



अप्रमत्तैर्न वेदुष्यन्

**Four-Year Undergraduate Programme (FYUGP)**  
Under the  
National Education Policy, 2020

**Department of Zoology**  
**Cotton University**



# Introduction to Zoology

The Department of Zoology at Cotton University, Guwahati stands as a beacon of academic brilliance and scientific inquiry in the realm of biological sciences. Established with a commitment to excellence, the department has carved a distinguished niche for itself, embodying a legacy of glory that spans years of dedicated education and ground breaking research. Nestled in the heart of Assam, this department has established itself as a preeminent institution, where the pursuit of knowledge and scientific inquiry converge seamlessly.

At the heart of the department's success is its unwavering dedication to imparting education at the highest standards. The faculty at Cotton University's Department of Zoology comprises eminent scholars and experts in various domains of zoological sciences. These educators bring forth a wealth of experience, fostering an environment where students not only acquire knowledge but also develop critical thinking and analytical skills.

One of the hallmarks of the department is its emphasis on cutting-edge research. The faculty members are actively engaged in pioneering research projects that contribute to the global scientific community's understanding of diverse aspects of zoology. The department's research initiatives span from ecological studies and biodiversity conservation to molecular biology and genetics, reflecting a comprehensive approach to the field.

The curriculum offered by the Department of Zoology is designed to be dynamic and up-to-date, reflecting the latest advancements in the field. The faculty regularly revisits and updates the curriculum to incorporate emerging trends, technologies, and methodologies. This ensures that students receive a well-rounded education that prepares them for the challenges and opportunities in the ever-evolving landscape of zoological sciences.

In alignment with the National Education Policy (NEP), the Department of Zoology at Cotton University has proactively embraced reforms to enhance the overall educational experience. The integration of NEP principles has led to a more interdisciplinary and holistic approach to education, fostering an environment where students are encouraged to explore and connect knowledge across various disciplines. The department's commitment to NEP principles is evident in its efforts to promote research-driven learning, critical thinking, and the development of a broad-based skill set among students.

In the current context, the study of zoology holds paramount importance. As the world grapples with environmental challenges, the insights gained from zoological research are instrumental in understanding and mitigating the impact of climate change, loss of biodiversity, and emerging infectious diseases. Zoology provides a lens through which we can comprehend the interconnectedness of life on Earth, making it an indispensable field of study for those seeking to contribute meaningfully to the global challenges of our time.

The Department of Zoology at Cotton University not only equips students with knowledge but also opens up exciting career prospects. Graduates find themselves in a myriad of roles, from wildlife conservationists and ecologists to researchers in pharmaceutical companies and environmental consultants. The department's commitment to practical skills and research-oriented learning ensures that its alumni are well-positioned for fulfilling and impactful careers in a diverse array of fields.

The Department of Zoology at Cotton University, Guwahati, is a testament to the pursuit of excellence in education and research. With a rich legacy of glory, a faculty dedicated to pushing the boundaries of knowledge, and a curriculum that stays abreast of the latest developments, the department continues to be a hub of intellectual growth and scientific discovery. The incorporation of NEP principles further cements its commitment to providing students with a well-rounded and forward-looking education in the field of zoological sciences.

**SYLLABUS STRUCTURE OF B. SC. HONOURS IN ZOOLOGY**  
**UNDER NEP**

Semester	Course code	Course detail	Credits (L+T+P)
<b>I</b>	<b>ZOO23C101</b>	Introductory Animal Biology, Systematics, Animal Diversity (Non-Chordates), Functional Biology of Non-Chordates	3+0+1
	<b>ZOO23M101</b>	Introductory Animal Biology, Systematics, Animal Diversity (Non-Chordates), Functional Biology of Non-Chordates	3+0+1
	<b>ZOO23MDE101</b>	Food, Nutrition and Health	2+0+1
	<b>ZOO23SEC001</b>	Seri-Biology and Sericulture Practices	1+1 <sup>#</sup> +1
<b>II</b>	<b>ZOO23C201</b>	Chordate Diversity, Comparative Anatomy and their Functional Biology	3+0+1
	<b>ZOO23M201</b>	Chordate Diversity, Comparative Anatomy and their Functional Biology	3+0+1
	<b>ZOO23MDE201</b>	Ethnobiology of North East India	2+0+1
	<b>ZOO23SEC002</b>	Aquarium Fish Keeping and Pearl Farming	1+1 <sup>#</sup> +1
<b>III</b>	<b>ZOO23C301</b>	Cell Biology	1+0+1
	<b>ZOO23C302</b>	Ecology and Wildlife Biology	3+0+1
	<b>ZOO23M301</b>	Cell Biology, Ecology and Wildlife Biology	3+0+1
	<b>ZOO23MDE301</b>	Environment and Public Health	3+0+1
	<b>ZOO23SEC003</b>	Vermicomposting and Biofertilizer	2+0+1
<b>IV</b>	<b>ZOO23C401</b>	Genetics	1+0+1
	<b>ZOO23C402</b>	Animal Behaviour and Chronobiology	3+0+1
	<b>ZOO23C403</b>	Physiology and Endocrinology	3+0+1
	<b>ZOO23M401</b>	Genetics, Animal Behaviour, Chronobiology, Physiology and Endocrinology	3+0+1
	<b>ZOO23I406</b>	<b>Summer Internship</b>	2
<b>V</b>	<b>ZOO23C501</b>	Biochemistry	3+0+1
	<b>ZOO23C502</b>	Developmental Biology and Reproductive Biology	3+0+1
	<b>ZOO23C503</b>	Evolutionary Biology	3+0+1
	<b>ZOO23C504</b>	Biostatistics and Computational Biology	3+0+1
	<b>ZOOM501</b>	Biochemistry, Developmental Biology, Evolutionary Biology and Biostatistics	3+0+1
<b>VI</b>	<b>ZOO23C601</b>	Molecular Biology, Microbiology and Biotechnology	3+0+1
	<b>ZOO23C602</b>	Economic and Applied Zoology	3+0+1
	<b>ZOO23C603</b>	Immunology	3+0+1
	<b>ZOO23C604</b>	Parasitology	3+0+1
	<b>ZOOM601</b>	Biotechnology, Applied Zoology, Immunology and Parasitology	3+0+1

<b>VII</b>	<b>*ZOO23C701</b>	Research Methodology	3+0+1
	<b>*ZOO23C702</b>	Tools and Techniques in Biology	3+0+1
	<b>*ZOO23C703</b>	Biomimicry and Science Communication	3+0+1
	<b>#ZOO23C704</b>	Climate Change and Sustainable Development	3+0+1
	<b>ZOO23M701</b>	Research Methodology	3+0+1
	<b>ZOO23DPW05A</b>	Dissertation Project Work	3+0+1
		<b>Dissertation/Project</b> of 12 credits over Semester VII and VIII, for Honors with Research Degree, only if CGPA $\geq$ 7.5 upto Semester VI. Students with DPW will study the first three core papers marked with ‘*’ along with the minor of their choice. Students without DPW have to study all the papers offered in this semester	4
<b>VIII</b>	<b>*ZOOC23801</b>	Environment and Fish Biology	3+0+1
	<b>*ZOO23C802</b>	Entomology and Cellular Dynamics	3+0+1
	<b>#ZOO23C803</b>	Advance Approach to Ecology and Fish Biology	3+0+1
	<b>#ZOO23C804</b>	Advance Approach to Entomology and Cellular Dynamics	3+0+1
	<b>ZOO23M801</b>	Biomimicry and Science Communication	3+0+1
	<b>ZOO23DPW05B</b>	Dissertation/Project	Dissertation/Project of 12 credits over Semester VII and VIII, for Honors with Research Degree, only if CGPA $\geq$ 7.5 upto Semester VI. Students with DPW have to study the first two core papers marked with ‘*’. Other students will study all the papers offered in this semester

#This credit is for Experiential Learning

§Students not doing DPW will be taking these papers *in lieu* of the dissertation along with other papers offered in that particular semester.

# **SEMESTER I**

**Course: Zoology Core**  
**Paper Code: ZOO23C101**  
**Paper Title: Introductory Animal Biology, Systematics, Animal Diversity**  
**(Non-Chordates), Functional Biology of Non-chordates**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1= 4**

**Course Outcome (CO):**

**CO1:** Understanding the diversity of non-chordates.

**CO2:** Apply the knowledge of taxonomy in understanding animal diversity.

**CO3:** Understanding the structure and functions to analyze the basic biological system in non-chordates.

**CO4:** Understanding the evolutionary relationship among different organisms and analyze their affinities.

**CO5:** Analyzing non-chordates by distinguishing their unique origin, complexity and developmental processes.

**Theory**

**Credit: 3**

**Unit 1: Introductory Animal Biology**

**7L**

a) Water and life, Properties of water and role of water in life, b) Properties and significance of carbon in life, c) Prokaryotic and Eukaryotic cells, **d)** Symmetry, e) Early development: Protostome and Deuterostome, f) Body cavities: Acoelomate, Pseudocoelomate, Coelomate and Enterocoelomate, g) Homology and Analogy.

**Unit 2: Taxonomy and Systematics**

**7L**

a) Definition of Taxonomy and relationship with Systematics. Application of taxonomy, b) Newer trends in taxonomy - chemo-, cyto- and molecular taxonomy, c) Zoological Nomenclature: Binomial and Trinomial Nomenclature, d) International Code of Zoological Nomenclature (ICZN): Origin, Components and Rules of Nomenclature, e) Taxonomic hierarchy (Linnaean hierarchy), f) Species concept, supra - infra specific and sibling species.

**Unit 3: Animal Diversity (Non-Chordates)**

**15L**

**3.1 Protozoa –**

a) General characters and classification up to orders with examples, b) Type study: *Amoeba* and *Paramecium*,

c) Life cycle and pathogenicity of *Plasmodium vivax*.

**3.2 Metazoa-**

a) Evolution of metazoan, b) Metamerism of metazoan and its significance.

**3.3 Porifera –**

a) General characters and classification up to orders with examples.

**3.4 Cnidaria –**

a) General characters and classification up to orders with examples, b) Type study: *Obelia*,

polymorphism in Siphonophora, c) Diversity of coral and coral reefs formations.

### **3.5 Ctenophora-**

a) General characteristics b) Difference between Cnidaria and Ctenophora.

### **3.6 Annelida**

a) General characters and classification up to orders with examples.

### **3.7 Arthropoda**

a) General characters and classification up to orders with examples in Arthropoda, b) Social life of Honey bees.

### **3.8 Onycophora**

a) General Characters and evolutionary significance of Onycophora, b) Structure (Anatomical peculiarities) and affinities of Onycophora (Peripatus).

### **3.9 Mollusca**

a) General characters and classification of Mollusca upto orders with examples.

### **3.10 Echinodermata**

1. General characters and classification of Echinodermata upto orders with examples.

## **Unit 4: Functional biology of non-chordates**

**16L**

a) Nutrition, Locomotion and Reproduction in Protozoa, b) Canal system in Porifera (Sponges), c) Excretory organ and mechanism of excretion in Annelids and Arthropods, d) Respiration in Arthropoda, e) Torsion and Detorsion in Gastropoda, f) Foot modifications in Mollusca, g) Larval forms of Mollusca and evolutionary significance (trochophore larva), h) Water Vascular System in Asteroidea, i) Larval forms of Echinodermata, j) Respiratory pigments of non-chordates.

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**1. Study and classification of invertebrates (Museum specimen):**

**Porifera** - *Grantia, Sycon, Spongilla, Obelia,*

**Coelenterata** - *Physalia, Aurelia, Metridium, Pennatula, Gorgonia, Medrepora*

**Platyhelminthes** - *Dugesia, Taenia, Fasciola*

**Aschelminthes** - *Ascaris*

**Annelida**-*Aphrodite, Nereis, Heteronereis, Chaetopterus, Pheretima, Hirudinaria*

**Arthropods**-*Limulus, Balanus, Cancer, Scolopendra, Julus, Queen termite, Stick insect, Lepisma,*

**Praying mantis, Peripatus.**

**Mollusca**- *Chiton, Unio, Octopus, Loligo, Mytilus, Dentalium, Pinctada.*

**Echinodermata**- *Asterias, Echinus, Cucumaria, Ophiura, Clypeaster.*

2. Identification of permanent whole mount preparation: (*Amoeba, Euglena, Paramecium, Entamoeba*).
3. Study of: sponge spicules and gemmules from slide.
4. Permanent staining and mounting of specimens-*Euglena, Paramecium, Obelia* colony, *Cyclops, Daphnia*.
5. Study of T.S. through pharynx, gizzard and typhlosolar intestine of earthworm through permanent slides.
6. Temporary mount: mouth parts of housefly and mosquito.
7. Study of larval forms: Nauplius, Trochophore, Bipinnaria, Ophiopluteus, Pluteus, Echinopluteus.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings:**

1. Dalela & Sharma: Animal Taxonomy and Museology (1976, Jai Prakash Nath).
2. Kapoor: Theory and Practical of Animal Taxonomy (1988, Oxford & IBH).
3. Jordan. K. and P. S. Verma, Invertebrate Zoology, S Chand and Co. Ltd.
4. Modern text book of Zoology, Invertebrates, R. L. Kotpal, Rastogi Publications.
5. F. C. Majupuria-Invertebrate Zoology, Vol I.
6. E. L. Jordan and Dr. P. S. Verma, Invertebrate Zoology, S Chand and Co. Ltd.

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**Course: Zoology Minor**  
**Paper Code: ZOO23M101**

**Paper Title: Introductory Animal Biology, Systematics, Animal Diversity (Non-Chordates), Functional Biology of Non-chordates**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1= 4**

**Course Outcome (CO):**

**CO1:** Understanding the diversity of non-chordates.

**CO2:** Apply the knowledge of taxonomy in understanding animal diversity.

**CO3:** Understanding the structure and functions to analyze the basic biological system in non-chordates.

**CO4:** Understanding the evolutionary relationship among different organisms and analyze their affinities.

**CO5:** Analyzing non-chordates by distinguishing their unique origin, complexity and developmental processes.

**Theory**

**Credit: 3**

**Unit 1: Introductory Animal Biology**

**7L**

a) Water and life, Properties of water and role of water in life, b) Properties and significance of carbon in life, c) Prokaryotic and Eukaryotic cells, d) Symmetry, e) Early development: Protostome and Deuterostome, f) Body cavities: Acoelomate, Pseudocoelomate, Coelomate and Enterocoelomate, g) Homology and Analogy.

**Unit 2: Taxonomy and Systematics**

**7L**

a) Definition of Taxonomy and relationship with Systematics. Application of taxonomy, b) Newer trends in taxonomy – chemo-, cyto- and molecular taxonomy, c) Zoological Nomenclature: Binomial and Trinomial Nomenclature, d) International Code of Zoological Nomenclature (ICZN): Origin, Components and Rules of Nomenclature, e) Taxonomic hierarchy (Linnaean hierarchy), f) Species concept, supra - infra specific and sibling species.

**Unit 3: Animal Diversity (Non-Chordates)**

**15L**

**3.1 Protozoa –**

a) General characters and classification up to orders with examples, b) Type study: *Amoeba* and *Paramecium*, c) Life cycle and pathogenicity of *Plasmodium vivax*.

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a) Evolution of metazoan, b) Metamerism of metazoan and its significance.

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### **3.6 Annelida-**

a) General characters and classification up to orders with examples.

### **3.7 Arthropoda-**

a) General characters and classification up to orders with examples in Arthropoda, b) Social life of Honey bees.

