National Curriculum and Credit Framework (NCCF)

Syllabus

for

ZOOLOGY

w. e. f. **Academic Session 2023-24**

Kazi Nazrul University

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Updated on March 19, 2026

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	GRP-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 I: 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 II: 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 III: 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 IV: 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 I: 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 II: 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 III: 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 IV: 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.** Excursion and field report-**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 Theoretical **15**	ESE Marks Theoretical **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)**
1. Assessment based on practical topics (class test)-**10** **2.** PPT/Poster preparation, presentation andwrite up submission-3+4+3=**10** **3.** Attendance and Participation in class-**5** **4.** 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 :

- *Study 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)**

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

UNIT II: Public Health and Nutrition **(15 Lectures)**

1. 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.
2. Important clinical manifestations of deficiency of minerals on human health: calcium, iron and iodine.
3. Concept of Recommended Dietary Allowance (RDA), Adequate Intake (AI), Tolerable

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

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

UNIT III: Human health and diseases (15 Lectures)

1. Pathogens: Outline idea; introduction to parasites causing human diseases (dengue, amoebiasis, malaria, ascariasis) and their control; Symptoms and treatment of these diseases.
2. Drug and alcohol abuse in adolescence
3. 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: **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 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: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
			15		**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.

SEMESTER-V
MAJOR COURSE - 7

Course Name: Cell Biology and Histology

Course Code: BSCZOOMJ501

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-7**			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 provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

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

- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
- Acquire the detailed knowledge of different pathways related to cell signalling and apoptosis thus enabling them to understand the anomalies in cancer.
- Develop an understanding how cells work in healthy and diseased states and to give a 'health forecast' by analyzing the genetic database and cell information.
- Get new avenues of joining research in areas such as genetic engineering of cells, cloning, vaccines development, human fertility programme, organ transplant, etc.
- Understand the principle of histopathological techniques.
- Understand how tissues are produced from cells in a normal course and about any malfunctioning which may lead to benign or malignant tumor.

THEORY (MJC-7)

UNIT I: The structure and organelles of prokaryotic and eukaryotic cells (16 Lectures)

1. **General idea about cell:** Cell theory and its modern version and interpretation; General structure of archaea, prokaryotes, and eukaryotes.
2. **Extra-nuclear cell organelles:** Ultrastructure and functions of Endoplasmic reticulum, Ribosome,Golgi apparatus. Functions of lysosome and peroxisome.
3. **Semi-autonomous organelle:** Mitochondria: Origin, structure, and function.
4. **Cytoskeleton:** Composition, assembly and functions; Microtubules, Intermediate Filament and microfilaments.
5. **Nucleus:** Structure and functions of nucleus; Ultrastructure of nuclear membrane and pore complex; Nucleolus: general organization.

UNIT II: Cell membrane and transport mechanism (14 Lectures)

1. **Fluid mosaic model:** Architecture and significance; Lipid Composition, inner and outer leaflets ; Structure and functions of membrane proteins: Integral, peripheral and lipid-anchored membrane proteins.
2. **Cell junction:** Junctional complexes, microvilli, desmosomes and plasmodesmata, Extracellular matrix.

3. **Transport across membrane:** Diffusion and osmosis, Active and passive transport, Endocytosis and exocytosis.

UNIT III: Cell cycle and cell signalling (12 Lectures)

1. **Cell cycle :** Cell division- mitosis and meiosis ; Cell cycle and Cell division checkpoints and their regulation; Mutations in the genes (p53, pRB) that regulate cell cycle and division and their role in causing cancer;Apoptosis: definition, characteristics, pathways, and difference with necrosis, blastomeric cell cycle.
2. **Cell signalling:** Modes of cell-cell signalling; Types of Signalling molecules (first messengers and second messengers); Receptor- GPCR, Adenylcyclase-cAMP.
3. **Cancer biology:** Hallmarks of cancer cells, Transformed cells vs normal cells, Benign vs malignant tumor, steps of malignancy - angiogenesis, invasion, metastasis.

UNIT IV: Animal tissues system and histochemistry (18 Lectures)

1. **Epithelial tissue**: Types, location, structure and characteristics
2. **Connective tissue** : Location and structure of cartilage and bone;
3. **Muscular tissue** : Ultrastructure of skeletal muscles, differences between smooth, skeletal and cardiac muscles.
4. **Nervous tissue** : Structure and classification of neurons ; Types of supporting (glial) cells and theirfunction; Membranes of the brain and spinal cord.
5. **Histochemistry:** Basic idea on histochemistry (fixatives, preservatives, stain, dyes, mordants); Application of histopathology in disease diagnosis.

PRACTICAL (MJC-7)

1. Study of prokaryotic and eukaryotic cell types with the help of chart, slide and video.
2. Study of chromosome segregation in mitosis and meiosis through the permanent slide.
3. Preparation of chromosome squashes from grasshopper/cockroach testes for the observation of stages ofmeiosis.
4. Temporary Squash preparation of squamous epithelial cell.
5. Microscopic study through permanent slides-
   a) Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue, etc.
   b) Histological structure – Stomach, intestine, pancreas, liver, Kidney, testis, ovary, thyroid, adrenal andpituitary.
6. Preparation of histological permanent slides by the process of block preparation (Liver and kidney- goat/fish), section cutting by microtomy and staining.
7. **Experiment:** Isolation (Ethanol ppt) of DNA (blood/liver tissue/plant tissue).
8. **Demonstration:** Localization of biomolecules like protein (Ninhydrin Schiff Method), carbohydrates (PAS reaction), lipids (Sudan black B method), DNA (Feulgen reaction), RNA(MGP) by Histochemistry techniques.
9. **Group discussion** or **Seminar presentation** on the following topics :

Pool of Topics for Group discussion or Seminar presentation :		
1. Histochemistry-a tool for disease diagnosis	2. Recent advances in tissue culture and engineering.	3. Cell signalling
4. Popular cell lines and their importance.	5. Mutations and cancer.	6. Apoptosis.
7. Fluid Mosaic Model	8. Stem cell & IPS cells.	9. Cell cycle
10.Cell organelle (any one)	11.Cytoskeletal elements	12. Nerve cell
13. Cell-based classification system	14. Nuclear Pore Complex	15.Cell Junction
16.Cellular Transport	17.Epithelial tissue	18.Connective tissue

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.** Histological preparation (Sl no 6)- Sectioning & Stretching-**5** / Staining -**5** OR, Experiment (Sl no 7)- Principle-1, Experiment-2, result and inference-2, (**5**) **2.** Squash preparation (Sl no 3, 4)- Preparation-2, Identification-1, characterization-1. (**4**) **3.** Identification (Sl no 2 and 5, 1 item from each group)- Identification-0.5, Characters-1.5 (2x2=**4**) **4.** LNB -**3,** **5.** Viva-**4**
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. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. (5th edition) ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. (7th edition) Pearson Benjamin Cummings Publishing, San Francisco.
5. Verma, P.S. and Agarwal, V.S.; (2016) Cell Biology, S.Chand Pub.
6. Rastogi, S.C. (2019) Cell biology, New Age Int. Pub.
7. Rastogi, V.B. (2021) Cell Biology, 1st Ed, MedTech.
8. Gupta, R. and Makhija, S. and Toteja, R. (2018) Cell biology: Practical Manual, Prestige Publishers.
9. Channarayappa (2010) Cell Biology, 1st Ed, Universities Press.
10. Alberts, B (2013) Essential cell biology, 4th Ed, Garland science.
11. Rej, S.K.; (2015) General concepts of Histology and endocrinology, NCBA.
12. Berry, A.K.; (2015) A textbook of Animal Histology, Emkay pub.
13. Gunasegaran J.P., (2016) Textbook of Histology: A practical guide, 3rd Ed, Elsevier India
14. Mescher, A., (2013) Junqueira's Basic Histology: Text and Atlas, 13th Ed, LANGE
15. Kiernan, J. A. (1999). Histology and Histochemical Methods: Theory & Practice. 3 rd Ed. Butter work Heinemann.

SEMESTER-V
MAJOR COURSE - 8

Course Name: Genetics and Molecular Biology
Course Code: BSCZOOMJ502

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-8**			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 designed to revise basic concepts of Genetics and then move on to advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, etc. will be covered. A strong emphasis will be laid on the modern tools and techniques used in genetics.

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

- Understand how DNA encodes genetic information and the function of mRNA and tRNA.
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Relate the conventional and molecular methods for gene manipulation in other biological systems.
- Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc
- Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.
- Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.
- Apply their knowledge in problem solving and future course of their career development in higher education and research.
- Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

THEORY (MJC-8)

UNIT I: Nucleic acid, Gene and Genome (12 Lectures)

1. DNA and RNA as genetic material (Griffith and Harshey-Chase experiment).
2. Classical and Modern concept of Gene, definition- Cistron, muton, recon, Alleles, operon, replicon.
3. Mitochondrial genome (structure).
4. Structure and Topology of DNA: A-form, B-form and Z-form, Supercoiled DNA (linking number, twist and writhe)
5. Physical and chemical properties of DNA: Denaturation-renaturation, cot curve, Hyperchromic shift,C-value paradox.
6. DNA polymorphisms (SNPs, RAPD, RFLP, VNTR).
7. Chromosome: Nucleosome concept, higher order model and structure; Giant chromosome- polyteneand lampbrush; Karyotyping, chromosomal banding (G, C, R).

UNIT II: Classical Genetics and Eugenesis (15 Lectures)

1. Mendel's laws of inheritance.
2. Non-mendelian traits (definitions with examples): Incomplete dominance, Codominance, Multiple allelism, Lethal alleles, expressivity and penetrance, Pleiotropy, Epistasis – Recessive and Dominant, Phenocopy.
3. Sex-Determination: Sex Chromosomes and sex-linkage: XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types, Dosage Compensation in *Drosophila* and Man.

4. Structural and numerical alterations of chromosomes with relevant diseases.
5. Human Genetics: Pedigree analysis; Genetic counseling.
6. Mutagens-types (physical, chemical and biological), mutation detection test (AMES, CLB).

UNIT III: The recombination and behaviour Genes (15 Lectures)

1. Linkage, Two factor and three factor crosses, Interference andcoincidence.
2. Examples of Transposons in Bacteria, maize and human.
3. Transformation, Conjugation, and transduction.
4. Extra chromosomal Inheritance: Criteria for extra-chromosomal inheritance, Maternal effects in snail.

UNIT IV: DNA replication, Gene regulation and Protein synthesis (18 Lectures)

1. Central Dogma of Molecular Biology.
2. DNA Replication: Meselson-Stahl Experiment, DNA replication in Prokaryote; Inhibitors of DNA replication; DNA repair; Chromatin remodeling (acetylation, methylation, and phosphorylation)
3. Transcription in Prokaryotes: Enzymes and Mechanism ; Inhibitors of transcription
4. Concept of operon of bacteria (Lac & Trp).
5. Genetic Code and its features, Wobble hypothesis, Discovery of genetic code.
6. Mechanism of Translation in Prokaryote .
7. Protein trafficking.
8. Brief idea on post-translational modification and processing of proteins

PRACTICAL (MJC-8)

1. Application of probability in the law of segregation with the coin tossing method.
2. Study of Mendelian Inheritance using suitable examples. Verify the results using Chi-square test (Goodness of fit).
3. Pedigree chart analysis (with standard symbols; autosomal and sex-linked inheritance patterns)
4. Prepare a study/survey report on-
   (a) Frequency of the following genetic traits in human: widow's peak, attached ear lobe, dimple inchin, hypertrichosis, colour blindness, PTC tasting and
   (b) Study of mode of inheritance of the following traits by pedigree charts – attached ear lobe,widow's peak
5. Temporary mounting of polytene chromosome from *Drosophila / Chironomous* larva.
6. Extraction of Genomic DNA from bacteria (Demonstration).
7. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs.
8. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome andTurner syndrome).
9. Demonstration: Familiarization with techniques of handling *Drosophila*, identifying males andfemales; observing wild type and mutant (white eye, wing less) flies, and setting up cultures.
10. Demonstration of AMES test or reverse mutation for carcinogenicity.
11. Qualitative and quantitative test for DNA (Diphenylamine method) & RNA (Orcinol method).

12. Group discussion or Seminar presentation on the topics given below.

Pool of Topics for Group discussion or Seminar presentation :		
1. Genome modification/ editing	2. Genetic control of sex determination.	3. Genetic Recombination
4. Mutagenesis	5. Diseases due to chromosomal anomalies	6. Chromosomal mutations
7. Complementation mapping	8. Recent advances in gene cloning	9. Genetic counseling
10.DNA markers and Genetic diversity	11. Epigenetic disorders in humans	12. Chromosome translocation
13.Model organisms (any one)	14. Giant chromosome	15. DNA polymorphism
16.Eukaryotic genome	17. Regulation of gene expression	18. Genetic code
19.DNA damage and repair	20. Central dogma of molecular biology	21. Why Lagging strand?
22.RNA editing and splicing	23. Why Telomerase is crucial in eukaryote DNA replication?	24. DNA polymorphisms & significance
25. RNA interference	26. Chromatin remodeling	27. Splicing & its significance

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.** Chi-Square test based on provided data-(Sl no 2)- Analysis-3, Inference-1 (4) OR, Mounting of giant chromosome.Mounting-2, drawing & labelling-2 (4) **2.** Pedigree analysis on provided chart-(Sl no 3)-Description-1, analysis-2 and mode of inheritance-1 (**4**) OR, Experiment from Sl. No. 11. Principle: 1; Experiment: 1; Result and inference: 2 (**4**) **3.** Identification based on provided chart/slide (Sl no 7 to 9)- Naming-0.5, Characters-1.5 (2x2=**4**) **4.** LNB and Survey report -2+2 = **4** **5.** Viva-**4**

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.*
- *Survey report should be done on specified topics and distributed among students.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings :

1. Russell, P.J. (2010) Genetics (Benjamin Cummings).
2. Pierce B.A. (2012) Genetics:A conceptual approach, 4Ed, W. H. Freeman and Co. Ltd.
3. Singh B.D.(2018) Fundamentals of genetics, Kalyani Publishers.
4. Miglani G.S. (2008) Fundamentals of genetics, Narosa publication.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
6. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings
8. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co. Ltd.
9. Banerjee P.K. (2011) Problems on genetics, molecular genetics and evolutionary genetics,2Ed, NCBA
10. Watson, J.D. *et al.* (2013) Molecular Biology of the Gene (7th edition) CSHL Press Pearson.
11. Green, M. R and Sambrook, J. (2012) Molecular Cloning: a Laboratory Protocol (4th edition) CSHL Press.
12. Walter, P. (2007) Molecular Biology of the Cell (5th edition) Garland Science.
13. Alberts B et al. (2008). Molecular Biology of the Cell. V Edition, Garland publishing Inc.
14. Allison LA. (2007). Fundamental Molecular Biology. Blackwell Publishing.
15. Karp G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
16. Lackie JM. (2013). Dictionary of Molecular Biology. Academic Press.
17. Lodish, B, Matsudaira, K B, Plough, A and Martin ;(2016). Molecular Cell Biology. W.H. Freeman
18. Meyers R.A. – Molecular Biology and Biotechnology; VCH Pub.

