

# **GOVT. BILASA GIRLS' POST-GRADUATE COLLEGE**

**[AUTONOMOUS]**



**BILASPUR (C.G.)**  
[Affiliated to Bilaspur University]

**SYLLABUS**  
**M.Sc. [Zoology]**  
**Semester I & II**

**Session - 2021-22**

## **SCHEME OF EXAMINATION**

1. Each Semester will have **FOUR** Theory papers and **TWO** Practicals, carrying 100 marks each.
2. Theory papers will have External and Internals examinations of 80 and 20 marks respectively. Passing with 36% of marks is compulsory in external and internal examinations separately as per table below.
- 3 Each Theory paper will contain eight questions out of which four questions will be required to be solved.
4. It will be compulsory for the candidate to appear in test and seminar before semester examination.

### **Scheme of Marks in each Semester**

Paper	External Examination (Theory Papers)		Internal Examination (Test & Seminars)		Total Max. Marks (External + Internal)
	Max. Marks	Mini. Pass marks	Max. Marks	Mini. Pass marks	
Paper I	80	29	20	07	100
Paper II	80	29	20	07	100
Paper III	80	29	20	07	100
Paper IV	80	29	20	07	100
Practical I	100	36			100
Practical II	100	36			100
<b>Grand Total</b>					<b>600</b>

<b><u>SEMESTER – I</u></b>			
<b>Paper</b>	<b>– I</b>	<b>Structure and Function in Invertebrates</b>	<b>80</b>
<b>Paper</b>	<b>– II</b>	<b>Biosystematics and Taxonomy</b>	<b>80</b>
<b>Paper</b>	<b>– III</b>	<b>General and Comparative Endocrinology</b>	<b>80</b>
<b>Paper</b>	<b>– IV</b>	<b>Molecular Cell Biology</b>	<b>80</b>
<b>Practical</b>	<b>– I</b>	<b>Structure &amp; Function in Invertebrate Biosystematics</b>	
		<b>&amp; Taxonomy</b>	<b>100</b>
<b>Practical</b>	<b>– II</b>	<b>General Comparative Endocrinology &amp; Molecular</b>	
		<b>Cell Biology</b>	<b>100</b>
<b><u>SEMESTER – II</u></b>			
<b>Paper</b>	<b>– I</b>	<b>Morphology and Physiology of Insects</b>	<b>80</b>
<b>Paper</b>	<b>– II</b>	<b>Population Genetics and Evolution</b>	<b>80</b>
<b>Paper</b>	<b>– III</b>	<b>Animal Behaviour</b>	<b>80</b>
<b>Paper</b>	<b>– IV</b>	<b>Tools and Techniques for Biology</b>	<b>80</b>
<b>Practical</b>	<b>– I</b>	<b>Insect physiology and Population genetics &amp;</b>	
		<b>Evolution</b>	<b>100</b>
<b>Practical</b>	<b>– II</b>	<b>Animal behavior &amp; Tools and Techniques</b>	
		<b>For Biology</b>	<b>100</b>

**Semester – I**  
**PAPER - I**  
**STRUCTURE AND FUNCTION IN INVERTEBRATES**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **Classification of invertebrates upto the orders.**
- **Locomotion :**
  - **Types of Pseudopodia and Theories of Amoeboid locomotion.**
  - **Flagella and ciliary movement in Protozoa**
  - **Hydrostatic movement in Coelentrata and Echinodermata**
- **Canal system in Porifera :**
  - **Ascanoid**
  - **Sycanoid**
  - **Leucanoid**
- **Polymorphism in Coelentrata, Corals.**
- **Nutrition and digestion :**
  - **Patterns of feeding in lower metazoa**
  - **Filter feeding in Polychaeta**
- **Respiration :**
  - **Organs of Respiration : Gills, Lungs, Trachea**
- **Excretion :**
  - **Organ of excretion, Protonephridia, Nephridia**
  - **Coelomoducts, & Nephridia.**
  - **Malpighian tubules**
- **Water vascular canal in Echinodermata**
- **Nervous systems :**
  - **Primary Nervous system : Coelentrata and Echinodermata**
  - **Advanced Nervous system : Mollusca**
- **Major Larval form of invertebrates :**
  - **Structure and development of Trochophore and its phylogenetic significance.**
  - **Larval forms of Crustacea, Larval forms of Echinodermata**

***Suggested Reading Material***

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 Ltd., London.
3. Jagestein, 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 & London
6. Barnes, R.D. Invertebrate Zoology, III edition, W.B. Saunders Co., Philadelphia.

7. Russel-Hunter, W.D. A biology of higher invertebrates, Macmillan 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, Macmillan Co., London.