### **3.8 Onychophora-**

a) General Characters and evolutionary significance of Onychophora, b) Structure (Anatomical peculiarities) and affinities of Onychophora (Peripatus).

### **3.9 Mollusca-**

a) General characters and classification of Mollusca up to orders with examples.

### **3.10 Echinodermata-**

General characters and classification of Echinodermata up to orders with examples.

## **Unit 4: Functional biology of non-chordates**

**16L**

a) Nutrition, Locomotion and Reproduction in Protozoa, b) Canal system in Porifera (Sponges), c) Excretory organ and mechanism of excretion in Annelids and Arthropods, d) Respiration in Arthropoda, e) Torsion and Detorsion in Gastropoda, f) Foot modifications in Mollusca, g) Larval forms of Mollusca and evolutionary significance (trochophore larva), h) Water Vascular System in Asterozoa, i) Larval forms of Echinodermata, j) Respiratory pigments of non-chordates.

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**Coelenterata** - *Physalia, Aurelia, Metridium, Pennatula, Gorgonia, Medrepora*  
**Platyhelminthes** - *Dugesia, Taenia, Fasciola*  
**Aschelminthes** - *Ascaris*  
**Annelida**-*Aphrodite, Nereis, Heteronereis, Chaetopterus, Pheretima, Hirudinaria*  
**Arthropods**-*Limulus, Balanus, Cancer, Scolopendra, Julus, Queen termite, Stick insect, Lepisma, Praying mantis, Peripatus.*  
**Mollusca**- *Chiton, Unio, Octopus, Loligo, Mytilus, Dentalium, Pinctada.*  
Echinodermata- *Asterias, Echinus, Cucumaria, Ophiura, Clypeaster.*
2. Identification of permanent whole mount preparation: (*Amoeba, Euglena, Paramecium, Entamoeba*).
3. Study of: sponge spicules and gemmules from slide.
4. Permanent staining and mounting of specimens-*Euglena, Paramecium, Obelia* colony, *Cyclops, Daphnia*.
5. Study of T.S. through pharynx, gizzard and typhlosolar intestine of earthworm through permanent slides.
6. Temporary mount: mouth parts of housefly and mosquito.
7. Study of larval forms: Nauplius, Trochophore, Bipinnaria, Ophiopluteus, Pluteus, Echinopluteus.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings:**

1. Dalela & Sharma: Animal Taxonomy and Museology (1976, Jai Prakash Nath).
2. Kapoor: Theory and Practical of Animal Taxonomy (1988, Oxford & IBH).
3. Jordan. K. and P. S. Verma, Invertebrate Zoology, S Chand and Co. Ltd.
4. Modern text book of Zoology, Invertebrates, R. L. Kotpal, Rastogi Publications.
5. F. C. Majupuria-Invertebrate Zoology, Vol I.
6. E. L. Jordan and Dr. P. S. Verma, Invertebrate Zoology, S Chand and Co. Ltd.

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**Course: Zoology**  
**Paper Code: ZOO23MDE101**  
**Paper Title: Food, Nutrition and Health**

**Total Lectures: 30**

**Credit (L+T+P): 2+0+1=3**

**Course Outcome (CO):**

**CO1:** Understanding basic concept of food and nutrition.

**CO2:** Create awareness about healthy eating and healthy life style.

**CO3:** Understanding about food hygiene.

**CO4:** Analysis of nutritional components of various food items.

**CO5:** Apply the knowledge gain about the nutritional components of the food in various food processing techniques.

**Theory**

**Credit: 2**

**Unit 1: Basic concept of Food and nutrition**

**8L**

Food composition, Balanced Diet, Food pyramid, Nutrient need for various groups: Children, Adolescents, Adults, Pregnant and nursing mother and Elderly, Recommended dietary allowances, Assessment of nutritional status, Food as medicine, Allergenic food

**Unit2: Nutritional Biochemistry**

**8L**

Carbohydrate, Protein, Lipid: Chemical composition, Classification, Dietary source and their functional role; Micronutrients-Vitamins, minerals and their biological significance  
Deficiency disorders: Major Nutritional problems- Protein energy malnutrition (Kwashiorkor, Marasmus), Anemia, Vitamin A deficiency, Iodine deficiency disorder  
Life style related diseases: Hypertension, Diabetes, Obesity-Prevention and management

**Unit 3: Food Hygiene**

**8L**

Food spoilage, causes and preventive measures; Food Poisoning, Food and water borne diseases-Bacterial, Viral, Protozoan, Helminths, Causes, pathogenesis, symptoms and prevention; Food quality control techniques and adulteration in Food

**Unit 4: Food processing**

**6L**

Food preparation methods (boiling, roasting, frying, sautéing, baking), Food preservation methods (canning, pickling, drying, roasting, freezing), Microorganisms important in food (Prebiotic and probiotic), Value addition processing of food.

1. Preparation of diet list for different age group based on secondary data sources.
2. Preparation of different nutritional components in different packaged food items and their comparative analysis (theoretical)
3. Estimation of Carbohydrate and protein in different food items
4. Estimation of Iron in food
5. Detection of adulteration in food (Ghee, sugar, tea leaves, turmeric, mustard oil)
6. Gram staining of bacteria

**Suggested Readings:**

1. Food Science by B. Srilakshmi
2. Food, Science and Nutrition. (2018), Sunetra Roday, Oxford University Press
3. Food, nutrition and Health. (2019), Beena Mathur, Rastogi Publications
4. Complete Book on Health and Nutrition. (2017). Dr. Walied Khawar Balwan,
5. Dietetics. (2019). B Srilakshmi , Vikas Book House, Pune.

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**Course: Zoology**  
**Paper Code: ZOO23SEC001**  
**Paper Title: Seri-Biology and Sericulture Practices**

**Total Lectures: 15**

**Credit (L+EL+P): 1+1+1=3**

**Course Outcome (CO):**

**CO1:** Understanding the basic of sericulture and their practices.

**CO2:** To know the importance of biology of silkworm in sericulture.

**CO3:** To expose the students to various entrepreneurship skill relating to sericulture and understanding the creation of job opportunities.

**CO4:** to be able to identify and understand the various pathogenesis of silkworm.

**CO5:** Understanding and applying rearing of silkworm and making handicrafts from waste cocoons.

**Theory**

**Credit:1**

**Unit 1: Introduction**

**5L**

Concept: Sericulture, Seri-biodiversity, Seri-biology, Seri-biotechnology; History: History of Sericulture, Silk route, History of sericulture in Assam; Sericulture Organization: Central Silk Board of India, Sericulture department of Government of India and Government of Assam, Types of silk insects: Mulberry and Non-Mulberry silk insects and their distribution.

**Unit2: Biology of Silkworm**

**5L**

Host plants: Host/Food plants of Major sericigenous insects (at least 4), distribution, cultivation and management; Life cycle: Mulberry, Muga, Eri and Tasar, rearing appliances, Pest and predators of silkworm and their management.

**Unit 3: Post Cocoon Technology**

**5L**

Preparation of cocoons for degumming, Silk reeling, Role of Silk other than in textile industry; Entrepreneurship development; Sericulture and Women empowerment

**Experiential learning (EL)**

**Credit: 1**

**(No. of hours:15)**

- Rearing of Eri silkworm
- Making handicrafts from waste cocoons.

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1. Identification of rearing appliances
2. Study of silkworm life cycle
3. Field visit and report submission.

**Suggested Readings:**

1. Sericulture with special reference to Assam. (2022), Tarali Kalita, North East Publishers, Guwahati, Assam.
2. A textbook on sericulture training. (2012), Amardev Singh, Oberoi book service.
3. Handbook of sericulture. (2019), Mukerji Nitya Gopal, Bangal secretariat book deport, Kolkata.
4. Application of Biotechnology in Sericulture.(2010), V. Shyam Kumar, Venkatesh Kumar R.
5. Vinesh A Text Book of Sericulture (Skill Enhancement Course). (2020), Dr. Hem Raj , S. Dinesh & Company

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# **SEMESTER II**



**Course: Zoology Core**  
**Paper Code: ZOO23C201**  
**Paper Title: Chordate Diversity, Comparative Anatomy and**  
**Functional Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1= 4**

**Course Outcome (CO):**

**CO1:** Understand about the different levels of organizations of chordates, their evolutionary relationship within and outside the phylum.

**CO2:** Ability to recall and remember basic characteristic concepts of every class of vertebrates along with their distinguishing features.

**CO3:** Knowledge gained will be used to analyze the adaptations operative in different organisms and their relevance in the biological systems.

**CO4:** Basic understanding of chordates and their biology will enable the students to synthesize/create information to appreciate the broader implications of chordate biology

**CO5:** Appreciate similarities and differences in life functions among various groups of Chordata.

**Theory**

**Credit: 3**

**Unit 1: Introduction to Chordates**

**8L**

General characteristics and classification of Chordata up to order.

**1.1. Protochordata:**

a) General characteristics and classification of sub-phylum Hemichordate, Urochordata and Cephalochordata up to classes, b) Salient features and affinities of *Balanoglossus*, c) Retrogressive metamorphosis in Urochordata (Ascidia), d) Affinities of *Amphioxus*.

**1.2. Agnatha:**

a) General characters and classification of cyclostomes up to order with examples, b) Ammocoete larva and its evolutionary significance, c) Distinction between *Petromyzon* and *Myxine*.

**Unit 2: Diversity of vertebrates**

**9L**

**2.1. Pisces:**

General characters and classification up to order with examples.

**2.2. Amphibia:**

General characters and classification up to living Orders with examples.

**2.3. Reptilia:**

General characters and classification up to living Orders with examples.

**2.4. Aves:**

a) General characters and classification up to living orders with examples, b) Archaeopteryx – a connecting link.

## **2.5. Mammals:**

- a) General characters and classification up to living orders with examples, b) Affinities of Prototheria and Marsupial, c) Adaptive radiation with respect to locomotory appendages.

### **Unit 3: Functional Biology**

**12L**

- a) Accessory respiratory organ, osmo-regulation, Migration and parental care in fishes. b) Respiration and parental care, Neoteny and paedogenesis in Amphibia, c) Poison apparatus and Biting mechanism in Snake. d) Migration, Perching and flight mechanism in birds. e) Sense organ and their functional significance in vertebrates.

### **Unit 4: Comparative Anatomy**

**16L**

#### **4.1 : Integumentary system**

Comparative structure, function and derivatives of integument in amphibian, birds and mammals.

#### **4.2 : Skeletal system**

Comparative account of the axial and appendicular skeleton in amphibia, birds and mammals.

#### **4.3 : Digestive System**

Comparison of dentition in vertebrates.

#### **4.4 : Respiratory system**

Comparative account of respiration through buccopharynx, skin, gills, lungs.

#### **4.5 : Circulatory system**

Comparative account of heart and aortic arches in vertebrates

#### **4.6 : Nervous system**

Comparative account of brain.

#### **4.7 : Urinogenital system**

Succession of kidney in vertebrates.

#### **4.8 : Sense organs**

Types of receptors in vertebrates.

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1. Study of Museum specimens: Identification and classification up to order. (Generic name should be given) *Balanoglossus, Herdmania, Amphioxus, Petromyzon, Myxine, Pristis, Torpedo, Hippocampus, Monopterus, , Notopterus, Rohu, Cyprinus, Hypophthalmichthys, Ctenopharyngodon, Clarius, Mystus, Nectures, Axoltol larva, Salamander, Hyla, Alytes, Chelone, , Draco, Chameleon, Naja, Hydrophis, Viper, Krait, House sparrow, Owl, Hedgehog, Manis, Bat, Monkey.*
2. Study of disarticulated skeleton of Toad, Pigeon and Guinea pig.
3. Comparative study of skull in vertebrates.
4. Temporary mounting: Placoid, Squamous and Ciliated Epithelium, Striated and non-striated muscles.
5. Permanent mounting: Cycloid, Ctenoid scales.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings:**

1. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill. McGraw Hill.
2. Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
3. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.

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**Course: Zoology Minor**  
**Paper Code: ZOO23M201**  
**Paper Title: Chordate Diversity, Comparative Anatomy and**  
**Functional Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1= 4**

**Course Outcome (CO):**

**CO1:** Understand about the different levels of organizations of chordates, their evolutionary relationship within and outside the phylum.

**CO2:** Ability to recall and remember basic characteristic concepts of every class of vertebrates along with their distinguishing features.

**CO3:** Knowledge gained will be used to analyze the adaptations operative in different organisms and their relevance in the biological systems.

**CO4:** Basic understanding of chordates and their biology will enable the students to synthesize/create information to appreciate the broader implications of chordate biology

**CO5:** Appreciate similarities and differences in life functions among various groups of Chordata.

**Theory**

**Credit: 3**

**Unit 1: Introduction to Chordates**

**8L**

General characteristics and classification of Chordata up to order.

**1.1. Protochordata:**

a) General characteristics and classification of sub-phylum Hemichordate, Urochordata and Cephalochordata up to classes, b) Salient features and affinities of *Balanoglossus*, c) Retrogressive metamorphosis in Urochordata (Ascidia), d) Affinities of *Amphioxus*.

**1.2. Agnatha:**

a) General characters and classification of cyclostomes up to order with examples, b) Ammocoete larva and its evolutionary significance, c) Distinction between *Petromyzon* and *Myxine*.

**Unit 2: Diversity of vertebrates**

**9L**

**2.1. Pisces:**

General characters and classification up to order with examples.

**2.2. Amphibia:**

General characters and classification up to living Orders with examples.

**2.3. Reptilia:**

General characters and classification up to living Orders with examples.

**2.4. Aves:**

a) General characters and classification up to living orders with examples, b) Archaeopteryx – a connecting link.

## 2.5. Mammals:

- a) General characters and classification up to living orders with examples, b) Affinities of Prototheria and Marsupial, c) Adaptive radiation with respect to locomotory appendages.

### Unit 3: Functional Biology

12L

- a) Accessory respiratory organ, osmo-regulation, Migration and parental care in fishes. b) Respiration and parental care, Neoteny and paedogenesis in Amphibia, c) Poison apparatus and Biting mechanism in Snake. d) Migration, Perching and flight mechanism in birds. e) Sense organ and their functional significance in vertebrates.

### Unit 4: Comparative Anatomy

16L

#### 4.1 : Integumentary system

Comparative structure, function and derivatives of integument in amphibian, birds and mammals.

#### 4.2 : Skeletal system

Comparative account of the axial and appendicular skeleton in amphibia, birds and mammals.

#### 4.3 : Digestive System

Comparison of dentition in vertebrates.

#### 4.4 : Respiratory system

Comparative account of respiration through buccopharynx, skin, gills, lungs.

#### 4.5 : Circulatory system

Comparative account of heart and aortic arches in vertebrates

#### 4.6 : Nervous system

Comparative account of brain.

#### 4.7 : Urinogenital system

Succession of kidney in vertebrates.

#### 4.8 : Sense organs

Types of receptors in vertebrates.

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## Practical

Credit:1

1. Study of Museum specimens: Identification and classification up to order. (Generic name should be given) *Balanoglossus, Herdmania, Amphioxus, Petromyzon, Myxine, Pristis, Torpedo, Hippocampus, Monopterus, Notopterus, Rohu, Cyprinus, Hypophthalmichthys, Ctenopharyngodon, Clarius, Mystus, Nectures, Axoltol larva, Salamander, Hyla, Alytes, Chelone, Draco, Chameleon, Naja, Hydrophis, Viper, Krait, House sparrow, Owl, Hedgehog, Manis, Bat, Monkey.*
2. Study of disarticulated skeleton of Toad, Pigeon and Guinea pig.
3. Comparative study of skull in vertebrates.
4. Temporary mounting: Placoid, Squamous and Ciliated Epithelium, Striated and non-striated muscles.

