



**Rayat Shikshan Sanstha's
Yashwantrao Chavan Institute of Science, Satara (Autonomous)**

**Under Choice Based Credit System (CBCS)
(June 2019-2020)**

SYLLABUS

For

M. Sc. Zoology

(Semester Pattern)

M. Sc. Sem. I to IV

Academic flexibility with credit system to be implemented

From

June, 2019 onwards

1. TITLE:Zoology

2. YEAR OF IMPLEMENTATION: 2019 – 2020

3. PREAMBLE:

M. Sc. Zoology course under autonomy has been prepared keeping in view the unique requirements of M. Sc. Zoology students. The prominence of the contents is to provide students the latest information along with due weightage to the concepts of traditional zoology so that they are able to understand and appreciate the current interdisciplinary approaches in the study of animal sciences and its role in societal and environmental development. The course content also advanced practical exercises so the students gets a hands on experience of the newest techniques that are currently in use. Project curriculum covering over the two years of the course which is designed in a way that, to give the students first hand research experience as it consists of writing of synopsis, literature review along with actual laboratory work and handling laboratory instruments. The course will also encourage students to hunt higher studies and research in life sciences, for becoming an entrepreneur and enable students to get employed in research institutes.

4. GENERAL OBJECTIVES OF THE COURSE:

- To impart the knowledge of animal science is the basic objective of the course.
- To develop scientific attitude among the students and to make the students open minded, enthusiastic, critical and curious so that they enter research field with a positive approach.
- To develop skill in practical work, experiments and handling laboratory instruments.
- To understand scientific terms, concepts, facts, phenomenon and their relationships.
- To make the students aware of natural resource, diversity, environment up to cell biology.
- To enable the students to acquire knowledge of animal cells and different molecules as well as genetics for the wellbeing of human.
- Enrichment of basic knowledge of techniques in zoology, bioinformatics and genetics.

5. DURATION:02 year

6. PATTERN:CBCS Semester

7. MEDIUM OF INSTRUCTION:English

Course Structure

M. Sc. I & II

Semester I

Semester II

Sr. No.	Paper code and Name	Theory (TH)	
		Lecture	Credits
1	MZT 101 Biosystematics and Biodiversity	4	4
2	MZT 102 Ecology and Environmental Pollution	4	4
3	MZT 103 Cell and Molecular Biology	4	4
4	MZT 104 Applied Entomology	4	4
5	MZP 105	4	4
6	MZP 106	4	4
Total Semester I		24	24

Sr. No.	Paper code and Name	Theory (TH)	
		Lecture	Credits
1	MZT 201 Physiological Chemistry	4	4
2	MZT 202 Quantitative Biology and Tools and Techniques in Biology	4	4
3	MZT 203 Elements of physiology	4	4
4	MZT 204 Biology of Parasites	4	4
6	MZP 205	4	4
7	MZP 206 + Project	4	4
Total Semester II		24	24

- Theory and Practical Lecture of 48 minutes each
- Z – Zoology (First letter of Subject Name)
- T- Theory, P – Practical
- Total Credit For Semester I – 24 Credits
- **Total Marks for M. Sc. Sem. I - 600**

- Total Credit for Semester II – 24 Credits
- **Total Marks for M. Sc. Sem. II – 600**
- **Total M. Sc. part I – 1200 marks**

Semester III

Sr. No.	Paper code and Name	Theory (TH)	
		Lecture	Credits
1	MZT 301 Genetics	4	4
2	MZT 302 Enzymology	4	4
3	MZT 303 Computational Molecular Biology	4	4
4	MZT 304 Molecular Biology Of Gene	4	4
5	MZP 305	4	4
6	MZP 306	4	4
	Total Semester III	24	24

- Total Credit For M. Sc. II Semester III – 24 Credits
- Total Marks for M. Sc. II Sem. III - 600

Semester IV

Sr. No.	Paper code and Name	Theory (TH)	
		Lecture	Credits
1	MZT 401 Animal cells in Biotechnology	4	4
2	MZT 402 Toxicology and Immunology	4	4
3	MZT 403 Cell In Differentiation, Development & specialization	4	4
4	MZT 404 Cell Pathology	4	4
5	MZP 405	4	4
6	MZP 406 + Project	4	4
	Total Semester IV	24	24

- Total Credit for M. Sc. II Semester VI – 24 Credits
- Total Marks for M. Sc. II Sem. VI – 600
- Total Marks for M. Sc. part II - 1200

Evaluation Structure for M. Sc. Zoology

Evaluation pattern for M.Sc.I : Semester – I from academic year 2020-21									
Paper Code	Theory			Practical			Total		
	ESE	ISE	Total	ESE	ISE	Total			
Theory Paper-I	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20 (Book Review) Total =40	100	---	---	---	100		
Theory Paper-II	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20 (CIII online course) Total =40	100	---	---	---	100		
Paper-III	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20 (Survey / Seminar) Total =40	100	---	---	---	100		
Theory Paper-IV	60	ISE-I =10 ISE-II=10 (Online Test) Activity=20(Group discussion / Innovative idea presentation) Total =40	100	---	---	---	100		
Practical Paper-I	---	---	---	60	Journal=10 Student Performance=10 Activity = 20(case study / Survey report) Total=40	100	100		
Practical Paper-II	---	---	---	60	Journal=10 Student Performance=10 Activity = 20(Model Presentation / Project –Part I) Total=40	100	100		
Total	240	160	400	120	80	200	600		



M.Sc. Zoology
Academic Flexibility, Credit System
M. Sc. I – Sem. I
MZT 101 – Biosystematics and Biodiversity

Credit: (Theory – 04 Practical-04) Theory Lectures:60

Unit I - Taxonomy

Introduction to taxonomy, Stages and importance of taxonomy; Problems, Aim and Tasks of Taxonomy.

Modern Trends in Taxonomy: Morphological approach, immature stages and Embryological approach, Ecological, behavioral and Cytological approach.

Methodologies in systematics: Molecular markers for detection/evaluation of polymorphism, RFLP, RAPD etc.

Learning outcome –

- 1) Student will be able to define taxonomy, and various tasks of taxonomists.
- 2) They will be able to learn recent trends and approaches in taxonomy.
- 3) Students will know the use of molecular markers in systematics.
- 4) They will be able to demonstrate the ability to identify organisms to taxonomic group.

