



Rani Channamma University

Vidyasangam, NH-4 (PB Road), Bhutaramanahatti,

BELAGAVI – 591 156

Department of Studies in Zoology

(Under the School of Basic Sciences)

Regulations and Course Structure for

M.Sc. Zoology

Choice-Based Credit System (CBCS)

Academic Year 2020-21 and onwards

Model Grade Card
Programme: M.Sc. ZOOLOGY

Name of the candidate:

Semester: I

Seat No:

Month & Year:

Course/Paper	Paper code	Credits	Max. Marks	Marks obtained	Semester Grade Point	Credit points
Compulsory Paper/ Core Courses		04	100	60	6.00	24.00
Course-I		04	100	74	7.40	29.60
Course-II		04	100	43	4.30	17.20
Course-III		04	100	52	5.20	20.80
Course-IV						
Practicals						
Course-V		04	100	90	4.50	36.00
Course-VI		04	100	60	3.00	24.00
Total		24	600	379		151.60

GPA for I Semester = Total no. of CP ÷ Total no. of Credits = 145.60/24.00 = 6.06
CGPA for I Semester = GPA = 6.15

CP (I Sem) +CP (II Sem)

CGPA for II Sem = -----

Credits (I Sem) + Credits (II Sem)

CP (I Sem) + CP (II Sem) + CP (III Sem)

CGPA for III Sem = -----

Credits (I Sem) + Credits (II Sem) + Credits (III Sem)

CP (I Sem) + CP (II Sem) + CP(III Sem) + CP(IV Sem) CGPA for the programme = -----

Credits (I Sem) + Credits (II Sem) + Credits (III Sem) + Credits (IV Sem)

(*CP: Credit Points)

SEMESTER I

Compulsory papers

Theory	Hrs/Wk	Credits	Practical	Hrs/Wk	Credits
ZCT-1.1 Biology of chordates	4	4	ZCP 1.5	4	4
ZCT-1.2 Biology of non-chordates	4	4			
ZCT-1.3 Animal Systematics & Evolution	4	4	ZCP 1.6	4	4
ZCT-1.4 Environmental Biology	4	4			
		16	+	8 = 24	

SEMESTER II

Compulsory papers

Theory	Hrs/Wk	Credits	Practical	Hrs/Wk	Credits
ZCT-2.1 Animal Physiology	4	4	ZCP 2.4	4	4
ZCT-2.2 Molecular Genetics	4	4	ZCP 2.5	4	4
ZCT-2.3 Molecular Cell Biology	4	4			
		12	+	8 = 20	

SEMESTER III

Compulsory papers

Theory	Hrs/Wk	Credits	Practical	Hrs/Wk	Credits
ZCT-3.1 Developmental Biology	4	4	ZCP 3.4	4	4
ZCT-3.2 Parasitology	4	4	ZCP 3.5	4	4
ZCT-3.3 Animal Biotechnology	4	4			
		12	+	8 = 20	

SEMESTER IV

Compulsory papers

Theory	Hrs/Wk	Credits	Practical	Hrs/Wk	Credits
ZCT-4.1 Gen. & Comp. Endocrinology	4	4	ZCP 4.4	4	4
ZCT-4.2 Biology of Reproduction	4	4	ZCP 4.5	4	4
ZCT-4.3 Applied Zoology	4	4			
4.6 Project Work	4	4	-	-	-
		16	+	8 = 24	

Total credits: 64 (Theory + project) + 32 (practical) = 96

Note: 1. *There shall be 20 marks as internal assessment (IA) for each theory paper and practical.*

2. *There shall be 80 marks for each theory paper and practical examination at the end of each semester.*

3. *The project work shall carry 100 marks (IA-20; Dissertation – 50; Viva-voce – 30 marks)*

Open elective papers (For other Department students)

Semester II

Theory	Hrs/Wk	Credits
ZET 2.4 Economic Zoology	4	4

Semester III

Theory	Hrs/Wk	Credits
ZET 3.4	4	4
Total ZET Credits		8

Note: 1. *There shall be 20 marks internal assessment (IA) for each theory paper.*

2. *There shall be 80 marks for each theory examination.*

RANI CHANNAMMA UNIVERSITY, BELAGAVI
DEPARTMENT OF ZOOLOGY
CHOICE-BASED CREDIT SYSTEM (CBCS)
COURSE STRUCTURE AND SCHEME OF EXAMINATION

Sem.	Course No.	Title of the course	Credits	Teaching hours/week	Maximum Marks		
					Written exam	I.A.	Total
I	Compulsory Courses:						
	1.1	Biology of Chordates	4	4	80	20	100
	1.2	Biology of Non-chordates	4	4	80	20	100
	1.3	Animal Systematics and Evolution	4	4	80	20	100
	1.4	Environmental Biology	4	4	80	20	100
	1.5	Practical – I Based on 1.1 and 1.2	4	4	80	20	100
	1.6	Practical – II Based on 1.3 and 1.4	4	4	80	20	100
II	Compulsory Courses:						
	2.1	Animal Physiology	4	4	80	20	100
	2.2	Molecular Genetics	4	4	80	20	100
	2.3	Molecular Cell Biology	4	4	80	20	100
	2.4	Practical – V Based on 2.1	4	4	80	20	100
	2.5	Practical – VI Based on 2.2 and 2.3	4	4	80	20	100
	Open Elective Course:						
2.6	Economic Zoology	4	4	80	20	100	
	Compulsory Courses:						

III	3.1	Developmental Biology	4	4	80	20	100	
	3.2	Parasitology	4	4	80	20	100	
	3.3	Animal Biotechnology	4	4	80	20	100	
	3.4	Practical – I Based on 3.1	4	4	80	20	100	
	3.5	Practical – II Based on 3.2 and 3.3	4	4	80	20	100	
	Open Elective Course:							
	3.6	Fundamentals of Animal Sciences	4	4	80	20	100	
IV	Compulsory Courses:							
	4.1	General & Comparative Endocrinology	4	4	80	20	100	
	4.2	Biology of Reproduction	4	4	80	20	100	
	4.3	Applied Zoology	4	4	80	20	100	
	4.4	Practical – IV Based on 4.1	4	4	80	20	100	
	4.5	Practical – V Based on 4.2 and 4.3	4	4	80	20	100	
	4.6	Project Work	4	4	80	20	100	

RANI CHANNAMMA UNIVERSITY, BELAGAVI
NAME OF THE COURSE: M.Sc. ZOOLOGY
SYLLABUS FOR SEMESTER I

PAPER ZCT- 1.1: BIOLOGY OF CHORDATES

UNIT I. Origin and interrelationships (12)

General characters and outlines of classification of Chordata - the construction and interpretation of classifications. Origin of chordates in the light of recent theories

Fine structure and role of notochord and endostyle in Amphioxus and Ascidia with their evolutionary significance

General characters and classification of Protochordata.. Phylogenetic relationship between Protochordates and Chordates

Reproduction in Tunicates and significance of retrogressive metamorphosis

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

Some principles and considerations. Origin and Classification of Vertebrates

UNIT II. Vertebrate Integument, Excretory system, Nervous system and Sense organs (12)

Development and general structure of skin and its functions; Integument of fishes with emphasis on dermal derivatives; Integument of Tetrapods with emphasis on epidermal derivatives - glands, scales, horns, claws, nails, hoofs, feathers and hairs.

Excretion- Evolution of uro-genital system in Vertebrates; Comparative account of kidney in Vertebrates

Nervous system: Development of spinal cord and peripheral nervous system; Evolution of spinal nerves, cranial nerves and autonomic nervous system; Development and organization of the brain; Comparative account of brain in Vertebrates.

Sense organs: Types of receptors; Organs of olfaction and taste- Vomero-nasal/Jacobson's organ in reptiles; lateral line system; electroreception in fish; ear and eyes in Vertebrates.

UNIT III. Respiration, circulation and locomotion: (12)

Structure and mechanism of cutaneous, branchial and pulmonary respirations

Outline of origin and evolution of cardiovascular system in vertebrates.

Form, function, size and skeletal and muscular elements of the body –Appendicular skeleton – origin of tetrapod limbs and their modifications. Appendicular musculature of Tetrapodes

Axial skeletons- Overview of Skull Morphology, Skull Function and Design. Origin of Jaw and modification of Jaw bones and types. 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 of Procoelus, Opisthocoelus, Amphicoelus, Amphiplatins, Heterocoelus, Axis and atlas vertebrae

Types of 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. Adaptive radiation in Vertebrates (12)

Origin, evolution and adaptive radiation in fishes, amphibians, reptiles, birds and mammals

References Books:

1. Barrington, E.J.W. (1965): The biology of Hemichordata and Protochordata. Oliver and Boyd, Edinborough, UK.
2. Colbert, E.H. (2011) Evolution of the Vertebrates. 5th Edn. John Wiley and Sons Inc., New York
3. Hyman, L.H. (1966): Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago
4. Milton Hildebrand and George Goslow (2002): Analysis of Vertebrate Structure, 5th Edn. John Wiley and Sons Inc., New York
5. Romer, A.S. Vertebrate Paleontology. 3rd Edn. University of Chicago Press, Chicago
6. Weichert, C.K. and Presch, W. Elements of Chordate anatomy. 4th Edn. McGraw Hill Book Co., New York.
7. Weichert, C.K., Anatomy of Chordates McGraw Hill Book Co. Inc. London.
8. Young, J.Z. (1981): The Life of Vertebrates, 3rd Edn. Clarendon Press Oxford.
9. Young, J.Z. (1976):, Life of mammals The Oxford University Press, London.
10. Barnes, R.S.K. (1993) The invertebrates: a new synthesis, Blackwell Scientific Publication.
11. Cleveland, H.P., Roberts, Larry S. (Jr) and Larson A. (1995) Integrated Principles of Zoology. 9th edition, WBC Brown publishers.
12. Gardiner, M. S. (1972) The Biology of Invertebrates, Mc. Graw Hill Book Co.
13. Hyman L. H. (2004) Anatomy of Comparative Vertebrates. Reprint. Satish Serial

Publishing, Delhi.