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**Semester – I**  
**PAPER - II**  
**BIOSYSTEMATICS & TAXONOMY**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **Definition and concepts of Biosystematics and Taxonomy -**
  - **Historical resume of biosystematics in biology**
  - **Importance and applications of biosystematics in biology**
- **Trends in biosystematics - Concepts of different conventional and newer aspects -**
  - **Chemotaxonomy**
  - **Cytotaxonomy**
- **Dimensions of speciation and taxonomic characters -**
  - **Species category, Different species concepts, sub-species and other infra-specific categories.**
  - **Theories of Zoological classification, Hierarchy of categories.**
  - **Taxonomic characters :- Different kinds, origin of reproductive isolation.**
- **Procedure Keys in Taxonomy -**
  - **Taxonomic collections, preservation, curation process of identification.**
  - **Process of typification and different Zoological types.**
  - **Outline idea of International Code of Zoological Nomenclature**
  - **(ICZN) - its operative principles, interpretation and application.**

***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 IBH Publishing Co.
4. E. Mayer, Elements of Taxonomy
5. E.O. Wilson. The Diversity of Life (The College Edition). W.W. Norton & Co.
6. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

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## Semester – I

### PAPER - III

#### **GENERAL AND COMPARATIVE ENDOCRINOLOGY**

Time : 3 hrs.

Max. Marks – 80

Min. Marks – 29

- **Aims and scope of endocrinology:**
  - **Hormones as messengers**
  - **Classification of Hormones**
  - **Discovery of Hormones**
  - **Experimental methods of Hormone research**
- **Phylogeny of Endocrine glands (Pituitary, Pancreas, Adrenal, Thyroid)**
- **Neuroendocrine system, Neurosecretion.**
- **General principles of Hormone action -**
  - **Nature of Hormone action**
  - **Signal transduction mechanisms**
  - **Hormone receptor**
- **Hormones and Homeostasis**
- **Hormonal regulation of carbohydrate, nitrogen and lipid metabolism**
- **Biosynthesis and secretion of Hormones -**
  - **Biosynthesis of steroid hormone**
  - **Biosynthesis of amino acid derived small size hormone (T<sub>4</sub>, Epinephrine)**
- **Hormone and Behaviour**
- **Hormones and Reproduction**
  - **Seasonal breeder**
  - **Continuous breeder**
- **Hormones and Development**
- **Hormones and Growth**

#### ***Suggested Reading Material***

1. E.J.W. Barrington. General and Comparative Endocrinology, Oxford, Clarendon Press
2. P.J. Bentley. Comparative Vertebrate Endocrinology. Cambridge University Press.
3. R.H. Williams. Text Book of Endocrinology. W.B. Saunders.
4. C.R. Martin. Endocrine Physiology. Oxford Univ. Press.
5. A Gorbman et al. Comparative Endocrinology, John Wiley & Sons.

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**Semester – I**  
**PAPER - IV**  
**MOLECULAR CELL BIOLOGY**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **Biomembranes : Structure, Molecular composition and function, of Plasma Membrane, Specialization of Plasma Membrane, Transport across cell membrane, Diffusion, Facilitated Diffusion, Ion channel, Active transport and pumps, Uniports, Symports and Antiports.**
- **Cytoskeleton**
  - Microfilaments and microtubules - structure and dynamics
  - Cell movements - intracellular transport
- **Cilia and flagella**
- **Cell-Cell adhesion and communication -**
  - $\text{Ca}^{++}$  dependent homophilic cell-cell adhesion
  - $\text{Ca}^{++}$  independent homophilic cell-cell adhesion
- **Cell Organelles:**
  - Mitochondria, Ribosome, Golgi bodies, Endoplasmic Reticulum
- **Morphological and functional elements of Eukaryotic chromosome**
  - DNA – Structure, Replication & Genetic Code, Repetitive DNA
  - RNA – Structure, Transcription
  - Transposon
- **Intracellular Protein traffic**
  - Protein synthesis in prokaryote and eukaryote
  - Uptake into E.R.
  - Uptake into Mitochondria
- **Biology of Cancer**
- **Biology of ageing**
- **Apoptosis - Definition, mechanism and significance**
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***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. Molecular Cell Biology, P.K. Gupta
4. Molecular Cell Biology, D. Robertis

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## **SEMESTER – I**

### **Practical – I**

**(Structure & Function in Invertebrates and  
Biosystematics & Taxonomy)**

**Time : 6 Hrs.**

**M.M. 100**

1. Dissection of various animals (Prawn, Squilla, Unio, Mytilus, Aplysia, Octopus, Holothuria, Sea Urchin – depending upon availability of dissecting material / study through alternative methods of dissection.
2. Preparation of slides by mounting of suitable materials.
3. Study of museum specimens from invertebrate phyla.
4. Study of histological studies from protozoa to Echinodermata.
5. Exercise related to Taxonomy.
6. Collection of fauna through field trips and excursion.

#### **Scheme of Examination :**

1.	Major Dissection	-	15
2.	Minor Dissection	-	10
3.	Micropreparation	-	10
4.	Exercise related to Taxonomy	-	15
5.	Spots (1 - 10)	-	20
6.	<i>Viva-voce</i>	-	10
7.	Record / Sessional	-	20
TOTAL			- 100

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## **SEMESTER – I**

### **Practical – II**

**(General Comparative Endocrinology & Molecular Cell Biology)**

**Time : 6 Hrs.**

**M.M. 100**

1. Dissection of Invertebrate/Vertebrate animal to show the position of Endocrine gland depending upon availability of dissecting material / study through alternative methods of dissection.
2. Histological study of various Endocrine glands and blood.
3. Microtomy of Endocrine tissues.
4. Study of Mitosis and Meiosis.
5. Study of Cell Organelles, Giant Chromosome, Cilia, Flagella.
6. Histological study of Cancer cell.