5. Permanent mounting: Cycloid, Ctenoid scales.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings:**

1. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill. McGraw Hill.
2. Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
3. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.

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**Course: Zoology**  
**Paper Code: ZOO23MDE201**  
**Paper Title: Ethnobiology of North East India**

**Total Lectures: 30**

**Credit (L+T+P): 2+0+1=3**

**Course Outcome (CO):**

**CO1:** Understand about the different ethnic practices and traditional knowledge prevalent in the society

**CO2:** Acquire knowledge on the importance of traditional knowledge and to create awareness about ways of safeguarding and documenting this knowledge.

**CO3:** Knowledge on different legal framework for the protection of TK would be learnt.

**CO4:** Application of traditional knowledge in medicine, healthcare, nutrition, biodiversity conservation etc. will be attained

**CO5:** Creating ways of developing entrepreneurship skills, addressing food security and many of the SDGs can be achieved with the application of knowledge gained in this area.

**Theory**

**Credit: 2**

**Unit 1:**

**7L**

Introduction to ethnobiology and traditional knowledge: nature and characteristics, scope and importance, Indigenous Knowledge (IK), Characteristics, traditional knowledge vis-a-vis indigenous knowledge.

**Unit 2:**

**8L**

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Geographical Indications (GI).value of TK in global economy, Role of Government to harness TK.

**Unit 3:**

**8L**

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016

**Unit 4:**

**7L**

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

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Field work: Survey of traditionally plants and animals as food and medicine and submission of report

**Suggested Readings:**

- 1) Traditional Knowledge System in India, by Amit Jha, 2009.
- 2) Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan, 2012.
- 3) Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002
- 4) "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino

**e-resource**

- 1) <https://www.youtube.com/watch?v=LZP1StpYEPM>
- 2) <http://nptel.ac.in/courses/121106003/>

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**Course: Zoology**  
**Paper Code: ZOO23SEC002**  
**Paper Title: Aquarium Fish Keeping and Pearl Farming**

**Total Lectures: 15**

**Credit (L+EL+P): 1+1+1=3**

**Course Outcome (CO):**

**CO1: Understanding** the potential scope of the Aquarium Fish Industry as a Cottage Industry.

**CO2: Analyze, compare and describe** the common characteristics and sexual dimorphism of freshwater and Marine Aquarium fishes.

**CO3: Acquire** knowledge of general Aquarium maintenance practices and entrepreneurship development.

**CO4:** Gain an in-depth **understanding** of pearl-producing mollusks, with a focus on species identification and biology of freshwater pearl mussels.

**CO5: Skill development** in surgical procedures involved in designer and round pearl surgery, along with post-operative care.

**Theory**

**Credit: 1**

**Part: 1 Aquarium Fish Keeping**

**Unit1: Introduction to Aquarium Fish Keeping and Biology of Aquarium Fishes**

**7 L**

1.The potential scope of Aquarium Fish Industry as a Cottage Industry, 2. Exotic and endemic species of Aquarium Fishes, 3. Common characters and sexual dimorphism of fresh water and Marine Aquarium tail, fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Bluemorph, Anemone fish and Butterfly fish.

**Unit2: Maintenance of Aquarium**

**1L**

1. General Aquarium maintenance, 2. Budget for setting up an Aquarium.

**Part: 2 Pearl Farming**

**Unit-I: General overview of pearl farming**

**7L**

1.Pearl-producing mollusks: Species identification and biology of freshwater pearl mussels (Unionidae); 2. Mechanism of pearl formation; 3. Surgical procedures: designer and round pearl surgery, post operative care, pond/tank culture of implanted mussels, 4. Harvesting and grading of pearls; 5. Soil and water quality for pearl farming; 6 Predators and diseases: Types and their control measures; 7. Setting up and managing a pearl farming venture.

## **Experiential learning**

**Credit: 1**

**No. of hours: 15**

1. Visit to a fish or pearl farm/Advanced laboratory/field collection of freshwater mussels, their identification and morphometric study.
2. Report submission on Field collection of freshwater mussels their identification and morphometric analysis.

## **Practical**

**Credit: 1**

1. Identification of Indigenous ornamental fish species of Assam (at-least10).
2. Identification of exotic ornamental (Aquarium) fish species (at-least10).
3. Study of different components of an aquarium.
4. Freshwater mussel's anatomy and morphometric study.
5. Freshwater mussel's food preparation: Culture of phytoplankton and zooplanktons in laboratory condition.
6. Surgical procedures: Preparation of nucleus and Designer pearl surgery.

### **Suggested Readings:**

1. A Manual of Freshwater Aquaculture, Santhanam, R.; Sukumaran, N.; Natarajan, P.; Oxford and IBH Publishing company.
2. Introduction to Economic Zoology, Sarkar, Kundu and Chaki; New Central Book Agency Ltd.
3. Fish and fisheries, Pandey and Shukla; Rastogi Publications.
4. Maria, H (2002). The Basic Methods of Pearl Farming: A Layman's Manual, University of Hawaii at Hilo Hilo, HI 96720, USA.
5. George, C.D. (1967). Techniques of pearl cultivation. South Pacific Bulletin
6. Gervis, M.H. & N.A. Sims. (1992). The biology and culture of pearl oysters (Bivalvia: Pteriidae). ICLARM. Manila, Philippines.
7. Doubilet, D (1995). Australia's magnificent pearls, farming oysters off their northwest coast Australia produces the world's largest cultured pearls. Published by Nat Geographic Mag,
8. Perveen, F. & Khan, A. (2012). Pearl Culturing Industry: Pearl Farming, Published by LAP Lambert Academic Publishing.
9. Mohamed, K.S. & Sasikumar, G. (2016). Overview of bivalve fisheries of India.
10. Subba Rao, N.V. (1989). Handbook, freshwater molluscs of India. Zoological Survey of India, Calcutta.

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# **SEMESTER III**

**Course: Zoology Core**  
**Paper Code: ZOO23C301**  
**Paper Title: Cell Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1. Understand** fundamental principles of cell biology and microscopy

**CO2. Understand** the structural organization and function of cell organelles involved in diverse cellular processes.

**CO3. Appreciate** how cells grow, divide, survive, die and regulate these important processes.

**CO4.** Comprehend the process of cell signaling and its role in cellular functions and to be able to analyze the anomalies in the functioning of the cellular processes that can develop into diseases.

**CO5.** Understand and correlate the histological structure of glands with its functioning

**Theory**

**Credit: 3**

**Unit 1: Introduction to Cells**

**10L**

**1.1 Basics of Cell**

Cell Theory, Basic structure of Prokaryotic and Eukaryotic cells, Basic structure of viruses, Elementary idea of microscopy.

**1.2 Organization of cell-I:**

Plasma membrane: Ultra-structure and composition of Plasma membrane, Function of plasma membrane, Transport across plasma membrane (active and passive), Elementary knowledge of cell communication and cell junctions.

**Unit 2: Organization of the cell-II**

**11L**

**2.1: Cytoplasmic organelles:**

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes & Ribosomes.

**2.2: Mitochondria and Electron transport chain**

Mitochondria: Structure and function, Mitochondrial Respiratory Chain.

**2.3: Nuclear organization**

Structure of nucleus (nuclear envelope, nuclear pore complex, nucleolus) and function, Interface

chromatin and its compaction into metaphase chromosome, euchromatin and heterochromatin.

### **Unit 3: Cytoskeleton and cell reproduction**

**12L**

#### **3.1: Cytoskeleton**

Cytoskeletons- Microtubules, Microfilament and Intermediate filament, their Structure and function.

#### **3.2: Cell division**

Cell cycle, Regulation of cell cycle progression, Events of mitosis and meiosis, Significance of mitosis, Elementary knowledge of cancer: its development, types and causes, Apoptosis and Necrosis.

#### **3.3 Cell signaling**

Cell signaling transduction pathways, Types of signaling molecules and receptors, GPCR and Role of second messenger (cAMP).

### **Unit 4 Histology**

**12L**

Basic principles of fixation and staining: classification, composition and properties of dye. Use of mordants. Microtomy technique. Cellular differentiation and its mechanism. Structure and function of epithelial, connective, muscular, nervous, cardiac tissues. Histology of GI tract, liver, pancreas, spleen, lung, kidney of mammal.

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### **Practical:**

**Credit – 1**

- 1) Study of prokaryotic cells and eukaryotic cells (slide/photographs).
- 2) Study of anatomical structure of skeletal, smooth and cardiac muscles using prepared permanent slides.
- 3) Microtomy and histology: Preparation of temporary and permanent slides.
- 4) Staining of mitochondria from buccal epithelium.
- 5) Study various stages of mitosis from the temporary squash preparation of onion root tip/tadpole tail.
- 6) Study of meiosis from the temporary squash preparation in Grasshopper/Gryllotalpa testes.

- 7) Study of permanent histological slides of mammal: Kidney, Liver, lungs, stomach, pancreas and spleen.
- 8) Study of normal and cancer cells (Slide/Photograph)
- 9) Measurement of cell size by ocular & stage micrometer.

**Suggested Readings-**

1. Lodish, H. and Berk, A et al. (2021). Molecular Cell Biology, 9<sup>th</sup> edition, WH Freeman.
2. Alberts, B. Johnson, A. Lewis, J. et al. (2022). Molecular Biology of the Cell. 7<sup>th</sup> edition. New York: Garland Science.
3. Geoffrey, M. Cooper, Robert, E. Hausman (2015). Molecular Biology of the Cell. 7<sup>th</sup> edition, Sunderland (MA).
4. Brown, T.A. (2022). Genomes 5, 5<sup>th</sup> edition, Garland Science
5. Liebich, H.G. (2019). Veterinary histology of domestic mammals and bird's 5<sup>th</sup> edition, 5M Books Ltd.
6. Brijesh Kumar (2023). Histology Text and Atlas, 3<sup>rd</sup> edition, Wolters Kluwer India Pvt. Ltd.
7. Eroschenko (2017). Atlas of Histology with Functional Correlations, 13<sup>th</sup> edition, Wolters Kluwer India Pvt. Ltd.
8. Mishra, T. and Singh, B.D. (2020). Cell Biology. 1<sup>st</sup> edition, Mahaveer Publications.
9. Kleinsmith (2016). Principles Of Cancer Biology. 1<sup>st</sup> edition, Pearson Education India.
10. Verma P.S., Agarwal V.K. (2019). Cell Biology, Genetics, Evolution & Ecology. S Chand & Company.



**Paper: Zoology Core**  
**Paper Code: ZOO23C302**  
**Paper Title: Ecology and Wildlife Biology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

CO 1: To **understand** the basic knowledge of ecology and ecosystem.

CO 2: To **know** about the important attributes of population and community.

CO 3: To **analyze** the impact and effects of different types of pollution on ecosystem.

CO 4: To **study** the importance of conservation and strategies adopted.

CO 5: To **acquire** the information and in depth **understanding** of different biomes and its species richness

**Theory**

**Credit: 3**

**Unit 1: Introduction to Ecology**

**12L**

Basic concepts and definitions: ecology, ecosystems, resistance and resilience; autecology; synecology; major terrestrial biomes, Biogeochemical cycles and sedimentary cycle, role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies. Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; thermoregulation; strategies of adaptation in plants and animals.

**Unit 2: Population and Community**

**15L**

a) Unique and important attributes of population (population characteristics density, natality, mortality, life tables, Fecundity tables, survivorship curve, age and sex ratio, Dispersion; b) Population Growth- Geometric and Exponential logistic growth equation, R & K strategies, Population regulation: density dependent and independent factors; c) Population interaction- Gause's principle with laboratory and field examples, Malthusian equation, Lotka-Volterra equation for competition, predator-prey cycle; d) Community characteristics, spurs diversity, Abundance, Dominance, richness, vertical stratification, Ecotone and edge effect; e) Ecological succession; f) Theories pertaining to climax community.

### Unit 3: Ecosystem and Pollution Biology

10L

a) Types of ecosystems with examples, Food Chain- Detritus & Grazing food chain (Linear & Y shaped), Food Web; b) Energy flow through ecosystem, Ecological pyramids & Ecological efficiency; c) Biogeochemical cycles (Nitrogen cycle, Carbon Cycle); d) Sources and impact of environmental pollutants– air, water and soil, Noise Pollution, Radioactive Pollution; e) Point and non-point sources of pollution; f) Pollution Control.

### Unit 4: Wildlife Biology

8L

a) Definition of Wildlife; b) Strategies for Wildlife Conservation & Management; c) *In-situ* and *Ex-situ* Conservation; d) IUCN Red list; e) Wild life (protection) Act of 1972 and 1991 amendment; f) Wildlife Sanctuaries, National Parks, Biosphere Reserves of NE India; g) Rare and Endangered mammalian species of NE India.

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### Practical

Credit-1

- 1) Study of population density in a natural/hypothetical community by quadrat method.
- 2) Study of an aquatic ecosystem: Phytoplankton and zooplankton.
- 3) Determination of temperature, turbidity, alkalinity, pH, dissolved oxygen content (Winkler's method) and free carbon dioxide with reference to aquatic ecosystem.
- 4) Determination of temperature, moisture content of soil.
- 5) Determination of BOD
- 6) Visit to Wildlife Sanctuary/Biodiversity Park/Zoological Park/Captive Breeding Center to study behavioral activities of animals and submission of report.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings:**



1. P. S. Verma and V.K. Agarwal, Text book of Ecology
2. Ecology-Theories and Applications 2001,4<sup>th</sup> edition, Peter Styling.
3. Odum, E. P., 2008, Fundamentals of Ecology, Indian edition, Brooks/Cole.
4. Krebs, C.J., 2001, Ecology, VI edition, Benjamin Cummings.
5. Smith, RM and Smith TM. 2000. Ecology and field Biology. Benjamin Cummings.



**Course: Zoology Minor**  
**Paper Code: ZOO23M301**  
**Paper Title: Cell Biology, Ecology and Wildlife Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1: Understand** fundamental principles of cell biology, structural organization and function of cell organelles and microscopy

**CO2: Comprehend** the process of cell division, regulation, signaling and its role in cellular functions and to be able to analyze the anomalies in the functioning of the cellular processes that can develop into diseases.

**CO3: Understand and correlate** the histological structure of glands with its functioning

**CO4: To understand** the basic knowledge of ecology and ecosystem.

**CO5: To know** about the important attributes of population and community.

**Theory**

**Credit: 3**

**Part – 1: Cell Biology**

**Unit 1: Introduction to Cells**

**8L**

- a) Introduction to Cell Theory.
- b) Basic structure of Prokaryotic and Eukaryotic cells and their comparison, Concept of viruses.
- c) Elementary idea of microscopy.

**1.1: Organization of cell-I**

- a) Ultra-structure and composition of Plasma membrane: Various models, Function of plasma membrane: permeability, osmosis, transport across membrane (active and passive), facilitated transport.

**Unit 2: Organization of the cell-II**

**8L**

**2.1: Cytoplasmic organelles I**

- a) Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Ribosomes.

**2.2: Cytoplasmic organelles II**

- a) Mitochondria: Structure and function.

### **2.3: Nuclear organization**

a) Structure of nucleus (nuclear envelope, nuclear pore complex, nucleolus) and function. Euchromatin and heterochromatin.

## **Unit 3: Cytoskeleton and cell reproduction**

**6L**

### **3.1: Cytoskeleton**

a) Types of cytoskeletons and their role in cell movement, b) Structure and function of microtubules, microfilament and intermediate filament.