14. Kenneth, V. K. (2006) Vertebrates: Comparative Anatomy, Function, Evolution. 4th edition, McGraw-Hill, New York, NY.
15. Kulshrestha, S. K. (2004) Comparative Anatomy of Vertebrates
16. Milton, H. (1995) Analysis of vertebrate structure. John Wiley & Sons Inc, New York

PAPER ZCT-1.2 BIOLOGY OF NON-CHORDATES

Unit I: Coelom, Body plan and Phylogeny (8)

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 and Ectoprocta

Unit II : Locomotion and Nutrition (12)

Amoeboid, Ciliary and Flagellar movements in Protozoa; Ultrastructural aspects of flagella; Principle of hydrostatic skeleton; hydrostatic movement in Annelida; Flight movement in insects

Nutrition in Protozoa and lower Metazoan; Filter feeding in Polychaeta, Mollusca, Crustacea and Echinodermata; Feeding patterns in insects

Unit III: Respiration and Circulation (10)

Respiratory organs in invertebrates – gills, lungs and trachea; Respiratory pigments - hemoglobin, hemocyanin, hemerythrin and chlorocruorin

Circulation – Patterns (open and closed types) with suitable examples

Unit IV: Excretion (6)

Excretory organs – Flame cells, coelomoducts, nephridia and Malpighian tubules – Morphology and mechanisms of excretion

Unit V: Nervous System (7)

Trends in neural evolution: Primitive nervous system in Cnidaria and Echinodermata; Advanced nervous system in Annelida, Arthropoda and Mollusca; Brief review of sense organs in different phyla

Unit VI: Reproduction (5)

Asexual, sexual and parthenogenetic modes of reproduction and their significance; Larval forms and their significance

ZCP- 1.5 PRACTICALS BASED ON 1.1 BIOLOGY OF CHORDATES AND 1.2
BIOLOGY OF NON-CHORDATES

1. Study of digestive system in shark and rat
2. Study of cranial nerves of shark.
3. Mounting: Ampullae of Lorenzini, and placoid scales of shark
4. Study of vertebrate nervous system: mounting of shark and rat brains
5. Study of museum specimens:
 - Protochordates: *Balanoglossus*, *Botryllus*, *Amphioxus*, *Doliolum*, *Ascidia*,
Petromyzon
 - Pisces: *Myxine*, *Clarius*, *Echeneis* (Sucker fish), *Scoliodon*, *Hippocampus*, Sting ray
 - Amphibians: *Ichthyophis*, *Siren*, *Bufo*, Axolotl larva, *Rana*, *Ambystoma*, *Rhacophorus*
 - Reptiles: Tortoise, *Phrynosoma*, Krait, *Draco* (flying lizard), *Varanus*, Russel's viper,
Typhlops, 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
6. Observation of zooplankton in water sample
7. Study of the digestive system: earthworm and starfish
8. Study of the nervous system of earthworm with mounting of ovary.
9. Study of water vascular system of starfish
10. Study of locomotory organs: a. Setae of earthworm, b. Tube feet of starfish, c. Leg of
cockroach
11. Study of excretory organs: a. Nephridia in earthworm, b. Malphigian tubules in cockroach
12. Study of respiratory organs: a. Branchial cone in *Terebella*, b. Ctenidia in *Unio*, c.
Tracheae in Cockroach

Reference Books:

- 1) Barrington, E J W, (1976): Structure and Functions of Invertebrates.

- 2) Barnes, RD, Invertebrate Zoology, Halt Saunders Intl. Edition
- 3) Hyman ,L.H, The invertebrates (all volumes), McGraw Hill, Philadelphia, USA
- 4) Huston, AM, Biological Diversity, Cambridge University Press, Cambridge
- 5) Kapoor V.C, Theory and Practice of Animal Taxonomy, Oxford and IBH Publ., Delhi
- 6) McNeely ,JA, Economics and Biological Diversity, IUCN, Gland, Switzerland
- 7) Miller,S.A. and Harley,J.P. (2005). Zoology. 6th Ed.,McGraw Hill Higher Education,
- 8) Boston, Toronto,Sydney
- 9) Prasad S.N, Life of Invertebrates, Vikas Publ. New Delhi
- 10) Sinha, A.K, Adhikari S and Ganguly BB, Biology of Animals (vol. I & II),
- 11) Central Book Agency, Kolkata
- 12) Young ,J.Z. Life of Vertebrates, Clarendon Press, Oxford
- 13) Invertebrate Zoology ----- EL Jordan; P.S. Verma
- 14) A Text Book of Zoology Vol. I ----- P.S. Dhami; Jk.Dhami.
- 15) A Text Book of Invertbrate zoology ----- R.L.Kotpal.
- 16) Biology of Animals --- Cleveland P. Hickman JR Larryds. Roberts.

PAPER ZCT-1.3 ANIMAL SYSTEMATICS AND EVOLUTION

Unit I: Science of Biosystematics and Species concept (6)

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)

Unit II: Taxonomic Collection, Preservation and Identification (6)

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; identification services.

Unit III: Classification and Phylogenetic Analysis (8)

Components of classification; Procedure of classification (phenetic and cladistic), presentation of classification - Linnaean/Taxonomic hierarchy, ways of constructing a phylogenetic tree. Phylogenetic analysis - Purpose, terminology, methods of phylogenetic analysis (Phenetic method, dendrogram method, pairwise distance; Cladistics method, parsimony, maximum likelihood); phylogenetic lineages

Unit IV: Application of Zoological Nomenclature (8)

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/ Bioinformatics.

Unit V: Introduction to evolution and Theories of evolution (10)

Evolution of evolutionary thoughts, Lamarckism; Natural Selection (Darwinism), Contributions of Charles Darwin, Alfred Russel Wallace, Thomas Malthus and Hugo de

Vries; Postulates of Natural Selection and evidences; Natural Selection in action- Industrial melanism; Darwin's finches, Experimental evidences of Natural selection- Endler's guppies ; Concepts of inclusive fitness – altruism and kin selection.

Unit VI: Neo-Darwinism and Non-Darwinism (10)

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

Non-Darwinism: Molecular polymorphism: Nucleic acids and proteins; Molecular clock; Neutral theory of evolution and evolution random walk; Forces in evolution- stochastic vs deterministic.

ZCP: 1.6: PRATICALS BASED ON 1.3 ANIMAL SYSTEMATICS AND EVOLUTIONARY BIOLOGY AND 1.4 ENVIRONMENTAL BIOLOGY

1. Evidence for Principle of Evolution:
 - a. Homologous organs and Serial homology
 - b. Analogous organs
 - c. Vestigial organs
2. Morphometric measurements of some locally available fishes
3. Construction of different types of Taxonomic keys for the identification of animals
4. Construction of phylogenetic trees by taking suitable examples
5. Embryological evidence for evolution: Descent with modification.
6. Study of fossils and living fossils.
7. Application of Hardy-Weinberg principle to determine allelic frequency of:
 - a. PTC trait in man
 - b. blood group trait in man
8. Estimation of dissolved oxygen (DO) in different water samples
9. Estimation of free carbon dioxide in different water samples
10. Estimation of chlorides in different water samples
11. Estimation of total hardness of different water samples
12. Estimation of total alkalinity of different water sample
13. Determination of Biological Oxygen Demand (BOD) in different water samples
14. Estimation of dissolved sulphates in water by the turbidometric method
15. Estimation of the organic carbon content of different soil samples

Reference Books:

- 1) Batschelet, E. (1975) Introduction to Mathematics for Life Scientists, 2nd edition, Springer-Verlag, Berlin-Heidelberg-New York
- 2) Koto, M. (2000) The Biology of biodiversity, 1st edition, Springer, Japan.
- 3) Murry J.D. (1993) Mathematical Biology, 2nd edition, Springer-Verlag, New York/Berlin.
- 4) Snedcor, G.W. and Cochran W.G. (1989) Statistical Methods , Affiliated-East-West Press, New Delhi.
- 5) Sokal, R.R. and Rohlf F. J.(1995) Biometry the principles and practice of statistics in biological research, 3rd edition, New York W.H. Freeman.
- 6) Wilson, E.O. (1988) Biodiversity, National Academy Press, Washington, D.C.
- 7) Ernest Mayr. Principles of Systematic Zoology, Tata-McGraw-Hill, New Delhi, 1997.
- 8) Simpson, G.G. Principles of Animal taxonomy. Columbia University Press, New York, 1961.
- 9) Barnes, R.D. Invertebrates Zoology. IInd Saunders, Philadelphia, 1968.
- 10) Kapoor, V.C. Theory of Animal Taxonomy, Oxford IBH Co. Pvt. Ltd., New Delhi, 1998.
- 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 Y.S. Shishodia. Biodiversity Conservation and Sustainable Development. Pointer Publications, Jaipur, 1998.
- 14) Futuyama, D.J. Evolutionary Biology- III Ed. Sinauer Associates Inc. Massachusetts, 1998.
- 15) Gerhart, J and Kirchner, M. Cell, Embryos & Evolution. Blackwell Science Publishers, 1997.
- 16) Keynes, R. Charles Darwin's Zoology Notes & Specimen List from H.M.S Beagle. Cambridge University Press, 2000.
- 17) Price, P.W. Biological Evolution. Saunders College Publishing, 1995.
- 18) Smith, J.M. Evolutionary Genetics. Oxford University Press
- 19) Dobzhansky, Th., F. J. Ayala, G. L. Stebbins and J. M. Balentine, (1976): Evolution. Surjeet Publication, Delhi.
- 20) Freeman, S and Herron J. C. (1998): Evolutionary Analysis. Prentice Hall, New Jersey.
- 21) Futuyama D. J. (1986): Evolutionary Biology. Sinauer Associates, INC. Sunderland.
- 22) Smith, J. M. (1998): Evolutionary Genetics. Oxford University Press. Oxford.
- 23) Stearns, S. C. and Hoekstra, R. F.(2000): Evolution: An Introduction.Oxford University Press. Oxford.
- 24) Strickberger, M. W. (1990): Evolution. Jones and Bartlett Publishers. Boston.
- 25) Strickberger,, M. W. (2014): Evolution 5th edition. Jones and Bartlett Publishers. Boston.
- 26) Futuyama, D. J. (2013): Evolution. Macmillan education.

ZCT-1.4: ENVIRONMENTAL BIOLOGY

Unit I: Introduction to Environmental Biology (8)

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

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

Biotic and abiotic components, basic loss of energy flow, food chain, food web, ecological pyramids, biogeochemical cycles and ecological succession.

Unit II: Population Growth and Regulation (4)

Types of population growth, physical and biological factors regulating population, population characteristics, mortality, natality, density, age distribution. Population pyramids, population explosion.

Unit III: Natural Resources (6)

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 IV: Animal biodiversity (12)

Global and Indian biodiversity; Levels of biodiversity- genetic, species, ecosystem diversity; Endangered species; Values of biodiversity- consumptive, productive, social, ethical, aesthetic (ecotourism) and health values; Conservation of biodiversity- ex-situ and in-situ; Mega-biodiversity centers- National parks, sanctuaries and biosphere reserves, biodiversity hotspots; Threats to biodiversity; Human-wildlife conflicts; Organizations associated with biodiversity management and its conservation.

Unit V: Climate change and environmental pollution (8)

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

Composition and structure of atmosphere; Climate- catastrophes and driving forces; Human caused climate change- ozone layer depletion, greenhouse gases and global warming, acid rain; Strategies for dealing with global warming

Unit VI: Environment and human health (10)

Types of environmental health hazards- infectious organisms, Toxicants- chemicals, natural and synthetic toxins, heavy metals; Bioaccumulation and bio-magnification; Toxicity measurement- animal testing; environmental legislation and protection.

Reference Books:

1. Chapman R. L. & Reiss, M. J. (2000). Ecology – Principles & Application. Cambridge Low Price Edition.
2. Chapman, J.L and Reiss, M.J. (1999): Ecology: Principles and Applications. Cambridge University Press
3. Collin R, Townsend, Harper J L, and Michael Begon (2000): Essentials of ecology. Blackwell Sci. Comp.
4. Jorgensen,S.E. Fundamentals of ecological modeling. Elsevier, New York.
5. Kormondy, E. J. (2007): Concepts of Ecology. 4 th ed. Indian reprint, Pearson Education.
6. Krebs, C J. (1994) Ecology , Harper and Collins
7. Odum E. P. (2008) : Fundamentals of Ecology .Indian Edition. Brooks /Cole.
8. Odum, E. P.and Barret, G. W. (2005). Fundamentals of Ecology. 5 th ed. Thompson Brooks/Cole.
9. Odum, E. P. (1971). Fundamentals of Ecology. W. O. Saunders company, Philadelphia.
10. Odum, E. P. (1983). Basic Ecology. CBS College Publishing.
11. Odum, E.P. 1(1983) Basic Ecology, Holt Saunders, Japan.
12. Odum. E.P. (1996).Fundamentals of Ecology. Nataraj Publishers, Dehra Dun.
13. Paul Colinvaux, (1986): Ecology. John Wiley and Sons, N.Y.
14. Peter Stilling, Ecology: Theory and applications. 2nd ed. Prentice Hall
15. Sharma P.D (2011): Ecology and Environment. Rastogi Publication, Meerut.
16. Environmental Science by Willam P. Cunninsham, Barbora woodworth saigo
17. The use of Earthworms in waste disposal by Edward, C.A.
18. Introduction to Environmental Engineering & Science Gilbert M. Masters.
19. Essential of Ecology by colin R. Townsend Michael Begon John.L.Harper.
20. Environmental Biology -- A.G.Agarwal.
21. Environmental Science by G.Tyler Miller.
22. Toxicology -- Y.K.Lahir.
23. Boughey A S 1971 Fundamental Ecology (Intext Educational Pub.) Pp 222
24. Chenn P 1999 Ecology (John Murray Pub.) Pp 213
25. Collin R, Townsend, Harper J L, and Michael Begon 2000 Essentials of ecology. (Blackwell Sci. Comp.)
26. Dilip R 1998 Environment management with Indian experience (APH Pub. Cor.)
27. Mackenzie A, Ball A S and Virdee S R 2002 Ecology (Viva Books Pvt. Ltd.) P 339
28. Miller Jr and G T 2002 Living in the environment (Wardsworth, Brooks/Cole)

29. Mishra P C 1990 Fundamentals of Air and Water Pollution (Ashish Publishing House)
30. Paul W P 1948 Limnological Methods (The Blakistan Co.)
31. Raven P H, Berg L R, Johnson G B 1993 Environment (Saunders College Pub.) pp 569
32. Singh M C 2000 Environment Protection and the Law (Ashish Publishing House)

RANI CHANNAMMA UNIVERSITY, BELAGAVI
NAME OF THE COURSE: M.Sc. ZOOLOGY
SYLLABUS FOR SEMESTER II

PAPER ZCT 2.1: ANIMAL PHYSIOLOGY

Unit I: Introduction to Physiology and Physiology of Respiration and Blood (12)

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

Respiration: The atmosphere, solubility of gases, respiratory organs in the vertebrates; Respiratory mechanisms in aquatic and air breathing fishes, birds and mammals; respiration in eggs; Exchange of O₂ and CO₂ and transport. Oxygen dissociation curve

Blood - components and functions; acid-base balance regulation

Circulation: General principle, vertebrate circulation, the physics of flow in tubes, Hemostasis.

Unit II: Water and Osmoregulation (6)

Properties of water molecules; Osmoregulation, osmoregulators and conformers; Obligatory exchanges of ion and water; Osmoregulatory organs; Osmoregulation in aqueous and terrestrial animals

Unit III: Temperature (6)

Classification of animals based on thermal biology.

Temperature effects: effects of temperature change, extreme temperatures-limits to life, tolerance to high temperature, tolerance to cold and freezing temperatures.

Temperature regulation: Body temperature of birds and mammals, heat transfer, heat balance, torpor and hibernation, aestivation.

Unit IV: Feeding and Digestion (12)

Feeding methods and mobility of the alimentary canal; Physiology of digestion and absorption, gastrointestinal secretions; nutritional requirements (micro and macro)

Enzyme catalysis: Enzymes as catalysts, enzyme kinetics, regulation of enzyme activity, active sites, coenzymes, activators, inhibitors, isoenzymes, allosteric enzymes, ribozymes.

Unit V: Muscle physiology (6)

Types of muscles: striated, nonstriated and cardiac muscles. Ultra structure of striated muscle. Muscle contraction – Muscle proteins, sliding filament theory, Energetics of muscle contraction.

Defects in muscle function, muscle coordination diseases, muscular dystrophy

Aging physiology concepts related to muscle function.

Unit VI: Nervous system (6)

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

ZCP 2.4 - ANIMAL PHYSIOLOGY PRACTICALS

- 1) Qualitative analysis of carbohydrates
- 2) Qualitative analysis of polysaccharides
- 3) Qualitative analysis of proteins
- 4) Qualitative analysis of lipids
- 5) Total count of blood corpuscles
- 6) Differential count of WBCs
- 7) Estimation of blood clotting time
- 8) Estimation of protein and hemoglobin
- 9) Estimation of cholesterol and triglycerides
- 10) Analysis of pathological contents of urine
- 11) Estimation of glucose
- 12) Identification of adulterants
- 13) Any other practical depending on feasibility.

