National Curriculum and Credit Framework (NCCF)

Syllabus

for

ZOOLOGY

w. e. f. Academic Session 2023-24

Kazi Nazrul University

Asansol, Paschim Bardhaman
West Bengal – 713 340

SEMESTER	COURSE NAME	COURSE TYPE	COURSE CODE	COURSE DETAILS	L - T - P	COURSE CREDIT
I	Diversity of Non-chordates	MAJOR	BSCZOOMJ101	MJC-1	3 - 0 - 4	5
	Public Health and Hygiene	SEC	BSCZOOSE101	SEC-1	3 - 0 - 0	3
II	Diversity of Chordates	MAJOR	BSCZOOMJ201	MJC-2	3 - 0 - 4	5
	Instrumentation and Clinical Diagnosis	SEC	BSCZOOSE201	SEC-2	3- 0- 0	3
III	Animal Physiology and Comparative Anatomy	MAJOR	BSCZOOMJ301	MJC-3	3 - 0 - 4	5
	Applied Zoology of Invertebrates	MAJOR	BSCZOOMJ302	MJC-4	3 - 0 - 4	5
IV	Ecology	MAJOR	BSCZOOMJ401	MJC-5	3 - 0 - 4	5
	Livestock Management and Animal Husbandry	MAJOR	BSCZOOMJ402	MJC-6	3 - 0 - 4	5
	Aquaculture	SEC	BSCZOOSE-401	SEC-3	3- 0- 0	3
V	Cell Biology and Histology	MAJOR	BSCZOOMJ501	MJC-7	3 - 0 - 4	5
	Genetics and Molecular Biology	MAJOR	BSCZOOMJ502	MJC-8	3 - 0 - 4	5
	Adaptation and Evolution of Animals	MAJOR	BSCZOOMJ503	MJC-9	3 - 0 - 4	5
VI	Biochemistry	MAJOR	BSCZOOMJ601	MJC-10	3 - 0 - 4	5
	Human Physiology	MAJOR	BSCZOOMJ602	MJC-11	3 - 0 - 4	5
	Developmental Biology of Animals	MAJOR	BSCZOOMJ603	MJC-12	3 - 0 - 4	5
	General Entomology	MAJOR	BSCZOOMJ603	MJC-13	3 - 0 - 4	5
	Summer Internship	SI	BSCZOOSI601	SI-1	0 - 0 - 4	2
VII	Genetic engineering and Biotechnology	MAJOR	BSCZOOMJ-701	MJC-14	3 - 0 - 4	5
	Parasitology and Vector Biology	MAJOR	BSCZOOMJ-702	MJC-15	3 - 0 - 4	5
	Microbiology and Immunology	MAJOR	BSCZOOMJ-703	MJC-16	3 - 0 - 4	5
	Bioinformatics, Biostatistics and Research Methodology	MAJOR	BSCZOOMJ-704	MJC-17	3 - 0 - 4	5
VIII	Toxicology and Environmental Management	MAJOR	BSCZOOMJ-801	MJC-18	3 - 0 - 4	5
	Animal Behaviour and Chronobiology	MAJOR	BSCZOOMJ-802	MJC-19	2 - 0 - 4	4
	Neuroscience and Endocrinology	MAJOR	BSCZOOMJ-803	MJC-20	2 - 0 - 4	4
	Wildlife management and Ecotourism	MAJOR	BSCZOOMJ-804	MJC-21	2 - 0 - 4	4

VIII	Toxicology and Environmental Management	MAJOR	BSCZOOMJ-801	MJC-18	3 - 0 - 4	5
	Research Methodology	RP	BSCZOORP-801	RP-1	4 - 0 - 0	4
	RESEARCH PROJECT / DISSERTATION	RP	BSCZOORP-802	RP-2	0 - 0 - 16	8

ASSIGNMENTS OF DIFFERENT SEMESTERS							
SEMESTER	**Course Details**	**PPT**	**Summer/Research / Project/ Survey Report**	**Field Report**	**EXCURSION**	**Lab/Farm Visit**	**Animal Album**
I	**MJC-1**	√					
	SEC-1						
II	**MJC-2**	√		√	√		√
	SEC-2						
III	**MJC-3**	√		√		√	
	MJC-4	√		√		√	
IV	**MJC-5**	√		√	√		
	MJC-6	√					
	SEC-3						
V	**MJC-7**	√					
	MJC-8	√	√	√		√	
	MJC-9	√					
VI	**MJC-10**	√					
	MJC-11	√					
	MJC-12	√	√				
	MJC-13	√	√				√
	SI-1		√				
VII	**MJC-14**	√					
	MJC-15	√	√			√	
	MJC-16	√					
	MJC-17	√					
VIII	**MJC-18**	√		√	√		
	MJC-19	√	√				
	MJC-20	√					
	MJC-21	√		√	√		
VIII	**MJC-18**	√		√	√		
	RP-1						
	RP-2		√				

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.

Video presentation

Students have to develop a short film (2-5 min duration) based on relevant animal/topic given solely by themselves along with voice command/floating comments. It will help them to be competent in video documentation of a matter also a career prospect too.

Summer internship

It should be done in any industry (related to medical/biological field), laboratory (research/clinical/diagonostic), hospital, dairy farm, sericulture farm, fishery farm, poultry farm, Zoo, Zoological museum, etc for a period of 1-3 month followed by a presentation during ESE in front of external examiner. The internship report should be submitted on typed A4 paper, 12 Font, 1.5 Space in spirally bound form and duly attested by the supervising authority 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.

Guidelines for Research Project

75% marks and attendance is a mandatory requirement for taking research paper in 8th semester as optional. Still depending upon the availability of research scope in the home institution or other institution/research lab final decision can be taken by the Co-Ordinator/HOD of the concerned department. 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. About 2 - 4 months of duration of the research project is mandatory. The project report should be submitted on typed A4 paper, 12 Font, 1.5 Space in spirally/hard bound form and duly attested by the supervising authority 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.

SEMESTER-I
MAJOR COURSE-1

Course name: Diversity of Non-chordates

Course code: BSCZOOMJ101

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-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 (MJC-1)

Unit I: Principles of Animal Classification (15 Lectures)

1. Definitions: Systematics, taxonomy, Hierarchy, taxonomic levels/types (alpha, beta, gamma, omega, cytotaxonomy, numerical taxonomy, and chemotaxonomy).
2. Principles of codes of Zoological Nomenclature: Binomial nomenclature and utility of scientific names.
3. Principle of priority; Principle of typification (Holotype, Syntype, Allotype, Paratype, Lectotype, Paralectotype, Neotype); Principle of Homonymy and synonymy.
4. Classification: morphological and evolutionary (molecular): Artificial, Natural and phylogeneticconcept, Basic idea on Phenetics and Cladistics.

