National Curriculum and Credit Framework (NCCF)

Syllabus

for

Minor Courses

ZOOLOGY

w.e.f. Academic Session 2023-24

Kazi Nazrul University

Asansol, Paschim Bardhaman
West Bengal – 713 340

Minor Courses

I	Diversity of Non-chordates	Minor	BSCZOOMN101	MNC-1	3 - 0 - 4
II	Diversity of Chordates	Minor	BSCZOOMN201	MNC-2	3 - 0 - 4
III	Animals of Economic Importance	Minor	BSCZOOMN301	MNC-3	3 - 0 - 4
IV	Ecology, Ethology and Evolution	Minor	BSCZOOMN401	MNC-4	3 - 0 - 4
V	Cytogenetics and Molecular Biology	Minor	BSCZOOMN501	MNC-5	3 - 0 - 4
VI	SUMMER INTERNSHIP	Minor	BSCZOOSI601	SI-1	0 - 0 - 4
VII	Parasitology, Microboiology and Immunology	Minor	BSCZOOMN701	MNC-6	3 - 0 - 4
VIII	Biochemistry and Physiology	Minor	BSCZOOMN801	MNC-7	3 - 0 - 4

ASSIGNMENTS OF DIFFERENT SEMESTERS

Semester	COURSE DETAILS	PPT PRESTN.	PROJECT REPORT	FIELD REPORT	EXCURSION	LAB/FARM VISIT	ALBUM/VIDEO DOCUMENTARY
I	**MNC-1**	√					√ **(Album)**
II	**MNC-2**	√		√	√		√ **(Album)**
III	**MNC-3**	√		√		√	
IV	**MNC-4**	√		√	√		
V	**MNC-5**	√		√		√	
VI	**SI-1**	√	√				
VII	**MNC-6**	√					
VIII	**MNC-7**	√					

Guidelines for Individual / Team Projects and Field Reports

The aim of the individual/ team project/s is to develop an aptitude for research in Zoology and to inculcate proficiency to identify appropriate research topic and presentation. The topics of biological interest and significance can be selected for the project. Project is to be done by a group not exceeding 5 students. The project report should be submitted on typed A4 paper, 12 Font, 1.5 Space in spirally bound form and duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for End Semester. The viva-voce based on the project is conducted individually. Project topic once chosen shall not be repeated by any later batches of students. The project report may have the following sections: 1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.) 2. Introduction with relevant literature review and objective 3. Materials and Methods 4. Result 5. Discussion 6. Conclusion / Summary 7. References.

Field Study / Study tour

Students have to visit one research institute and one wild life sanctuary / museum / zoo. Scientifically prepared hand-written study tour report along with photographs of candidate at the places of visit must be submitted by each student for End Semester on the day of the examination of project.

Semester-I
Course name: Diversity of Non-chordates
Course code: BSCZOOMN101

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-1**			L-T-P: **3-0-4**	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :
The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Learning outcomes :
After successfully completing this course, the students will be able to:
- Develop understanding on the diversity of life with regard to protists and non-chordates.
- Group animals on the basis of their morphological characteristics/structures.
- Develop a critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills.
- It will further enable the students to think and interpret individually due to different animal species chosen

THEORY (MNC-1)

Unit I: Principles of Animal Classification (15 Lectures)

1. Definitions: Systematics, taxonomy, Hierarchy, taxonomic levels/types (alpha, beta, gamma, omega).
2. Principles of codes of Zoological Nomenclature : Binomial nomenclature and utility of scientific names. Principle of priority; Principle of typification (Holotype, Syntype, Allotype, Paratype, Lectotype, Paralectotype, Neotype); Principle of Homonymy and synonymy.
3. Classification : Artificial, Natural and phylogenetic concept.

Unit II: Multicellularity and Origin of Metazoa

1. Species concept : Biological, evolutionary.
2. Origin of Metazoans: diploblastic and triploblastic organization; symmetries; body cavities; protostomes and deuterostomes.
3. Metamerism and its relevance.

UNIT III: Diversity in Protists, Acoelomate and Pseudocoelomate Metazoa (11 Lectures)

1. Structure and diversity in Protists (classification up to Phylum).
2. Porifera : Classification up to classes ; Structural diversity of skeletal organization.
3. Cnidaria : Classification up to classes ; Polymorphism and division of labour ;
4. Coral reef: types, formation& significance.