### **3.2: Cell division**

a) Basic features of cell cycle, Events of mitosis and meiosis and its significance.

## **Part – II: Ecology and Wildlife Biology**

### **Unit 1: Introduction to Ecology**

**3L**

a) History of ecology, autecology, synecology, levels of organization, abiotic factors and impact on animals. c) Soil types.

### **Unit 2: Population and Community**

**5L**

a) Population characteristics density, natality, mortality, life tables, Survivorship curve, Dispersion, b) Population Growth- Geometric and Exponential logistic growth equation.

### **Unit 3: Ecosystem and pollution Biology**

**9L**

a) Types of ecosystems with examples, Food Chain- Detritus & Grazing food chain, Food Web, b) Energy flow through ecosystem, Ecological pyramids, c) Biogeochemical cycles (Nitrogen cycle), d) Sources and impact of environmental pollutants– air, water and soil.

### **Unit 4: Wildlife Biology**

**6L**

a) Definition of Wildlife, b) Strategies for Wildlife Conservation & Management, c) IUCN Red list, d) Wild life (protection) Act of 1972 and 1991 amendment, e) Wildlife Sanctuaries, National Parks, Biosphere Reserves of NE India, f) Rare and Endangered mammalian species of NE India.

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**Practical**

**Credit – 1**

- 1) Diversity of eukaryotic cells – methylene blue staining of buccal epithelium, striated muscle, Leishman staining of mammalian blood cells.
- 2) Staining of mitochondria from buccal epithelium.
- 3) Study various stages of mitosis from the temporary squash preparation of onion root tip/tadpole tail.
- 4) Study of meiosis from the temporary squash preparation in Grasshopper/Gryllotalpa testes.
- 5) Study of sex chromatin from buccal epithelia.
- 6) Study of an aquatic ecosystem: Phytoplankton and zooplankton.
- 7) Determination of temperature, turbidity, alkalinity, pH, dissolved oxygen content (Winkler’s method) and free carbon dioxide with reference to aquatic ecosystem.
- 8) Determination of temperature, moisture content of soil.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings:**

- 1. The Cell: A Molecular Approach. V Edition. Cooper, G.M. and Hausman, R.E. (2009), ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- 2. Karp G. 2010, Cell and Molecular Biology, John Wiley Publication, 6th Edn. John Wiley and Sons.
- 3.P. S. Verma and V.K. Agarwal, Text book of Ecology
- 4.Odum, E. P., 2008, Fundamentals of Ecology, Indian edition, Brooks/Cole.
- 5. Krebs, C.J., 2001, Ecology, VI edition, Benjamin Cummings.



**Course: Zoology**  
**Paper Code: ZOO MDE301**  
**Paper Title: Environment And Public Health**

**Total Lecture: 30**

**Credits (L+T+P): 2+0+1=3**

**Course Outcome (CO):**

**CO1.** To **know** and **understand** the various aspects of environmental risks and hazards.

**CO2.** Ability to **analyze** the factors contributing to environmental hazards and disasters

**CO3. Know and learn** various waste management technologies and their utility.

**CO4. Understand** various diseases and ways to prevent them.

**CO5. Understand** the importance of healthy living and create awareness on life style disorders

**Theory**

**Credit: 3**

**UNIT I: Introduction**

**7L**

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

**Unit II: Waste Management Technologies**

**9L**

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, nuclear waste handling and disposal, Waste from thermal power plants, Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.

**Unit III: Epidemiology**

**7L**

Hepatitis, AIDS, Amoebiasis, Tuberculosis, Malaria, Dengue, Cholera, Minamata disease, typhoid, causative agent, prognosis, treatment and management, History, manifestation of novel corona virus disease and vaccine.

**Unit IV: Life style related and Genetic diseases:**

**7L**

Hypertension, diabetes and cardiac diseases – prevention and management, psychology and emotional wellbeing, Genetic and congenital diseases.

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**Practical:****Credit: 1**

1. Determination of pH, Cl, in water samples from different locations.
2. Hospital visit/ Municipal Corporation and record of biomedical/ common waste management.
3. Filed survey and report submission on life style related diseases.
4. Karyotyping from supplied photographs of chromosome plate.

**Suggested Readings-**

- 1.Environmental and Health Risk Assessment and Management, Principles and Practices, Paolo F. Ricci, 2006, volume 9, SpringerLink.
- 2.Global Environmental Risks, Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., V.N. University Press, New York, 2003.
- 3.Quantitative Environmental Risk Analysis for Human Health, Robert A. Fjeld, Norman A. Eisenber, Keith L. Compton, Willey 2006.
- 4.Basic epidemiology, 2nd ed, Bonita, Ruth, Beaglehole, Robert, Kjellström, Tord & World Health Organization. (2006). <https://apps.who.int/iris/handle/10665/43541>

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**Course: Zoology**  
**Paper Code: ZOO SEC003**  
**Paper Title: Vermicomposting and Biofertilizer**

**Total Lectures: 15**

**Credit (L+EL+P): 1+1+1=3**

**Course Outcome (CO):**

**CO1:** Knowing the basics of vermiculture techniques

**CO2:** Understanding the importance of vermiculture and applying the knowledge gained to consider eco-friendly ways of waste management

**CO3:** To know and learn about the different biofertilizers and their development and application

**CO4:** To understand the role of microbes and invertebrates in vermicomposting and biofertilizers.

**CO5:** Create awareness and entrepreneurship opportunities associated with it.

**Theory**

**Credit: 1**

**Unit 1: Vermicomposting I**

**8L**

Vermiculture- Definition, Scope and importance, Common species for culture, Environmental parameters; Vermicomposting of small scale, large scale composting process, harvesting, processing and drying, Nutrient content of vermi compost.

**Unit II: Vermicomposting I**

**7L**

Application of vermicomposting, earthworms for management of municipal, biomedical wastes; future perspective of vermicomposting, constraints for vermiculture in India.

**Unit III: Biofertilizer I**

**8L**

Biofertilizers - Introduction, scope, a general account of Biofertilizers organisms: Cyanobacteria (BGA), Bacteria and Mycorrhizae,

Cyanobacteria (BGA) as biofertilizers: *Anabaena*, *Cylindrospermum*, *Gloeocapsa*, *Lyngbya*, *Nostoc*, *Azolla*. Mass cultivation of *Azolla*, Symbiotic association of Cyanobacteria, Field application of Cyanobacterial inoculants.

#### Unit IV: Biofertilizer II

8L

General account of bacterial biofertilizer organisms: *Azospirillum*, *Azotobacter*, *Frankia*, *Phosphobacteria* and *Rhizobium*, Mechanism of nitrogen fixation (free-living and symbiotic), Phosphate solubilization and mobilization.

Mycorrhizal fungi as biofertilizers - Introduction, scope, A general account of Ecto, Endo and Arbuscular mycorrhizae, methods of collection, wet sieving and decanting method and inoculum production.

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#### Experiential learning

Credit: 1

1. Visit to relevant labs
2. Visit to compost making farms

#### Practical:

Credit: 1

1. Study of the earthworm digestive system and life cycle through charts.
2. Preparation of vermicompost
3. Learning storage and packaging

#### Suggested Readings:

1. The Complete Technology Book on Vermiculture and Vermicompost (Earthworm) with Manufacturing Process, Machinery Equipment Details & Plant Layout 2nd Edition, Himadri Panda, Asia Pacific Business Press Inc. 2022.
2. Vermicomposting for Sustainable Food Systems in Africa Hupenyu Allan Mupambwa, , Lydia Ndinela Horn, Pearson Nyari Stephano Mkeni, Springer 2023.
3. Economic Zoology, G.S. Sukla, Rustogi Publication.
4. A Textbook of Vermicompost: Vermiwash and Biopesticides, Singh, Keshav, Biotech Books, 2000
5. Handbook of Vermicomposting Technology by Dr.E. Sreenivasan, Technical Manager, R&D The Western India Plywoods Ltd, Kannur, Kerala.

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# **SEMESTER IV**

**Course: Zoology Core**  
**Paper Code: ZOO23C401**  
**Paper Title: Genetics**

**Toral Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** To learn the basic concepts of genetics and its principles in understanding the principles of inheritance

**CO2:** Understand the various kinds of gene and allelic interactions and apply that knowledge in understanding their manifestation on the Phenotype of the animal

**CO3:** Understand the process of variation generation through mutations and recombination and its implications on several diseases and genetic disorders

**CO4:** To learn the mechanism of sex determination and apply the knowledge of principles of inheritance in genetic counselling

**CO5:** To apply the knowledge and understanding of microbial genetics in genetic engineering and other related fields.

**Unit 1: Mendelian genetics and its extension**

**15L**

a) Mendelian genetics-monoybrid, dihybrid crosses, application of laws of probability to Mendelian inheritance laws; b) Principles of inheritance, Incomplete dominance and co-dominance, Epistasis, Multiple alleles, Lethal alleles; c) Extra-chromosomal Inheritance; d) Role of environment in phenotypic expression; e) Population genetics- Hardy Weinberg theorem and its applications, genetic drift

**Unit 2: Linkage and mutations**

**12L**

a) Linkage and Crossing Over; b) Measuring Recombination frequency and linkage intensity using three factor crosses, Interference and coincidence; c) cytological aspects of crossing over in *Drosophila*; d) mutagens and molecular basis of mutations in relation to UV light; e) Mutation-Gene and Chromosomes.

**Unit 3: Sex Determination and Human Genetics**

**12L**

a) Mechanisms of sex determination in *Drosophila*; b) Sex determination in mammals; c) Dosage

compensation in *Drosophila* & Human; d) Genetic disorders-aneuploidy (Down, Turner and Klinefelter syndromes), chromosome translocation (chronic myeloid leukemia, *cri-du chat*); f) Gene mutation (cystic fibrosis, sickle cell anemia); g) Genetic counselling and pedigree.

**Unit 4: Microbial Genetics and Applications of genetic engineering**

**6L**

a) Reproduction in Bacteria (conjugation, transformation, and transduction), recombination in bacteria and bacteriophage; d) Viral reproduction (lysogenic and lytic cycles); e) General concept of genetic engineering and its applications, Crop and livestock improvement.

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**Practical**

**Credit:1**

1. Pedigree analysis of some human inherited traits and solving related problems
2. Estimating allele and genotypic frequencies using Hardy-Weinberg law and verification using Chi-square test
3. Preparation and Mounting of sex chromatin (bar bodies) from the buccal epithelium.
4. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome) through charts.
5. Study of any two-case history of genetic disorders
6. *Drosophila* culture and study of mutant variety.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be maintained.**

**Suggested Readings –**

1. Brooker: Genetics: Analysis and Principles (1999, Addison-Wesley,)
2. Gardner et al: Principles of Genetics (2006, John Wiley)
3. Griffith et al: An Introduction to Genetic Analysis (2020, Freeman)
4. Hartl & Jones: Essential Genetics: A Genomic Perspective (2002, Jones & Bartlett)
5. Russell: Genetics (2002, Benjamin Cummings)
6. Snustad & Simmons: Principles of Genetics (2019, John Wiley)
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. XII Edition. Benjamin Cummings.
8. Hamilton, M.B. (2021). Population Genetics. Wiley Blackwell.

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**Course: Zoology Core**  
**Paper Code: ZOO23C402**  
**Paper Title: Animal Behaviour and Chronobiology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** The main aims of designing these topics of Animal Behavior and Chronobiology is to foster a multifaceted understanding of the intricate interplay between biological processes and behavior.

**CO2:** It will able to develop students' skills in observing, analyzing, and interpreting animal behavior, as well as comprehending the underlying principles of chronobiological phenomena.

**CO3:** Emphasis are given on encouraging critical thinking, data interpretation, and the application of theoretical concepts to real-world scenarios.

**CO4:** Additionally, it will underscore the importance of these disciplines as foundational pillars for pursuing higher education in areas like ecology ethology, and neuroscience.

**CO5:** Analytical and research skills will be developed preparing them for the challenges of advanced studies and future contributions to the broader scientific community.

**Theory**

**Credit: 3**

**A: Animal Behavior**

**Unit 1: Introduction to Animal Behavior**

**7L**

a) Introduction to animal behaviors, three key pioneers of animal behaviour and their contribution- Karl von Frisch and Konrad Lorenz, and Nikolaas (Niko) Tinberge; b) Behavior equipment – Sign, Stimuli, Stimulus filtering; d) Experience and learning

**Unit 2: Animal Behaviour and Pattern**

**8L**

a) Animal behavior-innate or inherent behavior, learned behavior, vision and behavior, sound and behavior; b) Behavioral ecology- territoriality and group living; c) Genetic, hormonal and evolutionary aspects of behavior

**Unit 3: Sociobiology**

**8L**

a) Social behavior: sexual strategy, altruism, parental care and cooperation, kin selection b) Eusocial organization- honey bees; c) animal communication- honey bee dance d) Primate social behavior.

## **B: Chronobiology**

### **Unit 4: Biological rhythms I**

**14L**

- a) Introduction to chronobiology, definition & types of rhythms, Types and characteristics of biological rhythms; b) Basic types of exogenous rhythms and their significance, c) Concept of central and peripheral clock system, d) Clock and clock genes; e) Photic and non-photic zeitgeber, f) Photoperiodism.

### **Unit 5: Biological rhythms II:**

**8L**

- a) Biosynthesis of melatonin; b) Role of melatonin in circadian control, c) neurotransmitters in circadian control, d). Pacemaker function of the SCN f) Role of SCN in the human, photic and non-photic pathways, g). Chronotherapy.

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### **Practical:**

**Credit - 1**

1. Study of any one social insect colony.
2. To study the geotaxis behavior of earthworm.
3. To study orientation response of woodlice to different stress.
4. To study the behavior of any animal of choice in captive or in open and record their observations.
5. Study of double plot actogram for locomotor activity rhythm through chart
6. Circadian behaviour of eclosion in *Drosophila*.
7. To study the record of bird's songs.

### **Suggested Readings:**

1. Alcock. Animal Behaviour- An Evolutionary Approach (7<sup>th</sup>ed.) Sinaur Associates, Inc.2001.
2. Drickamer & Vessey. Animal Behaviour Concepts, Processes and Methods (2<sup>nd</sup> ed.), Wadsworth, 1986.

3. Jonathan Ross. The Princeton Guide to Evolution. 2014. Princeton University Press
4. Bergstrom, CT and Dugatkin, LA. Evolution (1ed). 2012.
5. McFarland, D. Animal Behaviour. 1999. Addison Wesley Longman Limited
6. Circadian Physiology 3<sup>rd</sup> Edition by Roberto Refinetti, PhD. Copyright 2016, Taylor and Francis.
7. Biological Timekeeping: Clocks, Rhythms and Behaviour 1st ed. 2017 Edition, Kindle Edition by Vinod Kumar, Springer.

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**Course: Zoology Core**  
**Paper Code: ZOO23C403**  
**Paper Title: Physiology and Endocrinology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Gain comprehensive knowledge of the fundamental concepts underlying physiological and endocrine processes. Develop a deep understanding of the interplay between different physiological systems and hormonal regulation.

**CO2:** Understand the structures and physiological processes involved in maintaining homeostasis, including gas exchange, circulation, blood pressure regulation, physiological processes involved in digestion, including mechanical and chemical digestion, nutrient absorption, and waste elimination.

**CO3:** Develop a comprehensive understanding of the principles governing neural coordination, including synaptic transmission, muscles contractions and the system. Acquire in-depth knowledge of neuroanatomy, neurophysiology, and neurochemistry to comprehend the intricate processes involved in neural coordination.