References Books:

1. Neilsen, K.S. Animal Physiology: Adaptation & Environment. IV Ed. Cambridge University Press, 1995.

2. Prakash, M & Arora, C.K. Encyclopedia of Animal Physiology. Anmol Publications, New Delhi, 1998.
3. Pestonjee, D.M. Stress and Copping. Sage Publications, London, 1999.
4. Poole, M.C., Pilkey Grant and Johnson.E.C. Biology in Action. Harcourt Brace, Canada, 1995.
5. Hoar, W.S. General and Comparative Animal Physiology. Prentice Hall Inc, New Delhi, 1983.
6. Guyton C. Arthur and Hall J.E. Textbook of Medical Physiology. W.B.Saunders C. London, 1996.
7. Randall David., Burggren. W and French, K. Animal Physiology. W.H. Freeman and Co.New York, 1997.
8. Physiology by Best & Taylor.
9. Neilsen, K.S. Animal Physiology: Adaptation and Environment. IV Ed. Cambridge University Press, 1995.
10. Prakash, M. and arora C.K. Encyclopedia of Animal Physiology, Anmol Publications New Delhi, 1998.
11. Pestonjee, D.M. Stress and Copping, Sage Publications, London, 1999.
12. Poole, M.C., Pilkey, Grant and Johnson E.C. Biology in Action, Harcourt Brace, Canada, 1995
13. Hoar, W.S. General and Comparative Animal Physiology. Prentice Hall Inc., New Delhi, 1983
14. Randall David, Burggren, W and French, K. Animal Physiology.W.H. Freeman and Co., New York, 1997.
15. Guyton, A.G. (2002). Text Book of Medical Physiology, 12th Edn. Saunders Publication.
16. Hoar, W.S. (1983). General and Comparative Animal Physiology, 3rd Edn. Prentice Hall Inc.
17. Jayaraman, J. (981). Laboratory Manual in Biochemistry, Wiley Eastern Ltd.
18. Murray, RK, Garner, D.K., Mayes P.A. and Rodwell, V.W. (2003). Harper's Illustrated Biochemistry, 26th Edn. Lange Medical Books, McGraw Hill, New York.
19. Plummer, D.T. (1988). An Introduction to Practical Biochemistry. Tata McGraw Hill Publishing Company, Ltd. New Delhi.
20. Randal, D., Burggren, W. and French, K. (2002). Eckert Animal Physiology, Mechanisms and adaptations. 4th Edn. W. H. Freeman and Company, New York.
21. Schmidt-Nielson, K. (2002). Animal Physiology: Adaptations and Environment, 5th Edn. Cambridge University Press, UK.
22. Tyagi,V.K. (2005): Animal Physiology and Biochemistry.Kedar Nath Ram Nath, New Delhi, Meerut.

ZCT 2.2: MOLECULAR GENETICS

Unit I: Mendelian and Modern Genetics (10)

Overview of Mendelian principles and Post-Mendelian Genetics. Concept of alleles, complementation test, cistron, muton and recon. Linkage and crossing over. Non-Mendelian inheritance

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; organization of prokaryotic and eukaryotic genomes. Replication: Enzymology of replication, initiation, elongation and termination; models of replication. Protein synthesis: Genetic code, colinearity hypothesis. Transcription, post-transcriptional modifications; Translation: post-translational modification.

Unit II: Bacterial Genetics (5)

Genetics of bacterium and bacteriophage: Transformation, transduction and conjugation in bacteria; F- mediated sexduction, mechanism of recombination in bacteria, Life cycles of bacteriophage, plasmids and episomes.

Unit III: Gene Regulation in prokaryotes and Eukaryotes (6)

Gene regulation: Prokaryotes- operon model- positive and negative regulation; Eukaryotes - model of gene regulation, transcription factors, Cis and trans acting elements in eukaryotes. Dosage compensation in human, *Drosophila* and *Caenorhabditis elegans*. Genome imprinting

Unit IV. Chromosomal and Gene mutations: (14)

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. Causes of mutations. Mutational analysis in vitro and in vivo.

Unit V: Genetic Diseases (10)

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. Chromosome 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 VI: Genomics and Proteomics (3)

Salient features of yeast, Drosophila and Human genomes; Evolutionary genomics; Proteomics

Reference Books:

1. Anthony JF Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart. 2004. Introduction to Genetic Analysis, 7th Edition. W. H. Freeman and Company. New York.
2. Griffiths, Anthony J.F.; Gelbart, William M.; Miller, Jeffrey H.; Lewontin, Richard C. 1999. Modern Genetic Analysis.. W. H. Freeman and Company. New York.
3. Atherley A.G, Girton J.R and J.F.McDonald (1999). The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, N.Y.
4. Brooker RJ (1999) Genetics: Analysis and Principles. Benjamin/Cummings, Longman Inc.
5. Gardner EJ, Simmons M.J and D.P.Snustad (1991) Principles of Genetics. John Wiley and Sons. Inc. N.Y.
6. Goodenough U (1985) Genetics. W.H. Feeman and Co.N.Y.
7. Hartle D.L and E.W.Jones (1998) Genetics: Principles and analysis. Jones and Bartlett Publishers.
8. Jinks J.A. (1972) Extrachromosomal inheritance, Prentice Hall Inc. N.J
9. Brown T A (1989) Genetics. A molecular approach. Van Nostrand Co. N.Y
10. Snustad D.P and M.J.Simmons. 1997. Principles of Genetics. John Wiley and Sons, Inc. NY.
11. Stickberger, N.W. Genetics. MacMillan Publishing Co. New York, 1985.
12. Watson, J.D et al., Recombinant DNA. W.H.Freeman & Co, 1992.
13. Trevor,B.B and Julian Burke. Gene structure and transcription. Oxford Univ Press, 1998.
14. Benjamin Lewin. Genes Vols I-IV. Oxford Univ Press, 1995.
15. Brown T. A. (2007): Genomes 3. Garland Science Publishing, New York.
16. Cummings, M. R. (2014.): Human Heredity: Principles and Issues. West Publishing Company
17. Dunham, I., (200): Genome Mapping and sequencing. Horizon Scientific
18. Epstein, R. J. (2003): Human Molecular Biology. Cambridge Univ. Press, Cambridge
19. Graur, D and W H Li (2000):. Fundamentals of molecular evolution. Sinauer Associates.

20. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. (2004): Genetics from Genes to Genomes. McGraw Hill
21. Jobling, M. A., Hurler and Tyler-Smith. (2004.): Human Evolutionary Genetics – Origin, People & Disease. Garland & Science
22. Khoury, M. J., Little, J. and Burke, W. (2004): Human Genome Epidemiology. Oxford Univ. Press, Oxford.
23. Lewin B. (2014): Genes XI. Oxford University Press. Oxford.
24. Motulsky, V. (1977): Human Genetics. Springer & Verlag, Berlin. The Human Genome 2001, Nature Vol. 409.
25. Primrose, S. B., and R. M. Twyman(2006): Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
26. The Drosophila Genome. 2000, Science Vol. 267.
27. The Caenorhabditis elegans genome 1998. Science Vol. 282.
28. The Arabidopsis Genome, 2000 Nature vol. 408.

PAPER ZCT 2.3: MOLECULAR CELL BIOLOGY

Unit I: Introduction (4)

Scope of modern cell biology, historical highlights, Introduction to molecular cell biology: Levels of organization. Cell as a morphologic and functional unit within organisms. The central dogma of molecular biology. The scope of modern cell biology. Synthetic biology

Unit II: Molecular organization of bio membranes (8)

Organization and composition of plasma membrane, Fluid mosaic model. Membrane fluidity- role of cholesterol. Membrane asymmetry. Transport across membranes (solutes, gases, ions and water); Passive and active transport, Cell junctions: types, structure and functions .

Unit III: Molecular organization and functions of cell organelles (8)

Endoplasmic reticulum; 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. Mitochondria – bioenergetics, oxidative phosphorylation, protein import and transport metabolites; Peroxisomes.

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

Unit IV: Biomolecules (8)

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 V: Nucleus and Chromatin Biology (7)

Ultra structure of nucleus and functions. Molecular structure of chromosomes: Euchromatin and Heterochromatin; Role of histones in Packaging DNA; Nonhistone proteins; C- Value Paradox. Nucleolus – organization and functions.

Unit VI: Cell Cycle, Apoptosis, Cancer biology and Immunology (13)

Cell Cycle- Molecular events; Role of Cyclins and Cyclin Dependent Kinases (CDK) in cell cycle. Apoptosis - Mechanism and significance

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

Immunology: Cells and tissues of immune system, types of immunity, T and B lymphocytes; Cytokines, MHC molecules. Immunoglobulins: types, structure and functions of immunoglobulins.