5. Pseudocoelomates; Basic organization and Classification of Nematoda up to classes.
6. Type study: *Paramecium* (Cell structure and functions; Nutrition and feeding modes; reproduction), *Ascaris* (Morphology; life cycle, and pathogenicity)

UNIT IV: Diversity in and Coelomate Non chordates and hemichordates (13 Lectures)

1. Basic organization and diversity (classification up to classes) in Annelids.
2. Classification of arthropods up to classes.
3. Basic organization and diversity (classification up to classes) in Molluscs.
4. Basic organization and classification (up to classes) of Echinoderms; their affinity to Chordates.
5. Type study: *Periplaneta* (Digestive system; circulatory system; excretory system; reproductive system; respiratory system)

Note: ***Classification to be followed from Ruppert and Barnes Invertebrate Zoology VI edition, except for Protozoa (American Association of Protozoologist ref: Levine 1980) and Porifera (Brusca and Brusca 2002; IV edition. Invertebrate Zoology).***

PRACTICAL

1. **Study** of animals through slides and museum specimens/photographs in the laboratory with their classification, biogeography and diagnostic features **(record book)**. Animals to be included for the study are as follows:

Non-chordates :
i. **Protista:** *Euglena, Amoeba, Paramecium.*
ii. **Porifera:** *Euspongia, Scypha.*
iii. **Cnidaria:** *Obelia, Physalia, Porpita, Aurelia, Tubipora,* Sea Anemone, *Pennatula, Fungia.*
iv. **Platyhelminthes:***Fasciola hepatica, Taenia solium.*
v. **Nematoda:** *Ascaris.*
vi. **Annelida:** *Aphrodite, Sabella, Chaetopterus, Pheretima.*
vii. **Arthropoda:** *Carcinoscorpius, Macrobrachium, Balanus, Julus, Periplaneta, Peripatus.*
viii. **Mollusca:** *Chiton, Pila, Pinctada, Sepia.*
ix. **Echinodermata:** *Astropecten, Cucumaria* and *Antedon*
x. **Larval forms**: *Ephyra, Trochophore, Nauplius, Zoea, Veliger, Glochidium, Bipinnaria.*

2. **Insect album** preparation: 5 insects of different habitat belongs to different order.
3. **Dissection** of *Periplaneta* to expose- (a) Digestive, (b) Nervous and (c) Reproductive system.
4. **Group discussion** or **Seminar presentation** on following topics:

Pool of Topics for Group Discussion or Seminar presentation :		
1. Tree of Life.	2. Coral reef – A marine rainforest.	3. Protostome vs deuterostome
4. Polymorphism.	5. Metamerism and its relevance.	6. Principle of Typification
7. Freshwater sponges.	8. Coelom and animal development	9. Concept of symmetry
10.Species concept	11.Basis of classification	12. Significance of living fossils
13.Molecular system of classification.	14.Molecular systematics vs Traditional taxonomy.	15. Type study: Any one animal as per your syllabus.

Format for conducting CA and ESE practical examination :

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (class test)-**10** 2. PPT/Poster preparation, presentation and write up submission-5+5+2=**12** 3. Attendance and Participation in class-**5** 4. Practical skills, laboratory reports, etc-**3**	**1.** Identification - 2 items (item 1)- [Sc. Name, systematic position (3 taxa), generic characters, habit & habitat,] 0.5+0.5+1+0.5=2.5 **(2.5x2=5)** 2. Dissection/mounting- Exposing and display/mounting-4, Drawing-2, Labelling-1. **(7)** **3.** Insect album (Item no 3) **-2** 4. LNB (Laboratory Note Book) **-3** **5.** Viva **-3**

NOTE :