19. Pal A.(2011). Textbook of Cell and Molecular Biology 3rd Ed, Books and Allied, Kolkata.
20. Russel PJ. (2010). iGenetics: A Molecular Approach, Pearson Benjamin
21. Strachan T. & A. Read – Human Molecular Genetics; BIOS Scientific
22. Turner, McLennan, Bales & White ;(2005). Instant Notes in Molecular Biology. Taylor Francis
23. Twyman R.M. (2005) – Advanced Molecular Biology; Springer

SEMESTER-V
MAJOR COURSE - 9

Course Name: Adaptation and Evolution of Animals
Course Code: BSCZOOMJ503

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-9**			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 present course 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:

- 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 (MJC-9)

UNIT I: Life's Beginnings, Theories & Evidences of Evolution (16 Lectures)

1. **Origin of life:** Evolution of eukaryotes; Direct and indirect evidences of early life (chemogeny, biogeny, RNA world.
2. **Historical review of evolutionary concept:** Lamarckism, Darwinism, modern synthetic theory, Hardy-Weinberg Equilibrium.
3. **Major evolutionary transitions:** Geological time scale; Mass extinction-types, cause, and its role in evolution; Brief idea on anthropocene and its uniqueness.
4. **Evidences of Evolution** : Fossil and its types, neutral theory of molecular evolution, molecular clock (general idea).

UNIT II: Animal Distribution and Adaptation (20 Lectures)

1. **Biogeography:** Plate tectonic and Continental drift theory, Island Biogeography theory, Zoogeographical realms with special reference to the oriental realm.
2. **Speciation:** Some distinct events in evolution: Species concept, Isolating mechanisms, Modes of speciation, Adaptive radiations with special reference to Darwin's finches; Evolution in horse, Co-evolution (definition with examples).
3. **Adaptation:** Xeric /Desert adaptation (camel); Arboreal adaptation (sloth bear); Aquatic adaptation (Whale), Adaptive significance of colouration and Mimicry in the animal world; Evolution of symbiosis.

UNIT III: Process of Evolution and Evolution of Reproductive System (10 Lectures)

1. **Mechanism of evolution:** Genetic drift (mechanism), founder's effect, bottleneck phenomenon; Selection (Natural & artificial).
2. **Evolution of Reproductive system**: Heterozygous superiority, Cost-benefit of sexual reproduction, Sexual selection, Altruistic behaviour, Hamilton's rule.

UNIT IV: Hominid Evolution and Consequences (14 Lectures)

1. **Origin and evolution of man:** Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*.
2. **Study of Phylogeny:** Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees.
3. **Impact of evolution:** Basic concepts on Evolution of antibiotic Resistance, Virulence, Evolutionary medicine.

PRACTICAL (MJC-9)

1. Study of adaptive radiations in the feet of birds and mouth parts of insects.
2. Understanding embryological evidence of evolution (through charts and videos).
3. Study of types of fossils (through photograph/model/video).
4. Study and Chart preparation (any one):
    a) Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit).
    b) Serial homology in appendages of *Palaemon.*
    c) Adaptive radiation (Darwin Finches/Marsupials)
5. Study and verification of Hardy-Weinberg Law by chi-square analysis
6. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
7. **Group discussion or Seminar presentation** on one or two related topics (Given Below).

Pool of Topics for Group discussion or Seminar presentation :		
1. Origin of life	2. Mass extinction phenomenon	3. Animal connecting links
4. Living fossils	5. Were dinosauers warm blooded?	6. Sexual Selection vs Conflict
7. Mimicry	8. Evolution of major animal lineages	9. Balanced Polymorphism
10. Scope of evo-devo	11.Relevance of Palaentology in current scenario	12. Biochemical & Cytological Evidence of Evolution
13. Neutral theory	14.Parent-offspring conflict	15. Zoogeographical realms
16. Molecular Clock	17.Plate tectonic and Continental drift theory	18. Geological Time scale

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 based on provided chart/slide (Sl no 1 to 4)-Naming-0.5, Characters-1.5 (2x5=**10**) 2. Problem (based on sl no 5-6)-4 **3.** LNB & Chart-**2+2** **4.** 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. Gernart, J. *et al*. (1997) Cells, Embryos and Evolution. Blackwell Science.
5. Kardong K. (2004). An Introduction to Biological Evolution. McGraw Hill.
6. Page RDM, Holmes EC. (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell Sc
7. Rauchfuss H. (2010). Chemical Evolution and the Origin of Life. Springer.
8. Ridley M. (1996). Evolution. 2nd Edn. Blackwell Science.
9. Smith JM. (1998). Evolutionary Genetics. 2nd Edn. Oxford Univ Press.
10. Volpe EP, Rossenbaum PA. (1999). Evolution. McGraw Hill.
11. Darlington PJ. The Geographical Distribution of Animals, R.E. Krieger Pub Co
12. Dobzhansky T, Ayala FJ, Stebbins JL, Valentine JW. 1977. Evolution. Surajeet Pub., N.Delhi
13. Freeman S, Herron JC. 2016. Evolutionary Analysis. Pearson Education Limited, Noida, India.
14. Futuyma DJ. 1997. Evolutionary Biology. SinauerAssociates.
15. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing.
16. Barton, N.H., Briggs, D.E.G., Eisen, J.A., Goldstein, D.B. and Patel, N.H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
17. Hall, B. K. and Hallgrimsson, B. (2008). Strickberger's *Evolution*. IV Edition. Jones and Bartlett Publishers
18. Chattopadhyay, S (2014) LIFE: Evolution, adaptation, ethology, 3rd Ed, Books & Allied

SEMESTER-VI
MAJOR COURSE - 10

Course Name: Biochemistry
Course Code: BSCZOOMJ601

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-10**			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 provides an introduction to the structure of biomolecules with emphasis on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes.

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

- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the structure and function of immunoglobulins.
- Understand the concept of enzyme, its mechanism of action and regulation.
- Understand the process of DNA replication, transcription and translation.
- Learn the preparation of models of peptides and nucleotides.
- Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
- Learn measurement of enzyme activity and its kinetics.
- Learn about the detoxification system of our body.

THEORY (MJC-10)

UNIT I: Principles of Biochemistry (10 Lectures)

1. **Biological Bonds:** Basic concepts on H-bond, Di-sulphide bond, ionic bond, Van der Waals interaction, hydrophilic and hydrophobic bonds, covalent bond.
2. **Buffer systems:** pH, pI and pK, Major buffer systems in our body. Water as biological solvent.

UNIT II: Structural Biochemistry (22 Lectures)

1. **Carbohydrates:** Structure (D- and L-form); Classification - Reducing and non-reducing sugars, monosaccharides, Oligosaccharides (Disaccharides), Polysaccharides (glycogen, peptidoglycans and glycosaminoglycans) and biological importance
2. **Lipids:** Structure; Classification- Triglycerides, Sphingolipids, Cholesterol, and Biological significance; Fatty acids- Types and nomenclature (saturated and unsaturated).
3. **Proteins:** Structure (primary, secondary, tertiary, quaternary structure, Ramachandran plot, motif, domain), classification of proteins (simple, conjugated and derived), biological significance.
4. **Amino acids:** Structure, classification and properties.
5. **Enzymes:** Nomenclature and classification, prosthetic group and co-enzyme, general properties, Kinetics (determination of Km and Vmax using Michaelis-Menten and Lineweaver-Burk plots); Enzyme inhibition.

UNIT III: Metabolic Processes (14 Lectures)

1. **Catabolism of carbohydrates and ATP production:** Glycolysis, Krebs cycle, Functioning of Electron transport system, chemiosmosis, Q-cycle, paul boyer model; Inhibitors and uncouplers of Electron Transport system; Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.
2. **Lipid Metabolism:** β- oxidation of saturated fatty acids with even and odd number of carbon atoms, Ketogenesis.
3. **Catabolism of amino acids:** Transamination, Deamination, Urea cycle.

UNIT IV: Applied Biochemistry (14 Lectures)

1. Diseases related to Carbohydrate metabolism: Diabetes mellitus and Diabetes insipidus -hypoglycemia, hyperglycemia
2. Diseases related to Lipid metabolism: Atherosclerosis- risk factor, fatty liver.
3. Inborn errors of metabolism: Introduction - clinical importance, phenyl ketonuria, albinism.

PRACTICAL (MJC-10)

1. Ninhydrin test for α-amino acids (Paper chromatography).
2. Determination of pK and pI values of glycine.
3. Estimation of protein through Lowry's method (Quantitative).
4. Iodine test for starch.
5. Determination of acid value of oil.
6. Determination of the activity of enzyme (Urease/salivary amylase).
   - 6.1. Effect of [S] and determination of Km and Vmax.
   - 6.2. Effect of temperature.
   - 6.3. Effect of time.
7. **Group discussion or Seminar presentation** on topics given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Chemiosmosis and redox potential and ATP production	2. Essential and non-essential amino acids	3. Structural prediction of DNA by XRD
4. Vital body enzymes	5. Major metabolic pathways-(any one)	6. Carbohydrate and life
7. Metabolic disorders (any one)	8. Oxidative phosphorylation	9. Enzyme kinetics
10. Biological bonds	11. Proteins are the key regulators-Justify	12. Fatty acid oxidation
13.Enzyme kinetics	14. Nucleic acid metabolism	15. Important body lipids
16.Major lipids of importance	17. Major carbohydrate of importance	18. Buffer systems

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.** Experiment A (Sl no 1, 2,3)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) **2.** Experiment B (Sl no 4, 5, 6)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) **3.** LNB -**2** **4.** VIVA-**2**

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. Nelson, D.L. & Cox, M.M. (2017) Lehninger's Principles of Biochemistry (7th Ed) Worth.
2. Berg, J.M.; Tymoczko, J.L. and Stryer, L. (2012) Biochemistry (7th edition) Freeman.
3. Zubay, G. (2017) Biochemistry (4th edition) McGraw-Hill.
4. Conn, E.E.; Stumpf, P.K.; Bruening, G. and Doi, R.H. (2006) Principles of Biochemistry (5th edition) Wiley
5. Chatterjea M.N & Shinde R. (2012) Textbook of Medical biochemistry, 8Ed, Jaypee
6. Satyanarayana U & Chakrapani U. (2020) Biochemistry, 5Ed, Elsevier/Books & allied.
7. Murray R.K. et al., (2012) Harper's illustrated biochemistry, 29Ed, Lange
8. Rao AVVSR (2009) Textbook of Biochemistry, UBS Publishers' Distributors Pvt. Ltd.
9. Voet, D., Voet, J. G. & Pratt C. W. (1999). Fundamentals of Biochemistry. Upgrade edition. John Wiley & Sons.
10. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry. II Edition, BIOS Scientific Publishers Ltd., U.K.

SEMESTER-VI
MAJOR COURSE - 11

Course Name: Human Physiology

Course Code: BSCZOOMJ602

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-11**			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 deals with various physiological functions in mammals. It also gives an account of the metabolic/ biochemical pathways and the probable impact of environment on them.

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

- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Understand the process of vision and hearing.
- Understand the process of muscle contraction.
- Learn the determination of haemoglobin content, blood groups and blood pressure.

THEORY (MJC-11)

UNIT I: Physiology of muscle, respiration and circulation (18 Lectures)

1. **Muscle contraction:** Types, Ultra structure of skeletal muscles, muscle proteins. Properties of skeletalmuscle. Physiology of skeletal muscle contraction. Neuromuscular junction.
2. **Respiration:** Mechanism and regulation of breathing; Gas exchange, Transport of oxygen and carbondioxide; Respiratory quotient; Blood buffers, Hb and O_2 dissociation.
3. **Circulation:** Physiology of human heart- cardiac cycle, cardiac output, Frank-Starling Law of the heart; biochemistry of ABO blood groups, Rh and MN group, Mechanism of blood coagulation (intrinsic and extrinsic pathway).

UNIT II: Physiology of digestion and excretion (12 Lectures)

1. **Digestion:** Glands associated with the digestive system; Digestion and absorption of carbohydrates, proteins, and fats; Gastrointestinal hormones: role in digestion; Concept of BMR.
2. **Excretion:** Nephron; Urine formation in Human; Counter current mechanism; Role of ADH and RAAS in excretion.

UNIT III: Physiology of brain, neural coordination and nervous system (16 Lectures)

1. Organization of nervous system, neuron and glial cells- types and structure.
2. Basic structure of Brain.
3. Ionic basis of resting and action potentials, Nerve impulse and its transmission (myelinated and non-myelinated), Synapse types and synaptic transmission.

4. Diseases related to nervous system (symptoms)-Alzheimer's disease, Parkinson's disease.

UNIT IV: Physiology of endocrine and reproductive system (14 Lectures)

1. **Endocrine glands:** Functions of endocrine glands - pineal, pancreas, adrenal, testes andovary; Regulation of endocrine secretion; Hypothalamus and neuroendocrine control of anterior pituitary; Placental hormones. Disorders related to endocrine dysfunction (Addison's disease Cushing's syndrome, goiter, gigantism).
2. **Reproductive system:** Gestation, parturition, lactation.

PRACTICAL (MJC-11)

1. Preparation of temporary mounts: Blood film, Squamous epithelium, Striated muscle fibres and nerve cells.
2. Counting of white blood corpuscles and red blood corpuscles
3. Preparation of haemin crystals.
4. Estimation of haemoglobin content
5. Determination of blood groups
6. Measurement of blood pressure using sphygmomanometer
7. Recording of simple muscle twitch with electrical stimulation (or Virtual)
8. Demonstration of reflex action.
9. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum,lung, kidney and brain cells.
10. **Group discussion or Seminar presentation** on topics (Given Below):

Pool of Topics for Group discussion or Seminar presentation :		
1. Physiology of Lung	2. CO_2 transport & Chloride shift	3. Oxygen dissociation curve
4. Cardiac cycle	5. Buffer systems in human	6. Gastrointestinal hormone
7. Hemopoiesis	8. Heart valves & its dysfunction	9. Synaptic transmission
10. Countercurrent & RAAS	11. Absorption of biomolecules in gut	12. Neural regulation of digestion
13. Action potential	14. Mechanism of hearing and seeing	15. Muscle physiology

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.** Experiment (Sl no 2-8, any one)-Principle-1, procedure-2, Experiment-2, result -1, (6) **2.** Mounting (sl no 1)- Mounting-2, Drawing-1 & labelling-1 (4) **3.** Identification (Sl no 9)-Naming-0.5 and features-1.5 (2 x 3=6) **4.** LNB-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. Barret, K.; Brooks, H.; Boitano, S. And Barman, S. (2010) Ganong's Review of Medical Physiology (23rd edition) Lange Medical.
2. Guyton, A.C. and Hall, J.E. (2006) A text book of Medical Physiology (11th edition) Saunders.
3. Keele, C.A. & Neil, E. (1989) Samson Wright's Applied Physiology (13th edition) Oxford.
4. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology. XII Edition, John Wiley and Sons, Inc.
5. Chatterjee C.C. (2020) Human physiology: VOL 1 & 2, 13ED, CBS publishers.