**CO4:** Develop and encourage critical thinking and problem-solving skills to develop novel interventions for cardiovascular and renal problem.

**CO5:** Apply the acquired knowledge to address practical challenges in healthcare, exercise, pharmacology, and related fields.

**Theory**

**Credit: 3**

**A. Physiology**

**Unit 1: Life sustaining systems**

**1.1 Physiology of digestion:**

**5L**

a) Structural organization and functions of Gastrointestinal tract, b) Mechanical and chemical digestion of food, c) Absorptions of carbohydrates, lipids and proteins.

**1.2 Physiology of Respiration:**

**5L**

a) Foundational understanding of respiration and its various forms, b) Transport of Oxygen and Carbon dioxide in blood, c) Dissociation curves.

**1.3 Physiology of Circulation: 4L**  
a) Components of Blood and their functions; Structure and functions of hemoglobin, b) Homeostasis: coagulation of blood, c) Hemopoiesis: definition, type and process, d) Blood groups: ABO and Rh factor.

**1.4 Physiology of heart: 4L**  
a) Structure of mammalian heart, b) Coronary Circulation, Origin and conduction of cardiac impulses, c) Cardiac Cycle and cardiac output, d) Blood pressure and its regulation.

**1.5 Thermoregulation & Osmoregulation: 4L**  
a) Physiological classification based on thermal biology, b) Thermal biology of endotherms, c) Osmoregulation in aquatic vertebrates, e) Extra renal osmoregulatory organs in vertebrates.

**Unit 2: Control and coordinating systems**

**2.1: Nervous System 4L**  
a) Structure of neuron, resting membrane potential, b) Propagation of nerve impulse, c) Synaptic transmission and Neuromuscular junction, d) Reflex action and its types.

**2.2: Muscular system 3L**  
a) Ultra-structure of muscles, b) Mechanism of muscle contraction.

**2.3 Renal Physiology: 3L**  
a) Structure and functions of kidney b) Mechanism of urine formation, c) Regulation of acid-base balance, d) Dialysis.

**B. Endocrinology**

**Unit 3: Introduction to Endocrinology 8L**  
a) Brief account of structural and function of endocrine glands- pituitary, thyroid, parathyroid, pancreas, adrenal, gonadal glands b) Structure of pineal gland, secretions and their functions.

**Unit 4: Hormone action and Hormonal dysfunctions 5L**  
a) Basics of hormone action and feedback mechanism, b) Effects of abnormal secretions of hormones and associated diseases, c) Bioassays of hormones using RIA and ELISA.

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**Practical Credit-1**

1. Determination of ABO Blood group.



2. Enumeration of red blood cells and white blood (total /differential count) cells using haemocytometer.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Preparation of haemin (haemochromogen) crystals from mammal/fish blood.
5. Recording of blood pressure using a sphygmomanometer.
6. Determination of pulse rate at rest and after exercise.
7. To demonstrate the activity of salivary amylase and effect of acid & heat (temp) on its activity.
8. Study of permanent slides/photo of different endocrine glands in vertebrates (pituitary, thyroid, testis, ovary).

**\*\*Lab notes book, with drawing and labelling; methods where applicable.**

**Suggested Readings:**

1. Guyton, A.C. & Hall, J.E. (2020). Textbook of Medical Physiology. 14<sup>th</sup> Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
2. Verma, A.K. & Singh, S. (2022). General Zoology (for UG & PG students), Publisher: Blue Rose Publishers, Daryaganj, Delhi.
3. Eckert and Randal (2020) Animal Physiology: Mechanisms and Adaptations.
4. Rastogi, S.C. (2021) Essentials of Animal Physiology
5. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.
6. Sembulingam, K and Sembulingam, P. (2020). Essentials of Medical Physiology
7. L.O. DeGroot. W.B. (2020), Saunders, Endocrinology. Vols. I, II and III
8. David O. Norris (2018), Vertebrate Endocrinology
9. Mac E. Hadley (2022), Endocrinology, Pearson Education.
10. Philip C Withers (2020), Comparative Animal Physiology
11. Alice Roberts (2020), Human Anatomy
12. Ranganath (2019), Basics in Human Anatomy
13. A K Jain (2018), Human Physiology in Nutshell Vertebrate Endocrinology by David O. Norris.

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**Course: Zoology Minor**  
**Paper Code: ZOO23M401**  
**Paper Title: Genetics, Animal Behaviour, Chronobiology, Physiology and Endocrinology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** To learn and understand the inheritance pattern and phenotypic expression existing in population

**CO2:** Understand the process of variation generation through mutations and recombination and its implications on several diseases and genetic disorders

**CO3:** To develop skills in observing, analyzing, and interpreting animal behavior, as well as comprehending the underlying principles of chronobiological phenomena.

**CO4:** Understand the structures and physiological processes involved in maintaining homeostasis,

**CO5:** Gain comprehensive knowledge of the fundamental concepts underlying physiological and endocrine processes

**Theory**

**Credit: 3**

**Unit 1: Mendelian genetics and its extension**

**16L**

a) Mendelian genetics-monoybrid, dihybrid crosses, b) Principles of inheritance, Incomplete dominance and co-dominance, Epistasis; c) Population genetics- Hardy Weinberg theorem and its applications, genetic drift, d) Mutation- Gene and chromosome e) Genetic disorders-aneuploidy (Down, Turner and Klinefelter syndromes), chromosome translocation (chronic myeloid leukemia, *cri-du chat*); f) Gene mutation (cystic fibrosis, sickle cell anemia); g) Genetic counselling and pedigree

**Unit 2: Animal Behaviour and Chronobiology**

**8L**

a) Introduction to animal behaviour, Types of learning; and behavior; b) Territoriality and group living; c) sexual strategy, altruism, parental care; d) animal communication- honey bee dance; e) Introduction to chronobiology, characteristics of biological rhythms; f) Basic types of exogenous rhythms and their significance, g) Photic and non-photic zeitgeber.

**Unit 4: Physiology**

**15L**

a) Understanding the mechanism of digestion and absorption, b) process of mammalian respiration; c) components of blood and their function, blood groups and Rh factor; d) Coronary Circulation, Cardiac Cycle and cardiac output, e) Blood pressure and its regulation; f) osmoregulation in aquatic and terrestrial vertebrate; g) Process of nerve conduction, reflex action and its types; h) Mechanism of muscle contraction; i) Excretory organ and their functions

### **Unit 5: Endocrinology**

**6L**

a) Endocrine and nervous system in regulating animal's physiology; b) brief account of endocrine glands and its secretions and functions; c) Basics of hormone action and feedback mechanism, d) Effects of abnormal secretions of hormones and associated diseases.

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### **Practical**

**Credit:1**

- 1) Pedigree analysis of some human inherited traits through charts.
- 2) Determination of ABO blood group and genotypic frequency calculation.
- 3) Preparation and mounting of sex chromatin (bar bodies) from the buccal epithelium.
- 4) To study orientation response of woodlice to different stress.
- 5) Study of homologous and analogous organs through suitable museum specimen (wings of birds & insect, forelimbs of bat & rabbit)
- 6) Study of double plot actogram for locomotor activity rhythm through chart
- 7) Recording of blood pressure using a sphygmomanometer.
- 8) Estimation of haemoglobin using Sahli's haemoglobinometer.
- 9) Study of permanent slides/photo of different endocrine glands in vertebrates (pituitary, thyroid, testis, ovary).

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be maintained.**

### **Suggested Readings –**

1. Gardner et al: Principles of Genetics (2006, John Wiley)

2. Snustad & Simmons: Principles of Genetics (2019, John Wiley)
3. Lewin: Genes XII (2017, Jones & Bartlett).
4. Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. XII Edition. Benjamin Cummings.
5. Alcock. Animal Behaviour- An Evolutionary Approach (7<sup>th</sup>ed.) Sinaur Associates, Inc.2001.
6. Drickamer & Vessey. Animal Behaviour Concepts, Processes and Methods (2<sup>nd</sup>ed.), Wadsworth, 1986.
7. McFarland, D. Animal Behaviour. 1999. Addison Wesley Longman Limited
8. Circadian Physiology 3rd Edition by Roberto Refinetti, PhD. Copyright 2016, Taylor and Francis.
9. Guyton, A.C. & Hall, J.E. (2020). Textbook of Medical Physiology. 14<sup>th</sup> Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
10. Verma, A.K. & Singh, S. (2022). General Zoology (for UG & PG students), Publisher: Blue Rose Publishers, Daryaganj, Delhi.
11. Eckert and Randal (2020) Animal Physiology: Mechanisms and Adaptations.
12. Biological Timekeeping: Clocks, Rhythms and Behaviour 1st ed. 2017 Edition, Kindle Edition by Vinod Kumar, Springer
13. L.O. DeGroot. W.B. (2020), Saunders, Endocrinology. Vols. I, II and III
14. David O. Norris (2018), Vertebrate Endocrinology
15. Mac E. Hadley (2022), Endocrinology, Pearson Education.
16. Philip C Withers (2020), Comparative Animal Physiology.

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# **SEMESTER V**

**Course: Zoology Core**  
**Paper Code: ZOO23C501**  
**Paper Title: Biochemistry**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Understand the organization and functions of biomolecules, including proteins, nucleic acids, lipids, and carbohydrates.

**CO2:** Analyze and compare carbohydrate, protein and fat metabolism processes their regulations and significance in living organisms.

**CO3:** Understand the basics of thermodynamics, enzyme kinetics and their applications to biological systems.

**CO4:** Apply knowledge of factors influencing enzyme activity and the biological significance of enzymes.

**CO5:** Understand the types of nucleic acids (DNA and RNA), mechanism of transcription and translation and their functional differences.

**Theory**

**Credit: 3**

**UNIT 1-Introduction to Biochemistry**

**1.1. Chemistry of living system: 4L**

Chemistry of living system- Scope and importance; Overview of biochemistry and its significance  
2. Chemical bonds and energy; 3. Properties of water as biological solvent.

**1.2. Biomolecules 3L**

Definition of biomolecules and its Classification, Organization of biomolecules (proteins, nucleic acids, lipids, and carbohydrates).

**UNIT 2–Carbohydrates and proteins: their metabolism**

**2.1. Carbohydrate metabolism 7L**

1. Structure, functional and classification of carbohydrates; 2. Carbohydrate metabolism: glycolysis, citric acid cycle, Respiratory complexes (ETC); inhibitors and uncouplers, fermentation, gluconeogenesis: pentose phosphate pathway, shuttle systems (malate aspartate shuttle, glycerol -3- phosphate shuttle, and Cori cycle); 3. Glycogen metabolism (glycogenesis &

glycogenolysis)

## **2.2. Protein metabolism**

**7L**

1. General properties of amino acids; essential and non-essential amino acids; 2. Classification and general properties of proteins; 3. Structural organization and functional significance of proteins; 4. Protein metabolism (catabolism of amino acids: transamination, deamination and ornithine cycle, fate of glucogenic and ketogenic-amino acids).

## **UNIT 3–Lipids metabolism and oxidative phosphorylation**

### **3.1. Lipid metabolism**

**8L**

1. Classification, properties and functional significance of lipid; 2. Functional significance of fatty acids, triglycerides, Cholesterol and steroids; 3. Types and properties of lipoproteins; 4. Lipid metabolism ( $\beta$ -oxidation).

## **UNIT 4 –Enzymes and the laws of thermodynamics and Nucleic Acids**

### **4.1. Enzymes**

**6L**

1. Properties and classification of major types of enzymes; 2. Factors of enzyme activity, biological significance of enzymes; 3. Mechanism of enzyme action, enzyme kinetics (Michaelis–Menten hypothesis) and Inhibition; 4. Allosterism and types.

### **4.2. Thermodynamics**

**5L**

1. Basic concepts of thermodynamics applied to biological systems, Laws of Thermodynamics and its biological application, 2. Relevance of energy and entropy in living organisms

### **4.3. Nucleic Acids and protein synthesis**

**5L**

1. Types of nucleic acid (DNA and RNA) and their function and differences; 2. Structure of DNA (Watson and Crick Model of DNA); 3. Elementary knowledge on transcription, Different types of RNA and its functional significance; 4. Protein synthesis.

1. Qualitative detection of carbohydrates (Benedict's test for reducing sugars and Iodine test for starch), lipids and proteins.
2. Study of enzymatic activity of trypsin/ pepsin/ lipase and their inactivation by heat.
3. Detection for amino acids using Ninhydrin test through paper chromatography.
4. Quantitative estimation of protein by Lowry's method.
5. Quantitative estimation of cholesterol in animal tissue.
6. Quantitative estimation of carbohydrate by Anthrone method.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings –**

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H Freeman and Co.
3. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009). Harper's Illustrated Biochemistry, XXVIII Edition. Lange Medical Books/McGraw-Hill.
4. Concept of biochemistry, L.M. Srivastava, third edition.
5. Lehninger Principles of Biochemistry, Indian edition, English, Hardcover, David L. Nelson, Michael Cox).

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**Course: Zoology Core**  
**Paper Code: ZOO23C502**  
**Paper Title: Development Biology and Reproductive Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Understand the scientific concepts related to organism's development.

**CO2:** Knowledge on the genetic, cellular and molecular mechanism that underlie organism's development.

**CO3:** Learn and understand the organism development

**CO4:** Appreciate and appraise the process of ageing and related biological changes

**CO5:** To be able to understand and analyze the fertility issues and the technologies available to assisted reproductive technology

**Theory**

**Credit: 3**

**Unit 1: Introduction to Developmental Biology**

**8L**

Basic Concepts of potency, commitment, specification, induction, competence, determination and differentiation, imprinting, morphogenetic gradients, cell fate and cell lineages, stem cells

**Unit 2: Gamete Biology and early development**

**16L**

Gametogenesis, Mechanism of fertilization and prevention of polyspermy, cleavage, blastula formation, gastrulation, and formation of germ layers in amphibian, chick and mammal

**Unit 3: Morphogenesis and Organogenesis**

**5L**

Neurulation, Eye lens induction, Limb Development and regeneration in vertebrates, developmental defects- neural tube disorder, teratogenesis,

**Unit4: Reproductive Biology**

**12L**

Structure of male and female reproductive system in human, Reproductive cycles: Estrus and menstrual cycle, Hormonal regulation of reproductive physiology in human, Pregnancy and fetal development, Parturition, Lactation

Infertility in human- causes, diagnosis and management, Assisted Reproductive Technology-IVF, Gamete Banking.

**Unit 5: Programmed cell death, aging and senescence.**

**4L**

**Practical:****1 credit**

1. Study of different developmental stages of Chick embryo (Whole mount permanent slide)
2. Study of histological sections of testis and ovary.
3. Study of Chick embryo development through Window method.
4. Study of estrous cycle through examining vaginal smear of Rats.
5. Study of sperm morphology in Rat.
6. A visit to city-based Fertility Centre and report submission.