ZCP 2.5 – PRACTICALS BASED ON 2.2 (MOLECULAR GENETICS) AND 2.3 (MOLECULAR CELL BIOLOGY)

1. Study of polytene chromosomes in Chironomous larva and *Drosophila* larva
2. Study of genetics of ABO blood group in humans
3. Study of X-chromatin or Barr body in human buccal cells
4. Human Karyotype preparation and analysis: a. Normal male, b. Normal female, c. Down syndrome, d. Cri-du-chat syndrome, e. Klinefelter syndrome, f. Turner syndrome, g. Translocation
5. Study of *Drosophila* mutants: Normal male, Normal female, Yellow body, Bar eye, White-eye, Vestigial wing, Ebony body, Sepia eye
6. Study of sex combs and genital plates of different *Drosophila* species
7. Study of epithelial, nervous, and muscular tissues in frog: Ciliated, columnar, and squamous epithelium; myelinated and unmyelinated nerve cells; smooth, striated, and cardiac muscles.
8. Study of connective tissues: Bone and cartilage; Blood cells – erythrocytes and leucocytes.
9. Study of mitosis through onion root tip preparation and permanent slides.
10. Study of meiosis through the preparation of grasshopper testis and permanent slides.
11. Estimation of DNA by Diphenylamine (DPA) method.
12. Estimation of RNA by Orcinol method.
13. Observation of Lactobacillus in curd sample

References Books:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons
6. Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter 2008. Molecular Biology of the cell. V Ed. Garland Science, New York.
7. Brachet, J. 1985. Molecular Cytology, Academic Press, N. Y.
8. Furukawa, R., and M. Fechheimer. 1997. The structure, function and assembly of actin filament bundles. Int. Rev. Cytol. 175: 29-90.
9. Lodish, H., A. Berk, C.A Kaiser, M.P. Scott, A Bretscher, H. Ploegh, P. Matsudaira. 2008. Sixth Edition, Molecular Cell Biology. W. H. Freeman and Co., N. Y.
10. Pollard, T. D. and W. C. Earnshaw. 2002. Cell Biology. Saunders
11. Wolfe, A. 1995. Chromatin: Structure and function. Academic Press, N. Y.
12. Ashwerth, J. M. (1975) Cell differentiation, Chapman and Hall Publishers, London.
13. Avers, C. J. (1986) Molecular Cell biology, Addison Wasley Publishing Co., England.
14. Brachet, J. (1985) Molecular Cytology, Vol.I and Vol.II The Cell Cycles, Academic press Inc.,
15. Bray, B. A. D, Lewis J, Raff M, Roberts K and Watson J.D (1995) Molecular biology of the cell, II edition, Garland Publishing Company Ltd. New York and London.
16. Celis, J. E. (1994): Cell Biology – a laboratory hand book, Vol.I, II and III, Academic press.
17. Darnell, J. H., Lodish J. H and Baltimore D. (1995) Molecular Cell Biology, Scientific American Books, New York.
18. De Robertis, E. D. P, De Robertis E. M.F (1995) Cell and Molecular Biology, VIII edition, Indian edition.
19. Friefelder, D. (1987) Molecular Biology, II Edition, Jones and Barlett Publishers Inc., Boston.
20. Karp, G (1996) Cell and Molecular Biology: Concepts and experiments, John Wiley, New York.
21. Lewin, B (Ed) 1996) Genes, VII edition, John Wiley and Sons, New York
22. Kleinsmith, L. J. and Kish V. M (1995) Principles of Cell and Molecular Biology, II edition, Harper Collins College publishers.
23. Sadava, D. E (1993) Cell Biology – Organelles, Structure and function, Jones and Bartlett publication.
24. Schlieff, R. (1986) Genetics and Molecular Biology, Addison Wasley Publishing

25. Sheeler, P. and Bianchi D.E. (1987) Cell and Molecular Biology, III edition, John Wiley New York.
26. Swanson, C. P. and Webster P. L. (1989) The Cell, V Edition, Prentice Hall of India, New Delhi.
27. Watson, J. D, Hopkins N. H, Roberts J. W, Steitz J. A and Weiner A. M (1987) Molecular Biology of the Gene, Vol.I& II general principles, IV edition, The Benjamin Cummings Publishing Co., Inc.,
28. Watson, J. D, Gilman M, Witkowski J and Zooler M (1992) Recombinant DNA, II edition, Scientific American Books, Freeman & Company, New York.
29. Cooper, M. G (1997) The Cell: The Molecular approach, ASM Press, Washington.

OPEN ELECTIVE PAPER (FOR OTHER DEPARTMENT STUDENTS)

ZET- 2.6: ECONOMIC ZOOLOGY

Unit I Introduction (1)

Importance of Economic Zoology

Unit II: Vermiculture (6)

Establishment of vermiculture unit; Earthworm as a tool for the conversion of biodegradable waste into vermicompost; Earthworms as poultry and fish feed; Vermiwash

Unit III: Apiculture (9)

Beekeeping practices in India; Foraging and colony organization in honeybees; Composition and uses of honey and bee products.

Unit IV: Sericulture (9)

Importance of sericulture as a rural industry; Life cycle of Bombyx mori; Modern rearing methods, reeling, grading and marketing. Types of silk. Lac culture: Cultivation and uses of lac.

Unit V: Fisheries (10)

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; Fish by-products

Unit VI: Poultry keeping (4)

Introduction to poultry and their economic value

Breeding techniques of poultry breeds viz. white leghorn, jungle fowl, giriraj, turkey bird and duck

Housing techniques: diseases of poultry

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

Unit VII: Dairy management

(9)

Introduction: definition, types of indigenous cattle, breeds of cow, breeds of buffalo, high-yielding exotic breeds

Nutritive value of milk and milk products

Cattle by-products

References Books:

1. Hickling, C.E. 1962. Fish and fish culture. Faber and Faber, London.
2. Jhingran, V.G. 1977. Fish and Fisheries of India. Hindustan Publ., New Delhi.
3. Schmitz, R.J. 1996. Introduction to Freshwater Biology. Gulf Publishing Company, New Delhi.
4. T.V.R. Pillay 'Principles and practice of Aquaculture. 2nd edition, Fishing News books.
5. R.K.Rath. 'Fresh water aquaculture'. 2nd Edition. Scientific Publishers. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, (2006), DIPA, New Delhi, INDIA.
6. Srivastava., 1979. Applied Entomology. Vol II.
7. Singh .S., 1962. Beekeeping in India. ICAR. New Delhi.India.
8. Snodgrass,R.E. 1956. Anatomy of the Honeybee. Cornell Univ. Press. Ithaca. New York.
9. Winston, M. 1984. The Biology of the Honeybee. Harvard. Uni. Press. London. UK.
10. Tazima. Y. 1958. Silkworm egg. CSB Publication, Bombay.
11. Yashimoro Tanaka. 1964. Sericology, CSB Publication, Bombay.
12. Tanaka, Y. 1953. "Genetics of the silkworm, Bombyx mori" – advances in genetics, Demerec.M. (Ed), Vol.5, Academic press, New York.
13. Tazima, Y. !964. " The genetics of the Silkworm". Logos Press Ltd., London.
14. Hickling, C.E. 1962. Fish and fish culture. Faber and Faber, London.
15. Jhingran, V.G. 1977. Fish and Fisheries of India. Hindustan Publ., New Delhi.
16. R.K.Rath. 'Fresh water aquaculture'. 2nd Edition. Scientific Publishers. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, (2006), DIPA, New Delhi, INDIA.
17. Srivastava., 1979. Applied Entomology. Vol II.
18. Singh .S., 1962. Beekeeping in India. ICAR. New Delhi.India.
19. Snodgrass,R.E. 1956. Anatomy of the Honeybee. Cornell Univ. Press. Ithaca. New York.
20. Winston, M. 1984. The Biology of the Honeybee. Harvard. Uni. Press. London. UK.