Unit II: Multicellularity and Origin of Metazoa (12 Lectures)

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

UNIT III: Diversity in Protists, Acoelomate and Pseudocoelomate Metazoa (15 Lectures)

1. Structure and diversity in Protists (classification up to Phylum).

2. Porifera : Classification up to classes; Canal system; Structural diversity of skeletal organization.
3. Cnidaria : Classification up to classes ; Polymorphism and division of labour.
4. Coral reef: Types, formation & significance.
5. Classification and characteristics of Platyhelminthes up to classes.
6. Classification and characteristics of Nematoda up to classes.
7. Type study: *Paramecium* (cell structure and functions; nutrition and feeding modes; reproduction), *Taenia* (morphology; life cycle, and pathogenicity), *Ascaris* (morphology; life cycle, and pathogenicity)

UNIT IV: Diversity in and Coelomate Non chordates and hemichordates (18 Lectures)

1. Classification and characteristics of Annelids up to classes; Excretory organ in *Pheretima.*
2. Classification and characteristics of arthropods up to classes.
3. Affinities of living fossils: *Limulus* and *Peripatus.*
4. Classification and characteristics of Molluscs up to classes.
5. Torsion and Detorsion in Mollusca.
6. Classification and characteristics of Echinoderms up to classes; their affinity with Chordates.
7. Type study: *Periplaneta* (Digestive system; respiratory system; circulatory system; excretory system; reproductive system).

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

PRACTICAL (MJC-1)

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, Zoea, Nauplius, Veliger, Glochidium, Bipinnaria, Brachiolaria.*

2. Dissection of *Periplaneta* to expose- (a) Digestive, (b) Nervous and (c) Reproductive system.
3. Dissection of *Pheretima* to expose the Nervous system.

4. **Group discussion** or **Seminar presentation** on following topics:

Pool of Topics for Group Discussion or Seminar presentation :		
1. Tree of Life. 2. Polymorphism. 3. Freshwater sponges. 4. Concept of symmetry 5. Species concept	6. Molecular systematics vs Traditional taxonomy. 7. Metamerism and its relevance. 8. Principle of Typification 9. Basis of classification 10. Coral reef – A marine rainforest. 11. Type study: Any one animal as per your syllabus.	12. Protostome vs deuterostome 13. Coelom and animal development 14. Torsion-an evolutionary outbreak 15. Molecular system of classification. 16. Significance of living fossils

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 -4+4+2=**10** **3.** Attendance and Participation in class-**5** **4.** Practical skills, Album, laboratory reports, etc-**5**	**1.** Identification - 4 items (sl. no. 1)- [Sc. Name, systematic position (3 taxa), generic characters, habit & habitat] 0.5+0.5+1+0.5=2.5 **(2.5x4=10)** **2.** Dissection/mounting- Exposing and display/mounting-2, Drawing-2, Labelling-1. **(5)** **3.** LNB (Laboratory Note Book) -3 **4.** Viva -2

NOTE :

- *Identification could be done by using a card printed with a 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 in inter-leaf practical note book with date & Teacher's sign.*
- *Album should be prepared on item 3.*
- *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. 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. I. 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. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition,

Cengage Learning, India
15. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education
16. Miller S.A. & Harley J.P. (2015) Zoology. 10th Ed., McGraw-Hill Education

SEMESTER-I
SKILL ENHANCEMENT COURSE-1

Course Name: Public Health and Hygiene

Course Code: BSCZOOSE101

Course Type: **SEC (Theoretical)**	Course Details: **SEC-1**		L-T-P: **3-0-0**
Credit: 3	Full Marks: **50**	CA Marks Theoretical **15**	ESE Marks Theoretical **35**

About the course :
The course designed for public health and hygiene at graduation level will give understanding for healthhygiene, dietary issues, diseases related to malnutrition, communicable and non-communicable diseases.

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

- Identify current national and global public health problems.
- Aware about the issues of food safety, water safety, vaccination, exercise and obesity,exposure to toxins.
- Frame a public health plan during any epidemic or spread of infectious disease etc.
- Analyze case studies of infant mortality and obesity.
- Assess the health inequalities with regard to gender, race, ethnicity, income etc.

THEORY (SEC-1)

Unit-I: Maintenance of personal and community hygiene (15 Lectures)

1. Introduction to public health and hygiene- determinants and factors.
2. Pollution and health hazards; Causative agent, symptoms, and control/treatment of common waterand air borne diseases: Cholera, Typhoid, SARS-CoV.
3. Radiation hazards: Mobile Cell tower and electronic gadgets (recommended levels, effects and precaution).
4. Importance and maintenance Community Hygiene.

Unit-II: Nutrient deficiency diseases (15 Lectures)

1. Classification of food into micro and macro nutrients.
2. Balanced diet.
3. Importance of dietary fibers.
4. Significance of breast feeding.
5. Malnutrition anomalies – Anaemia (Iron and B12 deficiency), Kwashiorkar, Marasmus, Rickets, Goiter (cause, symptoms, precaution and cure).

Unit-III: Communicable and contagious diseases (15 Lectures)

1. Communicable viral diseases (causative agent, symptoms, precaution and remedy)- chicken pox, dengue, chickungunya, and hepatitis.
2. Communicable bacterial diseases (causative agent, symptoms, precaution and remedy)- tuberculosis, tetanus, plague, diphtheria.
3. Sexually transmitted diseases (causative agent, symptoms, precaution and remedy)- AIDS, syphilis and gonorrhoea.

Unit-IV: Non-communicable diseases and cure (15 Lectures)

1. Non-communicable diseases such as stroke, Osteoporosis, osteoarthritis and rheumatoid arthritis- cause, symptom, precautions.
2. Diabetes- types and their effect on human health.
3. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles (cause, symptoms, precaution and remedy). Obesity (Definition and consequences).
4. Mental illness (depression and anxiety).
5. Oral and lung cancer and their preventive measures.

Recommended readings :

1. Mary Jane Schneider (2011) Introduction to Public Health.
2. Muthu, V.K. (2014) A Short Book of Public Health.
3. Detels, R. (2017) Oxford Textbook of Public Health (6th edition).
4. Gibney, M.J. (2013) Public Health Nutrition.
5. Wong, K.V. (2017) Nutrition, Health and Disease.

SEMESTER - I
MULTI-DISCIPLINARY COURSE - 1

Course Name: Application of Bio-Science

Course Code: MDC106

Course Type: **MD (Theoretical)**	Course Details: **MDC-1**			L-T-P: **2-1-0**	
Credit: 3	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**15**	**-**	**35**

Learning outcome:

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It shows how each group of organisms arose and how they established themselves in the environment with their special characteristics.

Learning outcomes

Upon successful completion of this course, students should be able to:

- Develop their understanding on applied field to apply the principle in real and generate revenue.
- It helps to generate entrepreneurship development.
- Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.
- Be aware of a broad array of career options and activities in human medicine, biomedical research and allied healthprofessions
- Develops the understanding about clinical as well as experimental applications of biosciences.

THEORY (MDC-2)

Unit-1: Applied Zoology-I **(15 Lectures)**

1. Vermiculture: General idea and uses.
2. Apiculture: Caste of honey bees, bee hive-artificial and natural, Honey extraction technique;uses of honey.
3. Sericulture: silk worms and host plants, composition and properties of silk, a general idea ofrearing and reeling.
4. Concept of pest, Benefits of IPM.

Unit-2: Applied Zoology-II **(15 Lectures)**

1. Aquaculture: Basic idea of composite fish culture, induced breeding; pearl culture;
2. Aquarium fish keeping-general idea and common ornamental fishes;
3. Poultry rearing: Poultry breeds, deep litter system, Common diseases and management (elementary idea).
4. Animal husbandry: Characteristics, distribution, and economic yield of Indigenous Cattle breeds (Sahiwal, Tharparkar, Gir) and Exotic Cattle breeds (Jersey, Holstein Friesian).