#### **Scheme of examination:**

1. Dissection (showing position of Endocrine glands in invertebrates/vertebrates)	-	10
2. Spots (Related to Endocrine glands)	-	10
3. Histological preparation of Endocrine tissue	-	20
4. Study of Mitosis/Meiosis cell division	-	10
5. Study of cell organelles	-	10
6. Histological study of Giant Chromosome and Cancer cells/ Case study of Endocrine disorder.	-	10
7. <i>Viva-voce</i>	-	10
8. Record / Sessional	-	20
<b>TOTAL</b>	<b>-</b>	<b>100</b>

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**Semester - II**  
**PAPER - I**  
**MORPHOLOGY & PHYSIOLOGY OF INSECTS**

Time : 3 hrs.

Max. Marks – 80

Min. Marks – 29

- Outline classification of class Insecta upto orders.
- Head capsule and Head segmentation
- Structure and function of Integument
- Structure and modification of wings, Hypothetical wing venation
- Structure of typical legs and modification of legs
- Mouth parts - structure and variation among various insects and mechanism of feeding.
- Digestive system and physiology of digestion.
- Respiration in aquatic and terrestrial insects, and physiology of Respiration.
- Sense organs and perception
- Nervous system - General plan
- Physiology of Excretion
- Male and female reproductive systems, Pheromones.
- Endocrine system in insects, endocrine control of Moulting, Metamorphosis and Diapause.
- Diapause

***Suggested Reading Material***

1. Insect Physiology : V.B. Wigglerworth
2. The Insect structure and function : R.F. Chapman
3. Principles of Insect Morphology : R.E. Snodross
4. A Text book of Entomology : H.H. Ross
5. Introduction to Comparative Entomology : Fox and Fox
6. A General Text book of Entomology : A.D. Imms Revised by Richards & Davies
7. A Text book of Insect Morphology, Physiology & Endocrinology : D.B. Tembhare

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**Semester - II**  
**PAPER - II**  
**POPULATION GENETICS AND EVOLUTION**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **Concept of Evolution and theories of Organic Evolution with an emphasis on Darwinism, Neutral Theory of Evolution**
- **Neo-Darwinism -**
  - **Hardy-Weinberg Law of genetic equilibrium.**
  - **A detailed account of destabilizing forces –**
    - (i) Natural Selection      (ii) Mutation      (iii) Genetic drift**
    - (iv) Migration              (v) Meiotic drive.**
- **Genetics of Quantitative traits in population.**
  - **Analysis of quantitative traits.**
  - **Inbreeding depression and heterosis.**
- **Genetics of speciation.**
  - **Models of speciation (Allopatric, Sympatric and Parapatric).**
  - **Patterns and mechanisms of reproductive isolation.**
  - **Major trends in origin of higher categories.**
  - **Macro and micro Evolution.**
- **Molecular Evolution**
  - **Gene Evolution**
- **Molecular phylogenetics.**
  - **How to construct Phylogenetic trees ?**
  - **Molecular Clock.**
  - **Immunological techniques.**

***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, Suinaer 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. Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and Genetics. Holt, Rinchart and Winston Inc.
8. Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.
9. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston, London

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**Semester – II**  
**PAPER - III**  
**ANIMAL BEHAVIOUR**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **Introduction:**
  - **Ethology as a branch of Biology (History of Ethology)**
  - **Observation and description.**
- **Economical and social aspect of behaviour study:**
  - **Social organization of insects.**
  - **Aggression (schooling in fishes, flocking in birds)**
  - **Territoriability.**
- **Communication: Chemical, Visual, Audio, Specificity of songs.**
- **Learning and Memory:**
  - **Conditioning**
  - **Habituation**
  - **Insight learning**
  - **Reasoning.**
- **Reproductive behaviour:**
  - **Mating system**
  - **Sexual selection**
- **Ecological aspect of behaviour:**
  - **Feeding strategies.**
  - **Homing**
- **Bird migration.**
- **Fish migration.**

***Suggested Reading Material***

1. Alcock, J. Animal behavior : An evolutionary approach. Sinauer Assoc., Sunderland, Mass. USA
2. Bradbury, J.W., and S.L. Vehrencamp. Principles of animal communication. Sinauer Assoc., Sunderland, Mass. USA
3. Clutton-Brock, T.H. The evolution of parental care. Princeton Univ. Press, Princeton, NJ, USA
4. Eibl-Eibesfeldt, I. Ethology. The biology of behavior. Holt, Rinehart & Winston, New York.
5. Gould, J.L. The mechanisms and evolution of behaviour.
6. Hauser, M. The evolution of communication. MIT Press, Cambridge, Mass. USA
7. Hinde, R.A. Animal behaviour : A synthesis of Ethology and Comparative Psychology, McGraw-Hill, New York
8. Krebs, J.R. and N.B. Davier : Behavioural ecology. Blackwell, Oxford, UK
9. Wilson, E.O. Sociobiology : The new synthesis. Harvard Univ. Press, Cambridge, Mass. USA

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**Semester – II**  
**PAPER - IV**  
**TOOLS AND TECHNIQUES FOR BIOLOGY**

Time : 3 hrs.

