



**South Konkan Education Society's**  
**Govindram Seksaria Science College**  
**(Autonomous)**  
**BELAGAVI – 590 006**

**Post Graduate Department of**  
**Studies in Zoology**

**Course Structure and Syllabus for**  
**M. Sc. Zoology**  
**(1<sup>st</sup> and 2<sup>nd</sup> Semester)**

Under Choice-Based Credit System (CBCS) - SEP

Academic Year 2024-25 onwards

S. K. E. Society's  
Govindram Seksaria Science College (Autonomous)  
Belagavi

**COURSE STRUCTURE AND SCHEME OF EXAMINATION**

**Under CHOICE-BASED CREDIT SYSTEM (CBCS) - SEP**

Sem.	Course code	Title of the Paper	Teaching hours/ week	Credits	Maximum Marks		
					Written Exam	I.A.	Total
1	Compulsory Hardcore Papers (Theory)						
	ZHT 1.1	Biology of Chordates	4	4	80	20	100
	ZHT 1.2	Biology of Non-chordates	4	4	80	20	100
	ZHT 1.3	Animal Systematics and Evolution	4	4	80	20	100
	ZHT 1.4	Environmental Biology	4	4	80	20	100
	Practicals						
	ZHP 1.5	Practical I (Based on ZHT 1.1)	4	2	40	10	50
	ZHP 1.6	Practical II (Based on ZHT 1.2)	4	2	40	10	50
	ZHP 1.7	Practical III (Based on ZHT 1.3)	4	2	40	10	50
	ZHP 1.8	Practical IV (Based on ZHT 1.4)	4	2	40	10	50
		Total Credits		24			
2	Compulsory Hardcore Papers (Theory)						
	ZHT 2.1	Animal Physiology	4	4	80	20	100
	ZHT 2.2	Molecular Genetics	4	4	80	20	100
	ZHT 2.3	Cell Biology and Immunology	4	4	80	20	100
	Compulsory Softcore Paper (Theory)						
	ZST 2.4	Ethology	2	2	40	10	50
	Practicals						
	ZHP 2.5	Practical I (Based on ZHT 2.1)	4	2	40	10	50
	ZHP 2.6	Practical II (Based on ZHT 2.2)	4	2	40	10	50
	ZHP 2.7	Practical III (Based on ZHT 2.3)	4	2	40	10	50
	Open Elective Course						
	ZOT 2.8	Economic Zoology	4	4	80	20	100
		Total Credits		24			

Sem.	Course code	Title of the Paper	Teaching hours/ week	Credits	Maximum Marks		
					Written Exam	I.A.	Total
3	Compulsory Hardcore Papers (Theory)						
	ZHT 3.1	Developmental Biology	4	4	80	20	100
	ZHT 3.2	Parasitology	4	4	80	20	100
	ZHT 3.3	Animal Biotechnology	4	4	80	20	100
	Compulsory Softcore Paper (Theory)						
	ZST 3.4		2	2			
	Practicals						
	ZHP 3.5	Practical I (Based on ZHT 3.1)	4	2	40	10	50
	ZHP 3.6	Practical II (Based on ZHT 3.2)	4	2	40	10	50
	ZHP 3.7	Practical III (Based on ZHT 3.3)	4	2	40	10	50
	Open Elective Course						
	ZOT 3.8	Fundamentals of Animal Sciences	4	4	80	20	100
		Total Credits		24			
4	Compulsory Hardcore Papers (Theory)						
	ZHT 4.1	General and Comparative Endocrinology	4	4	80	20	100
	ZHT 4.2	Biology of Reproduction	4	4	80	20	100
	ZHT 4.3	Applied Zoology	4	4	80	20	100
	Compulsory Softcore Paper (Theory)						
	ZST 4.4		2	2			
	Practicals						
	ZHP 4.5	Practical I (Based on ZHT 4.1)	4	2	40	10	50
	ZHP 4.6	Practical II (Based on ZHT 4.2)	4	2	40	10	50
	ZHP 4.7	Practical III (Based on ZHT 4.3)	4	2	40	10	50
	ZOP 4.8	Project work	4	4	80	20	100
		Total Credits		24			

**Total credits:** 70 (Theory + Project) + 26 (Practical) = 96.

**Note:**

- 1) There shall be 20 marks as Internal Assessment (IA) for each hardcore theory paper and 10 marks for practical Internal Assessment.
- 2) There shall be 10 marks as Internal Assessment (IA) for softcore paper. There shall be no practical for softcore paper.
- 3) For open elective paper, there shall be 20 marks as Internal Assessment (IA).
- 4) The project work shall carry 100 marks [(IA) 20 (To be conducted by Project Guide); Dissertation - 50; Viva-voce - 30 marks).

**S. K. E. Society's**  
**GOVINDRAM SEKSARIA SCIENCE COLLEGE (AUTONOMOUS)**  
**BELAGAVI**

**NAME OF THE COURSE: M. Sc. ZOOLOGY**

**PROGRAMME OUTCOMES (PO's)**

After successfully completing of M. Sc. Zoology programme, the student will be able to:

- Develop practical skills along with their theory components, which will help in their research programme, both in academic institutions and in R & D programmes.
- Inculcate skills for teaching in academic institutions for undergraduate and postgraduate students.
- Develop confidence in taking competitive examination in the field of life science both in India and abroad so that they can pursue higher education.
- Become an entrepreneur in the field of vermiculture, apiculture, poultry, dairy science etc.
- Conduct research in the field of basic science/ applied science.
- Develop skill in writing dissertation, research papers and also effective data presentation.
- Work in Government departments and also in non-government organizations.

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BELAGAVI

**NAME OF THE COURSE: M. Sc. ZOOLOGY**

**SYLLABUS FOR SEMESTER I**

**PAPER ZHT 1.1: BIOLOGY OF CHORDATES**

**Total Hours: 60**

**Course outcomes:**

- Understanding of origin, evolution and inter-relationships of chordates
- Knowledge of development and evolution of various anatomical and physiological systems of chordates.
- Developing the concept on comparative account of various organ systems.
- To obtain comprehensive knowledge on adaptive characters of organisms with respect to their environment.
- Inculcate the details of various anatomical and morphological features of the vertebrate body.

**Unit I: Origin and Inter-relationships**

**(15)**

Origin of chordates in the light of recent theories.