Unit-3: Clinical & Experimental Bio-science-I **(15 Lectures)**

1. Vaccines and Immunization: Innate and acquired immunity, Active and Passive immunization, Common types of vaccines (Inactivated, Live-attenuated, Toxoid, Conjugate, DNA and RNA vaccines, Recombinant vaccines).
2. Cancer research: General idea and basic features of cancerous cells.
3. Hematological techniques: Basic ideas on TC, DC, blood grouping, ESR, PCV, Hemoglobin estimation, MCV, MCHC.

Unit-4: Clinical & Experimental Bio-science-II **(15 Lectures)**

1. Basic principle and application: Microscopy (Bright field and Fluorescence)
2. Basic idea (definition and general steps) of IVF.
3. Definition, general steps and applications of Amniocentesis.

SEMESTER-II
MAJOR COURSE-2

Course name: Diversity of Chordates

Course code: BSCZOOMJ201

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-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.

THEORY (MJC-2)

Unit 1: Protochordate and Agnatha **(15 Lectures)**

1. Characters and affinities of Hemichordates
2. General characteristics of Urochordata and Cephalochordata;
3. Study of larval forms in protochordate;
4. Retrogressive metamorphosis in Urochordata,
5. Origin of Chordata
6. General characteristics, affinities, and biology of cyclostomes

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

1. General characteristics and Classification of fish up to sub-class.
2. Fish migration
3. Affinities of lung fishes,
4. Origin of Tetrapoda (Evolution of terrestrial ectotherms),
5. General characteristics and classification of Amphibia up to order;
6. General characteristics and classification of reptiles up to order;

7. Affinities of *Sphenodon*;
8. Poison apparatus and Biting mechanism in snakes.
9. Type study: *Labeo (respiratory system; circulatory system), Duttaphrynus (respiratory system; circulatory system), Calotes (respiratory system; circulatory system).*

Unit 3: Endotherms: Aves and Mammalia **(15 Lectures)**

1. General characteristics and classification of Aves up to sub-class.
2. Archaeopteryx - a connecting link.
3. Principles and aerodynamics of flight, Bird migration.
4. Affinities of Prototheria.
5. Origin of Mammals- Special features of Monotremes and Marsupials.
6. Characteristics and classification of mammalian groups (up to orders) with special reference to primates.
7. Type Study: *Columba* (exoskeleton; digestive system; respiratory system), *Cavia* (respiratory system; circulatory system).

Unit 4: Specialized systems **(12 Lectures)**

1. Accessory respiratory organ, acoustico lateralis system, and swim bladder in fishes.
2. Poison apparatus and biting mechanism in snakes.
3. Echolocation in chiropterans and cetaceans.
4. Ruminant stomach.
5. Dentition in mammals.

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

PRACTICAL (MJC-2)

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, Mystusvitattatus, Catla, Labeo, 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 nerveof 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 the 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 and preparation of field report.

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. Migration of Fishes	6. Affinities of lung fishes
7. Affinities of *Sphenodon*	8. Retrogressive metamorphosis	9. Biting mechanism in snakes
10. Aerodynamics of bird flight	11. Monotremes and Marsupials	12. Venomous vs non-venomous snake
13. Affinities of Prototheria	14. Type study: any one in your syllabus	Adaptive radiation of mammals

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, (2x2=**4**) **2.** Dissection/mounting- Exposing and display/mounting-4, Drawing-2, Labelling-1. (**7**) **3.** Excursion and field report-**3** **4.** Bird album-**2** **5.** LNB -**2** **6.** Viva-**2**

NOTE :

- ***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).*
- *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. rma, 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-II
SKILL ENHANCEMENT COURSE-2

Course Name: Instrumentation and Clinical Diagnosis

Course Code: BSCZOOSE201

Course Type: **SEC (Theoretical)**	Course Details: **SEC-2**		L-T-P: 3-**0-0**
Credit: 3	Full Marks: **50**	CA Marks	ESE Marks
		Theoretical	Theoretical
		15	**35**

About the course :

This is the only laboratory course taught independently of lecture courses. It has full hands on approach to expose the students to modern techniques and methodologies. The diverse techniques from microscopy to spectroscopy, calorimetry, chromatography ELISA, tissue culture to cloning, medical diagonosis etc. are included to make the student well versed with these protocols and methods.

Learning outcomes

Upon successful completion of this course, students should be able to:

- Understand the purpose of the technique, its proper use and possible modifications/improvement.
- Learn the theoretical basis of technique, its principle of working and its correct application.
- Learn the construction repair and adjustment of any equipment required for a technique.
- Learn the accuracy of technique.
- Understand the application of medical diagnosis.
- Learn the maintenance laboratory equipments / tools, safety hazards and precautions.
- Understand the technique of cell and tissue culture. Learn the preparation of solution of givenpercentage and molarity.
- Understand the process of preparation of buffer. Learn the techniques of separation of aminoacids, proteins and nucleic acids.

UNIT I : Principles of Microscopy **(13 Lectures)**

1. Microscopy: Introduction to Microscopy (Discovery, General structure).
2. Definitions-Resolving Power, Limit of Resolution and Magnification, Numerical Aperture.
3. Types of Light microscopes; bright field, dark-field, phase contrast.
4. Basic principles and applications of Light, Electron (SEM, TEM), Fluorescence.
5. Measurements (Micrometer), Drawings (Camera Lucida)

UNIT II : Tools and techniques in Biochemistry and Physiology **(15 Lectures)**

1. Biochemistry and Physiology: Physiological Salines, Concept of Normality and Molarity. Buffersand the use of pH meter.
2. Principles and types of Centrifugation, Differential centrifugation.

3. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law.
4. Principle and applications of Agarose gel Electrophoresis and PAGE.
5. Principle and Applications of Paper chromatography, Thin layer chromatography

UNIT III : Tools and Techniques in Endocrinology and immunology (12 Lectures)

1. Principle and applications of Western Blotting, ELISA, RIA.
2. Principle and application of Immunological techniques (EIA, Coombs test and Widal test) in disease diagnosis.
3. Tracer techniques: Principle and Applications, Unit of radioactivity, half-life and measurement of radioactivity. Adverse effect of radioisotopes.

UNIT IV: Cell culture and clinical diagnosis (18 Lectures)

1. Introduction to Cell Culture**:** Cell culture (in vitro, in vivo, ex vivo) and its basic requirements (laboratory facility), application and limitation of animal cell culture.
2. Cell counting (Flow cytometer, haemocytometer) and cell viability testing (Trypan blue exclusion).
3. **C**ryopreservation (principle, cryopreservant, methodologies, cryoprotectant, revival/thawing,factors for good survivality, banking of cell lines, advantages, applications).
4. Medical applications of CT, MRI, EEG, ECG.
5. Haematology techniques: Glucometer, haemometer
6. Good laboratory practice (GLP) & Bioethics.

Recommended readings:

1. Pearse, A.G.E. (1980-1993) Histochemistry - Theoretical and applied, Volume I-III, Churchill-Livingstones.
2. Plummer, D. (2017) An Introduction to Practical Biochemistry (3rd edition) McGraw Hill.
3. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge.
4. Boyer, R. (2000). Modern Experimental Biology. Pearson Education. English Universities Cambridge Low-price Ed.
5. Cantor, C.R. & Schimmel, P.R. (2003). Biophysical chemistry (3 vol. set). W. H. Freeman & Co.
6. Bajpai, P.K. (2006). Biological Instrumentation and Methodology. 1st Ed. S. Chand & Company Ltd.
7. Ghoshal & Shrivastava (2009). Fundamentals of Bioanalytical Techniques and Instrumentation. PHI
8. Sharma, V. K. (1991). Techniques in Microscopy and Cell Biology. Tata-McGraw Hill.
9. Arya A & Kumar A, (2018) Methods in biology, 2nd Ed, Drawing Pin Publishing
10. Kumar, P.; (2016) Fundamentals and Techniques of Biophysics and Molecular Biology, 1st Ed, Pathfinder Publication
11. Roy, R.N. (2005). A Text Book of Biophysics. New Central Book Agency (P) Ltd. Kolkata.