SEMESTER-VI
MAJOR COURSE - 12

Course Name: Development Biology of Animals

Course Code: BSCZOOMJ603

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-12**			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 explains the sequence of events starting with a single cell to the production of a very complex organism. The course not only describes how embryos develop (embryology), but also highlights how the processes of development are brought about by changing individual cells into specialized cells with specific functions (the cellular level), and how genes within the genome of the organism drive and guide these changes (the molecular level). It also deals with a comparative account of development in some select groups of animals.

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

- Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
- Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.
- Understand how the field of developmental biology has changed since the beginning of the 19th century with different phases of developmental research predominating at different times.
- Examine the evolutionary history of the taxa based on developmental affinities.
- Understand the relevance of developmental biology in medicine or its role in development of diseases.

THEORY (MJC-12)

UNIT I: Basic concepts in developmental biology (14 Lectures)

1. **Gametogenesis:** Gamete formation; vitellogenesis.
2. **Fertilization:** Merit and demerits of external and internal fertilization; Mechanism of fertilization; Block to polyspermy in sea urchin and Human; elementary idea on parthenogenesis

UNIT II: Early developmental events: (16 Lectures)

1. **Cleavage:** Types of eggs and cleavage. Patterns of cleavage, Role of yolk during cleavage.
2. **Fate map:** Techniques, fate map of early blastula of Frog and chick, Fate of germ layers.
3. **Gastrulation:** Gastrulation in frog and chick.

UNIT III: Embryogenesis and Organogenesis (16 Lectures)

1. Mosaic and regulative development. Direct and indirect development.
2. Concept of organizer and competence.

3. Organogenesis: formation of Eye in Chick.
4. Extra-embryonic membranes in chick.
5. Placenta: types, formation and functions.

UNIT IV: Applied Developmental Biology (14 Lectures)

1. Metamorphosis in frog (hormonal regulation).
2. Regeneration: epimorphosis, morphallaxis and compensatory regeneration.
3. Assisted reproductive technologies: IVF, GIFT, Sperm injection.
4. Developmental biology in understanding of disorders: Prenatal Diagnostic techniques (Amniocentesis, TORCH); Teratogenic agents and their effects on embryonic development.

PRACTICAL (MJC-12)

1. Chart preparation: Comparative study of cleavage patterns in Frog and Chick models; Prepare chart on Fate map of Frog/Chick.
2. Demonstration on morphogenetic movement in Gastrulation of Frog.
3. Study of development of chick embryo through incubated chick eggs at 24, 48, 72 & 96 h.
4. Extra embryonic membranes of chick through permanent slides/photograph.
5. Some videos to develop understanding on the process of development.
6. **Project report** on *Drosophila* culture / chick embryo development / Birth defect (Survey-based).
7. **Group discussion or Seminar presentation** on one or two related topics (Given Below).

Pool of Topics for Group discussion or Seminar presentation :		
1. Fate map	2. Scope of evo-devo	3. Metamorphosis in insect
4. Metamorphosis in frog	5. Latest trends in developmental biology	6. Pleuripotency and its relevance
7. Birth defects	8. Prenatal Diagnostic techniques	9. Regeneration
10. Aging	11.Placenta types and formation	12. Morphogenetic movements
13. Development of Eye	14. Development of Brain	15. Concept of organizer
16. Vitellogenesis	17.Extra embryonic membrane	18. Gametogenesis

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 upsubmission-3+4+3=**10** **3.** Attendance and Participation in class-**5** **4.** Practical skills, laboratory reports, etc-**5**	1. Identification based on provided chart/slide (Sl no 2 to 5)-Naming-0.5, Characters-1.5 (2x6=**10**) **2.** Submission of project report & Chart -4+2=**6** **3.** LNB -**2** **4.** 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. Gerhart, J. *et al*. (1997) Cells, Embryos and Evolution. Blackwell Science.
2. Gilbert, S.F. (2006) Developmental Biology (8th edition). Sinauer.

3. Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press.
23. Campbell, N. and Reece, J. (2014) Biology (10th edition). Benjamin Cummings.
24. Chattopadhyay, S (2018) An introduction to Developmental biology, 1st Ed, Books & Allied
25. UK. Balinsky (2012). Embryology. 5th Ed, Thompson Brooks Cole (India) Pvt. Ltd.
26. Browder, L. W. (1984). Developmental Biology. 2nd Ed., CBS College Publishing.
27. Arumugam, N. (2014) An introduction to embryology (Developmental Zoology), Saras Publication.

28. Rastogi, V.B.; (2012) 1st Ed, Chordate Embryology, Kedar Nath Ram Nath
29. Carlson, B. M. (1999). Patten's Foundations in Embryology. 6th Ed. McGraw Hill.
30. Kalthoff, K., (2001). Analysis of Biological Development. 2nd Ed. McGraw Hill.
31. Moody, S.A. (Ed.) (2007). Principles of Developmental Genetics. Academic Press.
32. Shostak, S. (1991). Embryology - An Introduction to Developmental Biology. Harper Collins.
33. Slack, J. M. W. (2006). Essential Developmental Biology. 2nd Ed. Blackwell Publishing.
34. Twyman, R.W. (2001). Instant notes-Developmental Biology. Viva Books Private Ltd.
35. Verma, P.S. & Agarwal, V.K. (2005). Chordate Embryology. S. Chand & Company Ltd. New Delhi.
36. Das, N (2012) Fundamental concepts of developmental biology, Affiliated East-West Press pvt. Ltd.-new delhi
37. Wilt, F. H. & Hake, S. C. (2004). Principles of Developmental Biology. W. W. Norton Company.
38. Kardong K. (2004). An Introduction to Biological Evolution. McGraw Hill.

SEMESTER-VI
MAJOR COURSE - 13

Course Name: General Entomology

Course Code: BSCZOOMJ604

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-13**			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:

Insect diversity society and evolution introduce students to the various orders and some families of insects which form the basis of entomology. Insect Physiology is the study of the properties, processes and functions of insect systems.

Learning Outcomes:

To enable the students to understand

1. Ranging from basic aspects of arthropod ecology, morphology, anatomy, physiology, systematics andsociobiology, and adaptive features.
2. Basic insect biology, as well as natural history and evolutionary relationships of insect orders.
3. To have a deeper understanding of several aspects of the biology of insects.
4. To understand the physiological processes of insects.
5. Become familiar with the various physiological systems operating in insects. Develop a sense of howphysiology can be infused in major research to pics in entomology.

THEORY (MJC-13)

UNIT I: Insect Diversity and Evolution **(10 Lectures)**

1. General Features of Insects
2. Basis of insect classification up to orders (as per Ruppert Barnes 6th Ed),

UNIT II: Insect anatomy **(18 Lectures)**

1. Basic idea: Comparative study of head-antennae and mouth parts (*w.r.t* feeding habit); thorax – legs (adapted to diverse habitat)
2. Structure of compound eye; formation of mosaic vision.
3. Wings - venation (dipteran).

UNIT III: Insect Physiology **(22 Lectures)**

1. Fundamental idea on Moulting and Metamorphic development and role of neurohormones in these events.
2. Excretory physiology- Malpighian tubules, osmoregulation.
3. Circulation in insects- hemolymph (composition and functions), hemocytes (types and functions).
4. Tracheal system and physiology of gas exchange.
5. Mechanism and importance of bioluminescence (firefly) and sound production (cicadas).

UNIT IV: Insect Ecology **(10 Lectures)**

1. Social organization and social behavior in termites
2. Basic idea on insect-plant interaction

PRACTICAL (MJC-13)

1. Study of different kinds of mouth parts of insects
2. Study of insect wings and their venation.
3. Study of any three beneficial insects and their products
4. Morphological studies of various castes of *Apis*, *Camponotus* and *Odontotermes*
5. Methodology of collection, preservation and identification of insects
6. Study of any three insect pests and their damages
7. **Mounting: (a)** Mouthparts of mosquito/cockroach (**b**) sting apparatus and pollen basket of honey bee
8. **Dissection:** Expose Nervous system of the cockroach
9. **Insect album** preparation: 5 insects of different habitat belongs to different order.
10. **Field study** of insects and submission of a project report on the insect diversity
11. **Group discussion or Seminar presentation** on one or two related topics (Given Below).

Pool of Topics for Group discussion or Seminar presentation :		
1. Success of Insects onthe Earth	2. Origin and evolution of insects.	3. Formation and modification of cuticle
4. Insect wing	5. Insect Locomotion	6. Bioluminance of insect
7. Insect flight	8. Sensory receptors	9. Sound production of Insect
10.Social Insect (any one)	11. Insect Hormone	12. Insect metamorphosis

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)- Sc. Name-0.5, Characters-1, Habit & habitat-0.5, (2x3=**6**) **2.** Dissection/mounting- Exposing and display/mounting-3, Drawing-2, Labelling-1. (**6**) **3.** Project report and Insect album- **2+2 (4)** **4.** LNB -**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.*

SUGGESTED READINGS:

1. A general text book of entomology, Imms , A. D., Chapman & Hall, UK
2. The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
3. Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
4. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders, USA
5. The Insect Societies, Wilson, E. O., Harward Univ. Press, UK
6. Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA
7. Physiological system in Insects, Klowden, M. J., Academic Press, USA
8. The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK
9. Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

SEMESTER-VII
MAJOR COURSE - 14

Course Name: Genetic Engineering and Biotechnology
Course Code: BSCZOOMJ701

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-14**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :
This course gives an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way. It envisages concepts, mechanisms, biological designs, functions and evolutionary significance of genetic modification or manipulation in special organisms and also discusses the recent advance in recombinant DNA technology.

Learning outcomes
Upon successful completion of this course, students should be able to:
- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- 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 andapplied.
- Develop future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

THEORY (MJC-14)

UNIT I: Introduction to genetic engineering (15 Lectures)

1. Enzymes as Tools for Genetic Engineering (basic idea): Restriction Enzymes, T4 and *E. coli* DNA Polymerase (Klenow), DNA- methylase, Taq DNA polymerase, Reverse Transcriptase.
2. Vehicles for DNA cloning: Features and classification of Plasmid DNA vectors; Structural features of pSC101, pBR322, pUC8, Shuttle vector-pEB10, Cosmid vector, bacteriophage vectors (Phagemid, M13), YAC, Ti Plasmid, SV40, Expression vector.

UNIT II: Recombination and cloning (15 Lectures)

1. Basic idea on DNA (Gene) cloning, recombinant DNA technology.
2. Basic idea on cDNA library and genomic library
3. Isolation of gene from gene library. Expression of recombinant protein from a DNA clone in bacteria and purification of the protein, screening and identification of recombinant DNA clone from gene library.
4. Application of recombinant proteins (Insulin, Streptokinase, antibodies,vaccines).

UNIT III: Recent advances in gene technology (18 Lectures)

1. Transgenic animals: Principle, application, and ethical issues.
2. Mechanism of gene technology: Restriction enzyme-mediated digestion, ligation, cloning, transformation, Screening of Transformed cells: Blue-White screening, Replica plating.

3. Fundamental idea on Recent trends in Gene technology: Gene Targeting: Knock-ins and Knock-outs.Targeted Genome Editing: CRISPRs; RNAi technology.

UNIT IV: Genomic studies; ethical issues in genetic engineering (12 Lectures)

1. DNA Sequencing (Sanger method)
2. Overview of Human Genome Project
3. Applications of Genetic Engineering and Biotechnology in agriculture, medicine and its economicand social implications, Ethical precautions.

PRACTICAL (MJC-14)

1. **Video-graphic demonstrations** on the following topics- Microinjection, selection of recombinant clone, preparation of cDNA library, Knock-out method, CRISPR, RNAi, transgenic animal (zebra fish).
2. Chart presentation of Restriction enzyme digestion.
3. Separation of molecules (protein/DNA) using electrophoresis (demonstration).
4. Construction of circular and linear restriction map from the data provided.
5. Identification of vectors pSC101, pBR322, pUC8, Shuttle vector-pEB10, Cosmid vector, bacteriophage vectors (Phagemid, M13), YAC, Ti Plasmid, SV40 by model/photograph.
6. **Group discussion / Seminar presentation** on a related topic given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Growth hormone	2. Antibiotics from micro-organisms.	3. Streptokinase
4. Recombinant interferon	5. Microbial degradation of waste materials.	6. Insulin
7. Colony stimulating factors	8. Transgenic tomato & rice	9. Industrial enzymes
10. Expression vector	11. Knock-out mouse	12. cDNA Library
13. Genome Sequencing	14. Genetic engineering and Ethics	15. Replica plating

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 upsubmission-3+4+3=**10** 3.Attendance and Participation in class-**5** 4.Practical skills, laboratory reports, etc-**5**	1.Experiment (Sl no 3 & 4)-Principle-2, procedure-2, Experiment/construction/calculation-4, result and inference-2, (**10**) 2.Identification (Sl no 5)- Sc. Name-0.5, Character-1, importance-0.5 (2x3=**6**) 3.LNB -**2** 4.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. Primrose, S.B. and Twyman, R. (2014) Principles of Gene manipulation and Genomics (7th edition) Wiley-Blackwell.
2. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
3. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.
4. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007) Recombinant DNA:Genes and Genomes- A ShortCourse. III Edition, Freeman and Co.
5. Brown, T.A. (2010) Gene Cloning and DNA Analysis: An Introduction.6th Ed, Wiley-Blackwell.
6. A PBS Documentary entitled, "Playing God" [History of Genetic Engineering].
7. Das, H.K.; (2020) Genetic Engineering: Replication, Expression, Cloning, Manipulation, Wiley India.