- *Identification could be done by using card printed with photograph/drawing/data/preserved specimen/permanent slide.*
- *CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.*
- ***Study** of specimen should include-Scientific name, common name, Taxa as per theory syllabus, Habit (Nutritional, ecological, Reproductive, special habit if any) and Habitat (Distribution, endemic / cosmopolitan/sporadic, climatic type), Conservation status (if available), Generic character only, economic importance (if any).*
- *LNB should be prepared (item 1 & 3) in inter-leaf practical note book with date & Teacher's sign.*
- *Album should be prepared on item 4 & 5.*
- *Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VII Edition. Thompson Brooks Cole (International Edition)
2. Barnes, R.S.K., Callow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition.
4. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
5. Hall B.K. and Hallgrimsson B. (2008), Strickberger's Evolution. 4th Edition. Jones and Bartlett Publishers Inc.
6. Chattopadhyay, S (2014) LIFE: Evolution, adaptation, ethology, 2nd Ed, Books & Allied.
7. Lomolino, M. V. et al (2010) Biogeography, 4th Edition, Sinauer Associates.
8. Simpson, G G (2012) Principles of animal taxonomy, Scientific publishers.
9. Mayr, E and Ashlock P D (2014) Principles of systematic zoology, 2nd, McGraw-Hill Education.
10. Verma, A (2017) Principles of animal taxonomy, 1st Ed, Narosa.
11. Ghosal, S (2020) Taxonomy Principle and Problems, 1st Ed, Techno world.
12. Quicke, Donald L (1993) Principles and Techniques of Contemporary Taxonomy (Tertiary Level Biology), 1st Ed, Springer
13. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. I. New Central Book Agency (p) Ltd.
14. Kapoor, V C (2019) Theory And Practice Of Animal Taxonomy And Biodiversity 8th Ed, Oxford & IBH Publishing
15. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
16. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education
17. Miller S.A. & Harley J.P. (2015) Zoology. 10th Ed., McGraw-Hill Education
18. Hickman C., *et. al.* (2019) Integrated principles of zoology., 18th Ed., McGraw-Hill Education.

Semester-II

Course name: Diversity of Chordates

Course code: BSCZOOMN201

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-2**			L-T-P: **3-0-4**	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :
The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Learning outcomes :
After successfully completing this course, the students will be able to:
- Develop understanding on the diversity of life with regard to chordates.
- Group animals on the basis of their morphological characteristics / structures.
- Develop critical understanding of how aquatic to terrestrial journey happens in chordate animals.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills.
- It will further enable the students to think and interpret individually due to different animal species chosen.

Unit 1: Protochordata and Agnatha (15 Classes)

1. Characters and affinities of Hemichordates w.r.t *Balanoglossus* sp.
2. General characteristics of Urochordata and Cephalochordata;
3. Study of larval forms in protochordate;
4. Origin of Chordata
5. General characteristics, affinities and biology of cyclostomes

Unit 2: Ectotherms: Pisces, Amphibia and Reptilia (18 Classes)

1. General characteristics and Classification of fish up to sub-class,
2. Origin of Tetrapoda (Evolution of terrestrial ectotherms),
3. General characteristics and classification of Amphibia up to order;
4. General characteristics and classification of reptiles up to order;
5. Type study: *Labeo (Respiratory system; circulatory system), Bufo (Respiratory system; circulatory system),, Calotes (Respiratory system; circulatory system).*

Unit 3: Endotherms: Aves and Mammalia (15 Classes)

1. General characteristics and classification of Aves up to sub-class;
2. Principles and aerodynamics of flight and migration in birds

3. Origin of Mammals- Special features of Monotremes and Marsupials.
4. Characteristics and classification of mammalian groups (up to orders) with special reference to primates.
5. Type Study: *Columba (Exoskeleton; digestive system; respiratory system)*

Unit 4: Specialized systems (12 Classes)

1. Accessory respiratory organ and acoustico lateralis system in fishes
2. Poison apparatus and Biting mechanism in snakes
3. Echolocation in chiropterans
4. Ruminant stomach

Note: ***Classification from Young, J. Z. (1981) to be followed except for classification fishes. For Pisces classification scheme to be followed from Nelson, J. S. (2006).***

PRACTICAL

1. **Study** of animals through slides and museum specimens/photographs in the laboratory with their classification, biogeography and diagnostic features **(record book)**. Animals to be included for the study are as follows:

Chordates :
i. **Protochordata:** *Balanoglossus, Branchiostoma, Ascidia.*
ii. **Fishes:***Scoliodon, Torpedo, Mystus vitattatus, Catla, Exocoetus, Hippocampus,*
iii. **Amphibia:** *Ichthyophis, Necturus, Bufo, Rachophorous*
iv. **Reptiles:** *Chelone, Calotes, Chamaeleon, Draco, Bungarus, Vipera, Naja.*
v. **Birds:** *Psittacula, Pycnonotus.*
vi. **Mammals:** *Sorex, Pteropus, Funambulus.*

2. Dissection:a) Expose and display afferent Branchial system, weberian ossicles and IX-Xth cranial nerve of fish (carp).

b) Expose and display Vth and VIIth cranial nerve of Fowl.

