To separate a sample of amino acids with the help of paper chromatography and TLC.
8. To do a short term in vitro culture of a parasite.
9. Demonstration of SDS-PAGE and western blotting to students.
10. To demonstrate ELISA to students.

SUGGESTED READINGS:

Objectives
To acquaint the students with the biochemical events that occur at the molecular level including structure, chemical properties and biological significance of macromolecules of physiological importance.

UNIT – I
Introduction: Importance of Biochemistry in Animal Sciences
Carbohydrates: General structure, classification and chemical properties of carbohydrates.

Lipids: Simple lipids, general structure and chemical properties of simple lipids.
Compound lipids: Structure of phospholipids like lecithins, lysolecithins, cephalins, phosphatidyl serine, phosphatidyl inositol, plasmalogens, cardiolipids, sphingomyelins, glycolipids, cerebrosides, gangliosides, properties and functions of phospholipids.
Derived lipids: Cholesterol and steroid hormones (chemistry), biological functions of lipids.

UNIT – II
Proteins: Amino acids as monomers of proteins and their properties, types of proteins and their classification, levels of protein structure and forces stabilizing protein structure and shape, the conformation of proteins, subcellular assemblies of protein, functions and their denaturation.
Conjugated proteins: Lipoproteins, glycoproteins, nucleoproteins, metalloproteins and chromoproteins, biological functions of proteins.
Nucleic acids: Molecular structure and biological functions of DNA & RNA molecules, Z-DNA and its biological significance, physical properties of nucleic acid - denaturation of DNA, hydrolysis of nucleic acids, nucleic acids and protein interaction.

UNIT - III
Enzymes: Enzyme kinetics, mode of action of enzymes and biochemical role of coenzymes and isoenzymes, effect of enzyme concentration, substrate concentration and pH on enzyme activity, mechanism of enzyme action - a brief description, allosteric enzymes, concentration of effector, feed back inhibition - various mechanisms, covalent modifications irreversible and reversible.
Oxidation of fatty acids: Oxidation, biosynthesis of saturated and unsaturated fatty acids.

UNIT – IV

Metabolism: ATP - cycle, energy rich phosphate compounds, major pathways of catabolism of carbohydrates. glycolysis, tricarboxylic acid cycle, phosphogluconate pathway, glycogenolysis.

Mitochondrial - Electron Transport Chain, mechanism of mitochondrial oxidative phosphorylation, inhibitors of electron transport chain, inhibitors and uncouplers of mitochondrial oxidative phosphorylation.

Note: In all, nine questions to be set and five to be attempted. Q.No.1 is compulsory covering entire syllabus. It will consist of ten short answer questions of 2 marks each. For the remaining eight questions, two to be set from each unit, each carrying 15 marks. The candidate will be required to attempt one question from each unit.

BOOKS RECOMMENDED


Practicals based on Paper MZO 7101 (MZO 7151)

15. Qualitative estimation of proteins.
   • Quantitative estimation of proteins by Lowry’s Method.
   • Quantitative estimation of proteins by Bradford assay.
   • Qualitative estimation of fats.
   • Quantitative estimation of cholesterol.
   • Quantitative estimation of DNA.
   • Quantitative estimation of RNA.
   • Determination of acid phosphatase activity.
   • Effect of different substrate concentration on enzyme activity.
SEMESTER IV

Special Paper (either of these)

Paper XII Marks

i. Limnology & Fisheries
ii. Entomology
iii. Concepts in Parasitology 100
iv. Genetics & Molecular Cytogenetics
v. Stress & Reproductive Physiology

Dissertation 250
Seminar 50
Viva-voce test 60

(i) LIMNOLOGY & FISHERIES (MZO 7201)

Time: 3 hrs.
Total Marks: 100
Sem. Exam.: 80
Int. Ass.: 20

Theory hours per week: 4

Objectives
To acquaint the students about aquatic biodiversity in different water bodies in relation to the hydrobiological factors. Emphasis has been given to understand the techniques used in fish culture and management of fish ponds.