**Suggested Readings:**

1. Gilbert, S. F. (2019). *Developmental Biology* (12th ed.). Sinauer Associates.
2. Scott, F. W. (2020). *Developmental Biology* (1st ed.). Oxford University Press.
3. Kalthoff, K. (2019). *Analysis of Development* (8th ed.). Springer.
4. Wolpert, L., Beddington, R., Brockes, J., Jessell, T., Lawrence, P., & Meyerowitz, E. (2015). *Principles of Development* (5th ed.). Oxford University Press.
5. Slack, J. M. W. (2022). *Essential Developmental Biology* (4th ed.). Wiley-Blackwell.
6. Sinha, A. K. (2022). *Developmental Biology* (7th ed.). New Age International Publishers.
7. Kerszberg, M., & Wolpert, L. (2021). *The Origins of Developmental Biology* (1st ed.). Cambridge University Press.
8. Nieuwkoop, P. D., & Faber, J. (2020). *Normal Table of *Xenopus laevis* (Daudin): A Systematical & Chronological Survey of the Development from the Fertilized Egg till the End of Metamorphosis* (1st ed.). Garland Science.
9. Wolpert, L., Tickle, C., & Martinez Arias, A. (2015). *Principles of Developmental Genetics* (2nd ed.). Wiley-Blackwell.
10. Rossant, J., & Tam, P. P. L. (2018). *Mouse Development: Patterning, Morphogenesis, and Organogenesis* (1st ed.). Academic Press.
11. Galliot, B., & Schmidt, A. (2020). *Emerging Model Organisms: A Laboratory Manual Volume 2* (1st ed.). Cold Spring Harbor Laboratory Press.
12. Srivastava, V. P. (2017). *Invertebrate Zoology (Non-Chordata)* (3rd ed.). S. Chand Publishing.

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**Course: Zoology Core**  
**Paper Code: ZOO23C503**  
**Paper Title: Evolutionary Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Learn the various evolutionary theories that shape the living systems

**CO2:** Gain knowledge about evolutionary patterns and the mechanism of species formation and their distribution.

**CO3:** Analyze the environmental impact on the adaptation and survival of living organisms

**CO4:** Understand the importance of fossil records and apply the knowledge gained in understanding the evolutionary processes

**CO5:** Learning the evolution of some group of animals to help understand the role of adaptiveness over changing period

**Theory**

**Credit: 3**

**Unit I Evolutionary Concepts**

**10L**

Basic concepts of organic evolution, evolutionary theories since Darwin, the modern synthesis, evidences of evolution, Lamarckism, Darwinism, Modern synthetic theory of mutation.

**Unit II Mechanism of evolution**

**10 L**

Variation- Nature, type, sources of variation, Gene mutation and Chromosomal aberrations, Patterns of evolution-sequential, divergent, convergent and coevolution, Genetic drift, genetic load, Microevolution and macroevolution

**Unit III Speciation**

**13L**

Hardy Weinberg Principle and Evolution, Polymorphism-Balanced, Transient; Species Concept, Modes and consequences of speciation, Natural Selection in action and adaptation, Sexual Selection, molecular evolution and molecular clock concept

**Unit IV Fossils and History of Life**

**12L**

Fossils: definition, fossilization and significance, dating of fossils; Geological Time Scale, Extinction and mass extinction- Causes, impact, Biochemical origin of life, earliest cell and evolution of Eukaryotic organelles, Evolution of horse and man.

**Practical:**

**1 credit**

1. Demonstration of geological scale through chart and related different evolutionary events
2. Study of homologous and analogous organs through suitable museum specimen (wings of birds & insect, forelimbs of bat & rabbit)
3. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
4. Study of animals (from museum specimens) as an evolutionary connecting link and its significance (*Peripatus*, *Neoplinea*, *Protopterus*, *Balanoglossus*, *Archeopteryx*, Duck billed Platypus).
5. Study of Embryological evidences of evolution (through charts and models) (mammalian embryos).

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

**Suggested Readings –**

1. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings
2. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
3. Ridley. M, Evolution, Blackwell Publishing
4. Genetics: A Molecular Approach. 3rd edition. Peter J. Russell.
5. Barton, N. H., et.al. Evolution Cold Spring Harbon Laboratory Press.
6. Hal, B. K. et al. Evolution Jones and Barlett Publishers.
7. Hamilton, M.B. (2021). Population Genetics. Wiley Blackwell.
8. Rastogi: Organic Evolution (2015), Medtech publication)
9. Parker G., Adaptation and Ecology.
10. Rose E., Animal adaptation for survival; The Rosen Publishing Group.
11. Moody: Introduction to Evolution (1978, Kalyani).

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**Course: Zoology Core**  
**Paper Code: ZOO23C504**  
**Paper Title: Biostatistics and Computational Biology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1: Understand** the basic concepts of Bioinformatics and Biostatistics and its various applications in different fields of biological sciences

**CO2.** Develop skills in analyzing and interpreting different types of data—nucleic acids, protein sequence, metabolic pathways and small molecules.

**CO3:** Application of various computational tools and methodologies and their application in functional genomics and *in silico* drug discovery

**CO4:** Apply the knowledge of biostatistics in analyzing the various biological data

**CO5:** Apply the knowledge of Bioinformatics in modelling and systems biology

**Theory**

**Credit: 3**

**Unit-I**

**8L**

Introduction to biostatistics, sample and sampling, collection and representation of data in MS. Excel, Measures of central tendency and dispersion

**Unit II**

**14L**

Test of significance of mean, Distribution patterns, error types, F-Test, ANOVA, Chi square test, Correlation and regression, Probability

**Unit III**

**7L**

**Fundamentals of Bioinformatics:** Overview of Bioinformatics as an interdisciplinary field, Scope and applications in modern biological research, AI in Bioinformatics and Biomedical Applications.

**Unit-IV**

**8L**

**Computational Tools and Algorithms:** Primary databases and their importance: GenBank, DDBJ, EMBL; Sequence analysis: Pairwise and multiple sequence alignment, Data mining techniques in bioinformatics, BLAST tool.

## Unit-V

8L

**Protein Structure and cheminformatics:** Protein data bank (Sequence and structure), Proteomics: Protein structure, function prediction, and interaction networks, Systems Biology: Modeling of complex biological systems, Network pharmacology and drug designing.

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### Practical:

1 credit

1. Calculation of central tendencies and dispersions using MS EXCEL
2. To perform t-tests and ANOVA on any statistical package or MS EXCEL using a given data.
3. To learn graphical representation- Pie chart, histogram, bar diagram, line charts etc. with the help of MS-EXCEL
4. To do correlation/regression studies with statistical package
5. Use the NCBI website to retrieve a DNA or protein sequence of interest.
6. Perform a basic sequence alignment using tools like BLAST or Clustal Omega.
7. Search a protein sequence in the UniProt database to retrieve information about its function, domains, and known interactions.
8. Protein modelling and Ramachandran plot analysis.
9. Construction of Phylogenetic tree using PHYLIP/MEGA/PAUP/or any other package

### Suggested Readings:

1. Antonisamy, B., Christopher S. and Samuel, P. P. (2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India.
2. Pagana, M. and Gavreau, K. (2000). Principles of Biostatistics. Duxberry Press, USA
- Xiong J. Essential Bioinformatics. Cambridge University Press; 2006 Mar 13.
3. Zar J. H 2010. Biostatistical analysis. Pearson Education
4. Lesk, Arthur M. Introduction to Bioinformatics. Oxford University Press, 2018.
5. Claverie JM, Notredame C. Bioinformatics for dummies. John Wiley & Sons; 2006 Dec 18.
4. Sinha PK, Sinha P. Computer fundamentals. BPB publications; 2010.
6. Brookshear JG. Computer science: An overview. Benjamin-Cummings Publishing Co., Inc.; 1991 Jan 3.

7. Rajaraman V, Adabala N. Fundamentals of computers. PHI Learning Pvt. Ltd.; 2014 Dec 15.
8. Dale NB, Lewis J. Computer science illuminated. Jones & Bartlett Learning; 2007.
9. Abelson H, Sussman GJ. Structure and interpretation of computer programs. The MIT Press; 1996 Jul 25.

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**Course: Zoology Minor**  
**Paper Code: ZOO23M501**  
**Paper Title: Biochemistry, Developmental Biology, Evolutionary Biology,**  
**Biostatistics**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Learn and understand the biomolecules and the various interaction of the biomolecules and their importance in living systems

**CO2:** Understand the scientific concepts related to organism's development.

**CO3:** Knowledge on the genetic, cellular and molecular mechanism that underlie organism's development.

**CO4:** Understand the evolutionary patterns and mechanisms of speciation and analyse the environmental impact on the adaptation and survival of living organisms

**CO5:** Understand the importance of fossil records and apply the knowledge gained in understanding the evolutionary processes

**CO6:** Understand the importance of biostatistics and apply the knowledge of biostatistics in analyzing the various biological data

**Theory**

**Credit: 3**

**Unit I: Biochemistry**

**12L**

a) Biomolecules and their classification; b) Structure, functional and classification of carbohydrates; c): glycolysis, citric acid cycle, Respiratory complexes (ETC; c) gluconeogenesis: pentose phosphate pathway; d). Glycogen metabolism (glycogenesis & glycogenolysis); e) General properties of amino acids; essential and non-essential amino acids; f) Classification and general properties of proteins; g) Structural organization and functional significance of proteins; h) Classification, properties and functional significance of lipids; i) nucleic acids and classification and properties.

**Unit II: Developmental Biology**

**12 L**

Gametogenesis, Mechanism of fertilization and prevention of polyspermy, cleavage, blastula formation, gastrulation, and formation of germ layers, organogenesis, Structure of male and female reproductive system in human, Hormonal regulation of reproductive physiology in human,



Pregnancy and fetal development, Parturition, Lactation

**Unit 3: Evolutionary Biology**

**12L**

Basic concepts of organic evolution, evolutionary theories since Darwin, the modern synthesis, evidences of evolution, Variation- Nature, type, sources of variation, Gene mutation and Chromosomal aberrations, Natural Selection in action and adaptation, Fossil types and significance of fossil

**Unit 4: Biostatistics**

**9L**

Introduction to biostatistics, sample and sampling, collection and representation of data in MS. Excel, Measures of central tendency and dispersion, test of significance of mean, Distribution patterns, Error types.

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**Practical:**

**1 credit**

1. Qualitative detection of carbohydrates (Benedict test for reducing sugars and Iodine test for starch), lipids and proteins.
2. Study of enzymatic activity of trypsin/ pepsin/ lipase and their inactivation by heat.
3. Study of different developmental stages of Chick embryo (Whole mount permanent slide)
4. Study of histological sections of testis and ovary
5. Study of homologous and analogous organs through suitable museum specimen (wings of birds & insect, forelimbs of bat & rabbit)
6. Study of animals (from museum specimens) as an evolutionary connecting link and its significance (*Peripatus*, *Neoplinea*, *Protopterus*, *Balanoglossus*, *Archeopteryx*, Duck billed Platypus).
7. Calculation of central tendencies and dispersions using MS EXCEL
8. To learn graphical representation- Pie chart, histogram, bar diagram, line charts etc. with the help of MS-EXCEL.

**Suggested Readings:**

1. Antonisamy, B., Christopher S. and Samuel, P. P. (2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India.

2. Pagana, M. and Gavreau, K. (2000). Principles of Biostatistics. Duxberry Press, USA
3. Zar J. H 2010. Biostatistical analysis. Pearson Education
4. Developmental Biology by Scott F. Gilbert
5. Campbell, N.A. and Reece J.B (2011). Biology.IX Edition. Pearson, Benjamin, Cummings
6. Douglas, J. Futuyma (1997). Evolutionary Biology.Sinauer Associates.
7. Ridley. M, Evolution, Blackwell Publishing
8. . Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
9. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H Freeman and Co.

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# **SEMESTER VI**

**Course: Zoology Core**  
**Paper Code: ZOO23C601**  
**Paper Title: Molecular Biology, Microbiology and Biotechnology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Understand the mechanism of DNA replication, transcription, translation and gene regulation.

**CO2:** Analyze and compare the structure, functions and pathogenesis of different groups of microorganisms.

**CO3:** Apply the knowledge in understanding the working principles of different tools and techniques.

**CO4:** Apply the concept and scope of biotechnology, particularly in animal cell culture, understanding essential factors and applications.

**CO5:** Understand and apply knowledge in the production of cloned and transgenic animals, understanding the applications of transgenic animals.

**Theory**

**Credit: 3**

**Unit 1. Molecular Biology**

**12L**

1. DNA as a genetic material; 2. Mechanism of DNA replication in Prokaryotes, semi conservative, bidirectional and discontinuous replication, inhibitors of replication; 4. Replication of telomeres; 5. RNA polymerase and transcription unit; 6. Mechanism of transcription in prokaryotes and inhibitors; 7. Ribosomes structure and assembly in prokaryotes; 8. Genetic code, Protein synthesis and inhibitors.

**Unit II. Post Transcriptional Modification, Gene regulation and DNA repair 10L**

1. Structure of globin mRNA, Split genes, concept of introns and exons, Splicing, Mechanism, RNA editing; 2. Transcription regulation in prokaryotes, Principles of transcription regulation in lac operon, *trp* operon, Gene silencing, Genetic imprinting; 3. Types of DNA repair mechanisms.

**Unit III. Microbiology**

**10L**

1.Types of microbes and their protective role; 2. Gram positive and Gram-negative bacteria;

Structure of bacteria 3. General morphology and characters of Protista and economic importance; 4. Viruses- Structure, Genome, 5. Epidemiology of infectious disease with reference to human host. Bacterial (Tuberculosis), Viral (Hepatitis), Protozoan (Amoebiasis) disease.

#### **Unit IV. Biotechnology**

**13L**

1. Concept and scope of biotechnology, animal cell culture, essential factors and applications; 2. PCR and its types; Northern-, Southern-, Western blot, DNA sequencing techniques (chemical sequencing and chain-termination method); 3. Gene Cloning and vectors (Cloning and expression) 4. Restriction endonuclease: types and functions; 5. Production of cloned and transgenic animals, application of transgenic animals; 6. Application of recombinant DNA in medicine-recombinant insulin and human growth hormone.

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#### **Practical:**

**Credit-1**

1. Agarose gel electrophoresis for DNA- demonstration through instrument.
2. Preparation of solid culture medium (PDA) and growth of microbial by spreading and streaking.
3. Simple staining and Gram's staining of bacteria.
4. Sugar fermentation test.
5. Preparation of animal culture media and methods of cell culture.
6. Primer designing and Demonstration of PCR

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

#### **Suggested Readings-**

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia. Karp, G. (2010) Cell and Molecular Biology:

Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.

5. Lewin B. (2008). Gene XI, Jones and Bartlett
6. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.
7. Alexander, M. (1977). Introduction to Soil Microbiology. John Wiley and Sons, New York.
8. Atlas, R. M. and Bartha, R. (1997). Microbial Ecology: Fundamentals and Applications, 4th ed., Benjamin/ Cummings.
9. Black, J. G. (2011). Microbiology: Principles and Explorations. 8th ed. John Wiley and Sons, New York.
10. Campbell, R. (1983). Microbial Ecology. 2nd ed. Oxford, Blackwell.
11. T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
12. Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).

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**Course: Zoology Core**  
**Paper Code: ZOO23C602**  
**Paper Title: Economic and Applied Zoology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Understand the importance of different animals both from the perspective of damage and the benefits obtained from them.

**CO2:** Learn the various animal culture techniques

**CO3:** Ability to apply knowledge in skill development and entrepreneurship opportunities.

**CO4:** Comprehend the importance of cleanliness and hygiene in any animal culture, agriculture as well as in human life.

**CO5:** To develop and gain entrepreneurship skills in aquaculture and other allied subjects

**Theory**

**Credit: 3**

**Unit 1: Economic importance of non-chordates**

**10L**

1. General account, pathogenesis and prevention of Parasitic protozoa- *Entamoeba histolytica*, *Leishmania donovani*; 2. Soil protozoa and their role in agriculture; 3. Sponge culture and its importance in industry and commerce; 4. General account, pathogenesis and prevention of Zooparasitic helminths- *Fasciola hepatica*, *Taenia solium*, *Wuchereria bancrofti*; 5. Earthworm and soil improvement; 6. Prawn culture, 7. Pearl culture.