8. Singh, B.D.; (2015) Biotechnology: Expanding Horizons, 4th Ed, Kalyani Publishers.
9. Kumaresan V. (2014) Biotechnology –Saras publications
10. Balasubramaniam. D. C.F. A. Bryce, Dharmalingam. K. J. Green, Kunthala Jayaraman (2005) Concepts in Biotechnology,University Press (India) Pvt. Ltd.
11. Biotechnology Class XI & XII, (2019) NCERT Publication
12. Ignacimuthu, S. (1995), Basic Biotechnology, Tata McGraw Hill Publishing Company Ltd, New Delhi.
13. Howe, C., (2015) Gene Cloning and Manipulation; Cambridge University Press
14. Satyanarayana, U. and Chakrapani, U.; (2020) Biotechnology, Books & Allied Ltd
15. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology - Principles and Applications of RecombinantDNA. IV Edition, ASM press.
16. Clark, D. P. and Pazdernik, N.J. (2012) Biotechnology; Academic Press.

SEMESTER-VII
MAJOR COURSE - 15

Course Name: Parasitology and Vector Biology
Course Code: BSCZOOMJ702

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-15**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course:
The course provides an insight into the types of insect pests and vectors and the factors driving their spread. It also enlightens about the methodsused to bring down their population below the threshold for a better management.

Learning outcomes:
Upon successful completion of this course, students should be able to:
- Identify the types of pathogenic diseases, particularly the most common ones.
- Know the control methods of vector and vector-borne disease.
- Understand the mode of action of nematicides and the consequences of their use.
- Understand the effective way of vector management strategy.
- Understand the Govt policies and their relevance.

THEORY (MJC-15)

UNIT I: Parasitology: an overview (15 Lectures)

1 . Definition and types (if any) of parasite, parasitoid, vectors, and host.
2 . Concept of zoonotic diseases.
3. Parasitic adaptations in helminths.
4. Modes of disease transmission: vertical and horizontal transmission, biological, mechanical and contact transmission cycle.

UNIT II: Common parasitic infections (15 Lectures)

1. Protozoan diseases of medical importance: amoebiasis, malaria, leishmaniasis (Life cycle, pathogenesis, prophylaxis and Treatment).
2. Helminthic diseases of medical importance: taeniasis, ascariasis, and filariasis (Lifecycle, pathogenesis, prophylaxis and Treatment).
3. Vector-mediated Viral Diseases of medical importance: Dengue, Chikungunya (Biology, pathogenesis, prophylaxis, and Treatment).
4. Rickettsia disease: Typhus (Biology, pathogenesis, prophylaxis and Treatment).

UNIT III: Biology and Ecology of Vectors (15 Lectures)

1. Life cycle, importance and distribution of important vector species of Mosquito-*Anopheles (An. stephensi), Aedes (Ae. aegypti), Culex (Cx. quinquefasciatus),* Sand flies*(Phlebotomus sp),* Tsetse flies.

2. Biology: life cycle and distribution of Bed bugs and Head louse.
3. Salient features of tick and mites.

UNIT IV: Ecology, management and policies to control vector (15 Lectures)

1. Concept and definition of Integrated Vector Management (IVM), merits, and limitations.
2. Impact of insecticide resistance on the control of vectors.

PRACTICAL (MJC-15)

1. Preparation of temporary and permanent slides of fecal matter (cockroach/Ungulate) by saline preparation and concentration techniques to identify cysts of parasitic protozoans and helminth eggs.
2. Study of *Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale, Leishmania donovani* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
3. Identification through permanent slides of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes,* Fleas, Sandflies, Ticks and mites.
4. Conduct a field survey and prepare a **report** based on the occurrence, awareness, control, etc., of any pathogenic disease or vector of medical importance in your syllabus.
   OR, Alternatively, a **visit** can be made to any hospital/any institute of repute conducting diseases/vector-related research or provide treatment; and submit a **report**.
5. Group discussion / Seminar presentation on a related topic given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Any vector of your syllabus	2. Any disease of your syllabus	3. Zoonosis
4. Govt policies against contagious diseases	5. Govt policies against epidemic diseases	6. Govt policies against sporadic diseases
7. Evolution of Disease	8. Integrated Vector Management	9. Insecticide resistance
10. Vector-borne disease in India	11. Govt policies against vectors	12. Parasitic adaptation
13. Success stories of disease control in India	14. Role of parasite in evolution	15. Host-Pathogen interaction

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 upsubmission-3+4+3=**10** 3. Attendance and Participation in class-**5** 4. Practical skills, laboratory reports, etc-**5**	1. Mounting (Sl no 1)- Preparation-2, Drawing-1, Labelling-1.(**4**) 2. Identification (Sl no 2 and 3)- Sc. Name-0.5, Character-1,medical importance-0.5 (2x4=**8**) 3. Report-**4** 4. LNB -**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. Van Emden, H.F. and M.W. Service. (2004) Pest and Vector Control. Cambridge University Press.
2. Cameron, M. & Lorenz, L. (2013) Biological and Environmental Control of Disease Vectors. CABI, UK
3. Chaterjee, K.D. (1981) Parasitology : Protozoology and Helminththology : Introduction to Clinical Medicine.(12th .Edition) Chaterjee Medical Publishers
4. Mullen, G. and Durden L. (2009). Medical and veterinary entomology, Academic press, London.
5. Kochchar, S.K. (2009). A Text Book of Parasitology. Wisdom Press
6. Paniker CKJ, Ghosh S; (2013). Paniker's Text Book of Medical Parasitology. Jaypee
7. Chatterjee, K.D (2015) Parasitology (13th edition). CBS Publishers
8. Arora D R, Arora B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors
9. Bose M. (2017). Parasitoses and zoonoses. New Central Book Agency.
10. Bogitsch B J, Carter CE, Oeltmann TN. 2013. Human Parasitology. 4th Edn. Elsevier.
11. Jawetz, M. and Adelberg (2015) Medical Microbiology (27th edition).
12. Ahmed N, Dawson M, Smith C, Wood Ed. (2007). Biology of Disease. Taylor and Francis Group.
13. Chakraborty P. (2016).. Textbook of Medical parasitology, 3rd edition. New Central Book Agency.
14. Dailey MD. (1996). Meyer, Olsen & Schmidt's Essentials of Parasitology. W.C. Brown Publishers
15. John DT, Petri WA. 2006. Markell and Voge's Medical Parasitology. Elsevier.
16. Marr JJ, Nilsen TW, Komuniecki RW. 2003. Molecular Medical Parasiology. 2nd Edn. Academic Press.
17. Muller R, Wakelin D. 2002. Worms and Human Disease. CAB International Publication.
18. Noble ER, Noble GA. (1982). Parasitology: The biology of animal parasites. Lea & Febiger
19. Parija SC. (2013). Textbook of medical parasitology, protozoology & helminthology II Edition, All India Publishers and Distributers, Medical Books Publishers, Chennai, Delhi.
20. Baveja V. & Baveja C.P.; (2021) Parasitology, 5th Ed, Arya Publishing Company.

SEMESTER-VII
MAJOR COURSE - 16

Course Name: Microbiology and Immunology
Course Code: BSCZOOMJ703

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-16**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :
This is a composite course with remarkable utility and importance. Microbiology being the study of microorganisms such as viruses, bacteria etc., covers theoretical studies and practical proficiency training which may help in their placement at a clinical microbiological laboratory. Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free-living species, and the role of parasites in global, public, health. Immunology part provides the students with the fundamental knowledge of the immune system and its protective roles against diseases.

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

- Carry out common procedures for culturing, purifying and diagnostics of micro-organisms understand the disease-causing potential of bacteria and viruses, and the responses of the immune system.
- Summarise and orally present current microbiological problem areas.
- Describe the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organisms.
- Assess the importance of incidence, prevalence and epidemiology in microbiological diagnostic activities.Know how resistance development and resistance transfer occur.
- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.
- Understand how does the immune system distinguish self from non-self.
- Gain experience at reading and evaluating the scientific literature in the area.

THEORY (MJC-16)

UNIT-I: Microbiology: General Idea (12 Lectures)

1. Brief history of microbiology- germ theory of disease, discovery of penicillin.
2. Host pathogen interaction: invasion, antigenic heterogeneity, toxins and enzyme secretions.
3. Kinetics of bacterial growth.

UNIT-II: Common pathogenic Diseases (18 Lectures)

1. **Viral diseases:** rabies, hepatitis, influenza, COVID-19, chicken pox with emphasis on their causative agents, pathogenesis, diagnosis, and prophylaxis.
2. **Bacterial diseases** caused by *Streptococcus pneumoniae, Helicobacter pylori, Mycobacterium tuberculosis, Vibrio cholerae* with emphasis on pathogenesis, diagnosis, prophylaxis and chemotherapy.
3. **Fungal diseases:** Ringworm infection and candidiasis with emphasis on pathogenesis, diagnosis, and prophylaxis.

UNIT-III: Immunology: Immune mechanism and related pathways. (15 Lectures)

1. Cells and organs of the immune system- primary and secondary lymphoid organs.
2. Innate immunity: First and second lines of defense.
3. Acquired immunity: Humoral and cell-mediated immune response
4. Characteristics of antigen- antigenicity and immunogenicity, epitopes, haptens, adjuvant; Factors influencing immunogenicity; Antigenic determinants.
5. Structure of immunoglobulin.
6. Classification, properties, and functions of immunoglobulins.
7. Antigen and antibody interactions: agglutination, precipitation, affinity, avidity. Complement system (Classical, alternative, and lectin pathways).

UNIT-IV: Applied Immunology (15 Lectures)

1. MHC complex and molecules with classification and function. Graft rejection.
2. Antigen processing and their presentation.
3. Vaccine (types)
4. Hypersensitivity: Types with mechanisms and examples.
5. Autoimmune disorders (with reference to Pernicious anemia, Rheumatoid arthritis, Myasthenia gravis). Hybridoma technology, monoclonal antibodies and their applications.

PRACTICAL (MJC-16)

1. Pathological study (chart/photograph): sputum, blood, urine and stool.
2. Blood: Erythrocyte Sedimentation Rate (ESR), Haematocrit value.
3. Staining and identification of Gram-positive and Gram-negative bacteria.
4. Demonstration of antigen-antibody interaction in gel by the Ouchterlony method.
5. Separation of γ-globulin by salt precipitation (Demonstration only).
6. Group discussion / Seminar presentation on a related topics given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Autoimmune diseases	2. Hybridoma technology and its applications	3. Helminth infections in humans
4. Concept of Immunity	5. Immunological memory & Vaccination	6. Fungal infections in human
7. Zoonotic diseases	8. Host-parasite interaction	9. Common bacterial diseases
10. Hypersensitivity	11. Antigen-antibody interaction	12. Diseases caused by viruses

Format for conducting CA and ESE practical examination:

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (classtest)-**10** **2.** PPT/Poster preparation, presentation and writeup submission-3+4+3=**10** **3.** Attendance and Participation in class-**5** **4.** Practical skills, laboratory reports, etc-**5**	1. Identification (Sl no 1, 2, 5)- Sc. Name-0.5, Character-1, Pathologicalimportance-0.5 (2x4=**8**) 2. Experiment/slide preparation (Sl no 2 to 5)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) **3.** LNB -**2** **4.** Viva-**2**

NOTE :

- *Study includes identification, systematic position (major taxon), identifying character, pathological significance.*
- *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. Kanungu R., (2020) Ananthanarayan and Paniker's Textbook of Microbiology, 11th Ed, Universities Press (India) Pvt. Ltd.
2. Baveja C.P.; (2018) A textbook of Microbiology,6th Ed, Arya Publishing Company
3. Baker S., et al (2012) BIOS Instant Notes in Microbiology, 4th Ed, Taylor & Francis
4. Madigan M.T.; *et. al.* (2017) Brock Biology of Microorganisms, 4th Ed, Pearson Education
5. Prakash, G.; (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co Ltd.
6. Gunn A, Pitt SJ. (2012). Parasitology: an Integrated Approach. Wiley Blackwell.
7. Roitt, I.; Brostoff, J. and Male, D. (2012) Immunology (8th edition).Elsevier
8. Abbas K A, Lechtman H Andrew. (2003). Cellular and Molecular Immunology. Saunders Publication.
9. Abbas KA, Andrew, LH. (2011). Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier
10. Delves PJ, Martin SJ, Burton DR, Roitt I M. (2010). Roitt's Essential Immunology.11th Ed, Blackwell Pub.
11. Kindt TJ, Goldsby RA, Osborne BA, Kuby J (2006). Immunology, W.H. Freeman and Company.
12. Mohanty SK , Leela KS. (2014). Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi
13. Parija SC. (2012). Text book of Microbiology and Immunology. Elsevier.
14. Playfair, JHL, Chain BM (2001). Immunology at a glance. 7 th Edn. Blackwell Pub.
15. Shetty N. (2005). Immunology: Introductory Textbook, New Age International Pub.
16. Fatima D and Arumugam N, (2014)Immunology, Saras publication
17. Ramesh S.R. (2017)Immunology; 1st Ed, McGraw Hill Education India Private Limited
18. Khanna R.,(2011)Immunology; 1st Ed, Oxford University Press
19. Virella G. 2007. Medical Immunology, Informa Healthcare.
20. Chakraborty A.K., (2006) Immunology and Immunotechnology, 1st Ed, Oxford University Press
21. Annadurai B., (2010) A textbook of Immunology and Immunotechnology, 1st Ed, S.Chand Pub.
22. Ghosh S., (2017) Immunology and Immunotechnology, 1st Ed, Books & Allied.
23. Paul A., (2015) Textbook of Immunology : including Immunotechnology & Immunotherapy, 1st Ed, Books & Allied.
24. Pelczar: (1993) Microbiology, Tata McGraw Hill,
25. Dubey and Maheshwari; (2018) An Introduction to Microbiology,4th Ed; S Chand Publications, New Delhi

SEMESTER-VII
MAJOR COURSE - 17

Course Name: Bioinformatics, Biostatistics and Research Methodology

Course Code: BSCZOOMJ704

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-17**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :

The course is aimed at introducing the application of bioinformatics and statistics in biology. The course gives an insight into the key concepts and methods used in bioinformatics; and computer storage, retrieval, analysis, visualization and distribution of information data related to biological macromolecules like DNA, RNA and proteins. It provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. As an interdisciplinary field it integrates biology, computer science, chemistry and statistics together sequence analysis structure analysis and functional analysis of biological data.