UNIT - I (LIMNOLOGY)
Physico-chemical characteristics of water in relation to biota: Temperature, light and turbidity, dissolved oxygen, carbon dioxide, pH, nitrogen, phosphorus.

Plankton: Classification, distribution, diurnal movements of plankton.

Benthos: Zonation, phyto and zoo-benthos.

Lotic Waters: Characteristics and adaptations of organisms.

Thermal stratification in lakes.

UNIT - II
Aquatic ecosystem: Components, food chain, ecological energetics.


Bog Lakes: Physico-chemical conditions, biotic conditions - nature and quantity of plankton, faunal characteristics.

Aquatic pollution: Aquatic pollution in relation to biota, thermal pollution, treatment of waste waters - primary, secondary and tertiary, BOD and saprotric classification of waters, bioindicators of water pollution.
Role of limnology in the management of fish ponds.

UNIT - III (FISHERIES)

History of Indian fisheries.

Morphology of the following category of fishes: carp, cat-fish, perch, eel.

Indus and Ganga river system: Riverine fisheries of these two major river systems of India, their physico-chemical characteristics and important fishes.

Gobindsagar and Pong reservoir: Fishery, location, physico-chemical characteristics, management and present status of these reservoirs.

Fish culture in freshwater ponds: Kinds of ponds (contour, barrage, paddy), parts of ponds (walls, pond inlet, pond outlet, overflow, shape, size & depth), soil type, water quality, nursery pond, rearing pond, stocking pond, feeding pits, hatching pits, marketable tanks, hospital tanks.

Culturable fishes: Indian major carps, salt-water fishes, exotic fishes, air-breathing fishes.

Fish breeding: Types of breeding (natural and bundh breeding), fish seed collection from natural resources.

UNIT - IV

Types of fish culture: Composite-culture (fish-cum-paddy, fish-cum-duck, fish-cum-dairy), monoculture, sewage fish farming.

Induced breeding: History, technique, P.G. injection, use of synthetic chemicals for induced breeding.

Fish diseases and their control: Protozoan, viral, bacterial fungal, crustacean, helminthes, nematodes, environmental stress (temperature, light, DO, pH, ammonia, bicarbonates, acidity, nutritional deficiency diseases).

Note: In all, nine questions to be set and five to be attempted. Q.No.I is compulsory covering entire syllabus. It will consist of ten short answer questions of 2 marks each. For the remaining eight questions, two to be set from each unit, each carrying 15 marks. The candidate will be required to attempt one question from each unit.

BOOKS RECOMMENDED


(ii) ENTOMOLOGY  (MZO 7202)

Time :  3 hrs.
Total Marks : 100
Theory hours per week : 4
Sem. Exam. : 80
Int. Ass. : 20

Objectives:
The paper will provide the students, the much needed information about insect pests related to food crops and human health. It will inform them about the suitable methods of control.

UNIT - I
Systematic position, host plants, nature of damage and outlines of the life cycle of the following pests of crops, vegetables and fruits :

A. Crops:

Cotton : Pectinophora gossypiella (Pink bollworm), Empoasca devastans (cotton jassid), Bemisiata baci (cotton white fly), Dysdercus cingulatus (Red cotton bug), Myllocerus maculosus (Cotton grey weevil).

Sugarcane : Pyrilla perpusilla (Sugarcane leaf hopper), Aleurolobus barodensis (Sugarcane white fly), Scirpophaga nivella (Sugarcane top borer), Chilo infuscattellus (Sugarcane shoot borer).

Paddy : Hieroglyphus banian (Rice grass hopper), Dicladispa armigera (Rice Hispa), Leptocorisa varicornis (Gundhi bug).

Wheat : Tanymecus indicus (Ghujhia weevil), Mythimna separata (Army worm), Sesamia inferens (Wheat stem borer).

12. Vegetables : Pieris brassicae (Cabbage caterpillar), Plutella xylostella (Diamond-black moth), Urentiussentis (Brinjal lace wing bug), Epilachna Vigintioco punctata (Hadda beetle), Raphidopalpa foveicollis (Red Pumpkin beetle).

