

National Curriculum and Credit Framework (NCCF)

Syllabus

for

Major Courses and Skill Enhancement Courses

ZOOLOGY

w. e. f. Academic Session 2023-24

[3-Year UG Degree/4-Year UG Degree (Honours)/4-Year UG Degree (Honours with Research)]



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/diagnostic), 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

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 phylogenetic concept, 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; protostomes and 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 (American Association 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 :
<ol style="list-style-type: none"> i. Protista: <i>Euglena, Amoeba, Paramecium.</i> ii. Porifera: <i>Euspongia, Scypha.</i> iii. Cnidaria: <i>Obelia, Physalia, Porpita, Aurelia, Tubipora, Sea Anemone, Pennatula, Fungia.</i> iv. Platyhelminthes: <i>Fasciola hepatica, Taenia solium.</i> v. Nematoda: <i>Ascaris.</i> vi. Annelida: <i>Aphrodite, Sabella, Chaetopterus, Pheretima.</i> vii. Arthropoda: <i>Carcinoscorpius, Macrobrachium, Balanus, Julus, Periplaneta, Peripatus.</i> viii. Mollusca: <i>Chiton, Pila, Pinctada, Sepia.</i> ix. Echinodermata: <i>Astropecten, Cucumaria and Antedon</i> x. larval forms: <i>Ephyra, Trochophore, Zoea, Nauplius, Veliger, Glochidium, Bipinnaria, Brachiolaria.</i>

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

Format for conducting CA and ESE practical examination :

CA (30 marks)	ESE (20 marks)
<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 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
<p>NOTE :</p> <ul style="list-style-type: none"> • 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 Hallgrímsson 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
17. Hickman C., et. al. (2019) Integrated principles of zoology., 18th Ed., McGraw-Hill Education.

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	ESE Marks
		Theoretical	Theoretical
		15	35

About the course :

The course designed for public health and hygiene at graduation level will give understanding for health hygiene, 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 water and 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), Kwashiorkor, 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, chikungunya, 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-II

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 Classes)

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 Classes)

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 Classes)**

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 Classes)

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 classification scheme 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>i. Protochordata: Balanoglossus, Branchiostoma, Ascidia.</i>
<i>ii. Fishes: Scoliodon, Torpedo, Mystusvitattatus, Catla, Labeo, Exocoetus, Hippocampus</i>
<i>iii. Amphibia: Ichthyophis, Necturus, Bufo, Rachophorous</i>
<i>iv. Reptiles: Chelone, Calotes, Chamaeleon, Draco, Bungarus, Vipera, Naja.</i>
<i>v. Birds: Psittacula, Pycnonotus.</i>
<i>vi. Mammals: Sorex, Pteropus, Funambulus.</i>

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 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 <i>Sphenodon</i>	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)
<ol style="list-style-type: none"> 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 	<ol style="list-style-type: none"> 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.

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 diagnosis 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 given percentage and molarity.
- Understand the process of preparation of buffer. Learn the techniques of separation of amino acids, 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. Buffers and 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. Cryopreservation (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

Course Name: Animal Physiology & Comparative Anatomy

Course Code: BSCZOOMJ301

Course Type: Major (Theoretical & Practical)	Course Details: MJC-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 glands of 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:** Reproductive 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)
<ol style="list-style-type: none"> 5. Assessment based on practical topics (class test)-10 6. PPT/Poster preparation, presentation and write up submission-3+4+3=10 7. Attendance and Participation in class-5 8. Practical skills, laboratory reports, etc-5 	<ol style="list-style-type: none"> 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 : <ul style="list-style-type: none"> <i>Study of specimen should include-Scientific name, Habit and Habitat, Diagnostics feature, importance/values if any.</i> <i>Identification could be done by using card printed with photograph/drawing/data/preserved specimen/permanent slide.</i> <i>CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.</i> <i>LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.</i> <i>A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.</i> 	

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.

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 for cross-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)

- Lac culture:** Lac insect and its life cycle. Cultivation of lac insect, host plants, processing and uses of lac. Lac enemies
- 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)

- 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)

- Identification of *Bombyx mori*, *Eisenia foetida*, *Nilaparvata*, *Apion*, *Sitophilus*, *Meloidogyne*.
- Identification of life stages of *Bombyx mori* and *Antheraea mylitta*;
- Identification of Bivoltine and multivoltine mulberry cocoon and tasar cocoon.
- Castes (through charts/specimens) study of bees,
- Demonstration of the sting apparatus and pollen basket of honey bee.
- Worker honey bee with emphasis on leg modifications (through specimens/charts) and whole mount preparation of the 3 pairs of legs.
- Visit** to a sericulture / apiary /Lac farm/Institute and submit a report.
- 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)
<ol style="list-style-type: none"> Assessment based on practical topics (class test)-10 PPT/Poster preparation, presentation and write up submission-3+4+3=10 Attendance and Participation in class-5 Practical skills, laboratory reports, etc-5 	<ol style="list-style-type: none"> Identification (SI no 1-4)-Naming-0.5, character-1.5 (2X4=8) Demonstration (SI no 5)-representation-3, drawing-2, labelling-1 (6) LNB -2 Field report-2 Viva-2
<p>NOTE :</p> <ul style="list-style-type: none"> 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.