Max. Marks – 80  
Min. Marks – 29

- Principles and uses of analytical instruments :  
pH meter, Spectrophotometer
- Principle of light and electron microscope
- phase contrast, fluorescence microscope
- scanning electron microscope, transmission electron microscope.
- Microbiological Techniques :
  - Media preparation and sterilization.
  - Biochemical mutants and their use.
- Cell culture Technique :
  - Design and functioning of tissue culture laboratory
  - Culture media preparation and cell harvesting methods.
- Cryotechniques :
  - Cryopreservation for cells, tissue organisms.
- Separation techniques in Biology :
  - Molecular separation by chromatography, electrophoresis centrifugation.
- Immunological techniques based on antigen-antibody interaction.

***Suggested Reading Material (All latest Editions)***

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 & K.H. Goulding, ELBS Edn.

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## **SEMESTER – II**

### **Practical – I**

**(Morphology & Physiology of Insects and Population Genetics  
& Evolution)**

**Time : 6 Hrs.**

**M.M. 100**

- 1. Dissection :- Cockroach, Grasshopper, Honey bee, Housefly**
- 2. Micropreparation of suitable material**
- 3. Study of museum specimen and slides of class – Insecta.**
- 4. Exercise showing modern principles of population genetics (Hardy Weinberg Law, Natural Selection, Genetic Drift).**
- 5. Collection of insects by field trips and excursions**

#### **Scheme of Examination :**

<b>1. Major Dissection</b>	<b>-</b>	<b>15</b>
<b>2. Minor dissection</b>	<b>-</b>	<b>10</b>
<b>3. Micropreparation</b>	<b>-</b>	<b>05</b>
<b>4. Spotting 1 to 10</b>	<b>-</b>	<b>20</b>
<b>5. Exercise based on Evolution</b>	<b>-</b>	<b>10</b>
<b>6. Exercise based on Population Genetics</b>	<b>-</b>	<b>10</b>
<b>7. <i>Viva-voce</i></b>	<b>-</b>	<b>10</b>
<b>8. Record / Sessional</b>	<b>-</b>	<b>20</b>
<b>TOTAL</b>		<b>- 100</b>

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## **SEMESTER – II**

### **Practical – II**

**(Animal Behaviour and Tools & Techniques for Biology)**

**Time : 6 Hrs.**

**M.M. 100**

**Use of following instruments for different techniques –**

- 1. pH meter : Determination of pH in different soil and water samples.**
- 2. Colorimeter : Lambert Beer Law. Estimation of glucose.**
- 3. Chromatography : TLC/Paper chromatography.**
- 4. Centrifuge : Separation of blood components.**
- 5. Microscope : Study of different parts of microscope.**
- 6. Study of social organization in insects.**
- 7. Experiment showing behavior of animals.**

#### **Scheme of Examination :**

<b>1. Separation of biomolecules by Paper Chromatography /</b>		
<b>Thin Layer chromatography /Electrophoresis</b>	<b>-</b>	<b>15</b>
<b>2. Colorimetric estimation of biomolecules</b>	<b>-</b>	<b>15</b>
<b>3. Use of pH meter / Centrifuge</b>	<b>-</b>	<b>10</b>
<b>4. Application of Microscope, Chemical &amp; Physical balance</b>	<b>-</b>	<b>10</b>
<b>5. Experiment based on social organization.</b>	<b>-</b>	<b>10</b>
<b>6. Experiment showing behavior of animals – Taxis,</b>		
<b>Reflex action.</b>	<b>-</b>	<b>10</b>
<b>7. Viva-voce</b>	<b>-</b>	<b>10</b>
<b>8. Record / Sessional</b>	<b>-</b>	<b>20</b>
	<b>TOTAL</b>	<b>- 100</b>

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# **GOVT. BILASA GIRLS' POST - GRADUATE COLLEGE**

**[AUTONOMOUS]**



**BILASPUR (C.G.)**

**[ Affiliated to Bilaspur Vishwavidyalaya ]**

**SYLLABUS**

**M.Sc. [Zoology]**

**Semester III & IV**

**Session - 2021-22**

## **SCHEME OF EXAMINATION**

- 1. Each Semester will have FOUR Theory papers and TWO Practicals, carrying 100 marks each.**
- 2. Theory papers will have External and Internals examinations of 80 and 20 marks respectively. Passing with 36% of marks is compulsory in external and internal examinations separately as per table below.**
- 3 Each Theory paper will contain eight questions out of which four questions will be required to be solved.**
- 4. It will be compulsory for the candidate to appear in test and seminar before semester examination.**

### **Scheme of Marks in each Semester**

Paper	External Examination (Theory Papers)		Internal Examination (Test & Seminars)		Total Max. Marks (External + Internal)
	Max. Marks	Mini. Pass marks	Max. Marks	Mini. Pass marks	
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Paper II	80	29	20	07	100
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Practical I	100	36			100
Practical II	100	36			100
<b>Grand Total</b>					<b>600</b>