SEMESTER III

PAPER ZCT 3.1 DEVELOPMENTAL BIOLOGY

Teaching hours per week: 4; No. of credits: 4

Unit I: Introduction 14 hrs

Historical account of and developments in developmental biology;

Issues in developmental biology, Modern approaches; Mechanisms of regulating developmental processes; Implications of developmental biology and its applications in modern science

Pattern Formation: laying down the primary body axis in *Drosophila*, amphibians, and mammals; Segmentation genes, gap genes, pair-rule genes, segment polarity genes in *Drosophila*, homeotic selector genes in flies and mammals

Unit II: Morphogenesis and Neurogenesis 14 hrs

Morphogenesis: gastrulation, morphogenetic movements and selective affinities of cells (cadherins & differential adhesion), molecular regulation of mesodermal migration

Neurogenesis: neuronal specification, notch signaling, skin/nerve regulatory switch in flies, axonal path finding – attractants and repulsive signals, target selection and formation of synapse

Mesoderm, vertebrate heart development

UNIT III: Organogenesis and Regeneration 14 hrs

Limb development: limb bud formation & specification, digit formation, programmed cell death in digit formation

Metamorphosis and Regeneration: molecular mechanism of ecdysone action, cellular choice between apoptosis and differentiation, molecular responses to thyroid hormone during metamorphosis, blastema formation and differentiation during regeneration

Unit IV: Developmental mechanisms of evolutionary changes 6 hrs

Genetic mechanisms: heterotopy, heterochrony, heterometry, heterotypy; Homologous genetic pathways of development

PAPER ZCP 3.4 DEVELOPMENTAL BIOLOGY (PRACTICALS)

1. Live observation of embryogenesis in *Drosophila melanogaster*
2. Dissection and mounting of imaginal discs of *Drosophila*
3. Study of gene expression during development with lac-Z reporter gene in embryos (Demonstration)
- 4-5. Study of homeotic and maternal effect mutations
6. Mounting and staining of chick embryo
7. Study of different developmental stages of chick embryo (18, 24, 36, 48 and 72 hours) through permanent slides
8. Study of frog egg and its different developmental stages – cleavage, morula, blastula, gastrula, and neurula
9. Study of amphibian development – tadpole of frog
10. Any other practical depending on feasibility

REFERENCE BOOKS:

1. Gilbert S. F. *Developmental biology*. 8th edition. Sinauer Associates Inc., 2006.
2. Lewis Wolpert. *Principles of development*. 3rd edition. Oxford University Press, 2007.
3. Balinsky B. I. *An introduction to embryology*. 5th edition. Thomas Asia Pvt. Ltd., 2004.
4. Twyman R. M. *Developmental biology*. Bios Scientific Publishers Ltd., 2001.
5. Rao V. *Developmental biology: a modern synthesis*. Oxford and IBH, New Delhi, 1994.
6. Watson J. D., Baker T. A. et al. *Molecular biology of gene*. 5th edition. Pearson Education Ltd., 2004.
7. Alberts and Johnson. *Molecular biology of the cell*. 4th edition. Garland Science, New York, 2002.

PAPER ZCT 3.2 PARASITOLOGY

Teaching hours per week: 4; No. of credits: 4

Unit I: Introduction to parasitology **10 hrs**

Scope and importance of parasitology; Historical account on discovery of parasites and parasitic diseases; Types and classification of parasites; Bio-ecology of ectoparasites and endoparasites, facultative parasites and obligatory parasites; Host-parasite interactions with examples; Parasitoids, zoonosis; Symbiosis and commensalism

Unit II: Epidemiology of parasitic diseases **10 hrs**

Etiology, life cycle, hosts, transmission, pathology, distribution, symptomatology, diagnosis, treatment and prevention of common parasites and diseases caused by them

Protozoan parasites: *Entamoeba*, *Giardia*, *Leishmania*, *Plasmodium* and *Trypanosoma*

Flatworms & Nematodes: *Schistosoma*, *Taenia*, *Ancylostoma*, *Ascaris*, *Brugia*, *Dracunculus*, *Enterobius*, *Trichinella*, *Wuchereria*

Unit III: Pathology of parasitic diseases **8 hrs**

Immune response and self-defense mechanisms of the host; Immune evasion and biochemical adaptations of parasites, morphological adaptations of internal parasites; Parasites of veterinary importance

Unit IV: Disease causing vectors and external parasites **10 hrs**

Vector biology: Role of mosquitoes, house flies, cockroaches and bedbugs in transmission of diarrhea, dysentery, typhoid, cholera, conjunctivitis and skin infections

Life history of common ectoparasites: Ticks, mites and lice; Soft ticks and hard ticks, morphology and life history of *Argas* and *Haemaphysalis*; Life cycle, disease transmission and control measures

Unit V: Control of parasitic diseases

10 hrs

Traditional control methods, chemical methods, genetic and environmental methods; Biological control methods: microbes and predators; Integrated parasites control and management (IPC & IPM); Insecticide resistance in pests, Drug resistance in pathogens and parasites; Importance of education, social awareness and community participation in disease eradication

REFERENCE BOOKS:

1. Boyd W. *A text book of pathology: structure and function in disease*. 4th edition. Lea and Febiger, Philadelphia, 1976.
2. Chatterjee. *Parasitology*. Chatterjee medical publishers, 1981.
3. Chandler and Read. *Introduction to parasitology*. Wiley, 1970.
4. Cotran R. S., Kumar V. and Robbins S. L. *Robbins pathologic basis of disease*. 4th Ed. W. B. Saunders Company, London, 1989.
5. F. E. G. Cox. *Modern parasitology: a textbook of parasitology*. Wiley-Blackwell, UK.
6. Noble and Noble. *Parasitology*. Lea and Febiger, 1973.
7. Pearse A. G. E. *Histochemistry theoretical and applied*. J & A Churchill Ltd., London, 1980.
8. Roberts L. S. and Janovy J. *Foundations of parasitology*. McGraw-Hill publishers, New York, USA.
9. Rogers A. W. *Cells and tissues: an introduction to histology and cell biology*. Academic Press, New York, 1983.
10. Smith. *Animal parasitology*. Cambridge university press, 1996.
11. Telford I. R. and Bridgman C. F. *Introduction to functional histology*. Harper and Row, New York, 1990.

PAPER ZCT 3.3 ANIMAL BIOTECHNOLOGY

Teaching hours per week: 4; No. of credits: 4

Unit I: Introduction to cell culture

12 hrs

Historical account on cell culture; Advantages and limitations of cell/tissue culture; Methods and protocols for cell culture: handling, facilities required, media and cell lines; Types of culture; Primary culture: methods, nomenclature of cell lines, sub-culture and propagation; Immortalization of cell lines, cell line designation, selection of cell lines and routine maintenance

Cloning methods: suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate and selective inhibitors

Unit II: Cells isolation and characterization

12 hrs

Differential density-based isolation, antibody-based, magnetic and fluorescence-based cell sorting; Characterization of cells based on morphology, chromosome analysis, DNA content, RNA and proteins, enzyme activity, antigen markers, cell quantification; Cell culture contamination: monitoring and eradication, cryopreservation; Culturing of epithelial, mesenchymal, neuro-ectodermal, hematopoietic, gonadal and tumor cells, lymphocyte preparation, culture of amniocytes, stem cell culture and its applications; Embryo culture: whole embryo culture – eggs, chick and mammalian embryos

Unit III: Biotechnology in animal reproduction

12 hrs

Super ovulation and embryo transfer in cattle; Animal cloning: introduction, nuclear transfer for cloning (SCNT), cloning from embryonic, adult and fetal cells; Cloning from cultured cells; Cloning of sheep, monkeys, mice, goats, pigs and pets; Cloning of cows from aged animals; Cloning for production of transgenic animals, gene targeting for cloned transgenic animals, cloning for wildlife conservation

Cloning efficiency; Advantages and disadvantages of animal cloning; Human cloning: risks and ethical issues

Unit IV: Transgenic animals

12 hrs

Gene transfer: transfection of fertilized eggs/embryos, unfertilized eggs, cultured mammalian cells; Targeted gene transfer

Transgenic animals and their applications: mice, sheep, pigs, goats, cows and fish

Legal, ethical and socio-economic concerns of biotechnology at national and international levels; Biosafety regulations: guidelines for research on transgenic animals, public awareness regarding production of transgenic organisms

PAPER ZCP 3.5 PRACTICALS BASED ON 3.2 (PARASITOLOGY) AND 3.3 (ANIMAL BIOTECHNOLOGY)

1. Study of prepared slides and museum specimens of selected representative parasites (protozoa, helminthes and arthropoda)
2. Study of the life cycle of different mosquitoes
3. Identification of different species of mosquitoes by mounting mouth-parts (*Culex* and *Anopheles*)
4. Study of nematode parasites of plants with focus on tomato root-knot nematode
5. Study of nematode parasites of insects (with life-cycle)
6. Preparation of culture media
7. Culture and maintenance of cell lines; cell dissociation through trypsinization
8. Culture of transformed cells
9. *In vitro* study of the growth of blood vessels (angiogenesis)
10. Isolation and preparation of lymphocytes from whole blood
11. Any other practical depending on feasibility

REFERENCE BOOKS:

1. Boston M. A., Matthai W., Berg C. Y., Black J. G. *Microbiology principles and explorations*. John Wiley & Sons, 2005.
2. Donald V. and Judith G. V. *Biochemistry*. 5th ed. John Wiley and Sons Inc., 2016.
3. Garret R. H. and Grisham C. M. *Biochemistry*. Saunders College Publishing, 1995.
4. Lehninger A. L. *Principles of Biochemistry*. 6th ed. Worth, New York, 2012.

5. Pelczar M. J., Reid R. D. & Chan E. C. *Microbiology*. 5th ed. McGraw-Hill, New York, 2001.
6. Stryer L. W. H. Freeman, *Biochemistry*. 8th ed. New York, 2015.
7. Upadhyay & Upadhyay. *Biophysical chemistry*. Himalayan Publishing House, 1995.
8. V. Pattabhi and N. Gautham. *Biophysics*. Narosa Publishing House, 1999.
9. Willey J. M., Sherwood L., Woolverton C. J., Prescott L. M. & Willey J. M. *Prescott's Microbiology*. McGraw-Hill, New York 2011.
10. Wilson K. and Walker J. *Practical biochemistry: principles and techniques*. 5th Edition. Cambridge Univ. Press, 2000.