General characters and classification of Protochordata.

Phylogenetic relationship between Protochordates and Chordates.

Structure and function of notochord and endostyle in Amphioxus and Ascidia with evolutionary significance.

Tunicates and significance of retrogressive metamorphosis.

General characters and classification of Chordata – up to orders with examples.

The Nature of Vertebrate Morphology - Definition, Scope, Importance and Relation to other disciplines. Importance of the study of vertebrate morphology.

**Unit II: Vertebrate Integument, Nervous system and Sense organs**

**(15)**

Development and general structure of skin and its functions.

Scales of fishes with emphasis on dermal derivatives.

Integument of Tetrapods with emphasis on epidermal derivatives: glands, scales, horns, claws, nails, hoofs, feathers and hairs.

Nervous system: Development of spinal cord and peripheral nervous system.

Evolution of spinal nerves, cranial nerves and autonomic nervous system.

Comparative account of brain in Vertebrates.

Sense organs: Types of receptors.

Organs of olfaction and taste (Vomero-nasal and Jacobson's organ in reptiles).

Lateral line system and electroreception in fishes.

Specialized sense organs: Cutaneous in amphibians, pit organ in reptiles, Herbst corpuscles in birds, vision in birds, whiskers in mammals, echolocation in mammals.

### **Unit III: Respiration, Circulation and Locomotion**

**(15)**

Structure and mechanism of cutaneous, branchial and pulmonary respirations.

Origin and evolution of cardiovascular system in vertebrates.

Appendicular skeleton - Form, function, size and skeletal and muscular elements of the body.

Origin of tetrapod limbs and their modifications. Appendicular musculature of Tetrapods.

Axial skeletons - Skull morphology, structure and function in rat.

Jaw bones - Origin, types and modifications.

Functional and evolutionary significance of jaw suspension in vertebrates.

Origin and evolution of Weberian ossicles in fish and ear ossicles in mammals.

Types of vertebrae: Procoelus, Opisthocoelus, Amphicoelus, Amphiplatins, Heterocoelus, Axis and atlas.

Vertebrate musculature: Flight muscles of Birds, Skeletal and muscular elements in Running and jumping, Digging and crawling without appendages, Climbing, Swimming, diving, Flying and Gliding.

### **Unit IV: Excretory system and Adaptive radiation in Vertebrates**

**(15)**

Excretion: Evolution of urinogenital system in Vertebrates.

Comparative account of kidney in vertebrates.

Origin, evolution and adaptive radiation in pisces, amphibians, reptiles, aves and mammals.

### **ZHP 1.5 [(PRACTICAL I BASED ON ZHT 1.1) BIOLOGY OF CHORDATES]**

- 1) Study of external morphology of shark.
- 2) Study of digestive system in shark.
- 3) Study of female reproductive system in shark.
- 4) Study of male reproductive system in shark.
- 5) Study of cranial nerves of shark.
- 6) Mounting of brain of shark.
- 7) Mounting: Ampullae of Lorenzini and placoid scales of shark.
- 8) Study of external features in male and female rats.
- 9) Study of digestive system in rat.
- 10) Study of male and female urinogenital system in rat.
- 11) Mounting of brain of rat.
- 12) Study of museum specimens:
  - Protochordates: *Balanoglossus*, *Botryllus*, *Amphioxus*, *Doliolum*, *Ascidia*, *Petromyzon*, *Myxine*.
  - Pisces: *Clarius*, *Echeneis* (Sucker fish), *Scoliodon*, *Hippocampus*, Sting ray.
  - Amphibians: *Ichthyophis*, *Siren*, Axolotl larva, *Ambystoma*, *Bufo*, *Rana*, *Rhacophorus*.
  - Reptiles: Krait, Russel's viper, *Typhlops*, Tortoise, *Phrynosoma*, *Draco* (flying lizard), *Varanus*, Chameleon.
  - Birds: Cuckoo (male and female), Brahminy kite, *Gallus gallus* (male and female), Indian roller, Hornbill, Owl.
  - Mammals: Pangolin (Anteater), Loris, *Hystrix*, Hedgehog, Flying squirrel.
- 13) Any other practical depending on feasibility.

## **REFERENCE BOOKS:**

- 1) Young J. Z. The Life of Vertebrates (3<sup>rd</sup> Edition). Clarendon Press, Oxford. 1981.
- 2) Colbert E. H. Evolution of the Vertebrates (5<sup>th</sup> Edition). John Wiley and Sons Inc., New York.
- 3) Hyman L. H. Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago. 1966.
- 4) Young J. Z. Life of mammals. The Oxford University Press, London. 1976.
- 5) Hyman L. H. Anatomy of Comparative Vertebrates (Reprint). Satish Serial Publishing, New Delhi. 2004.
- 6) Barrington E. J. W. The biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh, UK. 1965.
- 7) Milton H. and George G. Analysis of Vertebrate Structure (5<sup>th</sup> Edition). John Wiley and Sons Inc., New York. 2002.
- 8) Romer A. S. Vertebrate Paleontology (3<sup>rd</sup> Edition). University of Chicago Press, Chicago.
- 9) Weichert C. K. and Presch W. Elements of Chordate anatomy (4<sup>th</sup> Edition). McGraw Hill Book Co., New York.
- 10) Weichert C. K. Anatomy of Chordates. McGraw Hill Book Co. Inc., London.
- 11) Barnes R. S. K. The invertebrates: a new synthesis. Blackwell Scientific Publication. 1993.
- 12) Cleveland H. P., Roberts L. S. (Jr) and Larson A. Integrated Principles of Zoology (9<sup>th</sup> Edition). WBC Brown Publishers. 1995.
- 13) Gardiner M. S. The Biology of Invertebrates, Mc. Graw Hill Book Co. 1972.
- 14) Kenneth V. K. Vertebrates: Comparative Anatomy, Function, Evolution (4<sup>th</sup> Edition). McGraw-Hill, New York. 2006.
- 15) Kulshrestha S. K. Comparative Anatomy of Vertebrates. 2004.
- 16) Milton H. Analysis of vertebrate structure. John Niley & Sons Inc, New York. 1995.