SEMESTER-III
MAJOR COURSE-3

Course Name: Animal Physiology and Comparative Anatomy
Course Code: BSCZOOMJ301

Course Type: **Major (Theoretical & Practical)**	Course Details: MJ**C-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 makes a detailed comparison of the anatomy and physiology of the different taxa of non-chordates and chordates. It also highlights how in the taxonomic hierarchy, there is an increase in the complexity of structure and function. The course thus gives an overview of the intricate life processes and adaptive radiations in non-chordates. This course also explores vertebrate morphology with the aims of understanding major events in the history of vertebrate evolution and integrating the morphology of vertebrates with their ecology, behaviour, and physiological adaptation in diverse habitats. Thermal relations encountered in endo- and ectothermic animals will be explained. Selective pressures that shape to different physiological phenotypes will also be addressed in the course.

Learning outcomes :
After successfully completing this course, the students will be able to:
- Develop an understanding of the characters used to classify besides being able to differentiate the organisms belonging to different taxa.
- Have hands on experience of materials demonstrating the diversity of protists and non-chordates.
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Develop an understanding of the evolution of vertebrates thus integrating structure, function and development.
- Have an overview of the evolutionary concepts including homology and homoplasy, and detailed discussions of major organ systems.
- Understand how cells, tissues, and organisms function at different levels. The course content also provides the basis of understanding their abnormal function in animal and human diseases and new methods for treating those diseases.
- Develop an understanding of the related disciplines, such as cell biology, neurophysiology, pharmacology, biochemistry etc.
- Get a flavor of research besides improving their writing skills and making them well versed with the current trends. It will further enable the students to think and interpret individually due to different aspects chosen.
- Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.
- Undertake research in any aspect of animal physiology in future.

THEORY (MJC-3)

Unit I: Teguments, skeletal and muscle system (15 Lectures)

1. **Tegument in non-chordates:** Helminthes (basic structure of cuticle in *Ascaris*), Annelida (Setae of earthworm; parapodium of *Neanthes*), Arthropoda (Cuticle of *Periplaneta*); Mollusca (Byssus thread in *Lamellidens*, shell of gastropods), Echinodermata (basic structure of body wall in *Asterias*)
2. **Integumentary system of chordates**: Types of scales in fishes, Types and structure of feathers in bird, Epidermal glandsof mammals. Epidermal derivatives of mammals (horn and hair).
3. **Muscular and skeletal system of Non-chordates**: Skeletal elements in major non-chordate phyla (Spicule and Spongin in Porifera).
4. **Muscular and skeletal of system Chordates**: Flight muscles in birds, Axial and appendicular skeleton of aves (*Columba*) and mammalia (*Cavia*). Comparative anatomy of visceral arches in vertebrates.

Unit II: Digestive, Locomotory, Respiratory systems (15 Lectures)

1. **Digestive system in non-chordates:** Structure and functions of digestive system in annelida (earthworm) and mollusca (*Pila*).
2. **Digestive system in chordates:** Comparative anatomy of jaw suspension. Structure and functions of digestive system in *Cavia*.
3. **Locomotory organs in non-chordates**: Structure and functions of cilia, flagella, tube feet.
4. **Respiratory organs in Non-chordates**: Structure and functions of book lung, book gill, and ctenidia. Chemical composition and functions of major respiratory pigments (hemocyanin and hemerythrin).
5. **Respiratory organs in Chordates:** Anatomy of fish gill and mammalian lung.Chemical composition and functions of respiratory pigment (hemoglobin).

Unit III: Diversity of Circulatory and Excretory systems (15 Lectures)

1. **Circulatory system in non-chordates:** Open vs closed circulation, water vascular system of *Asterias*.
2. **Circulatory system in chordates:** Evolution of aortic arches and their significance. Comparative anatomy of heart in vertebrates; Cardiac shunt in crocodile.
3. **Excretory system in Non-chordates**: Endocytosis, exocytosis; Excretion and diversity of excretory organs (flame cells, nephridia, malpighian tubules, organs of Bojanus).
4. **Excretory system in chordates**: Nephron- structure, types, and their function. Physiology of excretion (Ammonotelic, Uricotelic, Ureotelic) in vertebrates; Mechanisms of osmoregulation in fresh water and marine organisms (fishes); stenohalinity and euryhalinity.

UNIT IV: Diversity of Nervous, Endocrine and Reproductive systems (15 Lectures)

1. **Nervous system in non-chordates and chordates:** Comparison of nervous system- earthworm and *Pila*. Sensory organs in non-chordates (Statocyst, ommatidium). Types of cranial nerves in amphibians and mammals.
2. **Endocrine system of non-chordates:** Metamorphosis in insects (types and neuroendocrine regulation). Role of pheromones in insects.
3. **Endocrine glands in chordates:** Comparative structure of pituitary gland in chordates.
4. **Reproductive system in non-chordates and chordates: R**eproductive system in *Pheretima and Cavia*. Reproductive strategies (oviparity, ovo-viviparity and viviparity) in vertebrates.

PRACTICAL (MJC-3)

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium.*
2. Study of axial and appendicular skeleton of vertebrates (frog, lizard, bird, mammals).
3. Study of T.S. through pharynx, gizzard, and intestine of earthworm (Permanent slide/Photograph)
4. Mounting of Seta and nephridia of Earthworm.
5. Mounting of Mouth parts of cockroach and mosquito.
6. Comparative study of digestive system in *Oreochromis* sp. and *Channa* sp.
7. Study of structure of brain, heart and urinogenital system of fish, toad, *Galus, Cavia* from video recording/ Photograph.
8. Submit a report based on-Effect of temperature on rate of opercular movement of fish.
9. Project on modifications of Integumentary derivatives in vertebrates.
10. Group discussion or **Seminar presentation** on following related topics :

Pool of Topics for Group discussion or Seminar presentation :		
1. Jaw suspension in vertebrates	2. Thermoregulation in vertebrates	3. Osmoregulation in fish
4. Estrous and menstrual cycle	5. Blood groups and their importance	6. Scales in fishes and reptiles
7. Deep-sea Adaptation in mammals	8. Kidney development in vertebrates	9. Evolution of aortic arches
10.Cranial nerves in vertebrates	11. Integumentary derivatives in bird and mammals	12. Locomotory organs in non-chordates
13.Respiratory organs in non-chordates	14. Metamorphosis in arthropods	15. Parthenogenesis in animals

Format for conducting CA and ESE practical examination :

CA (30 marks)	**ESE (20 marks)**
5. Assessment based on practical topics (class test)-**10** **6.** PPT/Poster preparation, presentation andwrite up submission-3+4+3=**10** **7.** Attendance and Participation in class-**5** **8.** Practical skills, laboratory reports, etc-**5**	1. Mounting (Sl no 4,5)- Preparation-2, Drawing-1, Labelling-1. (**4**) 2. Identification (Sl no 1-3; any 2)- Sc. Name-0.5, Characters-1, Habit & habitat-0.5, (2x4=**8**) 3. Project report (sl no 8/9)-2 **4.** LNB -**3** **5.** Viva-**3**