3. Mounting: a) Temporary mount of external scales in fishes (cycloid, placoid, ganoid, ctenoid). **b)** Temporary mount of Pecten of Fowl.

4. Bird album: a) Comparison of two species of birds belonging to same genus (Interspecific difference). **b) Comparison and weighting** of characters of two birds belonging to same family but dissimilar genera.

5. Demonstration of Poisonous and non-poisonous snake by chart preparation.

6. Excursion: Study of animals in nature during a survey of a National Park or Forest area or any local biodiversity rich area.

7. Group discussion or Seminar presentation on following topics:

Pool of Topics for Group Discussion or Seminar presentation :		
1. Protochordates-the gateway of chordates	2. Evolution of terrestrial ectotherms	3. Affinities, and biology of cyclostomes
4. Origin of Chordata	5. Monotremes and Marsupials	6. Adaptive radiation of mammals
7. Affinities of Prototheria	8. Echolocation in bat	9. Lung Fishes
10. Type study: anyone in your syllabus	11. Venomous vs non-venomous snake	12. Physiology of Ruminating stomach

Format for conducting CA and ESE practical examination :

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (class test)-**10** 2. PPT/Poster preparation, presentation and write up submission-3+4+3=**10** 3. Attendance and Participation in class-**5** 4. Practical skills, laboratory reports, etc-**5**	1. Identification (Sl no 1)- Sc. Name-0.5, Characters-1, Habit & habitat-0.5, (2x3=**6**) 2. Dissection/mounting- Exposing and display/mounting-2, Drawing-2, Labelling-1. (**5**) 3. Excursion and Field report-3 4. Bird album-**2** 5. LNB -**2** 6. Viva-**2**

NOTE :

- *Study of specimen should include-Scientific name, Habit and Habitat, Diagnostics feature, importance/values if any.*
- *Identification could be done by using card printed with photograph/drawing/data/preserved specimen/permanent slide.*
- *CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.*
- *LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.*
- *Video should made on one or more animals on behavioral pattern/life cycle/feeding habit with sound commended by voice.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings

1. Young, J. Z. (1981). The Life of Vertebrates. 3rd Ed. Oxford university press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008), Strickberger's Evolution. 4th Edition. Jones and Bartlett Publishers Inc.
5. Chattopadhyay, S (2014) LIFE: Evolution, adaptation, ethology, 2nd Ed, Books & Allied.
6. Lomolino, M. V. et al (2010) Biogeography, 4th Edition, Sinauer Associates.
7. Simpson, G G (2012) Principles of animal taxonomy, Scientific publishers.
8. Mayr, E and Ashlock P D (2014) Principles of systematic zoology, 2nd, McGraw-Hill Education.
9. Verma, A (2017) Principles of animal taxonomy, 1st Ed, Narosa.
10. Ghosal, S (2020) Taxonomy Principle and Problems, 1st Ed, Techno world.
11. Quicke, Donald L (1993) Principles and Techniques of Contemporary Taxonomy (Tertiary Level Biology), 1st Ed, Springer
12. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
13. Kapoor, V C (2019) Theory And Practice Of Animal Taxonomy And Biodiversity 8th Ed, Oxford & IBH Publishing
14. Miller S.A. & Harley J.P. (2015) Zoology. 10th Ed., McGraw-Hill Education
15. Hickman C., *et. al.* (2019) Integrated principles of zoology., 18th Ed., McGraw-Hill Education.

Semester-III

Course name: Animals of Economic Importance

Course code: BSCZOOMN301

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-3**			L-T-P: **3-0-4**	
Credit: 5	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :

The course is a walk for the Bachelor's to learn about the animals that are economically important to the humans.

Learning outcomes :

After successfully completing this course, the students will be able to:

- Develop understanding regarding importance on aquaculture.
- Develop critical understanding bee and silkworm culture.
- Gain essential idea on vermiculture, lac culture and pest biology,

UNIT I: Aquaculture (15 Lectures)

1. **Carp Culture:** Indigenous and Exotic fish breeds, basics of Composite fish culture, pond management, Induced Breeding of Carps, Fish diseases and management.
2. **Prawn culture:** Basics of Fresh and Brackish water prawn culture, induced breeding, disease management.
3. **Pearl Culture:** Pearl formation process, Pearl culture technique.