## **PAPER ZHT 1.2: BIOLOGY OF NON-CHORDATES**

**Total Hours: 60**

### **Course outcomes:**

- A thorough understanding of coelom, body plan, phylogeny and minor phyla.
- Gain insight into comparative account of various organs of different physiological processes.
- A thorough knowledge of larval forms and their evolutionary significance.

### **Unit I: Coelom, Body plan, Phylogeny and Minor Phyla**

**(15)**

Symmetry and evolution of bilateria.

Evolution and significance of coelom.

Evolution and significance of metamerism.

Protostomia and Deuterostomia.

Phylogeny and systematic position of Ctenophora, Entoprocta, Sipunculida, Ectoprocta, Chaetognatha, Onychophora and Brachiopoda.

### **Unit II: Locomotion and Nutrition**

**(15)**

Amoeboid, Ciliary and Flagellar movements in Protozoa.

Ultrastructure of cilia and flagella.

Principle of hydrostatic skeleton.

Hydrostatic movement in Annelida (Earthworm and Neries) and Echinodermata.

Flight movement in insects.

Nutrition in Protozoa.

Nutrition in Metazoan (Macrophagous feeding in Cnidaria and Turbellaria).

Filter feeding in Polychaeta, Mollusca, Crustacea and Echinodermata.

Feeding patterns in insects.

### **Unit III: Respiration, Circulation and Nervous system**

**(15)**

Respiratory organs in invertebrates: Gills, Book-lungs and Trachea.

Respiratory pigments: Hemoglobin, hemocyanin, hemerythrin and chlorocruorin.

Circulation: Patterns (open and closed types) with suitable examples.

Primitive nervous system in Cnidaria and Echinodermata.

Advanced nervous system in Annelida, Arthropoda and Mollusca.

Brief review of sense organs in different phyla.

### **Unit IV: Excretion and Reproduction**

**(15)**

Excretory organs: Flame cells, coelomoducts, chloragogen, nephridia, coxal glands, green gland, Malpighian tubules.

Morphology and mechanisms of excretion.

Reproduction: Asexual, sexual and parthenogenetic modes and their significance.

Larval forms and their evolutionary significance: Cnidaria (Planula), Annelida (Trochophore), Arthropoda (Nauplius), Mollusca (Glochidium), Echinodermata (Dipleurula).

### **ZHP 1.6 [(PRACTICAL II BASED ON ZHT 1.2) BIOLOGY OF NON-CHORDATES]**

- 1) Observation of zooplankton in water sample.
- 2) Study of the digestive system of Earthworm.
- 3) Study of the nervous system of earthworm.
- 4) Mounting of setae, nephridia and ovary of earthworm.
- 5) Study of digestive system of starfish.
- 6) Study of water vascular system of starfish.
- 7) Study of locomotory organs: a. Setae of earthworm, b. Tube feet of starfish, c. Leg of cockroach.
- 8) Study of excretory organs: a. Nephridia in earthworm, b. Malpighian tubules in cockroach.
- 9) Study of respiratory organs: a. Branchial cone in *Terebella*, b. Ctenidia in *Unio*, c. Rectal gills in Nais, d. Tracheae in Cockroach.
- 10) Nutrition: a. Tubular feeding in *Hydra*, b. Eversible pharynx in *Planaria*, c. Filter feeding in sponges, *Terebella*, *Sabella* and *Unio*.
- 11) Reproduction: Conjugation in *Paramecium*.
- 12) Study of invertebrate larvae:  
Coelenterate - Ephyra.  
Platyhelminthes - Miracidium, Sporocyst, Redia, Cercaria, Metacercaria.  
Mollusca - Veliger.
- 13) Any other practical depending on feasibility.

## **REFERENCE BOOKS:**

- 1) Barrington E. J. W. Structure and Functions of Invertebrates. 1976.
- 2) Barnes R. D. Invertebrate Zoology, Halt Saunders Intl. Edition.
- 3) Hyman L. H. The invertebrates (all volumes), McGraw Hill, Philadelphia, USA.
- 4) Huston A. M. Biological Diversity. Cambridge University Press, Cambridge.
- 5) Kapoor V. C. Theory and Practice of Animal Taxonomy. Oxford and IBH Publ., New Delhi.
- 6) McNeely J. A. Economics and Biological Diversity, IUCN, Gland, Switzerland.
- 7) Miller S. A. and Harley J. P. Zoology (6<sup>th</sup> Edition). McGraw Hill Higher Education, Boston. 2005.
- 8) Prasad S. N. Life of Invertebrates. Vikas Publishers, New Delhi.
- 9) Sinha A. K., Adhikari S. and Ganguly B. B. Biology of Animals (Vol. I & II). Central Book Agency, Kolkata.
- 10) Jordan E. L. and Verma P. S. Invertebrate Zoology. S. Chand and Company Ltd., New Delhi.
- 11) Dhami P. S. and Dhami J. K. A Text Book of Zoology Vol. I. Pradeep Publications, Jalandhar.
- 12) Kotpal R. L. Modern Text Book of Zoology: Invertebrates (12<sup>th</sup> Edition). Rastogi Publications, Meerut.

## **PAPER ZHT 1.3: Animal Systematics and Evolution**

**Total Hours: 60**

### **Course outcomes:**

- Understanding the principles of Biosystematics and concept of Species.
- Gain the knowledge of collection, preservation, and identification of various species.
- Analysis of phylogenetic relationships between different taxas.
- Understanding of classical and modern theories of evolution and its impact on the process of speciation.

### **Unit I: Science of Biosystematics, Species concept and Phylogenetic analysis**

**(15)**

Concept of Biosystematics.

Terms used in systematic biology.

Historical review of taxonomic philosophies.

Future of taxonomic studies, Stages in taxonomy, Tasks of taxonomist.

Systematics as a profession.

Historical perspectives of species concept (typological, nominalist, biological).

Kinds of species: Sibling, sympatric, allopatric, syntopic, ring species, polytypic and monotypic species.

Intraspecific groups (variety, morphs, subspecies, temporal subspecies, race and clines).

Phylogenetic analysis: Purpose, terminology, methods (Phenetic method: Dendrogram and Pairwise distance. Cladistics method: Parsimony and Maximum likelihood).

Phylogenetic lineages.

### **Unit II: Taxonomic Collection, Preservation, Identification and Classification**

**(15)**

Collection: Purpose, value, scope of collection, content of collection, significance of museum collections, legal aspects of collecting animals, post collection processes.