OPEN ELECTIVE PAPER 3.6 FUNDAMENTALS OF ANIMAL SCIENCES

Teaching hours per week: 4; No. of credits: 4

Unit I: Introduction to animal taxonomy 9 hrs

Characteristics of animals; Branches of animal science; Classification and nomenclature of animals; Taxonomic hierarchy, Binomial nomenclature; Major and minor phyla – diagnostic features with examples from each phylum

Unit II: Organization of animals 9 hrs

Types of animal cells and tissues; Cell theory: brief description of animal cell, ultrastructure of cell, cell organelles and their functions; Cell division; Structure and functions of basic tissues

Unit III: Animal physiology 12 hrs

Nutrition: feeding mechanisms, alimentary canal and overview of digestion
 Respiration: respiratory structures, mechanism of gas exchange, cellular respiration
 Circulation: composition of blood and circulatory system
 Excretion: excretory organs, types of nitrogenous waste, mammalian kidney and urine formation
 Locomotion: locomotory structures and muscle contraction
 Nervous coordination: organization of nervous system, neural and chemical coordination;
 Endocrine system and hormones as chemical messengers
 Reproduction: types, significance of sexual reproduction, overview of mammalian reproduction, fertility control

Unit IV: Genetics, Evolution and Ecology 9 hrs

Genetics: Mendel's laws, structure of genes and chromosomes, nucleic acids as carriers of genetic information, central dogma of molecular biology; Heredity

Evolution: Major theories and evidences; Continuity of life

Ecology: abiotic and biotic factors of ecosystem; Population ecology; Environment and microorganisms; Environmental pollution

Unit V: Applied Zoology

9 hrs

Brief description and economic importance of apiculture, sericulture, fisheries, poultry, dairy and vermiculture; Vectors and common human parasites

REFERENCE BOOKS:

1. Miller S. A. and Harley J. P. *Zoology*. 6th ed. McGraw Hill Higher Education, 2005.
2. Barrington E. J. W. *Invertebrate structure and function*. Thomas Nelson and Sons Ltd., London, 1976.
3. Brooks and Marshall. *Essentials of endocrinology*. Blackwell Science, 1995.
4. Odum E. P. *Fundamentals of ecology*. Nataraj Publishers, Dehradun, 1996.
5. Sharma P. D. *Ecology and environment*. Rastogi Publications, Meerut, 2011.
6. Nelson R. J. *An Introduction to Behavioural Endocrinology*. Sinauer Associates Inc., 1995.
7. Norris D. O. *Vertebrate Endocrinology*. II Ed. Academic Press, 1997.
8. Jawaid and Sinha. *Handbook on Economic Zoology*. S. Chand & company, Delhi, 2000.
9. Dokuhon Z. S. *Illustrated text book of Sericulture*. Oxford publishing Co., Delhi, 1998.
10. Duncan F. N. *Bee-keeping for Profit and Pleasure*. Agrobios, India, 2004.
11. Jadhav and Sidiqi. *Handbook of poultry production and management*. Jaypee publishers, 2010.
12. Hoar W. S. *General and comparative animal physiology*. 3rd ed. Prentice Hall, 1983.
13. Randall D., Burggren W. and French K. *Eckert animal physiology: mechanisms and adaptations*. 4th ed. W. H. Freeman and Company, NY, 2002.
14. Schmidt-Neilson K. *Animal physiology: adaptations and environment*. 5th ed. Cambridge University Press, 2002.
15. Young J. Z. *The life of vertebrates*. Clarendon Press Oxford, 1981.
16. Young J. Z. *Life of mammals*. Oxford University Press, London, 1976.
17. Colbert E. H. *Evolution of the vertebrates*. 5th ed. John Wiley and Sons, New York, 2011.
18. Milton Hildebrand and George Goslow. *Analysis of vertebrate structure*. 5th ed. John Wiley and Sons, New York, 2002.
19. Jones R. E. *Human reproductive biology*. Academic Press, NY, 1991.
20. Raghavendra Puri. *Mammalian endocrinology*. Vol. I & II. Dominant Publishers,

New Delhi, 2003.

21. Albert N. T. *Neuroendocrinology of reproduction, physiology and behavior*. 1981.

22. Cummings M. R. *Human heredity: principles and issues*. West Publishing Company, 2014.

SEMESTER IV

PAPER ZCT 4.1 GENERAL & COMPARATIVE ENDOCRINOLOGY

Teaching hours per week: 4; No. of credits: 4

Unit I: Introduction to endocrinology **7 hrs**

Overview of vertebrate endocrine system; Pioneers in endocrinology – Discovery of hormones; Types of secretions – autocrine, holocrine and paracrine; Hormones as chemical messengers; Classification of hormones – peptides, steroids and amino acid derivatives

Unit II: Comparative anatomy of endocrine glands **8 hrs**

Hypothalamo-hypophysial system, pineal, thyroid, parathyroid, adrenal, endocrine pancreas, and gonads; Concept of neurosecretion, median eminence; Distribution of pituitary cell types and functions; Role of thyroid gland in amphibian metamorphosis

Unit III: Hormone synthesis, secretion and biological actions **10 hrs**

Synthesis and biological actions of hormones of hypothalamus, adenohypophysis, neurohypophysis, pineal, thyroid, parathyroid, adrenal cortex (adrenocorticosteroids), adrenal medulla (catecholamines) and endocrine pancreas; Hormones of gastrointestinal tract
Calcium and glucose homeostasis; Hormonal regulation of intermediary metabolism: carbohydrate, protein and lipid; Hormones and behaviour, milk ejection reflex

Unit IV: Mechanism of hormone action **9 hrs**

Hormone receptors: types and structure, regulation; Mechanism of action of peptide hormones and steroid hormones; Signal transduction, G-proteins, cyclic AMP cascade; Other membrane messengers: protein kinase-C; phospholipase-C
Positive and negative feedbacks in hormone action; Termination of hormone action

Unit V: Growth factors **7 hrs**

Insulin, prolactin, placental lactogen and IGFs; Neurotrophic growth factors; Hematopoietic growth factors; Epidermal growth factors; Transforming growth factors; Fibroblast growth factors; Cytokines and chaperones; Pheromones and eicosanoids

Unit VI: Immunoendocrinology

7 hrs

Organization and function of immune system; Effect of endocrine ablation and replacement on immune response; Sexual dimorphic immune response and its mechanism; Immune response in pregnancy; Hormonal regulation of immune responses; Immuno-endocrine interactions involved in immune response

ZCP 4.4 GENERAL AND COMPARATIVE ENDOCRINOLOGY (PRACTICALS)

1. Display of endocrine glands in rat
2. Study of pituitary and pineal glands in rat and fish
3. Preparation of fixatives and stains, fixation of endocrine glands as per the standard protocol
- 4-5. Tissue processing for histology: a) ovary b) testis c) adrenal d) thyroid with parathyroid e) pancreas (islets of Langerhans)
- 6-7. Comparative histoarchitecture of endocrine glands from fish to mammals: a) pituitary b) thyroid and parathyroid c) pancreas d) adrenal and inter-renal glands e) testis f) ovary
- 8-9. Enzyme histochemistry: localization of steroid dehydrogenase enzyme activity (Δ^5 - 3β -HSDH and 17 - 3β -HSDH) in adrenal, ovary and testis of rat
10. Estimation of Acetylcholinesterase (AChE) enzyme activity
11. ELISA- quantitative measurement of sex steroid hormones in rat serum
12. Any other practical depending on feasibility

REFERENCE BOOKS:

1. Bentley P. J. *Comparative Vertebrate Endocrinology*. Cambridge University Press, 1998.
2. Brooks and Marshall. *Essentials of endocrinology*. Blackwell Science, 1995.
3. Chester-Jones. *Fundamentals of comparative endocrinology*. Plenum press, New York, 1987.
4. Degroot L. J. and Neill J. D. *Endocrinology*. Vol. I-III. W.B. Saunders Company, 2001.
5. Gorbman. *Comparative endocrinology*. John Wiley & Sons, New York, 1983.
6. Hadley McE. *Endocrinology*. International edition. Prentice Hall, 2000.
7. Larson. *Williams textbook of endocrinology*. 10th edition. W. B. Saunders Company Philadelphia, 2002.

8. Mandal A. *Handbook of Neuroendocrinology*. EMKAY Publications, 1994.
9. Nelson R. J. *An Introduction to Behavioural Endocrinology*. Sinauer Associates Inc., 1995.
10. Norris D. O. *Vertebrate Endocrinology*. II Ed. Academic Press, 1997.
11. Pablo De Scanes C. G. and Weintraub B. D. *Hand book of Endocrine Research Techniques*. Academic Press Inc., 1993.
12. Turner C.D. and Bagnara J.T. *General Endocrinology*. W. B. Saunders Company, Philadelphia, 1984.