Unit II - Concept of species:

Introduction, Typological, Biological, Nominalistic, Evolutionary and recognition species concept with conclusions, taxonomic identification.

Zoological nomenclature: Origin of the code, international code of Zoological nomenclatures rules of nomenclature. Species and their number, polytypic species, Subspecies, other intraspecific group, super species.

Learning outcome –

- 1) Students will be able to define species.
- 2) They can summarize the different concept of species for taxonomic identification of the species.
- 3) They can classify the species based on the zoological nomenclature system by using the rules included in it

Unit III

Biodiversity Science: Evolution of biodiversity, Factors promoting high diversity, Endemism and Hotspots, Measures of Bio-diversity, Values of Biodiversity, Uses and Importance of Biodiversity.

Evaluation of priorities for conservation of habitats and species:

Selection criteria for protection of species–species quality, Hotspots, Conservation indices.

Learning outcome –

- 1) The students will be able to define biodiversity and study factors promoting and affecting biodiversity.
- 2) They can understand the concepts of hotspot diversity and roles to conserve that diversity.

Unit IV**Biodiversity Conservation:**

Loss of biodiversity, listing of threatened biodiversity, Threats to biodiversity, Role of NGOs, Colleges and Universities.

IUCN Guidelines for Red List categories and criteria (version 7.0), Red List of Indian Flora and Fauna.

Learning outcome -

- 1) Students will be able to determine the importance of conservation of biodiversity.
- 2) They will know the roles played by NGOs, and different communities in conserving the biodiversity.
- 3) They can learn to categorize the Red data list of IUCN.

❖ Recommended Books -

Alston, R.E. and B.L. Turner (1963): Biochemical systematics Prentices Hall Inc. Englewood Cliffs, N.J. 404 pp.

Avise, J.C. (1974): Systematic value of Electrophoretic data. Syst. Zool. 23 (4): 465 – 481.

Benazzi, M. (1973): Cytotaxonomy and evolution, General remarks vertebrate evolution. Ed. A.B. Chiarelli and Campus Academic Press, London and N.Y. pp. 1-3.

Blomback, B and M. Blomback (1968): Primary structure of animal proteins as a guide in taxonomic studies. In chemitaxonomy and serotaxonomy (ed.) Hawkers pp. 3 – 20.

Camp, W.H. (1951): Biosystematics Britania 7: 113 – 127.

Chamberlin, W.J. (1952): Entomological Nomenclature and Literature 3rd edition Dubuque Iowa William C. Brown Co.

Cole, A.J. (1969): Numerical taxonomy proceedings of the colloquium in numerical taxonomy held in the University of St. Andrews Sept. 1968. Academic Press, N.Y 324 pp.

Hennig, W. (1966): Phylogenetic systematics Univ. Illinois Press III, 263 pp.

Heywood, V.H. (1973): Taxonomy and Ecology Systematics Association special Vol. 5 Academic Press, London, and New York 370 pp.

Huxley, J.S. (ed.) The New Systematics Oxford Univ. Press London 538 pp.

- Jeffrey, C. (1977): Biological nomenclature Indian Ed. Oxford and IBH Pub.Co. New Delhi 72 pp.
- Mayr, E. (1969): Principles of systematics Zoology Mc. Graw Hill N.Y. 428 pp.
- Mayr, E. and E.G. Linsley and R.L. Usinger (1953): Methods and Principles of systematic Zoology, Mc Graw Hill N.Y. 328 pp.
- Oman, P.W. and A.D. Cushman (1948): Collection and Preservation of insects U.S. Dept. of Agric. Misc. Pub. 601: 1 – 42.
- Pankhurst, R.J. (1978): Biological identification Edwards Arnold Ltd. London, 104 pp.
- Pankhurst, R.J. (1984): Online identification programme version 4. British museum (Natural History) London.
- Strickland, H.E. (1842): Rules of Zoological nomenclature Report of the 12th meeting of British Association held at Manchester in 1842 Brit. Assoc. Adv. Sci. Rept. 1842: 7 – 18.
- Ernst Mayr (1969): Principles of Systematics Zoology TMH Ed. Tata McGraw Hill Publishing company Ltd. Bombay NewDelhi.
- Primack, R.B. (1950): A primer of conservation biology 3rd edition Sinauer Associates Inc. Publishers Sunderland Massachusetts USA.
- Ray Samit and Ray A.K. (2006): Biodiversity and Biotechnology New Central Book Agency (P) Ltd.
- Wilson, E.O.: Biodiversity.
- Knudsen, J.W.: Biological techniques collecting preserving and illustrating plant and animals.
- Black Welder, R.E. and Blair W.F. Guide to the Taxonomic literature of vertebrates.
- Alexander, R.M. The Chordate.
- Waterman, A.J. Chordate An advance Text book on Biodiversity- K. V. Krishnamurthy Biodiversity and Biotechnology- Ray and Ray Biodiversity – Mandal and Nandi -Perspective in environmental studies- Kaushik and Kaushik Biodiversity- K. C. Agarwal
- Theory and practice of animal taxonomy- V. C. Kapoor

M.Sc. Zoology
Academic Flexibility, Credit System
M. Sc. I – Sem. I
MZT 102 - Ecology and Environmental Pollution

Credit: (Theory – 04 Practical-04) Theory Lectures:60

Unit I

1. Habitat and Niche: Concept and types of habitat, Ecological niche, Niche width and overlap.
2. Species interaction: Types of interactions, interspecific competition, Symbiosis.
3. Community ecology: Types and nature of communities, Structure of community, Community dominance, edge and ecotones.

Learning outcomes –

- 1) Students will be able to describe behavioral and physiological mechanisms by which organisms interact with other organisms and with their physical environment.
- 2) They can explain the biotic and abiotic factors that influence the dynamics of populations.
- 3) They can summarize the local and geographical distribution and abundance of organisms (habitat niche, community, bio-geography)

Unit II

1. Ecological Succession: Types and Patterns of succession, Climax.
2. Ecosystem: Structure and Functions of ecosystem, Primary production.
3. Environmental Impact Assessment: Definition and scope, characteristics, objectives, components, methodology, procedure for obtaining EIA clearance, preparation of EIA document.
4. Biogeochemical Cycles

Learning outcomes -

- 1) Explain the importance of biodiversity to ecosystems.
- 2) They can describe What is ecological succession.
- 3) They can also describe how the pioneer organism changes the environment.
- 4) Describe how the biogeochemistry, energy flow, or biodiversity of ecosystems respond to climate change or another disturbance.