Preparation and packaging of specimen for posting.

Preservation Methods: Taxidermy, plastination, factors responsible for the deterioration of museum specimens.

Curating of collections, museum collection policy, preparation of material for study, housing and cataloging.

Identification: Systematic process of sorting and labelling, procedure of identification and identification services.

Classification: Components of classification, Procedure of classification (phenetic and cladistic).

Presentation of classification - Linnaean/ Taxonomic hierarchy.

Ways of constructing a phylogenetic tree.

### **Unit III: Introduction to evolution, Theories of evolution and Neo-Darwinism**

**(15)**

Geological time-scale.

Evolution of evolutionary thoughts.

Contributions of Charles Darwin, Alfred Russel Wallace, Thomas Malthus and Hugo de Vries.

Lamarckism. Natural Selection (Darwinism): Postulates of Natural Selection and evidences.

Natural Selection in action: Industrial melanism and Darwin's finches.

Experimental evidences of Natural selection: Endler's guppies.

Concepts of inclusive fitness: Altruism and kin selection.

Neo-Darwinism: Hardy-Weinberg Law of genetic equilibrium.  
Factors operating against Hardy-Weinberg Law.  
Genes and genotype frequencies.  
Concept of Mendelian Population and Gene pool.  
Selection: Types of selection (Balancing, frequency dependent, directional, disruptive, artificial)  
Random Genetic drift (Bottle neck effect, Founder's effect).  
Migration (Gene flow).

#### **Unit IV: Non-Darwinism and Application of Zoological Nomenclature**

**(15)**

Non-Darwinism: Molecular polymorphism - Nucleic acids and proteins.  
Molecular clock.  
Neutral theory of evolution.  
Evolution random walk, punctuated equilibrium.  
Forces in evolution: Stochastic vs Deterministic.  
Taxonomic keys and their significance.  
International rules of nomenclature: International Code of Zoological Nomenclature (ICZN).  
DNA bar coding.  
The taxonomic bottle neck.  
Digitization of taxonomic data and Bioinformatics.

### **ZHP 1.7 [(PRACTICAL III BASED ON ZHT 1.3) Animal Systematics and Evolution]**

- 1) Morphometric measurements of some locally available fishes.
- 2) Construction of different types of Taxonomic keys for the identification of animals.
- 3) Construction of phylogenetic trees by taking suitable examples.
- 4) Biosystematic position of specimens (Protozoa to Aschelminthes)
- 5) Biosystematic position of specimens (Annelida to Echinodermata)
- 6) Biosystematic position of specimens (Cyclostomata to Mammals)
- 7) Evidences for Principle of Evolution: a. Homologous organs, b. Serial homology.
- 8) Evidences for Principle of Evolution: a. Analogous organs, b. Vestigial organs.
- 9) Embryological evidence for evolution: Descent with modification.
- 10) Study of fossils.
- 11) Study of living fossils.
- 12) Application of Hardy-Weinberg principle to determine allelic frequency of:
  - a. PTC trait in man
  - b. blood group trait in man.
- 13) Any other practical depending on feasibility.

## **REFERENCE BOOKS:**

- 1) Kapoor V. C. Theory of Animal Taxonomy. Oxford IBH Co. Pvt. Ltd., New Delhi. 1998.
- 2) Batschelet E. Introduction to Mathematics for Life Scientists (2<sup>nd</sup> Edition). Springer-Verlag, Berlin-Heidelberg-New York. 1975.
- 3) Koto M. The Biology of Biodiversity (1<sup>st</sup> Edition). Springer, Japan. 2000.
- 4) Murry J. D. Mathematical Biology (2<sup>nd</sup> Edition). Springer-Verlag, New York-Berlin. 1993.
- 5) Snedcor G. W. and Cochran W. G. Statistical Methods. Affiliated-East-West Press, New Delhi. 1989.
- 6) Sokal R. R. and Rohlf F. J. Biometry the principles and practice of statistics in biological research (3<sup>rd</sup> Edition). W. H. Freeman, New York. 1995.
- 7) Wilson E. O. Biodiversity. National Academy Press, Washington, D.C. 1988.
- 8) Ernest Mayr. Principles of Systematic Zoology. Tata-McGraw-Hill, New Delhi. 1997.
- 9) Simpson G. G. Principles of Animal taxonomy. Columbia University Press, New York, 1961.
- 10) Barnes R. D. Invertebrates Zoology (2<sup>nd</sup> Edition). Saunders, Philadelphia. 1968.
- 11) Barrington E. J. W. Invertebrates structure and Function. Nelson, London. 1967.
- 12) Hawksworth D. L. (Ed). Biodiversity: Measurement and Estimation. Chapman and Hall. 1961.
- 13) Khan T. I. and Shishodia Y. S. Biodiversity Conservation and Sustainable Development. Pointer Publications, Jaipur. 1998.
- 14) Futuyma D. J. Evolutionary Biology. Sinauer Associates, INC. Sunderland. 1986.
- 15) Futuyama D. J. Evolutionary Biology (3<sup>rd</sup> Edition). Sinauer Associates Inc. Massachusetts. 1998.
- 16) Futuyma D. J. Evolution. Macmillan Education. 2013.
- 17) Strickberger M. W. Evolution (5<sup>th</sup> Edition). Jones and Bartlett Publishers. Boston. 2014.
- 18) Gerhart J. and Kirchner M. Cell, Embryos & Evolution. Blackwell Science Publishers. 1997.
- 19) Keynes R. Charles Darwin's Zoology Notes & Specimen List from H. M. S. Beagle. Cambridge University Press. 2000.
- 20) Price P. W. Biological Evolution. Saunders College Publishing. 1995.
- 21) Smith J. M. Evolutionary Genetics. Oxford University Press, Oxford. 1998.
- 22) Dobzhansky T. H., Ayala F. J., Stebbins G. L. and Balentine J. M. Balentine. Evolution. Surjeet Publication, New Delhi. 1976.
- 23) Freeman S. and Herron J. C. Evolutionary Analysis. Prentice Hall, New Jersey. 1998.
- 24) Stearns S. C. and Hoekstra R. F. Evolution: An Introduction. Oxford University Press, Oxford. 2000.