<b><u>SEMESTER – III</u></b>			
<b>Paper</b>	<b>– I</b>	<b>Comparative Anatomy of Vertebrates</b>	<b>80</b>
<b>Paper</b>	<b>– II</b>	<b>Physiology of Vertebrates</b>	<b>80</b>
<b>Paper</b>	<b>– III</b>	<b>Quantitative Biology</b>	<b>80</b>
<b>Paper</b>	<b>– IV</b>	<b>Ichthyology</b>	<b>80</b>
<b>Practical</b>	<b>– I</b>	<b>Comparative Anatomy &amp; Physiology of Vertebrates</b>	<b>100</b>
<b>Practical</b>	<b>– II</b>	<b>Ichthyology and Quantitative Biology</b>	<b>100</b>
<b><u>SEMESTER – IV</u></b>			
<b>Paper</b>	<b>– I</b>	<b>Gamete Biology &amp; Reproductive Physiology of</b>	
		<b>Human beings</b>	<b>80</b>
<b>Paper</b>	<b>– II</b>	<b>Environmental Physiology</b>	<b>80</b>
<b>Paper</b>	<b>– III</b>	<b>Population Ecology</b>	<b>80</b>
<b>Paper</b>	<b>– IV</b>	<b>Aquaculture &amp; Fisheries</b>	<b>80</b>
<b>Practical</b>	<b>– I</b>	<b>Reproductive Physiology &amp; Environmental</b>	
		<b>Physiology</b>	<b>100</b>
<b>Practical</b>	<b>– II</b>	<b>Population Ecology and Aquaculture</b>	<b>100</b>

**Semester - III**  
**PAPER - I**  
**COMPARATIVE ANATOMY OF VERTEBRATES**

Time : 3 hrs.

Max. Marks – 80  
Min. Marks – 29

- **Classification of vertebrates up to orders with examples.**
- **Vertebrate integument and its derivatives. Development and general structure and function of skin and its derivatives. Glands, Scales, Horns, Claws, Nails, Hoofs, Feathers and Hairs.**
- **Evolution of Heart, Evolution of aortic arches.**
- **Respiratory system: Comparative account of respiratory organs.**
- **Skeletal system: Comparative account of Jaw Suspensorium, Vertebral column, Limbs and Girdles.**
- **Comparative account of Urinogenital system in vertebrate series.**
- **Comparative account of Brain and Spinal cord in vertebrate series.**

***Suggested Reading Material***

1. Alexander, R.M. The Chordata. Cambridge University Press, London
2. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, NY
3. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick & Jackson, London
4. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates, Central Book Depot, Allahabad.
5. Malcom Jollie, Chordata morphology, East-West Press Pvt., New Delhi.
6. Milton Hilderbrand. Analysis of vertebrate structure. IV Ed. John Wiley, NY
7. Tansley, K. Vision in Vertebrate. Chapman and Hall Ltd., London.
8. Walters, H.E. and Sayles, L.D. Biology of Vertebrates. Macmillan & Co., NY
9. Romer, A.S. Vertebrate Body, IIIrd Ed. W.B. Saunders Co., Philadelphia.
10. Young, J.Z. Life of Vertebrates. Oxford University Press, London.
11. Montagna, W. Comparative anatomy. John Wiley & Sons Inc.
12. Andrews, S.M. Problems in Vertebrate Evolution. Academic Press, NY
13. Waterman, A.J. Chordata structure and function. Macmillan Co., New York
14. Lovtrup, S. The Phylogeny of Vertebrate, John Wiley & Sons, London.

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**Semester - III**  
**PAPER - II**  
**PHYSIOLOGY OF VERTEBRATES**

Time : 3 hrs.

Max. Marks – 80

Min. Marks – 29

- Water as solvent.
- Thermodynamics, Free energy, Entropy, High energy bond & ATP synthesis
- Muscle contraction: Types of muscles, Light and Electron microscopic structure of skeletal muscle, Molecular basis of muscle contraction – Proteins of myofilaments, Sliding filament hypothesis, Role of calcium in contraction, Energetics and thermal aspects of muscle contraction, Twitch, Summation, Tetanus & Fatigue.
- Physiology of Nerve and impulse transmission: Structure of Neuron, Excitability, Conductivity, Resting membrane & action potential, Refractory period, Summation, Chronaxie, Rheobase, All or None principle, Propagation of nerve impulse transmission, Synaptic transmission, Neurotransmitters.
- Blood: Structure & composition of blood, Blood cells and their origin, Haemopoiesis, Haemoglobin, Function of erythrocytes & leucocytes, Blood coagulation – theories and factors affecting blood coagulation.
- Defence Mechanism: Reticulo-endothelial system - Macrophages, Lymphocytes, Immuno-globulins - origin, properties and functions. Humoral immunity and cell mediated immunity, Blood groups and tissue antigens.
- Physiology of Excretion: Structure of Mammalian Kidney, Nephron, Urine production, Counter Current multiplication, Regulation of pH by kidney.
- Sense organs: Classification of sense organs, Photoreception, Auditory perception, Ecolocation,
- Bioluminescence
- Digestion: Physiology of digestion & absorption, Digestive glands, Gastro-intestinal hormones.
- Physiology of Respiration: Respiratory pigments, Oxygen transport in blood, Carbon dioxide transport in blood, Regulation of body pH.