13. Fruits : Drosicha mangiferae (Mango mealy bug), Dacus dorsalis (Mango fruit fly), Diaphorina citri (Citrus psylla).
UNIT – II
Pests of stored food products with particular reference to their habits, nature of damage caused by them and outlines of their life cycles:

*Callosobruchus maculatus* (Pulse beetle), *Sitophilus oryzae* (Rice weevil), *Rhizopertha dominica* (Lesser grain borer), *Trogoderma granarium* (Khapra beetle), *Tribolium castaneum* (Rust-red flour beetle), *Sitotroga cerealella* (Angoumois grain moth).

(i) Insects of medical and veterinary importance: (Mosquito, house fly, tsetse fly, sand fly, horse fly, blow fly, bot fly, warble fly, poultry louse, sucking louse, fleas, with particular reference to their systematic position, mode of infection and diseases caused by them.

UNIT - III
History of insect pest control, simple devices such as mechanical and cultural control.

Biological control of insect pests with reference to principles, strategies, use of parasites, predators and pathogens.
Integrated pest management (IPM).

UNIT - IV
**Chemical control of insect pests including classification of insecticides:** stomach poisons, contact poisons, botanicals, systemics, fumigants, common examples from each class and their mode of action, synergistic substances, resistance to pesticides.

**Physical methods of pest control:** use of radiations and chemosterilants, history and principle of sterile insect release method (SIRM).

Note: In all, nine questions to be set and five to be attempted. Q.No.1 is compulsory covering entire syllabus. It will consist of ten short answer questions of 2 marks each. For the remaining eight questions, two to be set from each unit, each carrying 15 marks. The candidate will be required to attempt one question from each unit.

**BOOKS RECOMMENDED**

(iii) CONCEPTS IN PARASITOLOGY (MZO 7203)

Time : 3 hrs.
Total Marks : 100
Theory hours per week : 4
Sem. Exam. : 80
Int. Ass. : 20

Objectives:
To enable the students to understand the basic concepts in parasitology and acquaint them with the different types of host parasite interactions, immune response generated during parasitic infections, ecological adaptations and transmission of the parasites. It will enable the students to understand the different vectors involved in transmission of parasitic diseases and various aspects involved in their diagnosis.

UNIT - I
Different types of animal associations: definitions; phoresis, commensalism, parasitisim, mutualism, hyperparasitism.

Evolution of parasites: Origin of parasitism, possible evolutionary pathways, adaptation to multiple hosts, some evolutionary patterns.

UNIT - II
Parasite host specificity: Kinds of parasite - host specificity, specificity factors related to infection and growth: host specificity of protozoa and helminth parasites.

Diagnosis of parasitic infections: Protozoans parasites, helminthic parasites.

UNIT - III
Host parasite interactions: Immunity to protozoans and helminths.

Pathogenesis of parasitic infection.

Vectors: Brief account of various insect vectors of human parasitic infections.

UNIT - IV
Parasite transmission: Introduction, mechanism for location of host, mechanism for penetrating the host, circadian rhythm associated with transmission.

Ecology of parasites: Ecological niche, host size, age and parasite numbers, biologic control, role of metazoan parasites in transmission of microbial infections.

Note: In all, nine questions to be set and five to be attempted. Q.No.1 is compulsory covering entire syllabus. It will consist of ten short answer questions of 2 marks each. For the remaining eight questions, two to be set from each unit, each carrying 15 marks. The candidate will be required to attempt one question from each unit.

BOOKS RECOMMENDED

1. GENETICS & MOLECULAR CYTOGENETICS (MZO 7204) Time :
   3 hrs. Total Marks
   : 100
Theory hours per week : 4
Sem. Exam. : 80
Int. Ass. :  20

Objectives:
To acquaint students with organization of genome and specialized chromosomes. To understand basic principles of genetics and its applications.

UNIT - I
Organization of the genetic material: Fine structure of eukaryotic chromosomes, chromosome models, chromosomal proteins, nucleosome concept, various types of DNAs-satellite DNA, palindromic DNA, promiscuous DNA, mitochondrial DNA.

Split genes, overlapping genes, plasmids, IS elements, transposons and retroposons.