## **PAPER ZHT 1.4: Environmental Biology**

**Total Hours: 60**

### **Course outcomes**

- Understanding of Structure and composition of Environment and Ecosystem.
- Impact of climate change and threats to Biodiversity.
- Various means and methods to counter climate change and depleting biodiversity.
- Knowledge of management and conservation of various natural resources.
- Effect of various harmful toxic substances on the environment and ways to measure them.

### **Unit I: Introduction to Environmental Biology, Population Growth and Regulation (15)**

History, definition, importance, scope, divisions and awareness of environmental biology.

Ecosystem: Structure, functions and types - terrestrial, freshwater, marine and estuarine.

Biotic and abiotic components.

Food chain and food web, energy flow and ecological pyramids.

Biogeochemical cycles.

Ecological succession.

Types of population growth.

Physical and biological factors regulating population.

Population characteristics: Natality, mortality, density, age distribution.

Population pyramids.

Population explosion.

### **Unit II: Environmental pollution and Natural Resources (15)**

Environmental pollution: air, water, soil, noise, radioactive, thermal pollution and their effect on living organisms.

Concept and classification of natural resources.

Non-renewable resources: Land, soil and mineral resources.

Renewable resources: Water, forest, wildlife, range lands, agriculture, livestock, aquaculture.

Energy resources (renewable and non-renewable).

Resource management and conservation.

### **Unit III: Animal biodiversity and Conservation (15)**

Global and Indian biodiversity.

Levels of biodiversity: Genetic, species, ecosystem diversity.

Values of biodiversity: Consumptive, productive, social, ethical, aesthetic (ecotourism) and health.

Conservation of biodiversity (*ex situ* and *in situ*).

Mega biodiversity centers: National parks, sanctuaries and biosphere reserves.

Biodiversity hotspots.

Threats to biodiversity. Endangered species. Human-wildlife conflicts.

Organizations associated with biodiversity management and conservation.



**Unit IV: Climate change, Environment and human health****(15)**

Composition and structure of atmosphere.

Climate - catastrophes and driving forces.

Human caused climate change - ozone layer depletion, greenhouse gases, global warming and strategies for dealing with global warming and acid rain.

Types of environmental health hazards - infectious organisms, Toxicants - chemicals, natural and synthetic toxins, heavy metals.

Biotransformation, bioconcentration, bio-magnification and bioaccumulation.

Toxicity measurement - animal testing.

Environmental legislation and protection.

**ZHP 1.8 [(PRACTICAL IV BASED ON ZHT 1.4) Environmental Biology]**

- 1) Estimation of free carbon dioxide in different water samples.
- 2) Estimation of dissolved oxygen (DO) in different water samples.
- 3) Estimation of total hardness in different water samples.
- 4) Determination of Biological Oxygen Demand (BOD) in different water samples.
- 5) Estimation of total alkalinity of different water sample.
- 6) Estimation of dissolved sulphates in water by the Turbidometric method.
- 7) Estimation of dissolved phosphates in water by the Turbidometric method.
- 8) Estimation of chlorides in different water samples.
- 9) Estimation of the organic carbon content of different soil samples.
- 10) Study of pH in different soil samples.
- 11) Study of pH in different water samples.
- 12) Study tour/ field visits to study ecology.
- 13) Any other practical depending on feasibility.

## **REFERENCE BOOKS:**

- 1) Chapman R. L. and Reiss M. J. Ecology - Principles & Applications. Cambridge Low Price Edition. 2000.
- 2) Collin R. T., Harper J. L. and Michael B. Essentials of Ecology. Blackwell Sci. Comp. 2000.
- 3) Kormondy E. J. Concepts of Ecology (4<sup>th</sup> Edition). Indian reprint, Pearson Education. 2007.
- 4) Krebs C. J. Ecology. Harper and Collins. 1994.
- 5) Odum E. P. Fundamentals of Ecology (Indian Edition). Brooks /Cole. 2008.
- 6) Odum E. P. and Barret G. W. Fundamentals of Ecology (5<sup>th</sup> Edition). Thompson Brooks/Cole. 2005.
- 7) Odum E. P. Basic Ecology. CBS College Publishing. 1983.
- 8) Odum E. P. Fundamentals of Ecology. Nataraj Publishers, Dehradun. 1996.
- 9) Paul Colinvaux. Ecology. John Wiley and Sons, New York. 1986.
- 10) Peter Stilling. Ecology: Theory and applications (2<sup>nd</sup> Edition). Prentice Hall.
- 11) Sharma P. D. Ecology and Environment. Rastogi Publication, Meerut. 2011.
- 12) Gilbert M. Masters. Introduction to Environmental Engineering & Science.
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S. K. E. Society's  
GOVINDRAM SEKSARIA SCIENCE COLLEGE (AUTONOMOUS)  
BELAGAVI

NAME OF THE COURSE: M. Sc. ZOOLOGY

**SYLLABUS FOR SEMESTER II**

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**PAPER ZHT 2.1: ANIMAL PHYSIOLOGY**

**Total Hours: 60**

**Course Outcomes**

- Knowledge of various adaptations evolved by animals to their environment.
- Thorough knowledge of various physiological processes involved in maintaining homeostasis in animals.
- Understanding the role of enzymes involved in various physiological processes.
- Assaying the role of neurotransmitters in muscle contraction and their role in nerve physiology.
- Understanding the role of environmental components in physiological processes.
- Application of physics involved in maintenance of different physiological functions.

**Unit I: Introduction to Physiology and Physiology of Respiration and Circulation (15)**

History and central themes of Animal Physiology and its sub-disciplines.

Respiratory organs in the vertebrates.

Respiratory mechanisms in aquatic and air breathing fishes, birds and mammals.

Respiration in eggs.

Exchange and transport of O<sub>2</sub> and CO<sub>2</sub>.

Oxygen dissociation curve.

Facilitated diffusion.

Neural regulation of respiration.

Blood: components and functions.

Acid-base balance regulation.

Circulation: General principle.

Vertebrate circulation.

The physics of flow in tubes.

Mechanism and significance of Hemostasis.

Regulation of circulation.

**Unit II: Temperature, Water and Osmoregulation (15)**

Classification of animals based on thermal biology.

Effects of temperature change.

Heat transfer, heat balance.

Temperature adaptation: Acclimatization.