Learning outcomes

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

- Know the theory behind fundamental bioinformatics analysis methods/tool.
- Be familiar with widely used bioinformatics databases.
- Know basic concepts of probability and statistics.
- Describe statistical methods and probability distributions relevant for molecular biology data.
- Know the applications and limitations of different bioinformatics and statistical methods.
- Perform and interpret bioinformatics and statistical analyses with real molecular biology data.
- Acquire knowledge of various databases of proteins, nucleic acids. Primary, secondary and composite databases. BLAST, FASTA,DOT PLOT
- Make phylogenetic predictions or prediction of structure of proteins and nucleic acids
- Develop understanding in Primer designing
- Understand data mining tool and its practical application in a case study
- Apply the knowledge in future course of their career development in higher education and research.
- Understand the concept of research and different types of research in the context of biology
- Have basic awareness of data analysis-and hypothesis testing procedures
- Have basic knowledge on qualitative research techniques
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research

  Evaluate the different methods of scientific writing and reporting.

THEORY (MJC-17)

UNIT I: Fundamentals of Bioinformatics (15 Lectures)

1. Concept of digital laboratory.
2. Introduction to data archiving systems (FASTA format, Accession, and GI Number)
3. Basic features and management systems of the followings: NCBI, PDB, RASMOL, Biodiversity and ecosystem-based databases.
4. Introduction to sequence retrieval system (SRS) and protein identification resource (PIR).
5. Introduction to molecular sequence analysis software packages and tools, Sequence alignments

(BLAST and Clustal W) and phylogenetic trees (Clustal W).

6. Applications of bioinformatics: Clinical informatics (Data compilation and interpretation for community and new resource of pathogen), Cheminformatic resources (Structure and interaction with, several different kinds of molecules) and pharmacoinformatic (Drug and vaccine designing).

UNIT II: Data collection, distribution, presentation, and authentication (15 Lectures)

1. Basic concept on collection and classification of data.
2. Brief idea on graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon.
3. Brief idea on Cumulative frequency curve (Ogive), Box plot.
4. Probability theory: Binomial distribution, Poisson distributions.
5. Measures of central tendency: Arithmetic Mean, Median, Mode.
6. Brief idea on measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient ofvariation.

UNIT III: Data analysis. (15 Lectures)

1. Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data.
2. Regression: Linear regression, regression coefficient.
3. Analysis of variance (ANOVA): One way.
4. Hypothesis testing: Parametric tests (Paired and unpaired t-test,) & Non-Parametric tests (Chi-square test).

UNIT IV: Basics of Research methodology & Ethics (15 Lectures)

1. Brief idea: Definition and types of research (Descriptive *vs* analytical; applied *vs* fundamental; quantitative *vs* qualitative; conceptual *vs* empirical). Research methods *vs* methodology. Field research; laboratory research.
2. Data Collection, Sampling Methods, Data Processing and Analysis
3. Brief idea on Ethical Issues, Intellectual Property Rights, Copyright

PRACTICAL (MJC-17)

1. Calculation of mean, standard deviation and standard error.
2. Calculation of correlation coefficient values and finding out the probability.
3. Student'st-test: Independent and dependent. Hand calculation and calculation using MS Excel.
4. Prepare histogram/chart using MS Excel.
5. ANOVA: Hand calculation and calculation using MS Excel.
6. Handling, Sequence retrieval and interpretation of Nucleic acid and protein from respective databases.
7. Pair-wise alignment of sequences (BLAST) and interpretation of the output.
8. Construction of phylogenetic tree (using Clustal W).
9. Comparative analysis of different databases in Genomics and Proteomics.
10. Group discussion or Seminar presentation on the following topic :

Pool of Topics for Group discussion or Seminar presentation :		
1. DNA barcoding	2. Application of metabolomics databases	3. Basics of informaion technology
4. Student -t test & utility	5. Graphical representation of biological results	6. Sequences alignment (BLAST)
7. Database management	8. Use of bioinformatics in biological research	9. MS-Excel and Histogram

10. Central Tendency	11. Information technology in data acquisitionand retrieval	12. Bioprospecting and Biopiracy
13. Drug designing	14. Statistical methods of hypothesis testing	15. Phylogenetic tree (ClustalW)

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 upsubmission-3+4+3=**10** **3.** Attendance and Participation in class-**5** **4.** Practical skills, laboratory reports, etc-**5**	1. Experiment A (Sl no 1-5)- Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) 2. Experiment B (Sl no 6-9)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) **3.** LNB -**2** **4.** Viva-**2**

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. Daniel, W.W. & Cross C.L.; (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10th edition) John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4. Rastogi, V.B., (2015) Fundamentals of biostatistics. 3rd Ed, Medtech.
5. Arora P.N & Malhan, P.K.; (2016) Biostatistics, Himalaya Publishing House
6. Antonisamy B., et. al. (2017) Principles and Practice of Biostatistics, Elsevier India
7. Pezzullo, J., (2013) Biostatistics For Dummies, 1st Ed, For Dummies Pub. (Wiley)
8. Motulsky, H., (1996) Intuitive Biostatistics, 1st Ed, OUP USA
9. Motulsky, H., (2017) Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 4th Ed, OUP USA
10. Barnes, M.R. and Gray, I.C. (2003) Bioinformatics for geneticists, Wiley.
11. Ghosh, J. and Mallick B.; (2008) Bioinformatics: Principles and Applications, OUP India
12. Rastogi, S.C. et. al.; (2013) Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, 4thEd, PHI Ltd.
13. Bosu, A. & Thukral, S.K.; (2007) Bioinformatics: Experiments, Tools, Databases, and Algorithms, 1st Ed, OxfordUniv. Press.
14. Mount, D.W. (2006) Bioinformatics (2nd edition) CBS

SEMESTER-VIII
MAJOR COURSE - 18

Course Name: Toxicology and Environmental Management

Course Code: BSCZOOMJ801

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-18**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course

This course is focused on theoretical and applied knowledge on the effects of chemical substances on human health. The students will also get introduced to the toxicological analysis and the signs and symptoms of important toxic syndromes. The students will also study the basic toxicokinetic principles and metabolic systemsto elucidate mechanisms of toxicity induced by xenobiotic compounds.

Learning outcomes

1. After completing this course the students will be able to
2. Learn basic principles of signaling pathways and mechanisms of cell death
3. understand gene-environment interactions
4. Examine the application how xenobiotics disrupt normal cellular processes of genomics, proteomics, andmetabolomics data
5. Understand mechanisms of systemic and organ toxicity induced by xenobiotics; and
6. Learn how to analyze and interpret complex data sets in toxicological research and deliver a scientificpresentation.
7. Use clinical and laboratory findings in the treatment of acute toxic exposures.

THEORY (MJC-18)

Unit I: Basic Concept of Toxicology (14 Lectures)

1. Definition of toxicology, venom, poison, toxicity.
2. Toxin types (definition with examples): natural toxins, animal toxins, plant toxins, Fungal toxin, food toxins, genetic poisons andchemical toxins.
3. Basic concept of Ecotoxicology, Clinical toxicology, and Nanotoxicology, Forensictoxicology, Cosmetic toxicology, and Wildlife toxicology.
4. Preventive toxicology- Bioremediation, Toxic site reclamation.

Unit II: Toxicants (16 Lectures)

1. **Xenobiotics:** Important of xenobiotics in Human health, Biological Magnification and Biotransformation - brief introduction to Phase-I and Phase-II reactions;
2. **Pesticides:** Classification and Toxicological Effects
3. **Heavy Metal Toxicity:** General idea of metal toxicity, sources, toxic metals, metalloids and their toxicity: Arsenic, Aluminium, Lead.
4. **Naturally occurring toxins** in foodstuffs.

Unit III: Evaluation of toxicity (12 Lectures)

1. Concept of risk assessment: Risk management of industrial chemicals, Acute, sub-Acute and chronic assays LD_{50}, LC_{50}, NOEL, NOAEL, LOEAL.
2. Dose-effect and dose-response relationship- acute and chronic toxicity, reversible & irreversible effects.
3. Concept of Systemic toxicity (organ toxicity)-Absorption, distribution, metabolism and elimination.
4. Concept of EIA.

Unit IV: Case study, Policy, legislation, and Environmental Management (18 Lectures)

1. **Case studies:** BHC poisoning in Turkey, Arsenic (Arsenicosis in Bengal), Cadmium (Itai-Itai disaster), Mercury (Minamata disaster).
2. **Radioactive pollution-** Sources of exposure to radiation, Biological effects of radiation, Famous accident of radioactive pollution: Chernobyl disaster
3. **Water pollution** (Cause, impact, mitigation policy)- Pollution of river Ganga, marine pollution (oil spill and plastic).
4. **Occupational diseases-** Pneumoconiosis, silicosis, asbestosis, Farmers' lung.
5. **Policy and Legislation:** Introduction to Regulatory institutions- EPA, CPCB, WHO, UNEP.

PRACTICAL (MJC-18)

1. Study of Bioassay techniques- use of *Daphnia*, Zebrafish, mouse, and fruit fly in toxicological studies.
2. Determination of LC_{50} and LD_{50} using mosquito larvae/chironomid larvae/fish/fruit fly.
3. Determination of cellular toxicity *w.r.t* glutathione peroxidase and catalase.
4. Cell viability test: MTT assay, trypan blue exclusion test.
5. **Submit a project report on a field survey** based on any relevant case study / heavy metal pollution / disease / pollution survey.
6. **Group discussion or Seminar presentation** on topics (Given Below):

Pool of Topics for Group discussion or Seminar presentation:		
1. Clinical toxicology	2. Aluminum toxicity a 21st gen. toxicity	3. EIA
4. LD50 & LC50	5. Arsenicosis in Bengal	6. Fluorosis in India
7. Xenobiotics	8. Biotransformation of xenobiotics	9. Forensic toxicology
10.Chernobyl disaster	11.Scope and career of toxicology	12.Occupational diseases

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 writeup submission-3+4+3=**10** 3. Attendance and Participation in class-**5** 4. Practical skills, laboratory reports, etc-**5**	1.Experiment (Sl no 1-4, any one)-Principle-2, procedure-3,Experiment-5, result and inference-2, (12) 2.Project report-4 3.LNB-2 4.VIVA-2
NOTE : • *Identification of behaviour/nest/ethogram could be done by using card printed with photograph/drawing/data.* • *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.*	

Recommended readings

1. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and IndustrialApplications, John Wiley & Sons, Inc.
2. Klaassen, C. (2007) Casarett and Doull's Toxicology The basic science of poisons – McGraw-Hill.
3. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publishing.
4. Ernest Hodgson (2010) A Textbook of Modern Toxicology, 4th Ed. John Wiley & Sons, Inc.
5. Regulatory Toxicology by Renuka Sengupta, Narosa Publishing House, Delhi
6. Toxicology by Hans Marquardt *et. al.* Academic Press.
7. Santra, S. C. (2010). Environmental science; NCBA

SEMESTER-VIII
MAJOR COURSE - 19

Course Name: Animal Behaviour and Chronobiology

Course Code: BSCZOOMJ802

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-19**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :

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 interactionsthat shape it.

Learning outcomes :

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

- 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.

THEORY (MJC-19)

UNIT I: Introduction and patterns of Behaviour (15 Lectures)

1. Proximate and ultimate causes of behavior.
2. Patterns of behaviour: Stereotype (Spatial orientation, Reflexes, Instinct); Learning (Associative, Non-associative, Latent, Insight, Imprinting).
3. Innate/ Instinct behaviour vs. Learnt Behaviour.
4. Elementary idea on contribution of Kal Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen

UNIT II: Innate behaviour; Evolution of reproductive behavior (15 Lectures)

1. Innate behaviour: Communication (primates and ants). Ritualization.
2. Sensorimotor integration: electric organ in electric fish, bird song.
3. Kinds of behaviour: Foraging behaviour-Honey bee, Nesting behaviour-Bird, Schooling behaviour-Fish

Unit III: Reproductive behaviour and socio-biology (15 Lectures)

1. Reproductive behaviour: Mate selection; Parental care (Fish), mating systems; sexual dimorphism.
2. Sociobiology: Social organization (e.g., Honey bee and Naked Mole Rat). Elements of Socio-biology: Selfishness,cooperation, altruism, kinship, and inclusive fitness.

UNIT IV: Genetic, Neural, and Hormonal regulation of behavior (15 Lectures)

1. Genetic basis of behaviour.
2. Neural Regulation of behaviour: kineses and taxes.
3. Hormonal control in Biological clocks: Melatonin.
4. Advantages of biological rhythms; Concept of Circadian and circannual rhythms; Photoperiodism, tidal, solar and lunar rhythms, Jet-lag, entrainments.

PRACTICAL (MJC-19)

1. Study of the Orientation of an Insect to Light.
2. To study the behavioural responses of wood lice to dry and humid conditions.
3. To study **geotaxis behaviour** in earthworm.
4. To study the **phototaxis behaviour** in insect larvae.
5. **Constructing an ethogram** (Documentation and drawing by studying the following Canine's behaviour -movement, feeding, caring of child, foraging, vigilance, vocalization, afraid, anxious/nervous, mating, aggressive, alert, playful, submissive).
6. **Study of Chemical communication** in ants (Ancestral, perception, communication, etc).
7. **Study of Nests and nesting habits of the birds** [Tailor bird (cup nest), Weaver bird (hanging/Pendant nest), Bustard/ostrich (Scrape nest), Kingfisher (Burrow nest), Bower bird (round nest), Parrot/owl (cavity nest), crow/osprey (flat/platform nest)] and social insects [Honey bee, Wasp, Termite].
8. **Study of circadian functions in humans** (daily eating, sleep and temperature patterns).
9. **Study of courtship behaviour** in birds and insects from short videos/films.
10. **Excursion: Field Visit** to Forest/Wildlife Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
11. **Group discussion or Seminar presentation** on topics (Given Below):

Pool of Topics for Group discussion or Seminar presentation :		
1. Parental care in animals	2. Instinctive behaviour invertebrates	3. Ethogram and its application
4. Learning in birds	5. Application of animal behaviour studies	6. Bee dance and Foraging
7. Circadian rhythm	8. Social behaviour in primates	9. Biological clock
10. Behaviour in captivity	11. altruism, kinship and inclusive fitness	12. Neural regulation of behaviour
13. Chronobiology	14. Mate selection and courtship behaviour.	15. Genetic basis of behaviour

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 upsubmission-3+4+3=**10** 3. Attendance and Participation in class-**5** 4. Excursion and field report - **5**	1. Experiment (Sl no 1-4, any one)-Principle-1, procedure-2, Experiment-3, result and inference-2, (8) 2. Identification of behaviour (Sl no 5, 6, 8,10; one from each)-Naming-0.5 and features-1 (1.5 x 4=6) 3. LNB & Field report- 2+2 4. VIVA-2

NOTE :

- *Identification of behaviour/nest/ethogram could be done by using card printed with photograph/drawing/data.*
- *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. McFarland, D. (1999) Animal Behaviour (3rd edition) Pitman Publishing Limited,London, UK.
2. Manning, A. and Dawkins, M. S. (2012) An Introduction to Animal Behaviour (6th edition) Cambridge, University Press, UK
3. Alcock, J. (2005) Animal Behaviour (8th edition) Sinauer Associate Inc., USA.
4. Sherman, P. W. and Alcock, J. (2013) Exploring Animal Behaviour (6th edition) Sinauer Associate Inc., assachusetts, USA.
5. Dunlap, J. C.; Loros, J.J. and DeCoursey, P. J. (2009) Chronobiology Biological Timekeeping (1st edition) Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
6. Danchin, E., Giraldeau, L. A., & Cezilly, F. (2008). Behavioural Ecology: An Evolutionary Perspective on Behaviour. Oxford University Press,
7. Drickamer LC , Vessey SH . (2001). Animal Behaviour. McGraw-Hill
8. Dugatkin LA. 2014. Principles of Animal Behaviour. 3rd Edn. W.W.Norton and Co.
9. Krebs J. R. & N. B. Davies – An introduction to Behavioural Ecology – Blackwell Scientific
10. Natarajan, P and Arumugam, N.; Animal behaviour (2018) 1st ed, Saras publication
11. Mathur, R.; (2018) Animal behaviour, 5th Ed Rastogi publication
12. Ruhela A, Sinha M. 2010. Recent Trends in Animal Behaviour. Oxford Book Co
13. Arora, M.P. (2014) Animal behaviour , 13th Ed, Himalaya Publishing House.
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. Kumar, V. (2002). Biological Rhythms: Narosa Publishing House, Delhi/ Springer - Verlag, Germany.