Specialized chromosomes: Lampbrush chromosomes - Methods of preparation, distribution of lampbrush chromosomes, structure in detail of the chromosomes in amphibians, in Drosophila spermatocytes and other organisms, significance of the studies of the lampbrush chromosomes.

UNIT - II
Polytene chromosomes: Distribution of the polytene chromosomes, organization and structure , relationship between the bands and genes, the puffing mechanism, DNA replication in polytene chromosomes, polytene chromosomes in the hypotrichous ciliates.

Mechanism of chromosome pairing: Synapsis and synaptonemal complex-structure and composition, attachment, biochemical process of pairing and synapsis. Synaptonemal complex in achiasmate meiosis, synaptonemal complex in non-homologous pairing, recombination nodules and their role in meiotic pairing, polycomplexes.

UNIT - III
Chromosome banding: Chromosome bands - What do they represent,techniques and their mechanisms, classification of bands, importance of banding, differences between banding of metaphase chromosomes and polytene chromosomes.

Gene expression: Transcription- In prokaryotes-RNA polymerase in E.coli, initiation, elongation and termination of RNA synthesis in prokaryotes. In eukaryotes RNA polymerases in eukaryotes, transcription factors and initiation of RNA synthesis, transcription factors for elongation of RNA chain, termination of RNA synthesis. RNA processing - capping, polyadenylation, splicing, introns and exons.
UNIT - IV

Translation: Activation of amino acids, transfer of amino acids to tRNA, initiation of synthesis, elongation of the polypeptide chain and chain termination.

Genetics of prokaryotes. Sexuality and recombination in bacteria and viruses - Transfer of genetic material-transformation, transduction and conjugation.

Applied genetics: Recombinant DNA, molecular probes, gene libraries and PCR.

Note: In all, nine questions to be set and five to be attempted. Q.No.1 is compulsory covering entire syllabus. It will consist of ten short answer questions of 2 marks each. For the remaining eight questions, two to be set from each unit, each carrying 15 marks. The candidate will be required to attempt one question from each unit.

BOOKS RECOMMENDED
• STRESS & REPRODUCTIVE PHYSIOLOGY (MZO 7205) Time : 3 hrs.

Theory hours per week : 4

Total Marks : 100
Sem. Exam. : 80
Int. Ass. : 20

Objectives:
To make the students aware about the physiological processes and the effects of stress on vertebrate physiology.

UNIT – I
Introduction : Physical and biological concept of stress and strain, stress and tolerance (conformity) avoidance, (retaliation), type of strain, injuries and homeostasis.

Thermal Stress : Ranges of environmental temperatures, heat exchange between organisms and environment, body temperature in aquatic amphibious and terrestrial animals to high and low temperature.

UNIT - II
Solvent and Solute Stress ; Osmotic and solute requirement of living organisms, principles of Water and solute movement. Patterns of body fluid, regulation in aquatic, amphibians and terresterial animals. Adaptive mechanism of body fluid balance under solvent and solute stress.

Atmosphere Pressure Stress : Structural and rate effects of pressure stress; mechanisms of adaptation in animals to high altitude and during prolonged diving.

UNIT - III
Aviation and Space Stress: Effects of centrifugal and linear acceleratory forces, perception of equilibrium and turning in blind flying, radiation at high altitude and in space, weightlessness in space.

Structure and physiology of mammalian ovary, folliculogenesis, corpus luteum and its functions.

Vertebrate reproductive cycles and factors regulating them.

UNIT - IV
Physiology of mammalian testis, sertoli cell-germ cell interaction, functions of Leydig cells, sperm maturation and capacitation.
Hypothalamic - pituitary - gonadal interaction.
Fertilization in mammals, and in vitro fertilization; parturition, lactation.

Note : In all, nine questions to be set and five to be attempted. Q.No.1 is compulsory covering entire syllabus. It will consist of ten short answer questions of 2 marks each. For the remaining eight questions, two to be set from each unit, each carrying 15 marks. The candidate will be required to attempt one question from each unit.

BOOKS RECOMMENDED


Balian and Glasser, Reproductive Biology by Excerpta Media Amsterdam (1984).