Thermoregulation in ectotherms, endotherms and heterotherms with suitable examples.

Thermoregulation: Positive and negative feedback mechanisms.

Neuronal control of thermoregulation.

Specialized metabolic state: Dormancy - Sleep, torpor, diapause, hibernation, aestivation.

Properties of water molecules.  
Osmoregulation, osmoregulators and osmoconformers.  
Obligatory exchanges of ion and water.  
Osmoregulatory organs.  
Osmoregulation in aquatic (freshwater and marine) and terrestrial animals.

**Unit III: Feeding, Digestion, Enzyme catalysis and Metabolism** (15)

Feeding methods and mobility of the alimentary canal.  
Physiology of digestion and absorption.  
Gastrointestinal secretions (enzymes and hormones).  
Nutritional requirements: micronutrients, macronutrients and vitamins.  
Nutritional disorders with suitable examples.

Enzyme classification, enzymes as catalysts, enzyme kinetics, regulation of enzyme activity, active sites, coenzymes, activators, inhibitors, isozymes, allosteric enzymes, and ribozymes.

Concept of energy metabolism: Metabolic rate and its measurement, standard metabolic rate and basal metabolic rate, and respiratory quotient.

**Unit IV: Muscle Physiology and Nervous system** (15)

Types of muscles: Striated, non-striated and cardiac muscles.  
Ultra structure of striated muscle.  
Muscle contraction - Muscle proteins, sliding filament theory.  
Energetics of muscle contraction.  
Transient production of force: Twitches and tetanus.  
Defects in muscle function, muscle coordination diseases, muscular dystrophy.  
Aging physiology concepts related to muscle function.

Structural organization and functions of nervous system.  
Electrochemical, resting and action potential.  
Transmission of information within neuron, synaptic transmission (electrical and chemical).  
Neurotransmitters.

## **ZHP 2.5 [(PRACTICAL I BASED ON ZHT 2.1) ANIMAL PHYSIOLOGY]**

- 1) Qualitative analysis of carbohydrates.
- 2) Qualitative analysis of polysaccharides.
- 3) Qualitative analysis of proteins.
- 4) Qualitative analysis of lipids.
- 5) Estimation of blood clotting time and bleeding time.
- 6) Estimation of hemoglobin.
- 7) Analysis of abnormal constituents of urine.
- 8) Identification of adulterants.
- 9) Determination of maximal heart rate and target zone heart rate for exercise.
- 10) Measurement of tidal volume and vital capacity.
- 11) Identification of heart disorders by ECG.
- 12) Study of bone and muscular disorders (Osteoporosis, Arthritis, Osteonecrosis, Myasthenia gravis, Tetany, Muscular dystrophy).
- 13) Any other practical based on feasibility.

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- 3) Prakash M. and Arora C. K. Encyclopedia of Animal Physiology. Anmol Publications, New Delhi. 1998.
- 4) Pestonjee D. M. Stress and Copping. Sage Publications, London, 1999.
- 5) Poole M. C., Grant P. and Johnson. E. C. Biology in Action. Harcourt Brace, Canada, 1995.
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- 20) Schmidt-Nielsen K. Animal Physiology: Adaptations and Environment (5<sup>th</sup> Edition). Cambridge University Press, UK. 2002.
- 21) Tyagi V. K. Animal Physiology and Biochemistry. Kedar Nath Ram Nath, New Delhi. 2005.

## **PAPER ZHT 2.2: MOLECULAR GENETICS**

**Total Hours: 60**

### **Course Outcomes**

- Understanding of Mendelian and Post-Mendelian Genetics.
- Understanding of Inheritance and Genetic Recombination in various organisms.
- Knowledge of causes of mutations and Chromosomal aberrations.
- Analysis of complete Genomics and Proteomics of selected organisms.

### **Unit I: Mendelian and Modern Genetics**

**(15)**

Overview of Mendelian principles: Law of dominance, segregation and independent assortment.  
Post-Mendelian Genetics: Incomplete dominance, linkage and crossing over, pleiotropy, codominance, sex-linked inheritance, multi-factorial and polygenic inheritance, phenocopy, penetrance.

Extra-chromosomal inheritance: Mitochondrial, chloroplast and cytoplasmic inheritance, maternal effect.

Concept of alleles, Complementation test.

DNA structure and functions: DNA as hereditary material experiments.

Watson and Crick model and alternate models of DNA.

Semi-conservative replication of DNA.

DNA repair mechanisms, *Cistron*, *muton* and *recon*.

Replication: Models of replication, enzymology of replication, initiation, elongation and termination.

Protein synthesis: Genetic code, colinearity hypothesis (Beadle and Tatum hypothesis).

Transcription, post-transcriptional modifications.

Translation: post-translational modification.

### **Unit II: Bacterial Genetics, Genomics and Proteomics**

**(15)**

Genetics of bacterium and bacteriophage.

Mechanism of recombination in bacteria: Transformation, transduction, conjugation and F-mediated sexduction.

Life cycles of bacteriophage, plasmids and episomes.

Salient features of yeast, *Drosophila* and Human genomes.

Types of genomics: Structural, functional, mutational, and comparative genomics.

Proteomics: Tools and applications.

### **Unit III: Gene Regulation and Genetic Diseases**

**(15)**

Gene regulation in Prokaryotes: *Lac* operon, *Trp* operon and Arabinose operon.

Eukaryotes: Model of gene regulation, transcription factors, *Cis* and *trans* acting elements in eukaryotes.

Dosage compensation in human, *Drosophila* and *Caenorhabditis elegans*.

Genome imprinting.

Genetic diseases: Single gene inheritance - Cystic fibrosis, sickle cell anemia, Marfan syndrome, Huntington's disease, and, hemochromatosis.

Multifactorial inheritance - Heart disease, high blood pressure, Alzheimer disease, arthritis, diabetes, cancer, and obesity.

Chromosomal abnormalities: Turner syndrome, Klinefelter syndrome, Down syndrome and Cri-du-chat syndrome.

Mitochondrial inheritance: Leber's hereditary optic atrophy, epilepsy, myoclonic epilepsy and dementia.



#### **Unit IV: Chromosomal and Gene mutations**

**(15)**

Causes of mutations.

Chromosomal mutations: Deletion, Duplication, Inversion, Translocation and their genetic implications.