***Suggested Reading Material :***

1. William S. Hoar : General and Comparative Physiology
2. David Randall : Animal Physiology – Mechanism & Adaptations
3. Schmidt Neilson : Animal Physiology, Adaptation & Environment
4. Chatterjee : Human Physiology

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**Semester - III**  
**PAPER - III**  
**QUANTITATIVE BIOLOGY**

Time : 3 hrs.

Max. Marks – 80  
Min. Marks – 29

- **Introduction to Biostatistics :**
  - Statistical application in some specific areas in Biology
- **Measures of Central Tendencies –**
  - Mean (Arithmetic, Geometric, Harmonic mean).
  - Median.
  - Mode.
  - Relation between mean, median and mode.
- **Measures of Dispersion –**
  - Range
  - Mean deviation
  - Variance, coefficient of variance
  - Standard deviation
- **Frequency distribution :**
  - General idea about Normal, Binomial and Poisson distribution.
- **Analysis of Variance.**
- **Correlation.**
- **Regression.**
- **Hypothesis testing :**
  - Chi square
  - f test
  - t test
- **Probability theory**
- **Presentation of data :**
  - Diagrammatic presentation
  - Graphic presentation

***Suggested Reading Material***

1. Batschelet, E. Introduction to mathematics for life scientists. Springer-Verlag, Berling.
  2. Jorgensen, S.E. Fundamentals of ecological modelling. Elsevier, New York.
  3. Swartzman, G.L., and S.P.O. Kaluzny. Ecological simulation primer. Macmillan, New York.
  4. Lendren, D. Modelling in behavioral ecology. Champman & Hall, London, UK
  5. Sokal, R.R. and F.J. Rohlf. Biometry. Freeman, San Francisco.
  6. Snedecor, G.W. and W.G. Cochran. Statistical methods. Affiliated East-West Press, New Delhi (Indian ed.)
  7. Green, R.H. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, New York.
  8. Murray, J.D. Mathematical biology. Springer-Verlag, Berlin.
  9. Pielou, E.C. The interpretation of ecological data : A primer on classification and ordination.
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**Semester - III**  
**PAPER - IV**  
**ICHTHYOLOGY**

**Time : 3 hrs.**

**Max. Marks – 80**  
**Min. Marks – 29**

- **Introduction and general organisation of fishes :**
  - **General organization of bony fishes**
  - **General organization of cartilaginous fishes.**
- **Origin and evolution of paired fins.**
- **Skin and scales.**
- **Respiratory system –**
  - **Gills**
  - **Accessory respiratory organs.**
  - **Air bladder, weberian ossicles.**
- **Digestive system.**
- **Blood vascular system .**
- **Electric organs.**
- **Excretion and Osmoregulation**
- **Parental care in fishes.**
- **Lateral line and internal ear.**
- **Adaptation of Hill stream fishes.**
- **Adaptation of Deep sea fishes**

***Suggested Reading Material***

1. Langler, Barclach : Study of Fishes
2. A.C. Gunther : Study of Fishes
3. S.S. Khanna : An Introduction to Fishes
4. G. Shrivastava : Fishes of U.P. and Bihar
5. Kyle, M. Harry : Biology of Fishes
6. Singh and Bhaskar : An Introduction to Fishes

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## **SEMESTER – III**

### **Practical – I**

**(Comparative Anatomy and Physiology of Vertebrates)**

**Time : 6 Hrs.**

**M.M. 100**

1. Dissection of animals :- Amphioxus, Scoliodon, Electric ray, Sting ray, Calotis, Bird head, Rat (Subject to availability of material) / study through alternative methods of dissection.
2. Micro preparation of suitable and available material.
3. Study of the representative examples of different classes of Chordates.
4. Study of permanent slides showing whole mount or section as per Theory syllabus, including embryological slides of Frog and Chick.
5. Osteology of Amphibia, Reptile, Bird, Mammal.
6. Experiment related to blood – Gram percent Hb, RBC counting, WBC counting, Blood Groups, Study of different Leucocytes.
7. Biochemical Tests – Protein, Fat, Carbohydrate
8. Study of animal diversity by field trip and excursion, Extension activity to spread health awareness

#### **Scheme of Examination :**

1.	Major Dissection	-	15
2.	Minor Dissection	-	10
3.	Micro preparation	-	05
4.	Spotting 1 to 10	-	20
5.	Experiment related to blood	-	10
6.	Biochemical Test	-	10
7.	<i>Viva-voce</i>	-	10
8.	Record / Sessional	-	20
TOTAL			- 100

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## **SEMESTER – III**

### **Practical – II**

(Ichthyology and Quantitative Biology)

Time : 6 Hrs.