Unit III

Concept, Scope and Definitions of Environmental Pollution

- Types of pollutants- based on physical properties, forms, causes of environmental pollution, pollution in relation to public health (Air, water, pesticide and radiation pollution).

Air pollution -Definition, sources, principle air pollutants, effects of air pollutants. **Smog** - Classical smog and industrial pollution, photochemical smog and vehicular emission. Prevention and control of air pollutants.

Environmental Legislation: Central and state boards for the prevention and control of environmental pollution, powers and functions of pollution control boards, penalties and procedure, duties and responsibilities of citizens for environmental protection, Wildlife Protection Act 1972.

Learning outcomes –

- 1) Students will be able to explain the causes of environmental pollution and preventive and control measures to eradicate pollution.
- 2) They will understand the role and sources of pollutants
- 3) They will get knowledge about the environmental protection laws and the legal standards to protect it.

Unit IV

Water pollution- Definition, Sources of water pollution, Types of water pollutants and their effects, BOD, COD water pollution control, Sewage treatment.

Soil pollution- Sources, effects of soil pollutants and remedial measures.

Radioactive pollution - Types, sources and effects of radiation.

Agricultural pollution- Farm animal waste, Soil erosion plants residues, agrochemical- fertilizers and pesticides.

Learning outcomes-

- 1) Students will get to know about the sources of pollution and their pollutants along with their control measures.
- 2) They will also be able to get awareness regarding diseases with pollution.

Suggested Readings:

1. Fundamentals of Ecology- Dash and Dash.
2. Basic Ecology- Odum E. P
3. Fundamentals of Ecology- Odum E.P
4. Modern concepts of ecology- K. D.Kumar.
5. Concepts of Ecology- H. D. Kumar.
6. Ecology - P. D. Sharma.
7. Environmental pollution Half, Rinehart and Winston, New York (1977)- Laurent Hodges.
8. Pandey Kamleshwar., Shuklar J. P. and Trivedi S. P. (2005): Fundamental of Toxicology. New Central book agency PVT. LTD. Kolkata.

M.Sc. Zoology
Academic Flexibility, Credit System
M. Sc. I – Sem. I
MZT 103 - Cell and Molecular Biology
Credit: (Theory – 04 Practical-04) Theory Lectures:60

Unit I - Membrane Structure and Function

1. Structure of model membrane, lipid bilayer and membrane protein diffusion,
2. Osmosis, ion channels, active transport, membrane pump
3. Cell-cell adherence, Gap junction, ECM, Integrin.

Learning outcome –

- 1) The students will be able to understand the role of membranes to protect the cell.
- 2) They will be able to explain the models of membrane structure and diffusion of molecules passing through it.
- 3) They will know the importance of cell to cell communication.

Unit II - Secretory Pathway:

1. ER-structure (SER, RER), transport.
2. Ribosomes, polysomes, free ribosomes, membrane associated ribosomes and secretory pathway.
3. Vesicles involved in intracellular transport.

Learning outcome–

- 1) Student will be able to explain detailed Location, structure, function and transport in Endoplasmic Reticulum.
- 2) They will know the pattern of secretion of protein and its intracellular transport through vesicles.
- 3) They will understand the role of ribosomes in protein synthesis.

Unit III- Cellular respiration & degradation:

1. Peroxisomes – structure and functions.
2. Endosomes – late and early – structure, formation, assembly & components.
3. Lysosomes – structure & polymorphism.
4. Proteasomes – types structures, assembly & functions.
5. Mitochondria -structure, assembly components.
6. Role of cyt.p.450 in detoxification (Xenobiotic Transformation)

Learning outcome-

- 1) Students will be able to explore the structure and function of cell organelles.
- 2) They will be aware about cellular activities like respiration and degradation in cell.
- 3) They will know the process of detoxification occurring in the body.

Unit IV- Nuclear Components:

1. Nucleus – EM. Structure.
2. Nuclear envelope – structure & function.
3. Chromosomes – Packaging of genome, genetic maps and nucleolus.
4. Heterochromatin.

Cell cycle division and signal transduction:

1. Cell cycle – cyclins & cyclin dependent kinases & checkpoints.
2. Cytoskeleton & intracellular movement – microtubule, MTOC.
3. Micro filaments & intermediate filaments.
4. Signal transduction pathway.

Learning outcome –

- 1) Student will be able to get the clear idea about the electron microscopic structure of Nucleus and various components related to it.
- 2) They can explain the pattern of packaging of chromosomes in nucleus.
- 3) Students can know the importance of cell cycle and its role during cancer.
- 4) They will be provided understanding of cellular signalling in the body.

Reference Book:

1. Molecular biology of the Cell – Bruce Albert Pub. By Garland Pub. Inc. New York & London.
2. Molecular Cell biology – Lodish Berk, Matsudaira, Kaiser, Krleger (2004) pub. By W., H. Freeman & Company, New York.
3. Molecular cell biology – Gerald carp (2005) pu. By John Wiley & Sons.
4. Avers C.J. (1986)/ latest edition) Molecular Cell Biology, Addison-Westey, Reading in Massachusetts.