UNIT II: Apiculture & Sericulture (15 Lectures)

1. **Apiculture**: Species of honey bees in India. Indigenous and modern methods of Bee keeping and apiary management, Bee products and their uses, Disease and their control.
2. **Sericulture:** Mulberry and non-mulberry Sericulture (Silk worm and respective host plants), Types of silk; silk glands, composition of silk, uses of rearing appliances. diseases of silk worm with prevention & control.

UNIT III: Lac culture, Vermiculture and pest biology (15 Lectures)

1. **Lac culture:** Lac insect and its life cycle. host plants, processing and uses of lac. Lac enemies.
2. **Vermiculture:** Devices used in vermiculture, Methods and products, Vermiwash Collection, Composition and use.
3. **Pest biology:**
   Classification of pests. Bionomics, Damage and Control measures of *Nilaparvata, Apion, Sitophilus, Meloidogyne incognita;* Concept of ETL and EIL. Integrated Pest Management.

Unit IV: Livestock management and Maintenance of breeds (15 Lectures)

1. Common Breeds (Exotic and Indigenous) of Livestock: Cattle and Poultry.
2. Housing, Equipment and management in cattle breeding, Deep litter poultry rearing.
3. Artificial insemination of cattle.
4. Disease and its management: Poultry;
5. Animal Products: Cow, Poultry.
6. Vaccination programmes and Deworming programmes for poultry.

PRACTICAL

1. Identification of *Pinctada*, *Palaemon*, *Bombyx mori*, *Eisenia foetida*, *Nilaparvata*, *Apion*, *Sitophilus*, *Meloidogyne*.
2. Identification of life stages of *Bombyx mori* and *Antheraea mylitta*;
3. Identification of Bivoltine and multivoltine mulberry cocoon and tasar cocoon.
4. Castes (through charts/specimens) study of bees,
5. Demonstration of the sting apparatus and pollen basket of honey bee.
6. **Visit** to a prawn/pearl culture pisciculture / poultry / Dairy / sericulture / apiary / Lac farm / Institute and submit a report.
7. **Group discussion or Seminar presentation** on following topic :

Pool of Topics for Group discussion or Seminar presentation :		
1. Silk worm products	2. Dairy management	3. Pearl culture & prospect in India
4. Bee products	5. Poultry management	6. Composite fish culture
7. Honey extraction and processing	8. AI technology in cattle breeding	9. Prawn culture & prospect in India
10. Breeding strategies in poultry	11. Silkworm rearing & diseases management	12. Vermicompost & organic farming
13. IPM	14. Bionomics of pests any one	15. ETL and EIL

Format for conducting CA and ESE practical examination :

CA (30 marks)	**ESE (20 marks)**
1. Assessment based on practical topics (class test)-**10** 2. PPT/Poster preparation, presentation and write up submission-3+4+3=**10** 3. Attendance and Participation in class-**5** 4. Practical skills, laboratory reports, etc-**5**	1. Identification (Sl no 1-4)-Naming-0.5, character-1.5 (2X4=**8**) 2. Demonstration (Sl no 5)-representation-3, Drawing-2, labelling-1 (**6**) 3. LNB -**2** 4. Field report-**2** 5. Viva-**2**

NOTE :

- *Identification could be done by using card printed with photograph/drawing/data/preserved specimen/permanent slide.*
- *CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.*
- *LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.*
- *Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings:

1. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
2. Mani, M.S. (2006). Insects, NBT, India.
3. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.
4. Arumugam, N. (2014) Aquaculture and Fisheries, Saras Publication
5. Sarkar, Kundu & Chaki, (2014) Introduction to Economic Zoology, 1st Ed, NCBA
6. Banerjee T.K., (2016) Applied Zoology, 1st Ed, NCBA
7. Handbook of Fisheries and Aquaculture, ICAR Pub.
8. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
9. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
10. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
11. Nagaraja, N. and Rajagopal , D. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
12. Atwal, A.S. (1986). Agricultural Pests of India and South East Asia, Kalyani Publishers.
13. Dennis, H. (2009). Agricultural Entomology. Timber Press
14. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher),Jodhpur.
15. Handbook of Animal Husbandry, (2008) ICAR Publication, New Delhi.
16. Prasad, J.; (2016) Animal Husbandry and Dairy Science, Kalyani Publishers.
17. Banerjee, G.C.; (2019) A Textbook Of Animal Husbandry, 8Ed, Oxford & IBH publishing.