Feature Article -- Types of Bird Nests and Nesting Schemes (utahbirds.org)

SEMESTER-VIII
MAJOR COURSE - 20

Course Name: Neuroscience and Endocrinology

Course Code: BSCZOOMJ803

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-20**		L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course

This course will start from the basics of the nervous system of invertebrates and will gradually move towards a more complex vertebrate nervous system. The students will also be taught about the types of synapse, neurotransmitters and their receptors besidesother related aspects. The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. The associated hormones and the related disorders will be explained.

Learning outcomes

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

- Understand the structure of brain and improved methods to study it.
- Understand the structure of different lobes of the brain and their corresponding functions.
- Understand intricacies of nerve impulse conduction.
- Understand neurohormones and neurosecretions.
- Learn about hypothalamo and hypapophysial axis.
- Understand about different endocrine glands and their disorders.
- Understand the mechanism of hormone action.

THEORY (MJC-20)

Unit-I: Development of the neuro-endocrine system **(12 Lectures)**

1. Structure of the human brain- forebrain, midbrain, and hindbrain and their functions.
2. Neuroendocrine system in mammals.

Unit-II: Physiology of the nervous system **(18 Lectures)**

1. **Ionic basis of resting membrane potential:** Nernst's potential, sodium-potassium pump; Donann's equilibrium
2. **Action Potential & propagation:** Nerve impulse propagation, IPSP, EPSP
3. **Neurotransmitters types:** catecholamines, amino acidergic and peptidergic; Significance of neurotransmitters.
4. **Agonist and antagonist for neurotransmitters:** Acetylcholine, Dopamine, GABA and Glutamate, Neuropeptide (Endorphin and Enkephalin).
5. **Neurotransmitter receptors:** (a) Ionotropic receptors (nicotinic receptors of acetylcholine) (b) Metabotropic receptors like G-protein coupled receptors (D1 and D2 of dopamine and muscarinic receptors of acetylcholine).

Unit-III: Physiology of the endocrine system **(14 Lectures)**

1. Physiological significance of hypothalamus: Hypothalamic nuclei (SCN, PVN) and their functions; Hypothalamo-hypophysial portal system.
2. Hormone action at Cellular level: Hormone receptors; Transduction and regulation of Hormone action at Molecular level.

Unit-IV: Molecular pathogenesis in neuroendocrine system **(16 Lectures)**

1. Molecular basis of behaviour including learning and memory.
2. Behavioural neuropharmacology: Effects of drug dependence and addiction.
3. Molecular neuropharmacology: Roles of neurotransmitters, neuropeptides, neurohormones and neuromodulators in neuropharmacology.
4. Neuroendocrine regulation: Stress and depression.

PRACTICAL (MJC-20)

1. Observation and counting of Dragon fly photoreceptor neurons.
2. Dissection and demonstration of the Endocrine glands and the brain in rat/mice.
3. Demonstration of Castration/ ovariectomy in laboratory-bred rats.
4. Study of neurons and/ or myelin by Nissl, Giemsa, or Luxol Fast Blue staining.
5. Estimation of the plasma level of any hormone using ELISA (demonstration).
6. Study the permanent slides: penial nuclei/gland, glial cell, ependymal cell, Neuronal cell, Hypothalamic nuclei.
7. Designing of primers of any hormone (Demonstration).
8. Group discussion or Seminar presentation on one or two related topics from the list

Pool of Topics for Group discussion or Seminar presentation:		
1. ANS	2. Neuroendocrine system	3. NLP
4. PNS	5. Action potential	6. Neurotransmitter
7. Lobes of brain	8. Evolution of nervous system	9. Hormone action
10. Limbic system	11.Neuropharmacology	12.Homeostasis

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. Experiment (Sl no 4-5, any one)-Principle-2, procedure-3, Experiment-5, result and inference-2, (12) OR, Dissection (Sl no 1-3)-Dissection-5, Display-3,Drawing and labelling-4, (12) 2. Identification (Sl no 6, any two)-Naming-0.5, character-1.5 (4) 3. LNB-2 4. VIVA-2

NOTE :

- *Identification of behaviour/nest/ethogram could be done by using card printed with photograph/drawing/data.*
- *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. Baer, M.F. and Connors B.W. (2015) Neuroscience: Exploring the brain.
2. Byrne, J.H.; Heidelberg, R. and Waxham, M.N. (2014) From Molecules to Networks: An Introduction to Cellular andMolecular Neuroscience.
3. Kandel, E.R.; Schwartz, J.H. and Jessell, T.M. (2000) Principles of Neural Science (4th edition) McGraw Hill Companies.
4. Simmons, J. and Young, D. (2003) Nerve Cells and Animal Behaviour (2nd edition) Peter. CUP.
5. Stahl, S.M. (2000) Essential Psychopharamacology- Neuroscientific Basis and Practical Applications (2nd edition) CUP
6. Vilayanur, S.R. and Blakeslee S. (1998) Phantoms in the Brain. Probing the Mysteries of the Human Mind.
7. Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
8. Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
9. Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
10. David, O.N. (2013) Vertebrate Endocrinology.

SEMESTER-VIII
MAJOR COURSE - 21

Course Name: Wildlife Management and Ecotourism

Course Code: BSCZOOMJ804

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-21**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :

The course is an introduction to wildlife management and gives an account of the tools used by wildlife managers. Topics covered are to equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation and management issues of vertebrate pests, wildlife conflict and overabundant species, wildlife healthand diseases. The course will give students to the concept of ecotourism and its economic, cultural and environmentalimpacts at different scales. Students will learn the methods through which ecotourism can be marketed and managed,together with its potential adverse impacts.

Learning outcomes

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

- Develop an understanding of how animals interact with each other and their natural environment.
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and nationalconservation and management issues.
- Develop the ability to work collaboratively on team-based projects.
- Demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlifetechnician.
- Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.
- Develop an ability to analyze, present and interpret wildlife conservation management information.
- Identify and manage for ecological impacts to soil, water, vegetation, and wildlife resulting from recreation and tourism development;
- Understand ecological impacts and ecotourism management approaches in a variety of ecosystems under diverselandowners;
- Ability to analyze the environmental and social consequences of ecotourism management strategies and decisions;
- Understand management tools to reduce visitor related impacts that occur in ecotourism areas (impacts of outdoorrecreation include impacts to soil, vegetation, water, wildlife, air, soundscape, night sky, historical/cultural resources, visitor experiences, and facilities/services).

THEORY (MJC-21)

UNIT-I: Wildlife value, Conservation strategy and tools (18 Lectures)

1. Definition, value and importance of wildlife.
2. Wildlife conservation, ethics, strategies (policy) and importance of conservation;
3. Important features of protected areas in India; Tiger conservation – Tiger reserves in India;Management challenges in Tiger reserve.
4. Brief idea about Rhino mission in India, crocodile conservation in India.

5. Causes of depletion of wildlife w. r. t. extinction of animals.
6. Tools and techniques used in wildlife: Use of Tools (Drone, radio collar, Camera trap) and Tracking by Remote sensing and GIS.

UNIT-II: Population dynamics in wildlife **(14 Lectures)**

1. Impact of topography, geology, soil and water on wildlife population.
2. Impact of habitat destruction, invasive species and fragmentation on preexisting flora and fauna ofwildlife.
3. Identification and counting of wild animals by fecal sample analysis, hair identification, pug marks and census methods.

UNIT-III: Conservation issues, Rehabilitation and Management **(16 Lectures)**

1. Wildlife conservation issues [Poaching, Forest fire, Mining, Hunting and illegal trading; Tourism;Wild life corridor]
2. National Organizations involved in wild life conservation; Wildlife Legislation – Wildlife ProtectionAct - 1972, its amendments and implementation; CITES; IUCN Red Data Book.
3. Inviolate area and critical habitats and their impact on wildlife; Restoration of degraded habitat.
4. Man-wildlife conflict (definition, causes, and mitigation).

UNIT-IV: Ecotourism **(12 Lectures)**

1. Ecotourism: Definition and Types (Extreme & Mass Ecotourism)
2. Possibilities & Problems: Environmental, socio-cultural and economic impacts of ecotourism.
3. Endemic animal species of West Bengal, Assam, Gujrat, MP.
4. Wildlife protected areas as venues of ecotourism in India

PRACTICAL (MJC-21)

1. Identification, ecotype with conservation status and preparation of colour album of fauna (*Ginkgo biloba*, Red sandalwood), mammalian fauna (Himalayan musk deer, Gangetic dolphin, Golden langur, Pangolin, Fishing cat), avian fauna (Great Indian bustard, Pink headed duck), herpeto-fauna (Gharial, Rock python, King cobra, Indian star tortoise).
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study by photographic plate of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques (wild life census: Jolly-Seber method) for fauna.
5. Determination of population density in a natural/ hypothetical community by quadrat method and calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for the same community.
6. **Visit to Forest**/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study distribution of animals and prepare a short report.
7. **Group discussion or Seminar presentation** on topics given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Project Tiger	2. Rhino vision in India	3. Crocodile conservation
4. Elephant project	5. Green corridor	6. Red data book
7. Ecotourism	8. GIS-Remote sensing & GPS	9. Wild life protection act
10. Invasive species	11. Man-wildlife conflict	12. Wetland management
13. Green bench	14. Operation Olivia	15. Wildlife Census

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 - **5**	1. Estimation of Species abundance/richness from provideddata (Sl no 5)-principle-1, Result & discussion-2+2 (**5**) 2. Identification (Sl no 1)- Naming-0.5, Conservation status-0.5, Ecotype-1, characters-1 (3x2=**6**) 3. Spotting (Sl no 3)- Naming-0.5, importance-0.5 (1x2=2) **4.** LNB & Field report: (3 + 2) = **5** **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.* • *Field report should be submitted after completion the field visit.* • *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*	

Recommended readings:

1. Caughley, G., and Sinclair, A.R.E. (1994) Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005) People and Wildlife, Conflict or Co-existence? Cambridge University.
3. Bookhout, T.A. (1996) Research and Management Techniques for Wildlife and Habitats (5th Ed) The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000) The Conservation Handbook: Research, Management and Policy. Blackwell Sciences.
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008) Problem solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing
6. Mathur, R. (2018) Wildlife conservation and management, 1st Ed, Rastogi Pub.
7. Saha, G.K. and Mazumdar, S.; (2017) Wildlife Biology: An Indian Perspective, PHI Learning.
8. Paul R. Krausman & James W. Cain; (2013) Wildlife Management and Conservation – Contemporary Principles and Practices, Johns Hopkins University Press.
9. Fryxell, J.M., Sinclair, A.R.E and Caughley, G.; (2014) Wildlife Ecology, Conservation, and Management, 3rd Edition, Wiley-Blackwell
10. Sharma, BD: High Altitude Wildlife of India. Oxford 7 IBH Publ. Co. Pvt. Ltd. 1994.
11. Negi, SS: Himalayan Wildlife: Habitat and Conservation. Indus Publ. Company, New Delhi 1992.
12. Pullin, AS: Conservation Biology, Cambridge University Press, 2002.
13. Mowforth, M., & Munt, I. (2009). Tourism and sustainability (3rd Edition). London, UK: Routledge.
14. Newsome, D., Moore, S.A., & Dowling, R.K (2002). Natural area tourism. Bristol, UK: Channel View. (Publications.
15. Weaver, D. (2008). Ecotourism (2nd Edition). Hoboken, NJ: JS Wiley. Staff : Dr Julian Clifton

SEMESTER-VIII
RESEARCH PROJECT - 1

Course Name: Research Methodology

Course Code: BSCZOORP801

Course Type: **RP (Theoretical)**	Course Details: **RP-1**			L-T-P: **4-0-0**	
Credit: **4**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		0	**15**	**0**	**35**

About the course

The aim of the course is to familiarize students with basics of research and the research process; provide anintroduction to research methods and report writing; give insight into various kinds research design and sampling.

Learning outcomes

At the end of the course the students will be able to,

- Understand the concept of research and different types of research in the context of biology
- Have basic awareness of data analysis-and hypothesis testing procedures
- Develop laboratory experiment related skills.
- Have basic knowledge on qualitative research techniques
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research
- Evaluate the different methods of scientific writing and reporting

THEORY (RP-1)

Unit-I: Basic Concepts of Research (14 Lectures)

1. Research-definition and types of research (Descriptive *vs* analytical; applied *vs* fundamental; quantitative
   vs qualitative; conceptual *vs* empirical).
2. Research methods *vs* methodology.
3. ***Literature-review:*** Criteria for systematic review - PRISMA guidelines; Importance of different types of literature review in research
4. Brief concept on library research, field research, and laboratory research.

Unit II: Research Design (15 Lectures)

1. Need for research design, Features of good research design
2. Important concepts related to good design-Observation and Facts, Prediction and Explanation.
3. ***Basic idea on developing a research plan:*** Problem identification, Experimentation.