5. Baserga, R (1985)/ latest edition) The Biology of Cell Reproduction. Harward University Press Cambridge, Massachuselts.
6. Beck, F. and J.B. Lloyd (eds) (1974) The Cell in Medical Science, Academic Press, London.
7. Callan, H.G (1986)/ latest edition) Lampbrush Chromosomes Springer –verlag New York.
8. Chambliss, G(ed)(1980)/latest edition) Ribosanes – Structure, Function & Genetics University of Park Press, Baltimore.
9. Edmunds, L.N. 1984 / latest edition- Cell Cycle Clock, Marcel Dekker, New York.
10. Edmunds, L.N. 1987/ latest edition. Cellular & Molecular Basis of Biological Clocks Springer – Verlag Berlin.
11. Gomperts, B.D.(latest edition) Plusma Membrane Academic press, New York.
12. Henning, W (ed) 1987/ latest edition Structure & Function of Eukaryotic Chromosanes Springer – Verlag, Berlin.
13. Moens, P.B. (ed) 1987/ latest edition Meiosis Academic Press, Orlands, Florida, USA.
14. Nomura, M.A./Tissiers &P. Lengyel (eds). 1974 Latest edition –Ribosomes Cold Spring Harber Laboratory Press, New York.
15. Tzagtoloff. A 1982/ latest edition Mitochondria Plenum Press, New York.
16. E. Munn 1982/ latest edition, Mitochondria: Structure, assembly & function.
17. Whaley – The Golgi apparatus 1976/ latest edition. The Frontiers in Cell Biology series Academic Press.
18. Holtzman E The frontiers in Cell Biology series Academic Press.
19. Petty H.R 1993. Molecular Biology of Membrane Plenum.
20. Yeagle P.L. 1993. The Membranes of Cells 2nd ed. Academic Press.
21. Berger E.G. et.al. 1998. Reviews of Golgi Complex Trends Cell Biology Vol. 8 No.1.
22. Rapoport, T.A. et.al. 1996. Protein Transport across the eukaryotic ER & Bacteria inner membrane Annu. Rev. Biochem. 65:271-303.

23. Robinron M.S. 1997. Coats & vesicle budding *Tred Cell Biol.* 799-102.
24. W.Baumeister et al. 1998- The Proteosome: Paradigm of a self-compartmentalizing protease *Cell*92:367-380.
25. Robison, M.S. et al 1996 Membrane dynamics in endocytosis *Cell* 84: 13-26.
26. Amos, L.A & Amos W.B. 1991 *Molecules of Cytoskeleton* GuilforPress.
27. Bay,D. 1992 *Cell Movement* Garkud.
28. Drubin, D & Hirokawa N. Eds 1998. *Cytoskeleton* *Curr. Opin. Cell. Biol.* Vol.10,1.
29. Hyams, J.S. & Lloyd, C.,W. 1994 *Microtubules*Wiley-liss.
30. Stearns, T. & Winey, M. 1997. The Cell Center at 100 *Cell*91:303-309.
31. Shaw, P.J. & Jordan, E.G. The nucleotus, 1995 *Ann. Rev.Cell. Dev. Bio.* 11:93-121.
32. Green, R. & Noller, H.F.1997.

M.Sc. Zoology
Academic Flexibility, Credit System
M. Sc. I – Sem. I
MZT 104- Applied Entomology

Credit: (Theory – 04 Practical-04) Theory Lectures: 60

Unit I -

Study of generalized insect: Grass hopper (Morphology and Anatomy Brief Account) Identification, Characteristics, Biology, Damage and Control of following insect pests.

House hold pests: Cockroach, Ant, Cricket, Clothes Moth, Carpet beetle, Furniture beetle, Cigarette beetle, House hold hairy caterpillar, Silverfish, Book louse, Wasp.

Medicinal Pests: Mosquitoes, Housefly, Bedbug, Sand fly, Human lice, Tsetse fly, Rat flea, Hippobosca.

Learning outcome –

- 1) Students will be able to understand the anatomy of insects, its biology and control measures of insectpests.
- 2) They will be able to classify, understand the life cycle damage and control of household and medicinalpests.

Unit II

Veterinary pests: Mosquitoes, Sandfly, Horsefly, Blowfly, Stable fly, Warble fly, Creep worm fly, Flea.

Forest Pests: Termites, *Eutectonama chearalis*, *Hyleapuera*, *Sahyadrassus malabaricus*, *Batocera rufumacualata*, Shisham defoliater *Plecoptera reflexa*, Deodar defoliater Oak bark weevil, Sal bostrichid beetle.

Learning outcome-

- 1) Student can know about the different veterinary and forests pests
- 2) They will be able to identify, classify, study morphological characters, Life cycle, damage and control of pests.

Unit III

Sericulture: History of Sericulture, Life cycles of Mulberry and Non-Mulberry Silkworms, Rearing technology of mulberry silkworm, Diseases and pests of Mulberry silkworm, Moriculture and cultural practices and pests of Mulberry.

Lac culture: Lac insect- Taxonomy, distribution and life history, Host plants and lac insects, Strains of lac insect and their propagation, Cultivation practices, Lac extraction and uses.

Apiculture: The honey bees, Social organization of honey bees, Life history of honey bees, Methods of bee keeping.

Learning outcome –

- 1) Students will be able to know the process to run sericulture technique by studying its various technology and cultural practices related to it.
- 2) Students will be able to understand the importance of lac culture, its cultivation and products of lac used for economic purpose.
- 3) They will be able to know different casts of honey bee, and methods to run the apiculture unit.

Unit IV

Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, Organic methods of domestic pest management.

Learning outcome –

- 1) Student will be able to know what are pests and control of pests.
- 2) They will understand the principles of it by integrating different ecofriendly methods to control the pest.
- 3) They will be able to create awareness about organic methods of domestic, house hold and residential pest management
- 4) They will understand the various methods of pest control utilized in an IPM program.

Suggested Readings -

1. A text book of Applied Entomology, vol.2 - K. P. Srivastava,1996.
2. Elements of Entomology- Rajendra Singh.
3. A text book of Forest Entomology – T.V. Sathe, 2009.
4. Sericulture and Pest Management – T.V. Sathe and A.D. Jadhav, 2001.
5. Sericultural crop protection – T.V Sathe,1998.
6. Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.
7. Crickets and Household pests – T.V. Sathe and M.R. Awate,2009.
8. Beekeeping in the tropics – G.S. Smit,1960.
9. Beekeeping in India, ICAR, New Delhi, S. Singh, 1975.
10. A handbook of practical Sericulture, CSB, Ullal and Narsimhanna,1981.
11. Lac culture in India farm information unit, DEMOFA, New Delhi, S.Krishnaswami,
12. A text book of applied entomology- K. P.Srivastava.
13. Elements of entomology- Rajendra Singh

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-I Sem.-I
MZP 105

(Practical based on paper – MZT 101& 102)

Learning Objectives:

Students will able to-

1. Understand all aspects of invertebrate animals.
 2. To study the Chordate phylum, systematic and biodiversity.
 3. To identify and classify the animals by the identification key.
 4. Able to understand the methods and procedure of animal collection and their preservation.
 5. Able to understand the different parameters of aquatic habitat.
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1. Study of museum specimens and slides invertebrate's phyla (one representative from each class) for biosystematics & biodiversity.
 2. Study of museum specimens of chordates phylum (one representative from each class) for biosystematics and biodiversity.
 - 3) Identification of insects/ molluscs with the help of keys up to orders. 4).
 - Identification of insects/ molluscs with the help of keys up to families.
 6. Identification of animals with the help of keys up to families (fish/amphibian with the help of preserved specimens / models / pictures).
 7. Methods of collection and preservation of animals.
 8. Visit to ZSI/fields.
 9. Study of inter relationships parasitism, symbiosis, commensalisms(2-3 examples from each).
 10. Study of endangered species. (Models, pictures, charts.).
 11. Study of adaptations in animals from Pisces, amphibian, reptilian, birds& mammals (2-3 examples from each).
 12. Visits to sanctuaries and National parks to study wild life management.
 13. Study biodiversity of platue by Quadrate& transect method, Shannon index and Simpsons index
 14. Detection of heavy metal by Atomic absorption Spectrophotometer
 15. Use of software for identification of plants & animals.
 16. Assessing existing data base on www.
 17. Harnessing information through Internet regarding Biodiversity.
 18. Preparation of culture media isolation of DNA from plants & animals.
 19. Study of microbes isolation, culture and staining from soil & water.
 20. Identification of planktons from different watersamples

21. Determination of DO, CO₂ Hardness, Chloride, Alkalinity of fresh water and sewage water.(Physicochemical parametres)
22. Determination of COD of sewage water.
23. Determination of BOD of sewage water.
24. Estimation of inorganic phosphate and nitrate from water sample.
26. Qualitative and quantitative estimation of Zooplanktons.
26. Detection of heavy metal from the water sample.
27. Practicals set on the network – internet, protein information, Genome& Chromosome database set by teacher.
28. Any other experiment set by the concerned teacher

Course Outcomes: After completion, students are able to

1. Understand the classification of non chordates and chordates.
2. Understand the Identification of animals with the help of keys up to families.
3. Able to study endangered species, adaptations and their interrelationships.
4. Able to study the parameters of different water samples.

Suggested Readings:

1. Alston, R.E. and B.L. Turner (1963): Biochemical systematics Prentices Hall Inc. Englewood Cliffs, N.J. 404 pp.
2. Avise, J.C. (1974): Systematic value of Electrophoretic data. Syst. Zool. 23 (4): 465 – 481.
3. Benazzi, M. (1973): Cytotaxonomy and evolution, General remarks vertebrate evolution. Ed. A.B. Chiarelli and Campus Academic Press, London and N.Y. pp. 1-3.
4. Blomback, B and M. Blomback (1968): Primary structure of animal proteins as a guide in taxonomic studies. In chemitaxonomy and serotaxonomy (ed.) Hawkers pp. 3 – 20.
5. Camp, W.H. (1951): Biosystematics Britania 7: 113 – 127.
6. Ernst Mayr (1969): Principles of Systematics Zoology TMH Ed. Tata McGraw Hill Publishing company Ltd. Bombay New Delhi.
7. Primack, R. B. (1950): A primer of conservation biology 3rd edition Sinuer Associates Inc. Publishers Sunderland Massachutts USA.
8. Ray Samit an Ray A.K. (2006): Biodiversity and Biotechnology New Central Book Agency (P) Ltd.
9. Theory and practice of animal taxonomy- V. C. Kapoor

10. Fundamentals of Ecology- Odum E.P
11. Ecology - P. D. Sharma.
12. Fundamentals of Ecology- Dash and Dash.
13. Modern Textbook of Zoology Invertebrates - R.L. Kotpal
14. Chemical and Biological Methods for Water Pollution Studies- R.K. Trivedy, P.K. Goel.

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-I Sem.-I
MZP 106

(Practical based on paper – MZT 103& 104)

Learning Objectives:

Students will able to-

1. Understand different staining techniques for extra cellular material
2. To Study of cell Organelles.
3. To identify and classify the animals by the identification key.
4. Able to understand the methods and procedure to Study of generalized insect, Identification economic importance of insect pests.
 1. Demonstration of extracellular material
 - a. Collagen, b. Elastin
 2. Demonstration of Glycosaminoglycans in the extracellular material using
 - b. AB-1
 - c. AB-2.5
 - d. PAS
 - e. AF +AB 2.5 (SialicAcid)
 - f. MgCl₂ influence on alcinopoilia.
 3. Study of cell Organelles.
 - g. Nucleus demonstration by
 - i) Basic Dyes : TB, HE, Methylene blue.
 - ii) Feulgen reaction Effect of temperature
 4. Lysosome demonstration (Acid phosphatase and any othe rmethod)
 5. Golgi bodies demonstration (Cajal Method)
 6. Effect of tonicity of solutions on plasma membrane –Isotonic, Hypotonic, Hypertonic
 - b) Fragility test of RBC & Osmotic Resistance.
 7. Study of generalized insect. Identification economic importance of following insect pests (6-8 pests from each category)
 8. Pests of stored gains.

9. Household pests.
10. Pests of medical importance.
11. Pests of veterinary importance.
12. Forest pests.
13. Types of silkmoths.
14. Rearing appliances of mulberry silk worm and demonstration.
15. Study of forensic insects
16. Study of nutritional insects.
17. Life cycle and types of honeybees.
18. Lac insect economic importance.
19. Field visit for demonstration of pest damage.
20. Field visit for collection of insects.
21. Any other practical set by concern teacher.