PAPER ZCT 4.2 BIOLOGY OF REPRODUCTION

Teaching hours per week: 4; No. of credits: 4

Unit I: Sex determination and differentiation

5 hrs

Differentiation of gonads, gonadal ducts & brain; Genetic and endocrine control of sex determination; Hermaphroditism

Unit II: Male reproductive system

10 hrs

Anatomy of male reproductive system: histo-architecture and functional morphology of testis, seminiferous tubules & interstitium; Functional morphology and hormonal regulation of epididymis, vas deferens, seminal vesicles, prostate, coagulating glands and bulbourethral glands; Functions of Sertoli and Leydig cells

Unit III: Male reproductive physiology

8 hrs

Spermatogenesis: events and processes, hormonal regulation; Seminiferous epithelial cycle and wave; Biology of spermatozoa: morphology, maturation & capacitation, Biochemistry of semen; Biological actions of androgens, secretions of accessory organs
Patterns of spermatogenesis and testicular cycles in non-mammalian vertebrates

Unit IV: Female reproductive system & physiology

10 hrs

Anatomy of female reproductive system, histo-architecture and functional morphology of ovary, oviducts and uterus; Folliculogenesis and oocyte maturation, follicular atresia, ovulation
Corpus luteum: formation and morphology of luteal cells, maintenance, and luteolysis
Hormonal regulation of reproductive cycles in mammals: menstrual cycle in primates, estrous cycle in non-primates; Biological actions of estrogens; Structure of ovary and ovarian cycles in non-mammalian vertebrates

Unit V: Reproductive processes and their control**8 hrs**

Puberty; Fertilization; Pregnancy: types of implantation; sequential events and hormonal regulation, gestation, maintenance of pregnancy

Placenta: histophysiology, endocrine functions – steroid hormones and polypeptides

Parturition; Lactation: development of mammary glands, endocrine control of lactation

Unit VI: Fertility control and Assisted reproduction**7 hrs**

Fertility control in male and females: natural methods of contraception, temporary and permanent (surgical) methods, barrier methods, IUDs, hormonal contraceptives, immunological methods;

Techniques of assisted reproduction: induction of ovulation, gamete preservation, artificial insemination, *in vitro* fertilization, gamete/zygote intrafallopian transfer (GIFT/ZIFT), ICSI; Surrogacy and gestational carriers; Amniocentesis and genetic diagnosis

REFERENCE BOOKS:

1. Adler N. T. *Neuroendocrinology of reproduction, physiology and behaviour*. 1981.
2. Austin C. R. and R. V. Short. *Reproduction in mammals*. Cambridge University Press, London, 1972.
3. Christina W. *Male reproductive function*. Kluwer academic publishers
4. Gadagkar, R. *Survival strategies*. University press. 1997.
5. Gerhart J., and Kirchner M. *Cells, Embryos and Evolution*. Blackwell Science Publishers, 1997.
6. Jones R. E. *Human reproductive biology*. Academic press, New York, 1991.
7. Kalthoff, K. *Analysis of Biological Development*. McGraw-Hill Inc., New York, 1996.
8. Keynes R. *Charles Darwin's Zoology notes and Specimen Lists from HMS Beagle*. Cambridge University Press, 2000.
9. Knobil E. and Neil J. D. *The Physiology of Reproduction*. Vol. I & II. Raven Press Ltd, New York, 1994.
10. Knobil E. and Neil J. D. *Encyclopaedia of Reproduction*. Vol. I-IV. Academic Press, 1998.
11. Rodolfo Rey, Nathalie J., Chrystele R. *Sexual differentiation*. 2016 (e-book).
12. Saidapur S. K. *Reproductive cycles of Indian vertebrates*. Allied Publishers Ltd, New Delhi, 1989.

PAPER ZCT 4.3 APPLIED ZOOLOGY

Teaching hours per week: 4; No. of credits: 4

Unit I: Vermiculture

8 hrs

Life cycle of earthworm; Establishment of vermiculture unit; Earthworm as a tool for conversion of waste into vermicompost; Vermiwash; Types of earthworm; Earthworms as fish and poultry feed

Unit II: Apiculture and Sericulture

10 hrs

Apiculture: life cycle, foraging and colony organization in different species of honeybee; Bee keeping practices in India; Composition and uses of honey; Bee products

Lac insect – life cycle, cultivation, and uses of lac

Sericulture: classification of silkworms based on moulting, voltinism and geographical distribution; Popular silkworm breeds and hybrids; Life cycle of *Bombyx mori*; Diseases and pests of silkworm: protozoan, bacterial, viral and fungal (mode of infection, transmission, prevention and control)

Unit III: Insect pest management

6 hrs

Crop pests: life cycle and damage caused by pests of cotton, sorghum, pulses and fruits; Household pests; Integrated pest management (IPM); Mass multiplication of bio-control agents

Unit IV: Dairy science

8 hrs

Indigenous and exotic breeds of cattle; Principles and methods of breeding; Modern trends in breeding cattle; Dairy products: processing, preservation and marketing of milk and milk products; Nutritive value of milk; Dairy pathology: viral, bacterial and parasitic (endo and ecto) infections; Vaccination and disease control

Unit V: Fisheries**8 hrs**

Freshwater, brackish water and marine fisheries resources of India and its importance; Culture of exotic fishes; Composite fish culture; Induced breeding; Cold water fisheries, Shell fisheries; Processing and preservation of fish and fish by-products

Unit VI: Poultry**8 hrs**

Indigenous and exotic breeds of poultry; Techniques and methods of breeding and rearing; Poultry products; Nutritive value of egg and meat; Poultry diseases: viral, bacterial, fungal, protozoan and helminthic diseases and their control; Poultry vaccines

ZCP 4.5 PRACTICALS BASED ON 4.2 (BIOLOGY OF REPRODUCTION) AND 4.3 (APPLIED ZOOLOGY)

1. Study of mammalian reproductive system: ovary and female accessory reproductive organs, and testis and male accessory reproductive organs in rat.
2. Comparative account of Ovary and Testis in non-mammalian vertebrates – T.S. of fish, amphibia, reptiles and birds.
3. Pathology of reproductive system: Males- Cryptorchid testis, prostate cancer
Females- Polycystic ovary, endometriosis.
4. Study of abnormal sperm morphology in rat
5. Study of bee-keeping appliances
6. Study of economically important fish:
Freshwater: *Catla*, *Labeo*, *Cirrhinus mrigala*, *Cyprinus*, *Wallago attu*, *Mystus seenghala* and *Channa punctatus*
Marine: sardine, mackerel, Bombay duck, pomfret; Shell fishes: prawn, pearl oyster, *Sepia*
7. Study of the life cycle of *Bombyx mori* and its pathogens
8. Mounting of silk gland and spiracles of *Bombyx mori*

REFERENCE BOOKS:

1. Arthur R. and William H. A. *Farming for pleasure and profit: Dairy farming Management of cows*. Kessinger Publishing Company, 2010.
2. Avatar Singh Joshi and Singh B. K. *Dairy farming*. ICAR publishers, 2010.
3. Clive A. E., Norman Q. A. and Rhonda S. *Vermiculture Technology*. CRC Press, 2011.
4. David D. V. and Kumaraswami T. *Elements of Economic Entomology*. Popular Book Depot. Madras. 1988.
5. Dent D. *Insect Pest Management*. II Ed. CABI, 2000.
6. Dhaliwal G. S. and Heinrichs E. A. *Critical issues in Insect Pest Management*. Commonwealth Publishers, New Delhi, 1998.
7. Dokuhon Z. S. *Illustrated text book of Sericulture*. Oxford publishing Co., Delhi, 1998.

8. Duncan F. N. *Bee-keeping for Profit and Pleasure*. Agrobios, India, 2004.
9. Gupta P. K. *Vermicomposting for sustainable Agriculture*. Agrobios, India, 2003.
10. Jadhav and Siddiqui. *Handbook of poultry production and management*. Jaypee publishers, 2010.
11. Jawaid and Sinha. *Handbook on Economic Zoology*. S. Chand & company, Delhi, 2000.
12. Jhingran V. G. *Fish and Fisheries of India*. Hindustan Publishing, New Delhi, 1983.
13. Mishra R. C. *Perspectives in Indian Apiculture*. Allied Scientific, Bikaner, 1999.
14. Pedigo L. P. *Entomology and Pest Management*. IV ed. Prentice- Hall of India, New Delhi, 2002.
15. Prasad D. and Goutam R. D. *Potential IPM tactics*. Westville publishing house, 1998.
16. Rajan R. K. Hemanth Raju. *Textbook on silkworm rearing*. Central Silk Board, Bangalore, 2005.
17. Sarker Dilip. *The Silkworm: Biology, genetics and Breeding*. UBS publishers, 1998.
18. Sathe T. V. *Vermiculture and Organic Farming*. Daya publishing house, Delhi, 2004.
19. Tribhuvan Singh, Promod Kumar Singh and Khursheed Ahmad. *Silkworm Rearing Technology*. Discovery publishing house.
20. Upadhyaya R. K., Mukerji K. G. and Rajak R. L. *IPM system in Agriculture*. Vol. I & II. Aditya books private ltd, New Delhi.
21. Van Emden H. F. *Pest Control*. II Ed. Cambridge University Press, 1989.