**Unit 2: Applied Entomology:**

**13L**

**Beneficial Insects:** 1. Culture of honeybees for commercial purpose, honeybee products; 2 Culture of lac insects and its importance; 3. Sericulture, pests and diseases of silkworm and silkworm products; 4. Economic importance of termites

**Harmful Insects:** Insects as carriers of plant pathogens; 2. Insect vectors- houseflies, mosquitoes, sandflies, human louse, fleas; 3. Stored grain pests; 4. Insect pests of crops- Paddy, Jute, Tea, Sugarcane, vegetables

### **Unit 3: Fish industry**

**10L**

1. Inland Fisheries; Marine Fisheries; 2. Pen and cage culture; Polyculture; Composite fish culture; Induced breeding of fish; 3. Fish diseases: Bacterial, viral and parasitic; 4. Preservation and processing of harvested fish, Fishery by-products; 5. Indigenous ornamental fishes.

### **Unit 4: Economic importance of tetrapoda: Amphibia and Reptilia, Aves and Mammalia**

**12L**

1. Amphibia as a biological control agent; 2. Snake venom and its uses; 3. Antivenin production, 4. Birds: in pollination, poultry; 5. Mammals: Basic knowledge about dairy and livestock breeding; 6. Animal husbandry: piggery; 7. Human's role in social welfare-mitigation of infertility problems, organ culture and transplantation.

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### **Practical:**

**(Credit-1)**

1. Study of permanent slides of protozoan, helminths and arthropod vectors.
2. Study of some important pests of Paddy, Jute, Tea, Cane sugar, vegetables and stored grain pest.
3. Study of the lifecycle of silk worms (Eri, Muga and Mulberry), life history of honey bee.
4. Dissection of mouth parts of Honey bee, Sting gland of honey bee.
5. Identification of commercially important (10 spp.) and ornamental fishes (5 spp.).
8. Identification of Exotic fishes.
8. In vivo demonstration of pituitary gland from commonly found fishes.
9. Maintenance of fresh water aquarium.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated. Field Visit may be organized if necessary.**

### **Suggested Readings -**

1. Ekambaranath Ayar: A manual of Zoology, Part I – Invertebrata & Vertebrata (1973, S. Vishwanathan)
2. Kotpal, Agarwal and Khetrapal: Modern Textbook of Zoology: Invertebrates & Vertebrates (Rastogi)
3. Marshall: Parker and Haswell Textbook of Zoology, Vol. I & Vol. II (7th ed. 1972, Macmillan)



4. Nigam: Biology of Non-chordates & Chordates (1985, S. Chand)

5. Jordon and Verma: Invertebrate& Vertebrate Zoology, Vol I and II (1995, S. Chand).

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**Course: Zoology Core**  
**Paper Code: ZOO23C603**  
**Paper Title: Immunology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Understand the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity.

**CO2:** Analyze and understand the cellular/molecular pathways of lymphocyte activation, homeostasis, differentiation, and memory

**CO3:** Understand and apply basic complex of Complement system, cytokine and hypersensitivity reactions in the immune system.

**CO4:** Understand and explain the functioning of higher-level systems in health and disease including basis of vaccination, autoimmunity, immunodeficiency, hypersensitivity and tolerance.

**CO5:** Apply the knowledge to understand and develop immunological techniques

**Theory**

**Credit: 3**

**Unit I: Introduction to immunity and organs of immune system:**

**13L**

1. Basic concepts of immunity; 2. Innate Immunity-Anatomical barriers, Inflammation, Cells involved in innate immunity; 3. Adaptive: humoral and cell mediated - Antigens, Immunoglobulins: types, structure and function; generation of immunoglobulin diversity, 4. Cells and organs of immune system, Types of immune cells: lymphoid and myeloid; 5. Structure and function of primary and secondary lymphoid organs.

**Unit II: Cells of the immune system:**

**10L**

1. T- cell generation activation and differentiation, 2. B-cell -generation activation and differentiation; 2. Major Histocompatibility Complex: Types, Structure and functions, 3. Antigen Processing and Presentation -The cytosolic pathway: endogenous pathway and exogenous pathway.

**Unit III. Complement system, cytokine and hypersensitivity reactions:**

**12L**

1. Complement proteins: Regulation of complement system, biological consequences of complement activation; 2. Cytokine receptors- properties of cytokines, cytokine receptors, cytokine 3. Hypersensitivity reactions- types, mechanisms of type I to IV hypersensitivity reactions

#### **Unit IV: Autoimmunity and Transplantation immunology-**

**10L**

1. Autoimmunity- Types, symptoms and causes of autoimmune diseases with examples; 2. Transplantation- blood antigens transplantation rejection, graft rejection, immune suppression, 3. Monoclonal antibodies, 4. Hybridoma technology, 5. Vaccines development, types of Vaccines.

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#### **Practical:**

**(Credit-1)**

1. Identification of lymphoid organs (primary & secondary) from mammals through slides.
2. Study of antigen –antibody reactions with ABO blood grouping.
3. Hemoglobin estimation by Sahli method.
4. Cell counting and viability assays of immune cells.
5. RBC & WBC counting by haemocytometer.
6. Preparation of blood smear and differential cell count.
7. Study of different immune cells/tissue using model or photographs.

**\*\* Lab notebook with labelled diagrams, methods (wherever applicable) and results must be incorporated.**

#### **Suggested Readings -**

1. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). Cellular and Molecular Immunology (10th ed.). Elsevier.
2. Murphy, K., & Weaver, C. (2020). Janeway's Immunobiology (10th ed.). Garland Science.
3. Male, D., Brostoff, J., Roth, D. B., & Roitt, I. (2019). Immunology (9th ed.). Elsevier.
4. Paoletti, R., & Notkins, A. L. (2020). Immunology (5th ed.). Wiley.
5. Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2023). Kuby Immunology (9th ed.). W. H. Freeman.
6. Ganesh, K. A., & Shrivastava, P. (2018). Essentials of Immunology (2nd ed.). Jaypee Brothers Medical Publishers.

7. Kumar, P., & Rana, A. K. (2022). Textbook of Immunology (3rd ed.). CBS Publishers & Distributors.
8. Kapoor, A., & Sehgal, K. (2019). Immunology Simplified (1st ed.). Elsevier India.
9. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2019). Kuby Immunology (8th ed.). W. H. Freeman.
10. Male, D., & Brostoff, J. (2019). Immunology for Medical Students (4th ed.). Springer.
11. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2021). Immunobiology: The Immune System in Health and Disease (10th ed.). Garland Science.
12. Roitt, I. M., Brostoff, J., Male, D. K., & Ray, A. (2016). Immunology (8th ed.). Elsevier.
13. Parham, P. (2014). The Immune System (4th ed.). Garland Science.

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**Course: Zoology Core**  
**Paper Code: ZOO23C604**  
**Paper Title: Parasitology**

**Total Lectures: 45**

**Credit (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

- CO1.** The course focus on cultivating a comprehensive understanding of parasitic organisms and their interactions with hosts, apply their understanding of parasitology in diverse contexts, contributing to improved health practices and sustainable agriculture.
- CO2.** Students will be able to know the identification and classification of various parasites, understand their life cycles, and analyze the impact of parasitic interactions.
- CO3.** Students will be expected to grasp the intricate mechanisms governing the growth and decline of parasite populations, including factors influencing transmission and prevalence. The objective extends to studying how parasites establish themselves within host bodies, exploring host-parasite co-evolution, and understanding adaptive radiations that contribute to the diversity of parasitic species.
- CO4.** It be able to well-equipped the student to apply their understanding of parasitology in diverse contexts, contributing to improved health practices and sustainable agricultural systems.
- CO5.** Developed a solid foundation in parasitology, equipping them with the necessary skills and knowledge for pursuing advanced studies in higher education and contributing to advancement in the field.

**Theory**

**Credit: 3**

**Unit 1: Introduction to Parasitology**

**(8L)**

a). Brief introduction of Parasitism, parasite, parasitoid and vectors (mechanical and biological vector); b). Host parasite relationship; c) Blood-sucking bugs; Chagas disease, bed bugs as mechanical vectors, control and prevention measures; d). SARS

**Unit 2: Non-chordates Parasites**

**(16L)**

**2.1.Parasitic Protists**

**8L**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment/ control measure of: a) *Entamoeba histolytica*, b) *Giardia intestinalis*, c) *Trypanosoma gambiense*, d) *Leishmania donovani*, e) *Plasmodium vivax*

## **2.2. Parasitic Platyhelminthes**

**8L**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of: a) *Fasciolopsis buski*, b) *Taenia solium*, c) *Schistosoma haematobium*.

## **Unit 3: Non chordate Parasites II**

**(20L)**

### **3.1 Parasitic Nematodes**

**12L**

a) Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of: a) *Ascaris lumbricoides*, b) *Ancylostoma duodenale*, c) *Wuchereria bancrofti*, d) *Trichinella spiralis*; b) Study of structure, life cycle and importance of *Meloidogyne* (root knot nematode) and *Pratylenchus* (lesion nematode).

### **3.2 Parasitic Arthropods**

**8L**

a). Biology, importance and control of: 1) ticks (soft tick *Ornithodoros*, hard tick *Ixodes*), 2) mites (*Sarcoptes*), 3) Lice (*Pediculus*), 4) Flea (*Xenopsylla*); b) Study of mosquito-borne diseases – a) Dengue, b) Chikungunya and d) Viral encephalitis.

## **Unit 4: Parasite Vertebrates**

**6L**

Brief account of parasitic vertebrates: a) Cookicutter shark, b) hood mockingbird and c) vampire bat.

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## **Practical:**

**(Credit-1)**

1. Study of life stages of any one: *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs
2. Study of adult and life stages of any one: *Schistosoma haematobium*, *Taenia saginata* through permanent slides/ micro photographs
3. Study of adult and life stages of any one: *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/micro photographs.

4. Study of monogenea from the gills of fresh/marine fish
5. Study of nematode/ cestode parasites from the intestines of Poultry bird.

**\*\*Lab notebook with labelled diagrams, methods and results.**

**Suggested Readings:**

1. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors.
2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger.
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group.
4. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi.
5. Rattan LalIchhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.
6. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers.
7. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

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**Course: Zoology Minor**  
**Paper Code: ZOO23M601**

**Paper Title: Biotechnology, Applied Zoology, Immunology and Parasitology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Apply the concept and scope of biotechnology, particularly in animal cell culture, understanding essential factors and applications.

**CO2:** Understand and apply knowledge in the production of cloned and transgenic animals, understanding the applications of transgenic animals.

**CO3:** Understand the importance of different animals both from the perspective of damage and the benefits obtained from them.

**CO4:** Understand the basic mechanisms, distinctions and functional interplay of immune system and immunity and apply the knowledge in immunological methods.

**CO5:** To develop understanding of interactions with hosts and parasites and apply their understanding of parasitology in diverse contexts, contributing to improved health practices and sustainable agriculture.

**Theory**

**Credit: 3**

**Unit 1: Biotechnology**

**11L**

1. Concept and scope of biotechnology, animal cell culture, essential factors and applications; 2. PCR and its types; Northern-, Southern-, Western blot, DNA fingerprinting-paternity test; 3. Gene Cloning and vectors (Cloning and expression) 4. Restriction endonuclease: types and functions; 5. Application of recombinant DNA in medicine

**Unit 2: Applied Zoology**

**12L**

1. Culture of honeybees for commercial purpose, honeybee products; 2 Culture of lac insects and its importance; 3. Importance of sericulture, 4. Insects as carriers of plant pathogens; 5. Insect vectors- houseflies, mosquitoes, human louse, 6. Inland Fisheries; Marine Fisheries, Pen and cage culture; 7 Induced breeding of fish; 8. Preservation and processing of harvested fish, 9. Fishery by-products; 10. Indigenous ornamental fishes.



### Unit 3: Immunology

12L

1. Basic concepts of immunity; 2. Innate Immunity-Anatomical barriers, Inflammation, Cells involved in innate immunity; 3. Adaptive immunity: humoral and cell mediated; 4. Antigens and Immuno-globulins: types, structure and function; 5. autoimmunity- Types, symptoms and causes of autoimmune diseases with examples; 6. Vaccine and types

### Unit 4: Parasitology

10L

1. Brief introduction of Parasitism, parasite, parasitoid and vectors (mechanical and biological vector); 2. Host parasite relationship; 3. Epidemiology of *Entamoeba*, *Plasmodium*, *Taenia*; 4. Study of mosquito-borne diseases – a) Dengue, b) Chikungunya and d) Viral encephalitis. 5. Brief account of parasitic vertebrate.

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### Practical:

(Credit-1)

1. Agarose gel electrophoresis for DNA- demonstration through instrument.
2. Preparation of solid culture medium (PDA) and growth of microbial by spreading and streaking.
3. Simple staining and Gram's staining of bacteria
4. Study of the lifecycle of silk worms (Eri, Muga and Mulberry), life history of honey bee.
6. Identification of commercially important, ornamental fishes and exotic fishes.
7. Identification of lymphoid organs (primary & secondary) from mammals through slides.
- 8 Cell counting and viability assays of immune cells.
9. Study of *Entamoeba*, *Plasmodium*, *Taenia* and mosquito vectors (through slide or specimen).

**\*\*Lab notebook with labelled diagrams, methods and results.**

### Suggested Readings:

1. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors.
2. E.R. Noble and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea &Febiger.
3. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

4. Kuby: Immunology (2003, Freeman)
5. Roitt and Delvis: Roitt's Essential Immunology (6th ed. 2006, Blackwell).
6. Ekambaranath Ayar: A manual of Zoology, Part I – Invertebrata & Vertebrata (1973, S. Vishwanathan)
7. Kotpal, Agarwal and Khetrapal: Modern Textbook of Zoology: Invertebrates & Vertebrates (Rastogi)
8. B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001).
9. T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).

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# **SEMESTER VII**

**Course: Zoology Core**  
**Paper Code: ZOO23C701**  
**Paper Title: Research Methodology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Will provide a comprehensive understanding of scientific research by exploring its fundamental characteristics and various types. Students will delve into the distinct methodologies and approaches employed in scientific inquiry, gaining insights into the diverse range of research types, from basic exploratory studies to applied research with practical implications.

**CO2:** It will instill a profound understanding and apply ethical principles in research, equipping students with the knowledge and skills to navigate complex ethical dilemmas and conduct research with integrity and responsibility.

**CO3:** Develop proficiency in data collection methods and the construction of meaningful indices. Through hands-on learning, students will acquire skills in gathering, organizing, and analyzing data, while also understanding the significance of constructing relevant indices to facilitate comprehensive and accurate interpretation of information.

**CO4:** Understanding of both basic and clinical research, equipping participants with essential knowledge to navigate the intricacies of scientific inquiry across fundamental laboratory investigations and applied clinical studies.

**Theory**

**Credit: 3**

**Unit-I Scientific research, characteristics and types**

**10L**

Scientific research: Characteristics, types, methods and Examples, 2. Retrospective and prospective studies, 3. Hypothesis testing, formulation of research problem and framing research objectives 4. research journals, societal journals impact factor, h-index, i-index 5. General format for research paper and research proposal.

**Unit-II Ethics on research**

**12L**

Biodiversity research: Biodiversity board, Wild Life Protection Act and its amendments and research clearance, Field, permits to import/export animals for research, 2. research ethics (Plagiarism), 3. Formation and working of ethics committees (Institutional Animal ethics

committee, Biosafety committee, and Institutional ethics committee), 4. Environment Impact Assessment (EIA), ZSI (Zoological survey of India) and BSI (Botanical survey of India).