Course Outcomes: After completion, students are able to

1. Understand the how to control stored grain pest.
2. Understand medicinal pest and its diseases.
3. Able to study forest pest and its economic importance.
4. Understand the knowledge of applied Zoology and their use in startup

Suggested Readings –

1. Cell Biology (Cytology, Biomolecules And Molecular Biology)- Agarwal V. K
2. Cell Biology : Practical Manual - Dr. Renu Gupta , Dr. Seema Makhija , Dr. Ravi Toteja
3. A handbook of practical Sericulture, CSB, Ullal and Narsimhanna,1981.
4. Lac culture in India farm information unit, DEMOFA, New Delhi, S. Krishnaswami,
5. A text book of applied entomology- K. P. Srivastava.
6. Elements of Entomology- Rajendra Singh

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-I Sem.-II
MZT 201: Physiological chemistry

Credit: (Theory – 04 Practical - 04) Theory Lectures: 60

Learning Objectives:
Students will able to-

1. Understand biochemistry of carbohydrates, protein and lipid.
2. To introduce structure, function and organization of various bio-molecules present in the living cell.
3. Students know the structure and properties of macromolecules that act together to maintain and perpetuate the living systems.
4. Understand the structure and function of nucleic acid.

Unit I

Principles of Biological chemistry:

Principles of biophysical chemistry (pH, buffer, reaction kinetics dissociation and association constants) Physical constants,

Structure of atoms, molecules and chemical bonds, Vander Waal's electrostatic, Hydrogen bonding and hydrophobic interactions. Thermodynamics, Concept of free energy, Enthalpy, Entropy,

Water: Structure and physicochemical properties, Energy rich bonds.

Basics of solution preparation: Molarity, Molality, Normality, W/V, % solution, ppm, Stock dilution

Unit II

Carbohydrates –

Structure, classification and function, Carbohydrate metabolism: Glycolysis, TCA cycle, Electron transfer and ATP generation, Bioenergetics of ATP cycle, glycogenesis, glycogenolysis, gluconeogenesis and Pentose phosphate pathway

Unit III

Proteins – structure, classification and function, Biosynthesis and Oxidation of amino acids. Primary structure of proteins and nucleic acids, Conformation of proteins and, Reverse turn and Ramachandran plot.

Nucleic acids: DNA, RNA structure, functions and Biosynthesis of nucleotides

Unit IV

Lipids- structure, classification and function, Catabolism of fatty acid – Beta oxidation, significance of beta oxidation, Biosynthesis of saturated and unsaturated fatty acids, Biosynthesis of triglyceride, biosynthesis of membrane phospholipids, Biosynthesis of cholesterol, Steroidal hormones- structure and functions.

Course Outcomes: After completion, students are able to

1. Knowledge on the structure and function of different biomolecules would enable the students to consolidate their focus on understanding various metabolic pathways crucial for the sustenance of living systems.
2. Understand the how to form proteins and how to work at molecular level.
3. Understand the metabolic pathways and their role in human bodies.
4. Get knowledge of micro and macromolecules and their concern diseases.
5. Acquired knowledge and importance of water for living system.

Suggested Reading:

1. A K Anderson- Essentials of physiological chemistry.
2. H. Harper- Review of physiological chemistry.
3. P. Karlson- Introduction to modern biochemistry
4. West E an Todd W- Text book of biochemistry
5. Mahler H and Cordes E – Biochemical chemistry
6. Lehninger's- Biochemistry – COX & Nelson.
7. Reithel F J- Concepts in Biochemistry
8. G H Bell , Je N Davdson and D E Smith- Text book of physiology and biochemistry
9. Mitlon and Toporely- Essentials of biochemistry
10. Outline of Biochemistry by Conn & Stump.

M.Sc. Zoology
Academic Flexibility, Credit System
M. Sc. I Sem. II
MZT 202 - Quantitative Biology and Tools and
Techniques in Biology

Credit: (Theory – 04 Practical - 04) Theory Lectures: 60

Learning Objectives:
Students will able to-

1. Understand about the terms Central tendency, correlations, regression and analysis of variance.
2. Understand how to apply testing hypothesis, Probability distribution, Student t- test and Chi- square test.
3. Understand how to separates molecules by using different techniques.
4. Understand analytical instruments and their applications in biology.

Unit I

1. Introduction, Application in Biology.
2. Measurement of Central tendency.
3. Measures of dispersion.
4. Correlation- Types and methods of correlation.
5. Regression- Regression lines and coefficients.
6. Analysis of Variance (ANOVA).

Unit II

1. Probability- Introduction, addition and multiplication theory.
2. Probability distribution- Binomial, Poisson and Normal.
3. Testing of hypothesis.
 - 3.1 Tests of Significance.
 - 3.2 Null hypothesis.
 - 3.3 Alternative hypothesis.
 - 3.4 Level of significance.
4. Student t- test.
5. Chi- square test (X²).
6. Confidence integral.

Unit III

Separation techniques:

2. Chromatographic techniques – Chromatography theory & practices, Molecular Sieve chromatography, affinity chromatography, ion exchange chromatography, HPLC, GLC, Thin layer chromatography.
3. Electrophoretic techniques – General principles, support media, electrophoresis of proteins and nucleic acids, Isoelectric focusing.
4. Density gradient centrifugation and its application

Unit IV

(A) Analytical instruments and their applications in Biology:

1. Spectroscopy (Spectrophotometry, Spectroflurometry, NMR, ESR).

(B) Microscopy, Radiometry &Immunochemical techniques.

1. Light microscope, phase contrast microscope, fluorescence microscope, Electron Microscope (SEM & TEM).
2. Immunoprecipitation, Labelling antibodies, immunoblotting, immunoassays & immunohisto /cytochemistry.

Course Outcomes: After completion, students are able to

1. Identify analyses appropriate for diverse types of data, and explain their theoretical fundamentals.
2. Describe, present, and critically evaluate analytical methods, models and theories used in published research, and identify, where relevant, more appropriate alternatives.
3. Apply and extend analytical methods, models and theories to biological datasets.
4. Acquire skills of separation technique, analytical instrumentation and their applications.

Suggested Reading:

1. Fundamentals of Statistics- Gupta S. C.
2. Basic Biostatistics and its applications- Datta A. K
3. Biostatistics and Biometry- Parihar and Parihar.
4. An Introduction to statistical Methods- C. B. Gupta.
5. Practical Biochemistry By Wilson and Walker
6. Cell : A molecular approach By Cooper
7. Molecular Biology of the Cell by Lodish et al.
9. Basic Biostatistics and its applications- Datta A. K
10. Biostatistics and Biometry- Parihar and Parihar.
11. An Introduction to statistical Methods- C. B. Gupta.

M. Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-I Sem.-II
MZT 203 - Elements of physiology
Credit: (Theory – 04 Practical - 04) Theory Lectures: 60

Learning Objectives:
Students will able to-

1. Understand Physiological concepts of homeostasis and control mechanisms and to study the functions of body systems.
2. Understanding of the physiology and basic regulatory concepts related to the functioning of life processes.
3. Understand physiology of gastro intestine, respiration , circulation and excretion.
4. Understand the use of the scientific method and quantitative reasoning to field of physiology.

Unit I

Gastrointestinal Physiology

1. Functional anatomy of gastrointestinal tract
2. Gastrointestinal tract associated glands (Liver, Pancreas and salivary gland) with their control mechanism
3. Digestion and absorption in gastrointestinal tract
4. Dietary balance, regulation of feeding, obesity and starvation, BMR, Vitamins and their role in metabolism

Unit II

Physiology of Respiration:

- 2.1 Mechanism of breathing and pulmonary ventilation
- 2.2 Pulmonary volumes and capacities
- 2.3 Physiology of gas exchange
- 2.4 Regulation of respiration

Unit III

Physiology of Circulation:

- 3.1 Body fluids, blood coagulation and homeostasis
- 3.2 Blood groups and blood transfusion
- 3.3 Cardiac muscles and cardiac cycle
- 3.4 Control of excitation and conduction in heart
- 3.5 Normal electrocardiogram

Unit IV

Physiology of Excretion:

- 4.1 Functional anatomy of the kidneys and Mechanism of urine formation
- 4.2 Regulation of urine formation,
- 4.3 process of micturition and diuretics
- 4.4 Cerebrospinal fluid and brain metabolism.
- 4.5 Conduction of nerve impulse and synaptic transmission
- 4.6 Pituitary, Thyroid and Parathyroid Structure and functions, Bone marrow and erythropoiesis

Course Outcomes: After completion, students are able to

1. Understand the functions of important physiological systems including the cardio-respiratory, renal and metabolic systems;
3. Understand how these separate systems interrelate to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude, and how they can sometimes fail.
4. Perform, analyse and report on experiments and observations in physiology;
5. Understand Pituitary, Thyroid and Parathyroid glands and their pathophysiology

Reference:

1. Human Physiology – by A.C. Guyton. Saunders Company London, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart 7th ed. New York McGraw- Hill Book Co. 1990.
4. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Micbel, C.C. (eds) Americal Physiological Society, 1984.
5. Gayton A.C. et al. Circulation Overall regulation Annu Re. Physiol. 34: 13 1972.
6. Guyton A.C. 1980 Arterial pressure & Hypertension Philadelphia, W.B. Saunders Co- Cartiar output & its regulation 1973.
7. Kaplan N.M. et al 1989- The Kidney in Hypertension (Perspectives in hypertension vol.2) New York. Raven Press.
8. Guyton A.C. et al 1975 Dy namics & Control of the Body flerids Philadelphia, W.B. Saunders, Co., 1975.
9. Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. Saunders Co., 1986.
10. Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.
Johnson L.R. et al Physiology of the gastrointestind tract 1987 New York Raven press.
Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
11. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
12. Guthrie H.A. 1988. Introductory Hutrition 7th ed. St.Lonis C.V. Mosby Co.,
13. Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book Co.,
14. DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. saunders Co. 1989.

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc. I Sem II
MZT 204 - Biology of Parasites
Credit: (Theory – 04 Practical - 04) Theory Lectures: 60

Learning Objectives:

Students will able to-

1. Understand animal association, types, types of host and interrelationship between host and parasite.
2. Understand the term vectors and arthropod vector of Medical and veterinary importance.
3. Understand protozoan parasite and their diseases.
4. Understand the life cycle, mode of transmission and control measures of different parasite.

Unit I

Animal association, Types of Parasites, Types of Hosts, Interrelationship between host and parasite responses and hosts to parasitic infection, Mode of transmission of parasite, Host specificity and parasitic adaptation

Unit II

Vectors,

i) Definition, types, Epidemiological consideration, Relationship of vertebrate pathogen to vector immunology, Physiology of vector, Population studies and effectiveness of vector.
ii) Arthropod vector of Medical and veterinary importance Human louse, Triatomid bugs, Black flies, Sand flies, Mosquitoes, and Rat flea, ticks, mites and Vector control. Horse fly, House fly, Tsetse fly, Stable fly

Unit III

Study of parasites from protozoa & cestoda

1. Trypanosoma and leishmania of humans.
2. Intestinal flagellates Giardia, Q Trichomonas, Gregarina.
3. General life cycle of cestodes: Taenia, Diphylobothrium, Diphylidium, Echinococcus.

Unit IV

Study of parasites from Trematoda & Nematoda: *Schistosoma*, *Fasciola*, *Nematodes: Wuchereria*, *Ancylostoma*, *Strongyloides*, *Enterobius*. Plant nematodes.

Biology, epidemiology and control of waterborne and food borne parasites. Ecological changes & emerging diseases. General pattern of parasitic transmission. Parasitic zoonosis.

Course Outcomes: After completion, students are able to

1. Understand the vectors and disease and control measures by the vectors.
2. Animal associations for living in nature.
3. Understand the knowledge of cestodes, trematodes, nematodes and their life cycle.
4. Understand intestinal parasites and disease caused by them.

Recommended Books:

1. Parasitology – By Ramnik sood, C.B.S. Publisher, New Delhi –1993.
2. Parasitology – By K.D. Chaterjee, Medical Pulisher Calcutta, 1987.
3. Physiology of parasites – By L.S. Chapell, John, Willey & Sions N.Y. (1980).
4. Parasitology – By Hobler, E.R. and Noble, G.A. (1982) 2nd Ed. Lea & Febieger U.S.A.
5. Parasitism & Symbiology – By C.P. Read (1970) Ronald Press New York.
6. Foundation of Parasitology – By Schmidt, G.D. & Robert, L.S. (1981) 2nd Ed. C.V. Mosby Co. St. Lohis ISSR.
7. Introduction Animal Parasitology – By Smit. D.G. (1997) 2nd Ed. Johns Willey Sons New York.
8. The Biology of parasitism and introduction to the study of associate organism- by White field, P.J. (1977) University Parks Press Baltimore.
9. Animal Parasitism – by Read C.P. Prenters Hall of India Pvt. Ltd., New Delhi.
10. Helminths, Arthropods & Protozoo of domesticated Animals. By E.J.L. souls by, ELBS publication London Ed. 1969 ed.
11. Parasitology – by Chandler and Chands, A Text book of Parasitology by S.S. Kelkar and Rohini S. Kelkar, Bombay popular prakashan.
12. Parasitology – By Ramnik sood, C.B.S. Publisher, New Delhi – 1993.