NOTE :

- *<u>Study</u> of specimen should include-Scientific name, Habit and Habitat, Diagnostics feature, importance/values ifany.*
- *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.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings:

1. Barrington, E J W. (1967) Invertebrate structure and function, Nelson, London.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
3. Marshall, A.J and Williams, W.D. (1995) Text book of Zoology-Invertebrates. VII Ed., Vol. I, A.L.T.B.S. Publishers.
4. Miller S.A. & Harley J.P. (2015) Zoology. 10Ed., McGraw-Hill Education
5. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India

6. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education
7. Nigam, H C (2020) Biology of Non-chordates, Vishal publication
8. Hickman C., *et. al.* (2019) Integrated principles of zoology., 18Ed., McGraw-Hill Education.
9. Weichert, C.K. (1970) Anatomy of Chordates (4th edition).
10. Jordan, E. L. and Verma, P. S. (2013) Chordate Zoology (14th edition). S. Chand & Company Ltd. New Delhi.
11. Saxena, R. K. and Saxena, S. (2015) Comparative Anatomy of Vertebrates (2nd edition).
12. Vander, A.; Sherman, J. and Luciano, D. (2003) Human Physiology (9th edition).
13. Randall, D. *et al*. (2002) Eckert Animal Physiology (5th edition) Freeman.
14. Hill, R.W. *et al.* (2008) Animal Physiology (3rd edition) Sinaur Associates.
15. Guyton, A.C. *et al*. (2008) Textbook of Medical Physiology (12th Ed) W.B. Saunders Co.
16. Withers, P.C. *et al.* (1992) Comparative Animal Physiology (1st edition) Brooks Cole.
17. Kent, G. C. and Carr, R. K. (2018) Comparative anatomy of vertebrates (9Ed), Mc Graw Hill.
18. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.

SEMESTER-III
MAJOR COURSE-4

Course Name: Applied Zoology of Invertebrates

Course Code: BSCZOOMJ302

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-4**			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 unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

Learning outcomes

Upon successful completion of this course, students should be able to:

- Understand the culture techniques of prawn, pearl.
- Understand silkworms rearing and their products.
- Understand the Bee keeping equipments and apiary management.
- Learn various concepts of lac cultivation.
- Development of entrepreneurship in vermicomposting.
- Understanding about pest control and management
- Be aware of a broad array of career options and activities in human medicine, biomedical research and allied health professions

THEORY (MJC-4)

UNIT I: Sericulture **(15 Lectures)**

1. The silkworms. Its morphological characteristics.
2. Mulberry and non-mulberry Sericulture (Silk worm and respective host plants).
3. Biology of silkworm (Mulberry and Tasar).
4. Types of silk; silk glands, composition of silk.
5. Model Rearing house and uses of rearing appliances.
6. Types of mountages, Spinning, harvesting and storage of cocoons.
7. Diseases & pests of silk worm with prevention & control.
8. Silk industry in different states, employment, potential in mulberry and non-mulberry sericulture.
9. Employment generation in sericulture: Role of women in sericulture.

UNIT II: Apiculture **(15 Lectures)**

1. Species of honey bees in India. Life history of *Apis.*
2. Indigenous and modern methods of Bee keeping and apiary management,
3. Bee products and their uses.
4. Natural enemies, disease and their control.
5. Bee flora and planned pollination services (Modern Methods in employing artificial Beehives forcross-pollination in horticultural gardens)
6. Extraction and processing of honey.

7. Harvesting and marketing of bee products.
8. Govt regulation maintaining the quality of honey.

UNIT III: Lac culture and vermiculture (15 Lectures)

1. **Lac culture:** Lac insect and its life cycle. Cultivation of lac insect, host plants, processing and uses oflac. Lac enemies
2. **Vermiculture:** Biology of *Eisenia foetida*. Rearing of earthworms, Equipments, devices used in vermiculture, Vermicompost Technology. Methods and products, Vermiwash Collection, Composition and use.

UNIT IV: Pest and pest management (15 Lectures)

1. **Pest biology:** Classification of pests. Bionomics, Damage and Control measures of *Nilaparvata, Apion, Sitophilus, Meloidogyne incognita;* Concept of ETL and EIL. Pests and their Control - Cultural, Mechanical, Chemical, Biological; Integrated Pest Management.

PRACTICAL (MJC-4)

1. Identification of *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. Worker honey bee with emphasis on leg modifications (through specimens/charts)and whole mount preparation of the 3 pairs of legs.
7. **Visit** to a sericulture / apiary /Lac farm/Institute and submit a report.
8. **Group discussion or Seminar presentation** on following topic :

Pool of Topics for Group discussion or Seminar presentation :		
1. Silk worm products	2. Apiculture & prospect in India	3. Medicinal properties of honey
4. Bee products	5. Sericulture & prospect in India	6. Artificial bee hive and its management
7. Honey extraction and processing	8. Lac culture & prospect in India	9. Silk moth-Life cycle
10. Honeybee diseases and their management	11. silkworm diseases and their 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. Banerjee, G. C. (2014) A textbook of animal husbandry, Oxford & IBH.
5. Arumugam, N. (2014) Aquaculture and Fisheries, Saras Publication
6. Sarkar, Kundu & Chaki, (2014) Introduction to Economic Zoology, 1st Ed, NCBA
7. Banerjee T.K., (2016) Applied Zoology, 1st Ed, NCBA
8. Handbook of Fisheries and Aquaculture, ICAR Pub.
9. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
10. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
11. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
12. Nagaraja, N. and Rajagopal , D. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
13. Atwal, A.S. (1986). Agricultural Pests of India and South East Asia, Kalyani Publishers.
14. Dennis, H. (2009). Agricultural Entomology. Timber Press
15. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher),Jodhpur.

SEMESTER-III
MULTI-DISCIPLINARY COURSE-3

Course Name: Indian Health Sciences
Course Code: MDC304

Course Type: **MD (Theoretical)**	Course Details: **MDC-3**			L-T-P: **2-1-0**	
Credit: 3	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		-	**15**	**-**	**35**

Learning outcome:

The course is a walk for the students to gain a holistic knowledge on human health. The course provides elementary idea on various nutrients and their impacts on human physiology. In addition, students will be able to learn some of the common diseases and their management strategies. The last segment of this course deals with the stress and its management.

Upon successful completion of this course, students should be able to:

- Develop their understanding on health and the strategies that can be employed for improvement of physiology.
- Gain knowledge on various macro and micro nutrients and their significance.
- Learn common diseases and their management strategies.
- Develops the understanding about the stress and the coping methods.

THEORY (MDC-3)

Unit-I: Fundamentals of health **(15 Lectures)**

5. Definition of health- WHO definition; Components of health- physical, social, mental, spiritual and its relevance. Concept of wellness.
6. Health enhancing behaviours and their impacts on physiology: Exercise, Nutrition, Meditation, Yoga.
7. Health compromising behaviours and their impacts on physiology: alcoholism, smoking.