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Unit III: Data Collection, Documentation, Analysis and Report Writing (16 Lectures)

1. Brief idea on Observation and Collection of Data-Methods of data collection- Sampling Methods.
2. Introduction to Data Processing and Analysis Strategies
3. Importance of maintaining laboratory record; Brief idea on common software used for generation of graphs; importance of graphical abstract, table of contents, and keywords in scientific articles.
4. ***Basic idea on:*** Components of thesis writing, short communication, and technical report writing: Introduction to different referencing styles (APA, Chicago, MLA, AMA, ACS); Importance of citation; Cross reference (definition)
5. ***Fundamental idea on publishing:*** Concept of manuscript and a scientific journal, volume & issue number; introductory idea to Corrigendum; Expression of Concern; Retraction of article. Brief knowledge on COPE; SCOPUS; WoS; Impact Factor; Cite Score; H-Index; Importance of Peer Review in research.

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Unit-IV: Ethics and Art of Scientific Writing (15 Lectures)

1. ***Brief idea on:*** requirements for authorship in a scientific article; acknowledgements; abbreviations; footnotes; Contributor Roles Taxonomy for authorship; Competing Interest/Conflict of Interest.
2. Basic criteria for preparing and significance of a good oral presentation and poster presentation in research.
3. Introduction to copyright-academic misconduct; plagiarism and its types; Introductory idea on some plagiarism checking platforms (URKUND; DrillBit; iThenticate; Turnitin)
4. ***Basic idea on:*** Intellectual Property Rights, Commercialization, Copyright, Royalty, Patent Law.
5. Importance of Research Grants/ Fellowships.

Recommended readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists –a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
4. Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
5. Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
6. Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, UniversalLaw publishing
7. C. R. Kothari: Research Methodology, New Age International, 2009
8. Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications.

SEMESTER-VIII
RESEARCH PROJECT - 2

Course Name: Research Project / Dissertation Course Code: BSCZOORP802

Course Type: **RP (Practical)**	Course Details: **RP-2**			L-T-P: **0-0-16**	
Credit: **8**	Full Marks: **250**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		150	**0**	**100**	**0**

Criteria / 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 labfinal 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 projectis 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 projectis conducted individually.

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. 2) -**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 :

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

Recommended readings

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

SEMESTER-III
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 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.

SEMESTER-V

MINOR COURSE-5

Course name: Cytogenetics and Molecular Biology
Course code: BSCZOOMN501

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

The course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.The course is designed to revise basic concepts of Genetics and then move on to advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, etc. will be covered. A strong emphasis will be laid on the modern tools and techniques used in genetics.

Learning outcomes :

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

- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
- Acquire the detailed knowledge of different pathways related to cell signalling and apoptosis thus enabling them to understand the anomalies in cancer.
- Understand how DNA encodes genetic information and the function of mRNA and tRNA.
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Relate the conventional and molecular methods for gene manipulation in other biological systems.
- Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc
- Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.
- Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.
- Apply their knowledge in problem solving and future course of their career development in higher education and research.
- Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

THEORY (MNC-5)

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

1. Ultra structure and function of Plasma membrane (Fluid mosaic model), Mitochondria, Golgi, Endoplasmic reticulum, Nucleus, Lysosome & Ribosome,
2. Chromosome structure: nucleosome model, giant chromosome
3. Tight and gap junctions

4. Cell division: Mitosis & Meiosis,
5. Cell cycle and regulation
6. Basic idea of animal Cell Culture.

UNIT II: Molecular Genetics (15 Lectures)

1. Classical and Modern concept of Gene (Cistron, muton, recon), Alleles etc.
2. Structure and Properties of DNA and RNA,
3. DNA and RNA as genetic material.
4. General idea and Criteria of Extrachromosomal Inheritance.
5. Linkage mapping (Three point cross) and crossing over (Holliday model);
6. Mutation types, mutation detection test (AMES, CLB),

UNIT III: Classical Genetics (15 Lectures)

1. Mendel's laws of inheritance; Genetics of Thalassemia and Hemophilia,
2. Non-mendelian traits: Incomplete dominance, Codominance, Multiple allelism, Pleiotropy, Epistasis
3. Down syndrome, Turner & Klinefelter syndrome,
4. Chromosomal Sex determination in *Drosophila* and Man.
5. Human Genetics: Pedigree analysis; Genetic counselling, its application.

UNIT IV: DNA replication, Gene regulation and Protein synthesis (15 Lectures)

1. DNA Replication: Meselson-Stahl Experiment, DNA replication in Prokaryote Inhibitors of DNA replication
2. Transcription in Prokaryotes: Enzymes and Factors, Mechanisms and Inhibitors of Transcription.
3. RNA processing: Capping, Polyadenylation and Splicing of mRNA;
4. Concept of operon of bacteria (*Lac*).
5. Genetic Code and its features,
6. Mechanism of Translation in Prokaryote.

PRACTICAL (MNC-5)

1. Preparation of chromosome squashes from grasshopper testes for the observation of stages of meiosis.
2. Identification of different stages of mitosis and meiosis from permanent slide.
3. Temporary Squash preparation of squamous epithelial cell.
4. Pedigree chart analysis (with standard symbols; autosomal and sex-linked inheritance patterns)
5. Temporary mounting of polytene chromosome from *Drosophila / Chironomous* larva.
6. Extraction of Genomic DNA from bacteria (Demonstration).
7. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome).
8. Qualitative and quantitative test for DNA (Diphenylamine method) & RNA (Orcinol method)

9. Group discussion or Seminar presentation on topics given below.

Pool of Topics for Group discussion or Seminar presentation :		
1. Diseases due to chromosomal anomalies	2. Extrachromosomal inheritance (any one)	3. Sex determination in *Drosophila*
4. Giant chromosome	5. Regulation of gene expression	6. Cell junctions
7. DNA damage and repair	8. Chromosome translocation	9. Genetic counseling
10.Genetic code	11. RNA processing	12. Why Lagging strand?
13.Fluid mosaic model	14. Crossing over model	15. Splicing & its significance
16. Cytoskeleton	17. Post-translational modifications of polypeptides	18. Mutation detection

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.** Mounting of giant chromosome. Mounting-2, drawing & labelling-2 (**4**) **2.** Pedigree analysis on provided chart-(Sl no 3)-Description-1, analysis-2 and mode of inheritance-1 (**4**) **3.** Identification based on provided chart/slide (Sl no 2 & 7)- Naming-0.5, Characters-1.5 (2x2=**4**) **4.** LNB = **4** **5.** Viva-**4**

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.*
- *Survey report should be done on specified topics and distributed among students.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

Recommended readings :

1. Channarayappa (2010) Cell Biology, 1st Ed, Universities Press.
2. Alberts, B (2013) Essential cell biology, 4th Ed, Garland science.
3. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
4. Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. (7th edition) Pearson Benjamin Cummings Publishing, San Francisco.
5. Verma, P.S. and Agarwal, V.S.; (2016) Cell Biology, S.Chand Pub.
6. Rastogi, S.C. (2019) Cell biology, New Age Int. Pub.
7. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition)
8. Russell, P.J. (2010) Genetics (Benjamin Cummings).
9. Pierce B.A. (2012) Genetics:A conceptual approach, 4Ed, W. H. Freeman and Co. Ltd.
10. Singh B.D.(2018) Fundamentals of genetics, Kalyani Publishers.
11. Miglani G.S. (2008) Fundamentals of genetics, Narosa publication.
12. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
13. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
14. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings
15. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co. Ltd.
16. Banerjee P.K. (2011) Problems on genetics, molecular genetics and evolutionary genetics,2Ed, NCBA
17. Watson, J.D. et al. (2013) Molecular Biology of the Gene (7th edition) CSHL Press Pearson.
18. Green, M. R and Sambrook, J. (2012) Molecular Cloning: a Laboratory Protocol (4th edition) CSHL Press.

19. Walter, P. (2007) Molecular Biology of the Cell (5th edition) Garland Science.
20. Alberts B et al. (2008). Molecular Biology of the Cell. V Edition, Garland publishing Inc.
21. Allison LA. (2007). Fundamental Molecular Biology. Blackwell Publishing.
22. Karp G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
23. Lackie JM. (2013). Dictionary of Molecular Biology. Academic Press.
24. Lodish, B, Matsudaira, K B, Plough, A and Martin ;(2016). Molecular Cell Biology. W.H. Freeman
25. Meyers R.A. – Molecular Biology and Biotechnology; VCH Pub.
26. Pal A.(2011). Textbook of Cell and Molecular Biology 3rd Ed, Books and Allied, Kolkata.
27. Russel PJ. (2010). iGenetics: A Molecular Approach, Pearson Benjamin
28. Strachan T. & A. Read – Human Molecular Genetics; BIOS Scientific
29. Turner, McLennan, Bales & White ;(2005). Instant Notes in Molecular Biology. Taylor Francis
30. Twyman R.M. (2005) – Advanced Molecular Biology; Springer

Semester-VII

Course name: Parasitology, Microbiology and Immunology

Course code: BSCZOOMN701

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-6**			L-T-P: **3-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

About the course :

This is a composite course with remarkable utility and importance. Microbiology being the study of microorganisms such as viruses, bacteria etc., covers theoretical studies and practical proficiency training which may help in their placement at a clinical microbiological laboratory. Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free-living species, and the role of parasites in global, public, health. Immunology part provides the students with the fundamental knowledge of the immune system and its protective roles against diseases.

Learning outcomes

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

- Carry out common procedures for culturing, purifying and diagnostics of micro-organisms understand the disease- causing potential of bacteria and viruses, and the responses of the immune system.
- Summarise and orally present current microbiological problem areas.
- Describe the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organisms.
- Diagnose the causative agents, describe pathogenesis and treatment for important diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.
- Assess the importance of incidence, prevalence and epidemiology in microbiological diagnostic activities. Know how resistance development and resistance transfer occur.
- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.
- Understand how does the immune system distinguish self from non-self.
- Gain experience at reading and evaluating the scientific literature in the area.

THEORY (MNC-6)

UNIT-I: Microbiology: General concepts and common diseases (16 Lectures)

1. Brief history of microbiology- germ theory of disease, discovery of penicillin.
2. Basic idea of Host pathogen interaction:
3. Kinetics of bacterial growth and principles of staining techniques.
4. **Viral diseases:** hepatitis, chicken pox, dengue with emphasis on their causative agents, pathogenesis, diagnosis, and prophylaxis.
5. **Bacterial diseases** caused by *Streptococcus pneumoniae, Mycobacterium tuberculosis, Vibrio cholerae* with emphasis on pathogenesis, diagnosis, prophylaxis and chemotherapy.
6. **Fungal diseases: C**andidiasis with emphasis on pathogenesis, diagnosis, prophylaxis and chemotherapy.

UNIT-II: Parasitology: an overview of common parasitic infections. (14 Lectures)

1. Concept of zoonotic diseases.
2. Parasitic adaptations in helminths.
7. Protozoan diseases of medical importance: amoebiasis, malaria (Life cycle, pathogenesis, prophylaxis and Treatment).
8. Helminthic diseases of medical importance: ascariasis, and filariasis (Life cycle, pathogenesis, prophylaxis and Treatment).

UNIT-III: Immunology: Immune mechanism and related pathways. (15 Lectures)

1. Cells and organs of immune system- primary and secondary lymphoid organs.
2. Innate immunity: First and second lines of defense.
3. Characteristics of antigen- antigenicity and immunogenicity, epitopes, haptens, adjuvant.
4. Structure, Classification, properties and functions of immunoglobulins.
5. Basic idea on complement system.
6. Cytokines: Properties and function.

UNIT-IV: Applied Immunology (15 Lectures)

1. Acquired immunity: Humoral and cell mediated immune response.
2. Basic concept of hypersensitivity.
3. Vaccine (types) and vaccination;
4. MHC complex: classification and function.
5. Autoimmune disorders (Pernicious anaemia, Rheumatoid arthritis).

PRACTICAL (MNC-6)

1. Study of permanent slides and specimens of parasitic protozoans and helminthes (as per theory syllabus).
2. Pathological study (chart/photograph): sputum, blood, urine and stool.
3. Blood: Erythrocyte Sedimentation Rate (ESR), Haematocrit value.
4. Staining and identification of Gram positive and Gram negative bacteria.
5. Preparation of temporary and permanent slides of faecal matter (cockroach/Ungulate) by saline preparation and concentration techniques to identify cysts of parasitic protozoans and helminth eggs.
6. Group discussion / Seminar presentation on a related topics given below:

Pool of Topics for Group discussion or Seminar presentation :		
1. Autoimmune diseases	2. Hybridoma technology	3. Helminth infections in humans
4. Concept of Immunity	5. Immunological memory & Vaccination	6. Antigen-antibody interaction
7. Zoonotic diseases	8. Host-parasite interaction	9. Common bacterial diseases
10. Hypersensitivity	11. Fungal infections in human	12. Diseases caused by viruses

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, 2, 5)- Sc. Name-0.5, Character-1, Pathological importance-0.5 (2x4=**8**) 2. Experiment/slide preparation (Sl no 3 to 8)- Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) 3. LNB -**2** 4. Viva-**2**
NOTE : • *Study includes identification, systematic position (major taxon), identifying character, pathological significance.* • *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. Paniker CKJ, Ghosh S; (2013). Paniker's Text Book of Medical Parasitology. Jaypee
2. Kanungu R., (2020) Ananthanarayan and Paniker's Textbook of Microbiology, 11th Ed, Universities Press (India) Pvt. Ltd.
3. Chatterjee, K.D (2015) Parasitology (13th edition). CBS Publishers
4. Arora D R, Arora B. (2001). Medical Parasitology. II Edition. CBS Publications and Distributors
5. Bose M. (2017). Parasitoses and zoonoses. New Central Book Agency.
6. Chakraborty P. (2016).. Textbook of Medical parasitology, 3rd edition. New Central Book Agency.
7. Parija SC. (2013). Textbook of medical parasitology, protozoology & helminthology II Edition, All India Publishers and Distributers, Medical Books Publishers, Chennai, Delhi.
8. Baveja V. & Baveja C.P.; (2021) Parasitology, 5th Ed, Arya Publishing Company
9. Baveja C.P.; (2018) A textbook of Microbiology,6th Ed, Arya Publishing Company
10. Roitt, I.; Brostoff, J. and Male, D. (2012) Immunology (8th edition).Elsevier
11. Abbas K A, Lechtman H Andrew. (2003). Cellular and Molecular Immunology. Saunders Publication.
12. Abbas KA, Andrew, LH. (2011). Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier
13. Delves PJ, Martin SJ, Burton DR, Roitt I M. (2010). Roitt's Essential Immunology.11th Ed, Blackwell Pub.
14. Kindt TJ, Goldsby RA, Osborne BA, Kuby J (2006). Immunology, W.H. Freeman and Company.
15. Mohanty SK , Leela KS. (2014). Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi
16. Parija SC. (2012). Text book of Microbiology and Immunology. Elsevier.
17. Playfair, JHL, Chain BM (2001). Immunology at a glance. 7 th Edn. Blackwell Pub.
18. Shetty N. (2005). Immunology: Introductory Textbook, New Age International Pub.
19. Fatima D and Arumugam N, (2014)Immunology, Saras publication
20. Ramesh S.R. (2017)Immunology; 1st Ed, McGraw Hill Education India Private Limited
21. Khanna R.,(2011)Immunology; 1st Ed, Oxford University Press
22. Virella G. 2007. Medical Immunology, Informa Healthcare.
23. Chakraborty A.K., (2006) Immunology and Immunotechnology, 1st Ed, Oxford University Press
24. Annadurai B., (2010) A textbook of Immunology and Immunotechnology, 1st Ed, S.Chand Pub.
25. Ghosh S., (2017) Immunology and Immunotechnology, 1st Ed, Books & Allied.
26. Paul A., (2015) Textbook of Immunology : including Immunotechnology & Immunotherapy, 1st Ed, Books & Allied.
27. Pelczar: (1993) Microbiology, Tata McGraw Hill,
28. Dubey and Maheshwari; (2018) An Introduction to Microbiology,4th Ed; S Chand Publications, New Delhi

MINOR COURSE

Semester-VIII

Course name: Biochemistry and Physiology

Course code: BSCZOOMN801

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-7**			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 provides an introduction to the structure of biomolecules with emphasis on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes. The course deals with various physiological functions in mammals. It also gives an account of the metabolic/ biochemical pathways and the probable impact of environment on them.