Genes mutations: Types and Molecular mechanisms of mutations, transposable elements.

Structural mutations: Point mutations - Silent, missense, and nonsense mutations.

Functional mutations: Loss-of-function and Gain-of-function mutations.

Mutational analysis *in vitro* and *in vivo*.

## **ZHP 2.6 [(PRACTICAL II BASED ON ZHT 2.2) MOLECULAR GENETICS]**

- 1) Study of polytene chromosomes in *Chironomous* larva.
- 2) Study of polytene chromosomes in *Drosophila* larva.
- 3) Study of genetics of ABO blood group in humans.
- 4) Study of X-chromatin or Barr body in human buccal cells.
- 5) Human Karyotype preparation and analysis: a. Normal male, b. Normal female.
- 6) Human Karyotype preparation and analysis: a. Down syndrome, b. Cri-du-chat syndrome, c. Klinefelter syndrome, d. Turner syndrome, e. Translocation.
- 7) Study of *Drosophila* mutants: Normal male, Normal female, Yellow body, Ebony body, Bar eye, White-eye, Sepia eye, Vestigial wing.
- 8) Study of sex combs in different *Drosophila* species.
- 9) Study of genital plates of different *Drosophila* species.
- 10) Study of karyotype of different *Drosophila* species.
- 11) Study of eye pigments of *Drosophila* by paper chromatography.
- 12) Study of Sternopleural and Acrostical bristles.
- 13) Any other practical depending on feasibility.

## **REFERENCE BOOKS:**

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- 25) The *Caenorhabditis elegans* Genome. Science Vol. 282. 1998.
- 26) The *Arabidopsis* Genome. Nature. Vol. 408. 2000.

## **PAPER ZHT 2.3: CELL BIOLOGY AND IMMUNOLOGY**

**Total Hours: 60**

### **Course Outcomes**

- Thorough understanding of the structure of cell and its organelles.
- Knowledge of role of various cell organelles and biomolecules in different biological processes.
- Understanding of the ultrastructure of Nucleus, Chromosome and role of histones in packaging DNA.
- Understanding the role of Biomolecules in regulating cell cycle and apoptosis.
- Knowledge of Cancer biology and Immunology.

### **Unit I: Molecular organization of bio-membranes and cell organelles (15)**

Organization of a cell (Prokaryotic and Eukaryotic cell): cell as a morphologic and functional unit within organisms.

Fluid mosaic model of plasma membrane.

Membrane fluidity: Role of fatty acids, temperature and cholesterol.

Membrane asymmetry.

Transport across membranes: Passive and active transport.

Cell junctions: Types, structure and functions.

Endoplasmic reticulum: Structure and functions.

Ribosomes: Structure, translation and translocation, nascent polypeptide chain, protein folding and processing.

Golgi apparatus: Signal hypothesis, protein glycosylation, protein sorting and transport, endocytosis and lysosome formation.

Cytoskeleton: Molecular organization of microfilaments, Intermediate filaments and microtubules and their role in cell architecture and functioning.

### **Unit II: Nucleus, chromatin biology and biomolecules (15)**

Cell Cycle: Molecular events, Role of Cyclins and Cyclin Dependent Kinases (CDK) in cell cycle.

Ultra structure of nucleus and functions.

Molecular structure of chromosomes: Euchromatin and Heterochromatin.

Role of histones in Packaging DNA; Non-histone proteins.

C-Value Paradox.

Nucleolus - organization and functions.

Amino acids: Structure and classification. Peptide bond formation.

Proteins: Primary, secondary and tertiary structures.

Polypeptide folding: Random coiling, Alpha helix and Beta sheet.

Protein modifications: Glycoproteins, Proteoglycans and Lipoproteins.

Carbohydrates: Complex polysaccharides.

Lipids: Triglycerides and compound lipids

### **Unit III: Bioenergetics and Cancer biology (15)**

Mitochondria: Structure and functions.

Bioenergetics - Glycolysis, Krebs's cycle, Oxidative phosphorylation.

Protein import and transport of metabolites.

Peroxisomes: Types and functions.

Cancer Biology: Benign and Malignant tumors. Characteristics and properties of cancer.  
Development and causes of cancer.  
Carcinogens, Oncogenes, Oncoviruses and Tumor suppressor genes.  
Diagnosis and treatment of cancer.

#### **Unit IV: Immunology**

**(15)**

Types of immunity: Innate and Acquired.

Cells of immune system: Lymphoid cells, Mononuclear phagocytes and Granulocytic cells.

Organs of immune system: Primary lymphoid organ and Secondary Lymphoid organ.

Antigen: Epitope and Hapten.

Antibodies: Structure, Classes, Biological activities.

Major Histocompatibility Complex: Types, Role of antigen presenting cells and Antigen recognition by cytosolic and endocytic pathway.

Cytokines and Chemokines.

Transplantation and Graft rejection.

Clinical immunology: Principles of vaccination, Recombinant and DNA vaccines.

Principles of monoclonal antibody production and its applications.

Deficiencies in the immune system – AIDS, autoimmune diseases, Hypersensitivity.

**ZHP 2.7 [(PRACTICAL III BASED ON ZHT 2.3) CELL BIOLOGY  
AND IMMUNOLOGY]**

- 1) Study of mitosis through permanent slides.
- 2) Study of mitosis through onion root tip preparation.
- 3) Study of meiosis through permanent slides.
- 4) Simple and Gram's staining of bacteria (curds sample).
- 5) Estimation of DNA by Diphenylamine (DPA) method.
- 6) Estimation of RNA by Orcinol method.
- 7) Study of epithelial (columnar: ciliated and non-ciliated), cuboidal, squamous and transitional epithelium.
- 8) Study of nervous tissue (myelinated and unmyelinated) and muscular tissues (smooth, striated, and cardiac).
- 9) Study of connective tissues: Bone and cartilage; Blood cells (erythrocytes and leucocytes).
- 10) Study of preparation of stains and fixatives.
- 11) Mitochondrial staining using Janus green stain.
- 12) Differential count of Leucocytes.
- 13) Any other practical depending on feasibility.