Unit-II: Public Health and Nutrition **(15 Lectures)**

5. Macronutrients and Micronutrients; Functions, dietary sources and clinical manifestations of deficiency/ excess of the following nutrients: Carbohydrates, lipids and proteins; Fat soluble vitamins-A, D, E and K; Water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C.
6. Important clinical manifestations of deficiency of minerals on human health: calcium, iron and iodine.
7. Concept of Recommended Dietary Allowance (RDA), Adequate Intake (AI), Tolerable

Upper Intake Level (UL), and Estimated Average Requirement (EAR)

8. Determination and importance of BMI. Idea on overweight and obesity. Outline idea on Indian food pyramid.

Unit-III: Human health and diseases (15 Lectures)

4. Pathogens: Outline idea; introduction to parasites causing human diseases (dengue, amoebiasis, malaria, ascariasis) and their control; Symptoms and treatment of these diseases.
5. Drug and alcohol abuse in adolescence
6. Elementary idea on lifestyle disorders –Cerebrovascular Disease, Hypertension, cancer, Type 2 Diabetes, Chronic Obstructive Pulmonary Disease (COPD), Osteoarthritis, Osteoporosis, Cataracts.

Unit-IV: Mental health and wellbeing (15 Lectures)

1. Importance of Mental Health Awareness, Introduction to Anxiety, Stress, and Resilience; causes, symptoms and management of distress
2. Effects of Stress on Physical and Mental Health
3. Neurological disorders: Elementary idea on Parkinson's Disease, Dementia (Including Alzheimer's Disease), amyotrophic lateral sclerosis

SEMESTER – IV
MAJOR COURSE - 5

Course Name: Ecology

Course Code: BSCHZOOMJ401

Course Type: Major **(Theoretical & Practical)**	Course Details: **MJC-5**			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:
This course will take students on a journey through the physical workings of the Earth, the interactions between species and their environments. The course highlights on some of the important aspects *viz*. growth and survival of populations and communities in different habitats, energy flow in the ecosystems, interactions between the communities, exclusion of niches and consequences of changing environment on the biodiversity.

Learning outcomes:
After successfully completing this course, the students will be able to:
- Know the evolutionary and functional basis of animal ecology.
- Understand what makes the scientific study of animal ecology a crucial and exciting endeavor.
- Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- Analyze a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- Solve the environmental problems involving interaction of humans and natural systems at local or global level.

THEORY (MJC-5)

UNIT I: An overview of Ecology and Ecosystems (15 Lectures)

1. Structure and function of ecosystem. Major world biomes.
2. Abiotic and biotic factors of ecosystem and their relevance. Concept of limiting factors in ecosystem.
3. Zonation and classification of organisms of fresh water and marine ecosystems.
4. Energy flow in ecosystem, models, relevance with law of thermodynamics.
5. Ecological pyramid, Food chain and food web; Productivity and ecological efficiencies.
6. Mineralization and recycling of nutrients: C, N & P.

UNIT II: Population ecology (12 Lectures)

1. Attributes of population: Density, natality, mortality, life tables, survivorship curves,age ratio, sex ratio, dispersal.
2. Concept of carrying capacity, Factors regulating population dispersal, Exponential, geometric & logistic growth.
3. Population regulation: density-dependent and independent factors; r and k strategies.

UNIT III: Biotic community, characteristics and attributes (15 Lectures)

1. Community characteristics: Dominance, diversity, species richness, abundance, Evenness.
2. Diversity and food-web indices.
3. Positive interactions: commensalism, proto-cooperation, and mutualism.
4. Negative interactions: parasitism and allelopathy; predation and predator-prey dynamics; herbivory.
5. Inter and intra-specific competition and Gause's Principle with laboratory and field examples.

6. Niche concept, types, Niche overlap and Resource partitioning; Ecotone and edge effect.
7. Ecological succession: Definition, Process, types, theories of succession.

UNIT IV: Environmental degradation; Biodiversity, Environmental movement etc. (18 Lectures)

1. Environmental pollution: Air, water and noise pollution and their control; EIA. Solid waste management
2. Biodiversity: Types, Hotspots of biodiversity. Threat and Major drivers of biodiversity. Conservation strategies; Biodiversity status in India, Ecosystem and biodiversity services.
3. Environmental movement: Chipko, Silent valley movements.

PRACTICAL (MJC5)

1. To measure microclimatic variables *viz*., temperature and humidity conditions in a microhabitat.
2. Constructing a food web by observing organisms from a given area.
3. Constructing distribution map of species of a genus through GPS by estimating the coordinates (virtual demonstration).
4. Determination of pH, and Dissolved O_2 (Winkler's Method) and Free CO_2 in water.
5. Preparation of nested quadrate and estimation of effective quadrate size.
6. Study of aquatic ecosystem: Spot identification of major zooplankton (up to class).
7. Excursion/Field study in a biodiversity rich area like national park, biosphere reserve, sea shore or nearbyplaces.
8. Preparing an essay (review work) and Seminar presentation on one or two related topics (Given Below).

Pool of Topics for Group discussion or Seminar presentation		
1. Biodiversity Hotspots.	2. Marine zooplanktons and their ecological importance including oxygen evolution.	3. Negative interactions in Ecosystem
4. Biodiversity mapping.	5. Biodiversity under climate changing scenario.	6. Ecological indices.
7. Niche segregation.	8. Air pollution and climate change.	9. Bioprospecting and Biopiracy.
10. Population explosion.	11. Climate change: threat to food security.	12. Water regulation in marine animals.
13. Carrying capacity.	14. Stratospheric Ozone depletion and marine productivity.	15. Good ozone vs. bad ozone.

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+3+2=**8** 3. Attendance and Participation in class-**4** 4. Practical skills, laboratory reports, etc-**3** 5. Field report-**5**	1. Experiment : (Sl no 4); Principle-1, Method-2, Result and inference-2, Precaution-1 (**6**) 2. Nested Quadrat : Preparation-2 and estimation-2 (**4**) OR Estimation of ratio of producers and consumers based on provided data. (**4**) 3. Identification (two zooplankton)- Sc. Name-0.5,systematic position-0.5, Habit & habitat-0.5, characters-0.5 (2 x 2=**4**) 4. LNB & Excursion Report-**2+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.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings:

1. Krebs, C. J. (2001) Ecology (6th edition) Benjamin Cummings.

2. Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
3. Ricklefs, R.E. (2000) Ecology (5th edition) Chiron Press.
4. Southwood, T.R.E. and Henderson, P.A. (2000) Ecologial Methods (3rd edition) Blackwell Sci.
5. Stiling, P. D. (2012) Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.
6. Basu, R.N. (2004). A Compendium of Terms in Ecology and Environment. Naya Udyog.
7. Begon, M., Harper, J. L. & Townsend, C. R. (2006). Ecology: Individuals, Populations and communities. 4thEd. Blackwell science.
8. Chapman, R. L. and Reiss, M. J. (2000). Ecology - Principles & Application. Cambridge University Press.
9. Dash, M. C., (2001). Fundamental of Ecology. 2nd Ed. Tata McGraw-Hill Company.
10. Enger, E. D. & Smith, B. F. (2008). Environmental Science: A study of Interrelationships. 11th Ed. McGraw-Hill Higher Education.
11. Faurie, C., Ferra, C., Medori, P. & Devaux, J. (2001). Ecology-Science and Practice. Oxford & IBH PublishingCompany.
12. Joshi, P.C. & Joshi, N. (2009). A Text Book of Ecology and Environment. Himalaya Publishing House.
13. mith, T. M & Smith, R. L. (2006). Elements of Ecology. 6th Ed. Pearson Education.
14. Van Dyke, F. (2008). Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science andBusiness Media.
15. Sharma, P.D. (2017). Ecology and Environment.13th Ed Rastogi Publications.
16. Saha, T.K. (2013) Ecology and Environmental biology, Books & allied.
17. Molles, Jr. M.C. (2005). Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.
18. Santra, S.C (2005). Environmental Science. New Central Book Agency (P) Ltd. Kolkata.
19. Timbrell, J. (2002). Introduction to Toxicology, 3rd Ed. Taylor & Francis, London.
20. Raven, P. H. & Berg, L.R. (2004). Environment. 4th Ed. John Wiley & Sons, Inc.
21. Mathur, R. (2018) Wildlife conservation and management, 1st Ed, Rastogi Pub.
22. Saha, G.K. and Mazumdar, S.; (2017) Wildlife Biology: An Indian Perspective, PHI Learning.