Learning outcomes :

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

- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the structure and function of immunoglobulins.
- Understand the concept of enzyme, its mechanism of action and regulation.
- Understand the process of DNA replication, transcription and translation.
- Learn the preparation of models of peptides and nucleotides.
- Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
- Learn measurement of enzyme activity and its kinetics.
- Learn about the detoxification system of our body.
- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Understand the process of vision and hearing.
- Understand the process of muscle contraction.
- Learn the determination of haemoglobin content, blood groups and blood pressure.

THEORY (MNC-7)

UNIT I: Principle and Structural Biochemistry (15 Lectures)

1. **Basic idea on biological bonds:** H-bond, Di-sulphide bond, ionic bond, Vander-waal interaction, hydrophilic and hydrophobic bonds, covalent bond.
2. **Buffer systems:** Principle, Major buffer systems in our body. Water as biological solvent.
3. **Biomolecules:** Classification and biological importance of Carbohydrate, Protein and Lipid.
4. **Enzymes:** Nomenclature and classification, general properties.

UNIT II: Metabolism and Applied Biochemistry (15 Lectures)

1. **Catabolism of carbohydrates and ATP production:** Glycolysis, Krebs cycle, Functioning of ETS, pentose phosphate pathway.
2. **Lipid Metabolism:** β- oxidation of saturated fatty acids with even number of carbon atoms.
3. **Catabolism of amino acids:** Transamination, Deamination, Urea cycle.
4. **Metabolic Diseases:** Introduction to diabetes, PKU.

Unit-III: Physiological processes (18 Lectures)

1. **Muscle contraction:** Properties of skeletal muscle. Physiology of skeletal muscle contraction.
2. **Respiration:** Transport of oxygen and carbon dioxide;
3. **Circulation:** Cardiac cycle and electrocardiogram. Mechanism of blood coagulation.
4. **Digestion:** Glands associated with the digestive system; Digestion and absorption of carbohydrates, proteins, and fats; Concept of BMR.
5. **Excretion:** Structure of kidney and nephron; Urine formation in Human.
6. **Reproductive physiology:** Menstrual cycle, estrous cycle.

Unit-IV: Regulatory Physiology (12 Lectures)

1. Outline idea on structure of Brain and limbic system
2. Nerve impulse and its transmission;
3. Diseases related to nervous system (symptoms)-Alzheimer's disease, Parkinson's disease.
4. **Endocrine glands:** Endocrine mode of action; Basic idea on major hormonal glands and their hormones, Placental hormones. Disorders related to hypo and hyper endocrine secretions (general idea).

PRACTICAL (MNC-7)

1. Ninhydrin test for α-amino acids.
2. Benedict's test for reducing sugars (Qualitative).
3. Iodine test for starch.
4. Determination of the activity of enzyme (Urease/salivary amylase).

4.1. Effect of [S] and determination of Km and Vmax.
4.2. Effect of temperature.
4.3. Effect of time.

5. Determination of acid value of oil.
6. Estimation of protein by Lowery method.
7. Preparation of temporary mounts: Blood film,
8. Counting of white blood corpuscles and red blood corpuscles
9. Preparation of haemin crystals.

10. Determination of blood groups
11. Measurement of blood pressure using sphygmomanometer
12. **Group discussion or Seminar presentation** on topics (Given Below):

Pool of Topics for Group discussion or Seminar presentation :		
1. Chemiosmosis and ATP production	2. CO_2 transport & Chloride shift	3. Synaptic transmission
4. Enzyme kinetics	5. Buffer systems in human	6. Cardiac cycle
7. Fatty acid oxidation	8. Heart valves & its dysfunction	9. Muscle physiology
10. Biological bonds	11. Absorption of biomolecules in gut	12. Carbohydrate and life
13.Enzyme kinetics	14. Oxygen dissociation curve	15. Important body lipids
16.Major lipids of importance	17. Neural regulation of digestion	18. Buffer systems
19.Countercurrent & RAAS	20. Mechanism of hearing and seeing	21. Action potential

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. Experiment A (Sl no 1- 6)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) 2. Experiment B (Sl no 7-11)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (**8**) 3. LNB -**2** 4. VIVA-**2**

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.*

KAZI NAZRUL UNIVERSITY

National Curriculum and Credit Framework (NCCF)

Internship guidelines

for

ZOOLOGY

(Undergraduate)

w. e. f. Academic Session 2023-24

Updated on March 19, 2026

Programme: B.Sc.	Year: III	Semester: VI
Discipline: ZOOLOGY		
Course Name: Summer Internship		
Course Code: SI601		
Course Type: **Summer Internship**	Course Details: **SIMC-1**	L-T-P: **0 - 0 – 4**

Course Credit: **2**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	---	**20**	---

Course Overview:

Internship in **ZOOLOGY** is gaining wide attention and importance in course curriculum as it promises to provide first-hand experience to the students, along with conventional class room teaching. It enables students in comprehending the way of working in an organization, leading to improvement of the skill/ aptitude needed to tackle real-world spatial challenges and building research capabilities with learning opportunities.

Course Objectives:

Following are the intended objectives of engaging undergraduate students with Major Course as **ZOOLOGY** in internship for employability and research internship programmes: ***1. Integration of workshop with workplace:*** To see the internship in a broader, integrated and holistic manner where the delivery of the classroom is aligned with outcomes of the workplace. The objectives of the internship need to be designed with the intention of integrating workshop / classroom / lab/research lab learnings with the workplace (organisation / enterprise / start-ups / corporate / farmlands / artisans / gig workers / Non-government organisations (NGOs)/research & development organisations, higher education institutions (HEIs), etc.). ***2. Understanding of the world of work:*** To provide undergraduate students with an opportunity to improve their understanding of the experiences, challenges, and opportunities of the real world of work, as well as to set their expectations and behaviour in accordance with the demands, culture, and values of current and emerging jobs. ***3. Phygital and hybrid model learning:*** To broaden learning opportunities by combining physical and digital modes of learning while working in industry corporate, research & development organisations, workplace, within or outside HEIs, blended with a mentor or research expert and as per the need and convenience. ***4. Developing research aptitude:*** To create and facilitate conditions that allow students in their quest for knowledge, its discovery, learn, understand and sharpen research acumen, familiarising with analytical tools and techniques with appropriate usage, research methodologies, data analysis, integrity and ethical behaviour, manuscripts preparations, identification of appropriate journals, patent and intellectual property rights, and their application in solving research/complex/real-life problems. ***5. Exposure to emerging technologies:*** To provide exposure to emerging technologies/ automation and how it can support, facilitate, improve and reinforce work processes/ culture/ job roles/art and craft, including the traditional areas of art-craft/ heritage skills, agriculture, etc. ***6. Enhance entrepreneurial capabilities:*** Understand how organisations/enterprises are formed for sustainable progress so that start-ups and entrepreneurial capabilities are strengthened among students and they are encouraged to be job creators. ***7. Development of decision-making and teamwork skills:*** To facilitate the development of problem-solving and decision-making skills, enable teamwork & collaboration culture to promote research, academic, and professional developments. ***8. Cultivate a sense of Social Imagery and Citizenship Responsibility:*** To develop a sense of social imagery (issues) and philanthropic versatility among the graduating students that will facilitate towards the development of an attitude towards citizenship responsibility. ***9. Stimulate collaborative works:*** To promote HEIs collaboration, industry-academia partnership will be developed to provide collaborative internships, apprenticeships, and research opportunities to the students in the predefined areas of importance which will lead institutions, universities, organisations, academicians, and students to collaborate on how to learn with one

another. ***10. Enhancing professional competency:*** The internship should not only focus on employability or research capabilities; there is also a need for professional principles, ethics, values, and integrity which will enable them to gain perspective, practice, develop as competency and perform professional tasks in the way that the employment market demands.

Learning Outcome:

✧ Students shall get an excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience during the internship provides much more professional experience, often worth more than classroom teaching.

✧ The students will learn various soft skills such as time management, positive attitude and communication skills while performing the tasks assigned in the internship organization.

Professional Skill Development:

✧ The obtained knowledge is vital to test the theoretical learning in practical situations by accomplishing the tasks assigned during the internship.

✧ This knowledge will help to develop essential soft skills like time management, organization, adaptability, problem-solving, and teamwork.

	Internship Categories (Students can opt for any one; individual/group internship is allowed)	60 hrs

I. Internship for enhancing the employability

Graduates face many difficulties after graduation to enroll in the workforce. Recent graduates are lacking knowledge, practical skills, and experience, which are mandatory requirements demanded by employers for recruitment. Employability refers to certain attributes of an individual that enable him/her to perform any job opportunity in line with the set standards of performance to meet expectations for the expected job. Employability is a set of skills and attributes developed through a range of experiences at workshops and workplaces. It states that when a student can demonstrate skills on the job. Individuals need to develop such competencies that reduce the obstacles as job seekers and also increase their potential as job providers.

Suggested activities for enhancing employability (students can gain knowledge on one or more activities):

1. Hands-on training on beekeeping and its techniques.
2. Hands-on training on Poultry farming and its techniques.
3. Hands-on training on Sericulture and its techniques.
4. Hands-on training on lac culture and its techniques.
5. Hands-on training on animal husbandry/fisheries and their techniques.
6. Field-based projects to study any branch of Zoology/Allied sciences [examples: Water quality assessment/ Assessment of vectors of a particular locality for any given human disease/ Epidemiological study/biodiversity study/bioprospecting of natural products, etc.].

II. Internship for developing the research aptitude

Research aptitude refers to the attribute of inquiry/investigation, analysis, and interpretation in a scientific and objective method that facilitates uncovering facts and presents an individual viewpoint in an organized manner. Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, equipment, policy framework, and various other aspects in pursuing quality research.

Suggested activities for developing the research aptitude (students may gain knowledge on one or more activities)

1. Handling of equipment (for example, Centrifuge machine, spectrophotometer, microplate reader, PCR, RT-PCR, fluorescence microscopy, microtome, bright field/phase contrast microscopy, stereo binocular microscope, laminar airflow, western blot apparatus, electrophoresis, and others. Experience on handling of at least five research-oriented equipment is essential.)
2. Culture and maintenance of model/lab organisms (Experience on at least one model/lab organism is essential).
3. Museum specimen preservation and maintenance (preserving and cataloging specimens; preserving at least six specimens of at least three different phyla (Invertebrates) / classes (vertebrates) is mandatory following standard protocol)
4. Training on project development, manuscript writing (research, review-systematic, meta-analysis; types of plagiarism), and ethics in research. Latest policies and responsible use of AI in research and publications, 3R policy in animal research.
5. Gaining experience in research design and the conduction of *in vivo/in vitro* experiments/short-term research projects, Preparation of laboratory reagents, Data analysis, presentation, and interpretation.
6. Short research projects on/learning of *in silico*/bioinformatics/computational-based studies/techniques.

Scope of Internship

❖ Students will undergo internship at Home Institutions (from departments excepting the parent departments), University, Academic and research Institutions, local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations. Internship may be as field-work training/training in the laboratory under the supervision of Supervisor from the parent department (own college) and Mentor from host department/Institution/Organization. One or more activities to be performed under internship should follow the list provided above.

Nodal Officer and Research & Development (R&D) Cell

❖ The R&D Cell of each affiliated institution shall oversee implementation of the Internship Programme through a designated Nodal Officer, appointed by the Principal/ TIC of the concerned Institution. Affiliated colleges are to develop an online internship registration system on their college websites to facilitate the process for students.

Duration of Internship

❖ 60 Working Hours (preferably offline)
❖ Equivalent to 2 Credits
❖ From the completion of the 4th sem (ESE) exam till the commencement of the 6th semester Examinations (ESE) – subject to prior approval of the Principal/TIC of the college / Head or Coordinator in case of University Department

Report Submission Requirements

Each student must submit:

a) Internship Report (3000–5000 words)

b) Internship Completion Certificate issued by Supervisor and Mentor certifying the performance and attendance of the intern.

c) Self-Assessment and Feedback Form

d) COPY OF DECLARATION FORM regarding IPR issue

e) COPY OF DECLARATION FORM FROM STUDENT

f) Any additional documents if required by the college/university.

Evaluation Process

Continuous Assessment (CA): 30 Marks

To be assessed by Supervisor in consultation with the Mentor

Based on attendance, performance, and report quality

Marks distribution: Attendance (**10**), Overall performance based on punctuality, sincerity, domain knowledge, work performance (**20**).

Marks for Attendance: < 50% attendance (=4 marks); 50-60% (=6 marks); 61-70% (=7 marks); 71-85% (=8 marks); 86-95% (=9 marks); 96-100% (=10 marks).

End Semester Evaluation (ESE): 20 Marks

To be conducted at the home institution

Through seminar presentation and/or viva-voce

To be assessed by **ATLEAST two Internal Examiners** from the Home institution (concerned Colleges) comprising of supervisor and another teacher nominated by the R& D Cell of the concerned college.

Marks Pattern*:* Academic quality of the intern's report**: 10**; *Viva voce*: **10.**

All evaluation processes including mark submission for SI601 must be completed by 10th July -2026 (For the session -2025-26 only)

Compliance

All UG students are directed to strictly adhere to these guidelines. non-completion of the internship will result in withholding of results/degree award as per university regulations

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