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-I Sem.-II
MZP 205

Practical based on paper – MZT 201 & 202

Learning Objectives:
Students will able to-

1. Understand human systems physiology, building on knowledge of basic physiological principles.
 2. Understanding practical biological skills in physiology of organisms.
 3. Acquire skills in conducting collaborative research in the field of Physiology and allied sciences.
 4. Understand how to apply testing hypothesis, Probability distribution, Student t- test, ANOVA and Chi- square test with examples
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- 1 Estimation of glycogen.
 2. Estimation of lipids & phospholipids.
 3. Estimation of Vitamin C.
 4. Estimation of Cholesterol.
 5. Estimation of alpha-amino nitrogen by formol titration.
 6. To find saponification value for a given fat.
 7. To prepare solution of given concentration change in normality/Molarity Prepare phosphate buffer of known pH and molarity- pH measurement, measurement of pH of lemon juice, urine and serum.
 8. To find absorption spectrum of hemoglobin, bovine serum albumin, tyrosine and (uv-visible).
 9. To estimate free amino acids by Ninhydrin method.
 10. To estimate protein content by Biuret method/ Lowry et.al./ Bradford method.
 11. To estimate the sugar by Nelson-Somogyi method and glucose.
 12. Separation of sugars by TLC.
 13. Spot test of amino acids.
 14. Serum cholesterol, Calcium estimation
 15. Examples based on different population genetical principles (Based on theory).
 16. To isolate proteins by salting out or by adjusting isoelectric point.
 17. To estimate tyrosine content by Folin-phenol method.

18. To estimate the purity of ATP.
19. Examples based on Chi-square test & student t-test.
20. Examples based on regression.
21. Examples based on Correlation coefficient.
23. Examples based on Coefficient of variance.
24. Examples based on ANOVA.
24. Examples based on Probability.
25. Any other practical set by the concerned teacher.

Course Outcomes: After completion, students are able to

1. Estimate total amount of protein, lipid, glycogen, cholesterol and vitamin C from sample.
2. Apply the knowledge of biostatistics in routine life.
3. Separate out molecules from the sample by using different techniques
4. Acquire skills of analytical instrumentation and their applications

References:

1. R. C. Gupta and S. Bhargava, 2013. Practical Biochemistry, Fifth Edition, CBS Publishers & Distributors.
2. Practical Biochemistry By Wilson and Walker
3. D. T. Plummer, 2012. An Introduction to Practical Biochemistry, Third Edition, Tata McGraw Hill Education Pvt Limited.
4. Techniques in Life Sciences by D. B. Tembhare (2008), First Edition, Himalaya Publishing House Pvt. Ltd.
5. Principles and practice of Biostatistics by B. Antonisamy, Prasanna, S. Premkumar and Solomon Christopher (2017), Elsevier India.

M.Sc. Zoology
Academic Flexibility, Credit System
M.Sc.-I Sem.-II
MZP 206
Practical based on paper – MZT 203&204

Learning Objectives:
Students will able to-

1. Understand Physiological concepts of homeostasis and control mechanisms and to study the functions of body systems.
 2. Understanding of the physiology and basic regulatory concepts related to the functioning of life processes.
 3. Understand physiology of gastro intestine, respiration , circulation and excretion.
 4. Understand the identification and Preservation of different parasites.
- Determination of bleeding time
 - Determination of clotting time
 - Estimation of Haemoglobin (Hb) concentration and oxygen carrying capacity
 - Enumeration of Red blood corpuscles (R.B.C)
 - Enumeration of white blood corpuscles (W.B.C)
 - Differential count of W.B.C.
 - Erythrocyte sedimentation rate (E.S.R)
 - Detections of digestive enzymes
 - Microanatomy of Endocrine glands
 - To estimate amylase from saliva
 - To study normal constituents of urine
 - Measurement of breathing rate, heart beat and study of heart sound
 - Collection of parasites: Protozoans/ Nematodes/ Helminthes/ Insects.
 - Preservation and Identification of parasites: Protozoans
 - Preservation and Identification of parasites: Nematodes
 - Preservation and Identification of parasites: Helminthes
 - Preservation and Identification of parasites: Insects
 - Lifecycle studies of parasites: Protozoans
 - Lifecycle studies of parasites: Nematodes
 - Lifecycle studies of parasites: Helminthes
 - Lifecycle studies of parasites: Insects

- Any other practical set by concern teacher.

Course Outcomes: After completion, students are able to

1. Understand different physiological techniques for identified disease.
2. Estimate different enzymes from saliva.
3. Acquired the knowledge of life cycle of different Protozoans, Nematods, Helminths.
4. Acquire Knowledge of Endocrine gland and their role in Physiology.

References:

1. Techniques in Life Sciences by D. B. Tembhare (2017), First Edition, Himalaya Publishing House Pvt. Ltd.
2. Parasitology – By Ramnik sood, C.B.S. Publisher, New Delhi –1993.
3. Parasitology – By K.D. Chatterjee, Medical Publisher Calcutta, 1987.
4. Physiology of parasites – By L.S. Chapell, John, Willey & Sions N.Y. (1980).
5. Parasitology – By Hobler, E.R. and Noble, G.A. (1982) 2nd Ed. Lea & Febieger U.S.A.
6. Parasitism & Symbiology – By C.P. Read (1970) Ronald Press New York.
7. Foundation of Parasitology – By Schmidt, G.D. & Robert, L.S. (1981) 2nd Ed. C.V. Mosby Co. St. Lohis ISSR.
8. Introduction Animal Parasitology – By Smit. D.G. (1997) 2nd Ed. Johns Willey Sons New York.
9. Parasitology Protozoology and Helminthology 13Edition by Chatterjee, K. D. 2019.