SEMESTER-IV
MAJOR COURSE - 6

Course Name: Livestock Management and Animal Husbandry Course Code: BSCHZOOMJ402

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-6**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

About the course :
The course provides intensive study in livestock production, management, marketing, nutrition, breeding, production records, selection, animal health, waste management, and conservation practices.

Learning outcomes
Upon successful completion of this course, students should be able to:
- Understand skills and requirements necessary to find and maintain a job.
- Select and develop a breeding system for a livestock enterprise.
- Understand the importance of genetic improvement in animal production.
- Formulate feed rations for different classes of livestock.
- Identify common problems associated with livestock and horse herd health and solutions.
- Identify current and future issues relating to animal husbandry.
- Understand different marketing opportunities available for livestock production.

THEORY (MJC-6)

Unit I: Animal products and breeding systems (15 Lectures)

1. Scope of livestock industry; issues in animal agriculture.
2. Animal products: Cow, Poultry.
3. Advanced reproduction and breeding: Common breeding systems including cattle breeding, and poultry breeding.
4. Reproductive Technologies (AI, MOET).

Unit II: Animal nutrition (15 Lectures)

1. Nutritional requirements: Energy requirements for maintenance, growth; production of milk, egg, and meat.
2. Feedstuffs, Systems for expressing energy value of foods in ruminants, and poultry.
3. Ration formulations for cattle and poultry.

Unit III: Animal Breeds and Maintenance of breeds (18 Lectures)

1. Common breeds (exotic and indigenous) of livestock: Cattle, Goat and Poultry.
2. Housing, equipment and management of cattle breeding.
3. Disease and its management: Cattle and Poultry.
4. Health care: Vaccination programmes and Deworming programmes for Cattle and Poultry

Unit IV: Marketing and related issues (12 Lectures)

1. Planning and Marketing; Culling, Forward Contracting, Backgrounding.

2. Quality control; Future prospects.
3. Stock improvements (genetic improvement) and maintenance: Cattle and Poultry
4. Current issues affecting the livestock industry.

PRACTICAL (MJC-6)

1. Virtual demonstration of endocrine glands and their influence on growth of livestock.
2. Estimation of albumen and yolk quantity in eggs.
3. Estimation of calcium in egg shell (Back Titration method).
4. **Farm Visit:** Visit to any dairy/poultry farm to understand the rearing techniques, rationing, disease management, marketing and submit a report.
5. **Group discussion or Seminar** presentation on topics given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Dairy management	2. Breeding system and grading up	3. Livestock feed formulations
4. Poultry management	5. Pink revolution in India	6. Goat breeding and management
7. AI technology	8. White revolution in India	9. Scope of Livestock Industry in India

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+3+2= **8** **3.** Attendance and Participation in class- **5** **4.** Practical skills, laboratory reports, etc- **3** 5. Field report- **4**	1. Experiment A (Sl no 2, 3)- Principle-1, procedure-2, Experiment-4, result and inference-2, precaution-1 (**10**) 2. Field report- **4** **3.** LNB - **2** 4. Viva- **4**
NOTE : • *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.* • *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*	

Recommended readings:

1. Taylor, R.E and Field, T.G. (2004).Scientific Farm Animal Production: An Induction to Animal Science. Prentice-Hall.
2. Acker, D. and Cunningham, M. (1998). Animal Science & Industry. Prentice-Hall.
3. Blakely, J. and Bade, D. (1985). The Science of Animal Husbandry. Prentice-Hall.
4. Cambell, J. and Lasley, J. (1975). The Science of Animals that Serve Mankind. McGraw-Hill.
5. Cooper, E. L. (1990). Agriscience: Fundamentals & Applications Delmer: Albany.
6. American Youth Horse Council (1999) Handbook: A Guide to Equine Care and Management.
7. Morrison, F. (1949). Feeds and Feeding (8th edition) Morrison: Ithaca
8. Handbook of Animal Husbandry, (2008) ICAR Publication, New Delhi.
9. Prasad, J.; (2016) Animal Husbandry and Dairy Science, Kalyani Publishers.
10. Banerjee, G.C.; (2019) A Textbook Of Animal Husbandry, 8Ed, Oxford & IBH publishing.
11. Banerjee, G.C.; (2019) Principles of animal nutrition and feeds, Revised Ed, Oxford & IBH publishing.
12. Reddy, D.V.; (2018) Principles Of Animal Nutrition And Feed Technology, 3Ed, Oxford & IBH publishing.

SEMESTER-IV
SKILL ENHANCEMENT COURSE - 3

Course Name: Aquaculture

Course Code: BSCHZOOSE401

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

About the course

This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, andprawn. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals

Learning outcomes

- After completing this course the learners will be able to
- Understand the aquaculture systems
- Understand conditioning factors and how they can be manipulated
- Describe water depuration mechanisms
- Understand the environmental impacts of aquaculture

THEORY (SEC-3)

Unit I : Traditional and modern aquaculture systems (16 Lectures)

1. Cultivable carp species: Indigenous and Exotic.
2. Culture systems: Types of culture (extensive and intensive fish culture), composite fish culture, Techniques of brackish water shrimp culture and freshwater prawn culture.
3. Pearl Culture: Pearl producing mollusks, Pearl formation process; Artificial pearl culture technique: Collection and Rearing of oysters, insertion of nucleus, harvesting of pearls; Composition & quality of pearl, Prospect of pearl industry in India.

Unit II: Feed formulation, propagation and harvesting of fish (18 Lectures)

1. Fish feed: Feed formulation for shrimps and carps, Live feed for fish and shrimp.
2. Induced Breeding of Carps: Brood-stock maintenance, hypophysation and induced breeding with synthetic hormones, hatchery systems.
3. Selective breeding and transgenesis in fish.
4. Production of prawn and shrimp seeds.
5. Harvesting: Fishing techniques, preservation and processing of fish.

Unit III: Aquarium fish keeping (18 Lectures)

1. Aquarium fish keeping: Preparation and management of fish aquarium.
2. Biology of common ornamental fish: Guppy and Gold fish.
3. Ornamental fish breeding and rearing.

4. The potential scope of the Aquarium Fish Industry as a Cottage Industry.

Unit IV: Fish Disease (8 Lectures)

1. Parasitic diseases: Causative agents, symptoms and control measures: Bacterial diseases- Dropsy, Fin , and gill rot. Protozoan disease- White Spot Disease; Fungal disease-Saprolegniasis and branchiomycosis Ectoparasitic disease- Argulosis.
2. Non parasitic diseases: Nutritional deficiency and pollution-related diseases.

References:

I. Jingran, V. G. (1983) Fish and fisheries of India , Hindustan pub. corp. New Delhi.

2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.

3. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House NewDelhi.