## **REFERENCE BOOKS:**

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- 2) Bruce Alberts, Bray Dennis, Lewis Julian, Raff Martin, Roberts Keith and Watson James. Molecular Biology of the Cell (5<sup>th</sup> Edition). Garland Publishing Inc., New York. 2008.
- 3) Cooper G. M. and Hausman R. E. The Cell: A Molecular Approach (5<sup>th</sup> Edition). ASM Press and Sunderland. Washington DC. Sinauer Associates, MA. 2009.
- 4) De Robertis E. D. P. and De Robertis E. M. F. Cell and Molecular Biology (8<sup>th</sup> Edition). Lippincott Williams and Wilkins, Philadelphia. 2006.
- 5) Karp G. Cell and Molecular Biology: Concepts and Experiments (6<sup>th</sup> Edition). John Wiley and Sons. 2010.
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- 21) Sadava D. E. Cell Biology - Organelles, Structure and Function. Jones and Bartlett Publication. 1993.
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- 25) Cooper M. G. The Cell: The Molecular approach. ASM Press, Washington. 1997.
- 26) Owen J., Punt J., Stanford S. A. and Jones P. P. Kuby Immunology (7<sup>th</sup> Edition). W. H. Freeman and Company, USA. 2014.
- 27) Flajnik M. F., Singh N. J. and Holland S. M. Paul's Fundamental Immunology (8<sup>th</sup> Edition). Wolters Kluwer
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- 29) Fahim Ali Khan. Elements of Immunology. Pearson Education. 2009.

## **PAPER ZST 2.4: ETHOLOGY**

**Total Hours: 30**

### **Course Outcomes**

- To get a better understanding about the reflexes, genetics and complex, innate and learned behaviour and different kinds of biological communications.
- Developing observative and analytical skills for studying animal behavior.
- Understanding ethological theories (e.g. by Konard Lorenz and Niko Tinbergen).

### **Unit I: Introduction to Animal Behavior**

**(6)**

Brief contribution of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen.  
Proximate and ultimate causes of behavior.

### **Unit II: Patterns of Behavior**

**(8)**

Stereotyped Behavior: Orientation and reflex.  
Individual behavioral patterns: Instinct and learned behavior.  
Associate learning, classical and operant conditioning, Habituation and Imprinting.  
Biological communication and biological clocks.

### **Unit III: Social Behavior and Communications in animals**

**(8)**

Social Behavior in termites and honey bees.  
Altruism, kinship theory: Relatedness and Inclusive fitness.  
Conflict behavior: Monkeys and dogs.  
Bioluminescence in deep sea fishes and insects.  
Role of pheromones in animal communication: Insects and Vertebrates.

### **Unit IV: Sexual Behavior**

**(8)**

Sexual dimorphism.  
Sexual selection: Mate choice in peacock and red deer.  
Fighting behavior.  
Parental care (Nest Building and Cost benefit).  
Defensive behavior.



## **REFERENCES:**

- 1) Drickamar L. C., Vessey S. H. and Mickle D. Animal Behavior: Mechanisms, ecology and evolution (4<sup>th</sup> Edition). Brown Willium C. Co. USA. 1995.
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- 6) Vinod Kumar. Biological Rhythms. Narosa Publishing House, New Delhi/ Springer- Verlag, Germany. 2002.
- 7) Aubrey, Manning and Marian, S. Dawkins. An Introduction to Animal Behavior. Cambridge University, Press. 1995.
- 8) Krebs J. R. and Davies N. B. An Introduction to Behavioural Ecology-III (ed). Blackwell Science Ltd. 1993.
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- 11) Slater P. J. B. Essentials of Animal Behavior. Cambridge University Press. 1999.

**PAPER ZOET 2.8: ECONOMIC ZOOLOGY**  
**[OPEN ELECTIVE PAPER (FOR OTHER DEPARTMENT STUDENTS)]**

**Total Hours: 60**

**Course outcomes**

- Understand the scope and importance of economic zoology.
- Recognize and elucidate the materials and methods involved in vermiculture practice.
- Management and recognition of importance of products, byproducts and value added products of dairy and poultry.
- Understand the developmental practices of apiculture, sericulture and lac culture.
- Learn the methods of aquaculture practices and its importance.

**Unit I: Vermiculture and Apiculture**

**(15)**

Life-cycle of earthworm.

Types of earthworms.

Establishment of vermiculture unit.

Earthworm as a tool for the conversion of biodegradable waste into vermicompost.

Earthworms as poultry and fish feed.

Vermiwash.

Species and castes of honeybees.

Colony organization in honeybees.

Foraging behaviour in honeybees.

Beekeeping practices in India.

Composition and uses of honey and bee products.

**Unit II: Sericulture and Poultry keeping**

**(15)**

Life cycle of *Bombyx mori*.

Classification of silkworms based on moulting, voltinism and geographical distribution.

Importance of sericulture as a rural industry.

Modern rearing methods: Reeling, grading and marketing.

Types of silk.

Important poultry breeds (Indigenous and exotic).

Rearing methods in poultry.

Diseases of poultry.

Marketing of poultry products e.g. Eggs, meat and poultry waste.

Nutritional value of egg and meat.

**Unit III: Dairy Management and Fisheries**

**(15)**

Types of indigenous and exotic cattle.

Breeds of buffaloes.

Dairy products: Processing, preservation, marketing of milk and milk products.

Nutritive value of milk, milk products, by-products and meat.

Introduction: definition, scope and status of aquaculture in India.

Culture techniques of fin fish and shell fish.

Composite fish culture.

Ornamental fishes.

Pearl oyster culture.

Processing and preservation of fish and fish by-products.

#### **Unit IV: Lac culture and Insect Pest Management**

(15)

Life cycle of Lac insect, cultivation of lac, composition of lac, uses of lac.

Crop pests: Life cycle, damage caused and control measures of pests of cotton, sorghum, pulses, fruits and Household pests.

Integrated pest management (IPM).

Mass multiplication of bio-control agents (Coccinellids, *Trichogramma* sps.).

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- 2) Shukla G. S. and Upadhyay V. B. Economic Zoology. Rastogi Publications, Meerut. 2020.
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- 9) Srivastava K. P. and Dhaliwal G. S. A Textbook of Applied Entomology (Vol. II). Kalyani Publishers, New Delhi. 2011.
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- 11) Snodgrass R. E. Anatomy of the Honeybee. Cornell Univ. Press. Ithaca. New York. 1956.
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