M.M. 100

1. Dissection of fishes : Scoliodon, Torpedo, Trygon, Labeo, Wallago depending upon availability of dissecting material / study through alternative methods of dissection.
2. Micropreparation of suitable material
3. Study of representative fishes.
4. Study of histological slides.
5. Osteology of fish.
6. Simple exercise regarding Central Tendencies & Standard Deviation.
7. Various ways of presentation of data.
8. Collection of Fishes by field trips and excursions.

#### **Scheme of Examination :**

1. Major Dissection	-	15
2. Minor Dissection	-	10
3. Micropreparation	-	10
4. Spotting 1 to 5	-	15
5. Simple experiment regarding Central Tendency & S.D.	-	10
6. Presentation of Data	-	10
7. <i>Viva-voce</i>	-	10
8. Record / Sessional	-	20
Total		- 100

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**Semester - IV**  
**PAPER - I**  
**GAMETE BIOLOGY & REPRODUCTIVE PHYSIOLOGY OF**  
**HUMAN BEINGS**

Time : 3 hrs.

Max. Marks – 80

Min. Marks – 29

- Reproduction of Primary and Secondary sexual organs.
- Heterogamy in eukaryotes.
- Gametogenesis – Spermatogenesis and Oogenesis
  - Leydig cells
  - Biochemistry of semen - Semen composition and formation, Assessment of sperm functions.
  - Ovarian follicular growth and differentiation, Vitellogenesis, Ovulation and ovum transport in mammals.
- Collection and cryopreservation of gametes.
- Puberty, Menstrual cycle, Menopause.
- Fertilization –
  - Pre-fertilization events
  - Biochemistry of fertilization
  - Post-fertilization events.
- Pregnancy and its hormonal control.
- Parturition and Lactation, mentioning the role of hormones.
- Prenatal sex determination.
- Artificial insemination.
- Concept of sex determination and sex-differentiation.
- Multiple Ovulation and Embryo Transfer Technology [MOET]
  - *In vitro* oocyte maturation
  - *In vitro* fertilization
- Embryonic stem cells
- Concept of cloning

***Suggested Reading Material***

1. Austen, C.R. and Short, R.V. Reproduction in animals.
2. Schatten and Schatten. Molecular biology of fertilization.
3. F.T. Longo. Fertilization, Chapman & Hall
4. R.G. Edwards, Human Reproduction
5. Reproductive Physiology by Gyatan
6. Reproductive Physiology by A.K. Das
7. Reproductive Physiology by A.K. Jain

**Semester - IV**  
**PAPER - II**  
**ENVIRONMENTAL PHYSIOLOGY**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **Ecology :**
  - **Abiotic, Climatic, Edaphic and Biotic Factors**
  - **Limiting Factor**
  - **Community Ecology**
  - **Ecological Succession**
- **Adaptation :**
  - **Mechanisms of Adaptation.**
  - **Significance of body size.**
- **Physiological adaptation to different environments :**
  - **Marine**
  - **Fresh water**
  - **Terrestrial**
  - **Parasitic habitats**
- **Stress Physiology :**
  - **Basic concept of environmental stress and strain, stress resistance, stress tolerance, stress avoidance**
  - **Adaptation – acclimation and acclimatization.**
  - **Concept of homeostasis.**
  - **Endothermy and physiological mechanism of regulation of body temperature**
- **Osmoregulation in aqueous and terrestrial environments.**
- **Physiological response to deficient stress.**
- **Physiological response to body exercise.**
- **Meditation, Yoga and their effects.**

***Suggested Reading Material***

1. Eckert, R. Animal Physiology : Mechanisms and Adaptation. W.H. Freeman & Co, NY
2. Hochanchka, P.W. and Somero, G.N. Biochemical Adaptation, Princeton, NJ
3. Hoar, W.S. General and Comparative Animal Physiology, Prentice Hall of India.
4. Schiemdt Nielsen. Animal Physiology : Adaptation and Environment. Cambridge.
5. Strand, F.L. Physiology : A Regulatory Systems Approach. Macmillan Pub. Co., NY
6. Pummer, L. Practical Biochemistry, Tata McGraw-Hill.
7. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., NY
8. Wilson K. and Walker, J. Practical Biochemistry.
9. Willmer, P.G. Stone, and I. Johnston. Environmental Physiology. Blackwell Sci. Oxford,
10. Newell, R.C. (ed.) 1976 Adaptation to environment. Essays on the physiology of marine animals. Butterworths, London, UK.
11. Townsend, C.R. and P. Calow. Physiological Ecology : An evolutionary approach to resource use. Blackwell Sci. Publ., Oxford, UK.
12. Alexander, R.M.N. Optima for animals. Princeton Univ. Press, Princeton, NJ
13. Dejours, P., L. Bolis, C.R. Taylor and E.R. Weibel (eds.) Comparative Physiology : Life in Water and on Land. Liviana Press, Padova, Italy.
14. Johnston, I.A., & A.F. Bennett (eds.) Animals and Temperature : Phenotypic and evolutionary adaptation. Cambridge Univ. Press, Cambridge, UK.
15. Louw, G.N. Physiological animal ecology. Longman Harloss, UK.

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**Semester - IV**  
**PAPER - III**  
**POPULATION ECOLOGY**

Time : 3 hrs.