4. Yawn Mehta, Fisheries & Aquaculture Biotechnology (2011) Campus Books International, Prahalad street,Ansari Road, Durga Ganj, New Delhi.

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
MINOR COURSE-1

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 (11 Lectures)

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.
   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
MINOR COURSE-2

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 :

- *<u>Study</u> 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
MINOR COURSE-3

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.

SEMESTER-IV
MINOR COURSE- 4

Course name: Ecology, Ethology and Evolution

Course code: BSCZOOMN401

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-4**			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:

This course will take students on a journey through the physical workings of the Earth, the interactions between species and their environments. The course highlights on some of the important aspects *viz*. growth and survival of populations and communities in different habitats, energy flow in the ecosystems, interactions between the communities, exclusion of niches and consequences of changing environment on the biodiversity. The course aims to explain the natural behaviour patterns, how the behaviour varies among individuals and species (wild, domestic, and captive), how current and past environments and ecology influence not only behaviour, but also the underlying gene environment interactions that shape it. The present course also gives insight into the origin of life and the related evolutionary processes. The evolutionary theories and the process of species formation will be elaborated in view of the natural selection process.

Learning outcomes:

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

- Know the evolutionary and functional basis of animal ecology.
- Understand what makes the scientific study of animal ecology a crucial and exciting endeavour.
- Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- Analyse a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- Solve the environmental problems involving interaction of humans and natural systems at local or global level.Learn a wide range of theoretical and practical techniques used to study animal behaviour.
- Develop skills, concepts and experience to understand all aspects of animal behaviour.
- Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
- Understand and be able to objectively evaluate the role of behaviour in the protection and conservation of animals in the wild.
- Consider and evaluate behaviour of all animals, including humans, in the complex ecological world, including the urban environment.
- Acquire an in-depth knowledge on the diversity and relationships in animal world.
- Develop a holistic appreciation on the phylogeny and adaptations in animals.
- Enable the students to understand the evolution of universe and life.
- Understanding on the process and theories in evolutionary biology.
- Develop an interest in the debates and discussion taking place in the field of evolutionary biology.

THEORY (MNC-4)

UNIT I: An overview of Ecology, Ecosystems and Biomes (15 Lectures)

1. Structure and function of ecosystem; Abiotic and biotic factors of ecosystem.
2. Major biomes in world,
3. Energy flow in ecosystem.
4. Ecological pyramid, Food chain and food web; Productivity and ecological efficiencies.
5. Ecological succession: Definition, and process.

UNIT II: Community Ecology and Biodiversity (15 Lectures)

1. Attributes of population: Natality, mortality, survivorship curves.
2. Concept of carrying capacity, Exponential and logistic growth; r and K strategies.
3. Community characteristics: diversity, species richness, abundance, and evenness.
4. Brief concept of Population interactions; Niche concept and resource partitioning.
5. Biodiversity: Types and Hotspots of biodiversity. Threat and Major drivers of biodiversity. Man-wildlife conflict.

Unit III: Ethology (15 Lectures)

1. Types of Learning
2. Mimicry and colouration.
3. Migratory behaviour in birds.
4. Parental care in Fish.
5. Chronobiology and Biological clocks: Concept of Circadian rhythms; Role of melatonin.

Unit IV: Evolutionary Biology (15 Lectures)

1. Origin of Life.
2. Lamarckism, Darwinism, Neo-Darwinism.
3. Types of fossils, significance
4. Hardy Weinberg Principle, Factors, Gene and allele frequency.
5. Adaptive radiation, Genetic drift, Bottleneck effect, Founder effect.
6. Species concept: Allopatric & Sympatric speciation.

PRACTICAL (MNC-4)

1. Preparation of nested quadrate and estimation of effective quadrate size.
2. Study of an aquatic ecosystem: Spot identification of zooplankton (Up to Class).
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Understanding embryological evidence of evolution (through charts and videos).
6. Study of types of fossils (through photograph/model/video).
7. Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit).
8. **Excursion/Field study** in a biodiversity rich area like national park, biosphere reserve, sea shore or nearby places to study behavioural activity of animal or biodiversity study/mapping.
9. Group discussion or **Seminar presentation** on one or two related topics (Given Below).

Pool of Topics for Group discussion or Seminar presentation		
1. Biodiversity Hotspots.	2. Parental care in fish/amphibia	3. Tiger project
4. Negative and positive interactions in Ecosystem	5. Biodiversity under climate changing scenario.	6. Environmental movements in India
7. Crocodile project	8. Man-wildlife conflict	9. Biological clock
10. Population explosion.	11. Natural selection	12. Hominid Evolution
13. Carrying capacity.	14. Animal migration	15. Ecological succession

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. Excursion Field report - 2, LNB-3	1. Identification (based on item 5, 6 & 7): Naming-0.5 and character/significance-1.5 (2 X 2=4) 2. Nested Quadrat : Preparation-2 and estimation-2 (4) 3. Identification (zooplankton)- Sc. Name-0.5, systematic position-0.5, characters-1 (2 x 2=4) 4. LNB & Excursion Report-2+4 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.* • *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*	

Recommended readings:

1. Krebs, C. J. (2001) Ecology (6th edition) Benjamin Cummings.
2. Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
3. Stiling, P. D. (2012) Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education.
4. Basu, R.N. (2004). A Compendium of Terms in Ecology and Environment. Naya Udyog.
5. Begon, M., Harper, J. L. & Townsend, C. R. (2006). Ecology: Individuals, Populations and communities. 4th Ed. Blackwell science.
6. Chapman, R. L. and Reiss, M. J. (2000). Ecology - Principles & Application. Cambridge University Press.
7. Dash, M. C., (2001). Fundamental of Ecology. 2nd Ed. Tata McGraw-Hill Company.
8. Smith, T. M & Smith, R. L. (2006). Elements of Ecology. 6th Ed. Pearson Education.
9. Van Dyke, F. (2008). Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science and Business Media.
10. Sharma, P.D. (2017). Ecology and Environment.13th Ed Rastogi Publications.
11. Raven, P. H. & Berg, L.R. (2004). Environment. 4th Ed. John Wiley & Sons, Inc.
12. Mathur, R. (2018) Wildlife conservation and management, 1st Ed, Rastogi Pub.
13. Saha, G.K. and Mazumdar, S.; (2017) Wildlife Biology: An Indian Perspective, PHI Learning.
14. Shukla, J.P. (2021) Fundamentals of Animal Behaviour, 1st Ed, Atlantic
15. Agarwal V.K.; (2010) Animal behaviour, 1st Ed, S Chand & Company
16. McFarland, D. (1999) Animal Behaviour (3rd edition) Pitman Publishing Limited,London, UK.
17. Manning, A. and Dawkins, M. S. (2012) An Introduction to Animal Behaviour (6th edition) Cambridge, University Press, UK
18. Alcock, J. (2005) Animal Behaviour (8th edition) Sinauer Associate Inc., USA.
19. Natarajan, P and Arumugam, N.; Animal behaviour (2018) 1st ed, Saras publication
20. Hall, B. K. and Hallgrimsson, B. (2008). Strickberger's *Evolution*. IV Edition. Jones and Bartlett Publishers
21. Chattopadhyay, S (2014) LIFE: Evolution, adaptation, ethology, 3rd Ed, Books & Allied
22. Arumugam N.; Organic Evolution (2020), Saras publication.
23. Saha, T.K. (2013) Ecology and Environmental biology, Books & allied.