Max. Marks – 80

▪ Min. Marks – 29

- **Demography :**
  - Population characteristics,
  - Survivorship,
  - Life tables,
  - Net reproductive rate.
- **Population growth :**
  - Exponential growth, Sigmoid growth and J-shaped growth,
  - Verhulst Pearl Logistic growth model,
  - Case study, Stable age distribution.
- **Predation :**
  - Prey - Predatory dynamics
  - Optimal foraging theory
- **Parasitism :**
  - Nature of Parasitism, Social Parasitism
  - Dynamics of Parasitism
- **Competition :**
  - Intra-specific competition
  - Inter-specific competition
  - Niche concept.
- **Mutualism :**
  - Plant pollinator
  - Animal interaction
  - Evolution of Mutualism
- **Population regulation :**
  - Density independence and Density dependence
  - Extrinsic and Intrinsic mechanisms
  - r- and k- selection.

***Suggested Reading Material***

1. Begon, M., J.L. Harper and C.R. Townsend. Ecology, Individuals, Populations and Communities, Blackwell Science, Oxford, UK.
2. Cherrett, J.M. Ecological concepts. Blackwell Sci. Publi. Oxford, UK.
3. Elseth, B.D. and K.M. Baumgartner, Population biology. Van Nostrand Co., NY
4. Chapman & Reiss : Ecology, Cambridge University Press
5. Krebs, C.J. Ecology, Harper & Row, New York.
6. Pianka, E.R. Evolutionary ecology. Harper & Row, New York.
7. Ricklefs, R.E. and G. Miller. Ecology. W.H. Freeman & Co., New York.
8. Roughgarden, J., Ecological methods.
9. Roff, D.A. The evolution of life histories. Theory and Analysis. Chapman & Hall, London, UK

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**Semester - IV**  
**PAPER - IV**  
**AQUACULTURE & FISHERIES**

**Time : 3 hrs.**

**Max. Marks – 80**

**Min. Marks – 29**

- **General classification of fishes, by Berg.**
- **General organisation and affinities of Holocephali.**
- **General organisation and affinities of Coelocanth.**
- **General organisation and affinities of Dipnoi.**
- **Introduction of major carps, Exotic fish.**
- **Larvivorous fishes of India.**
- **Establishment of fishes farm and maintenance of nursery, rearing and stocking ponds.**
- **Fish culture in fresh water.**
- **Paddy-cum-fish culture.**
- **Induced breeding methods, like Bandh and Hormonal method.**
  - **Physio-chemical and Biological condition of fishery water**
  - **Economic importance of fishes, including by-products**
- **Prawn culture : Physio-chemical and biological condition of fresh water and marine water for prawn culture.**
- **Pearl culture : Physio-chemical and biological condition of fresh water and marine water for pearl culture.**

***Suggested Reading Material***

1. B.N. Yadav : Fish and Fisheries
  2. Pandey and Shukla : Fish and Fisheries
  3. Somsuk Singholka : Prawn Farming
  4. S. Suja Begum : Aquaculture Principle and Methods
  5. Grover and Sharma : Fish and Fisheries
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## **SEMESTER – IV**

### **Practical – I**

**(Gamete Biology & Reproductive Physiology of Human beings  
& Environmental Physiology)**

**Time : 6 Hrs.**

**M.M. 100**

1. Dissection showing Reproductive system depending upon availability of dissecting material / study through alternative methods of dissection.
2. Demonstration of Meiosis division in any experimental animal.
3. Study of endocrine glands & Hormonal disorders.
4. Study of animals showing adaptation to different environments.
5. Soil analysis : Physical condition of soil, Chemical composition of soil.
6. Experiments showing Stress on physiology.

#### **Scheme of Examination :**

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| 1. Dissection – showing male and female reproductive system by the available mammal / fish | - 15 |
| 2. Study of Spermatogenesis / Oogenesis  | - 10 |
| 3. Exercise related to hormonal disorders in Human beings                                  | - 10 |
| 4. Exercise related to Adaptation of animals towards different Environmental conditions.   | - 20 |
| 5. Study of effect of emotional and physiological stress on human beings.                  | - 15 |
| 6. <i>Viva voce</i>  | - 10 |
| 7. Record / Sessional  | - 20 |

**TOTAL - 100**

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## **SEMESTER – IV**

### **Practical – II**

**(Population Ecology and Aquaculture)**

**Time : 6 Hrs.**

**M.M. 100**

1. Dissection of Nervous system of Prawn, Mytilus and Fish. Dissection showing Reproductive system depending upon availability of dissecting material / study through alternative methods of dissection.
2. Physico-chemical properties of water.
3. Study of local fish fauna.
4. Study of representative types showing animal interaction (Interspecies, Intraspecies).
5. Various measures to study population density.
6. Presentation of Demographic data.
7. Study of diversity and population density of animals by field trip and excursion,

#### **Scheme of Examination :**

1. Dissection	-	15
2. Physico-chemical properties of water.	-	10
3. Spots	-	15
4. Study of Population density	-	10
5. Study of Mutualism and Parasitism	-	10
6. Presentation of Demographic data	-	10
7. <i>Viva voce</i>	-	10
8. Record / Sessional	-	20
Total		- 100

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