### **Unit-III Data Collection**

**13L**

1. Sampling design: Types, Techniques and Examples, 2. fundamental of data collections, types of data: qualitative and quantitative (discrete and continuous), 3. Role of Bioinformatics in the pharmaceutical research, 4. Research design, Formation of research questionnaire, Consent form, 5. Quantitative ethnobotanical indices: Fidelity Level (FL), Relative Importance (RI), Use Value (UV) or Cultural Importance Index (CI), the 'Cultural Value Index (CV) and the Relative Frequency of Citation (RFC).

### **Unit-IV Fundamental of basic and clinical research**

**10L**

1. Basic of Clinical research: Fundamental of Allopathy, Ayurveda, Siddha, Unani and Yoga, Naturopathy and Homoeopathy, placebo and nocebo effect, 2. Basic and clinical research, phases of clinical research. 3. Research model: choosing a good model for research, Mouse, birds, zebra fish, *Drosophila*, *Caenorhabditis. Elegans*, yeast.

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### **Practical:**

**(Credit-1)**

1. Literature review and domain wise listing using different databases.
2. Reference writing, formatting and managing software.
3. Guidelines for keeping a laboratory notebook.
4. Review writing on the given topic and report submission.
5. Statistical analysis of given biological data using different software packages.
6. Project writing, hypothesis design, framing research objectives
7. Online tools for plagiarism checking.

### **Suggested Readings:**

1. Research Methodology (2018): A Step-by-Step Guide for Beginners by Ranjit Kumar
2. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (2016) by John W. Creswell and J. David Creswell

3. Social Research Methods: Qualitative and Quantitative Approaches (2018) by W. Lawrence Neuman
4. Research Methodology: Methods and Techniques (1982) by C.R. Kothari
5. The Craft of Research (2020) by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
6. Qualitative Inquiry and Research Design (2018): Choosing Among Five Approaches" by John W. Creswell
7. Research Methodology: A Step-by-Step Guide (2017) by Mugenda and Mugenda
8. Experimental and Quasi-Experimental Designs for Generalized Causal Inference (2020) by Donald T. Campbell and Julian C. Stanley
9. Designing Clinical Research (2020) by Stephen B. Hulley, Steven R. Cummings, Warren S. Browner, Deborah G. Grady, and Thomas B. Newman
10. Clinical Trials: A Practical Guide to Design, Analysis, and Reporting (2010) by Duolao Wang, Ameet Bakhai, and S. (Mitch) H. Gail
11. Ayurvedic Pharmacology and Therapeutics (2005), by: Author: Vaidya V. M. Gogte
12. Healing: A Practical Guide (2007), by: Author: Dr. Vasant Lad
13. Textbook of Ayurveda (2012), by: Vasant D. Lad, David Frawley.

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**Course: Zoology Core**  
**Paper Code: ZOO23C702**

**Paper Title: Tools and Techniques in Biology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** To develop a comprehensive understanding of various biological instruments

**CO2:** To apply acquired skills in practical scenarios, analyze experimental data using diverse methods.

**CO3:** It will enable the students to demonstrate a comprehensive understanding of various Molecular and Biochemical Techniques and their working principles isolations and applications.

**CO4:** Upon completion of the Histology Techniques course, students will showcase a thorough understanding of histological principles, recall key histological concepts, apply various histological techniques proficiently, analyze tissue samples critically, evaluate the results of histological experiments, and creatively devise new approaches for histological investigations.

**Theory**

**Credit: 3**

**Unit 1: Bioinstrumentation-1**

**11L**

1. Principle of microscopy and application - Bright-field microscope, Dark-field microscope, Phase-contrast microscope, 2. Principle and application of -Fluorescence microscope, Confocal microscope, 3. Principle and application of- Electron microscopy (SEM and TEM). 4. Chromatography techniques: Thin layer chromatography (TLC); High Performance Liquid Chromatography (*HPLC*), Gas chromatography (GC), 5. Principle and application of - pH meter.

**Unit 2: Bioinstrumentation-II**

**10L**

1. Principle and different types of centrifugations - differential, density gradient and ultra-centrifugation and their biological applications in biology. 2. Spectrophotometric techniques: principles and biological applications: UV, Atomic absorption and mass spectrophotometric, 3. IR and NMR spectroscopy. 4. GM counter and liquid scintillation counter.

**Unit 3: Molecular and Biochemical techniques****12L**

1. Electrophoresis techniques – principles and applications of Agarose gel and polyacrylamide gel, Two-dimensional (2D), Isoelectric focusing. 2. PCR techniques- RT-PCR and qPCR, NGS. principle and application. 3. Flowcytometry-principle and its biological application, 4. Microarray techniques, 5. ELISA types and applications 6. Fluorescence in-situ hybridization (FISH) technique.

**Unit 4: Histology techniques:****12L**

1. Mechanism of Fixation and Fixatives-Types, Chemistry and Choice of Fixatives, 2. Tissue Staining-Principle and Mechanism of histological staining, 3. mordants, 4. Microtomy, cryotomy and tissue processing. 5. Principle and methods of histochemical reaction and localization of Carbohydrate by PAS (Periodic Acid Schiff) method, Protein by bromophenol blue method, Lipid moieties by Sudan black B method, Nucleic acid by methyl green pyronin method, Enzymes by alkaline phosphatase metal precipitation method, 6. Immuno histochemistry, 7. Cryo preservation techniques.

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**Practical:****(Credit-1)**

1. Preparation of buffer and determination of pH.
2. Isolation of cellular organelles by Centrifugation.
3. Determination of OD by spectrophotometer method.
4. Detection of amino acid in mixture using ninhydrin through paper chromatography
5. Histological staining of carbohydrate, protein and lipids
6. Supravital staining of blood cells/spleen.
7. Microscopic measurement of cell by ocular and stage micrometer.

**Suggested Readings:**

1. Suhasini S (2020). Tools and Techniques in Biology. Adv Tech Biol Med.8: e113.
2. Bisen and Malik 2004, Life Science in Tools and Techniques, CBS Publishers & Distributors Pvt Ltd, India.



3. Bancroft and Stevens. Theory and Practice of Histological techniques, Churchill-Livingstone,2002
4. Casselman, W.G.B: Histochemical techniques, John Wiley,1959
5. Pearse, A.G.E.: Histochemistry; Theoretical and Applied (Vol. I, II & III), (4th ed.), Churchill-Livingstones,1980-1993
6. Nelson et al: Lehninger Principles of Biochemistry(3rdEd.), MacMillan Worth,2000
7. Berg et al.: Biochemistry (5th Ed.), Freeman,2002
8. Mathew Setal.: Biochemistry (3rd Ed.), Pearson,2004.
9. Campbell, A. M. and Heyer L P., Discovering genomics, proteomics and Bioinformatics, II Edition, Benjamin Cummings.

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**Course: Zoology Core**  
**Paper Code: ZOO23C703**  
**Paper Title: Biomimicry and Science Communication**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1: To understand and appreciate** the pattern and processes in nature

**CO2: Application** of the knowledge gained in developing designs and technology

**CO3: Analyse** the nature inspired innovation for critical thinking

**CO4: Learn and understand** the importance of science communication and its various ways

**CO5: To be able to apply** the knowledge in creating awareness in science

**Theory**

**Credit: 3**

**Unit 1**

**11L**

(a) Introduction to biomimicry/biomimetics & its history-Janine Benyus; (b). Categories of natural objects & their functions (with respect to biomimicry)-bacteria, invertebrate, vertebrate, plants; (c) Importance of biomimicry; (d) Study of nature inspired innovations in biological/zoological field [any 5-6 case studies]

**Unit 2**

**12L**

a) Steps to develop design based on biomimicry (design process); b) understanding systems-properties and interconnections; c) Nature's unifying patterns- 10 patterns (explanations with examples); d) study of any 5 innovations through videos on biomimicry and their relevance.

**Unit 3**

**12L**

Basics of Communication; Functions of Mass Media, Grassroots Communication; Science Communication; Importance and use of Science Communication - Public Understanding of Science (PUS); Science popularization: programmes, organizations, individuals; Sources of scientific information- books, scientific reports, scientific journals, magazines, feature syndicates, leaflets, tabloids, wall magazines, speeches, seminars, press releases, databases, encyclopedias on science, etc.

**Unit 4**

**10L**

Ethical concerns and critical areas in Science Communication- healthcare, environment, diversity, and indigenous knowledge, etc.; Science Communication with reference to India, Northeast and

Assam; Science communication and policy formulation; Scientific content creation: Print, Electronic (audio and audio-video) and New Media content designing; creating scientific posters, pamphlets, short videos/documentaries, short films, Public Service Announcements (PSAs), etc.;; Relevant case studies

**Practical:** **(Credit-1)**

1. Visit to RSC & preparation of documents on biomimicry
2. Study of some invertebrate and vertebrate models commonly used in biomimicry (concept, principle. Design and application)
3. Field visits to understand indigenous practices and prepare reports
4. Making brochure, announcements and scientific posters
5. Making short video/ documentary on everyday science or on any scientific news or event
6. To report about any 2 new scientific development in the recent times.

**Suggested Readings:**

1. Benyus, J. B. 2002. Biomimicry- Innovations inspired by Nature.
2. Biomimicry.org
3. Sites.udel.edu/bioinspired
4. Graeff et al. (2001). Research in Engineering design.
5. Fayemi et al. (2017). Bioinspiration and biomimetics 12 (1).
6. Stem.org.uk/ resources
7. Poepsel, MA, Media, Society, Culture and You.
8. Turner, L.H. and West, R. 2019. An Introduction to Communication. Cambridge University Press
9. Peters HP. Gap between science and media revisited: scientists as public communicators. Proc National Academy of Science USA. 2013 Aug 20;110 Suppl 3(Suppl 3):14102-9.
10. Matthews JR., Matthews RW, (2008) “Successful Scientific Writing: A Step-By-step Guide for the Biological and Medical Sciences” 3 rd Edition, Cambridge University Press.
11. Yousuf A, Sidiq M, Acharya S, (2018) “Publish and Cherish – The Art and Craft of Publishing Scientific Research” 1st Edition, Sara Book Publication.

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**Course: Zoology Core**  
**Paper Code: ZOO23C704**  
**Paper Title: Climate Change and Sustainable Development**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** To identify the main causes of climate change and understand the difference between climate and weather, how the world is taking action and making progress on climate change.

**CO2:** To comprehend the impacts of climate change on the environment and its consequences for the poor, and understand the principles of sustainable development.

**CO3:** To create awareness how climate change may impact threatened habitats or species, suggest ways that people could respond to the issue of climate change, and conduct an interview with people expressing different perspectives on climate change.

**CO4:** To apply different strategies that might help people to act on climate change, and summarize the world's progress in responding to climate change.

**CO5:** To understand the concept of sustainable development and environmental risk and impact assessment.

**Theory**

**Credit: 3**

**Unit I: Introduction**

**18L**

Definition of weather and climate, meteorology and climatology, elements, types of classification systems empirical, applied and genetic systems, Koeppen classification system, three basic climate groups: low latitude, mid-latitude, high latitude; aridity index, drought; Holdridge life zones system: global bioclimatic scheme for the classification of land areas; Weather and climate change, Geological time scale, ice ages, record of past 1000 years, human influences; Internal forcing mechanisms and external forcing mechanisms, The Milankovitch Cycle theory, Solar variation.

**Unit II: Principle and Approaches**

**15L**

Climate change and Global warming, Climate change: Evidences, Greenhouse effect, Greenhouse gases, increase in greenhouse gas concentrations, Global-warming potential of greenhouse gases

Environment and Pollution, Anthropogenic activities responsible for climate change: Source activities (Burning of fossil fuel, Industrial activity, Urbanization, Agriculture, transportation, waste generation) Removals of Sinks and LULUCF.

### **Unit III**

#### **Policies and Programs**

**12L**

Kyoto Protocol. Doha Amendment, Kyoto mechanisms, Copenhagen Accord, Paris Agreement, Emission trading/Carbon trading, Environmental Laws in India- Forest and Biodiversity, Environmental footprints -Carbon footprint, Nitrogen footprint, Water footprint.

### **Unit IV**

#### **Environmental risk and impact Assessment**

Concept hazard identification, dose-response evaluation, exposure assessment, risk characterization, Risk evaluation, Public perception of risk, Risk communication Concept, Screening, scoping, prediction and mitigation, management and monitoring, Preparing an Environmental Statement, making a planning application and consultation, Projects considered within the town and country planning regime. Local planning authorities.

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#### **Practical:**

**(Credit-1)**

1. Study physicochemical properties of soil and water.
2. Collect climate data (temperature, precipitation, etc.) for your region analyze trends, seasonal variations, and anomalies.
3. Youth participation and engagement activities for awareness towards sustainable development and Climate change.
4. Field visit to study impact of climate change.

#### **Suggested Readings:**

- Suraj Mal, R.B. Singh, Christian Huggel, Editors. Climate Change, Extreme Events and Disaster Risk Reduction, Towards Sustainable Development Goals. Book · Springer International Publishing AG 2018.

- Joachim Monkelbaan. Governance for the Sustainable Development Goals, Book · Springer International Publishing, Nature Singapore Pte Ltd, 2019.
- Climate and Global Environmental Change by L.D. Danny Harvey, Prentice Hall publication
- Climate Change- An Indian Perspective by S.K. Das, Foundation books
- Global Warming- A very short introduction by Mark Maslin, Oxford publication.



**Course: Zoology Minor**  
**Paper Code: ZOO23M701**  
**Paper Title: Research Methodology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** Will provide a comprehensive understanding of scientific research by exploring its fundamental characteristics and various types. Students will delve into the distinct methodologies and approaches employed in scientific inquiry, gaining insights into the diverse range of research types, from basic exploratory studies to applied research with practical implications.

**CO2:** It will instill a profound understanding and apply ethical principles in research, equipping students with the knowledge and skills to navigate complex ethical dilemmas and conduct research with integrity and responsibility.

**CO3:** Develop proficiency in data collection methods and the construction of meaningful indices. Through hands-on learning, students will acquire skills in gathering, organizing, and analyzing data, while also understanding the significance of constructing relevant indices to facilitate comprehensive and accurate interpretation of information.

**CO4:** Understanding of both basic and clinical research, equipping participants with essential knowledge to navigate the intricacies of scientific inquiry across fundamental laboratory investigations and applied clinical studies.

**Theory**

**Credit: 3**

**Unit-I Scientific research, characteristics and types**

**10L**

Scientific research: Characteristics, types, methods and Examples, 2. Retrospective and prospective studies, 3. Hypothesis testing, formulation of research problem and framing research objectives 4. research journals, impact factor, h-index, 5. General format for research paper and research proposal.

**Unit-II Ethics on research**

**12L**

Biodiversity research: Biodiversity board, Wild Life Protection Act and its amendments and research clearance, Field, permits to import/export animals for research, 2. research ethics

(Plagiarism), 3. Formation and working of ethics committees (Institutional Animal ethics committee, Biosafety committee, and Institutional ethics committee), 4. Environment Impact Assessment (EIA), ZSI (Zoological survey of India) and BSI (Botanical survey of India).

### **Unit-III Data Collection**

**13L**

1. Sampling design: Types, Techniques and Examples, 2. fundamental of data collections, types of data: qualitative and quantitative (discrete and continuous), 3. Role of Bioinformatics in the pharmaceutical research, 4. Research design, Formation of research questionnaire, Consent form, 5. Quantitative ethnobotanical indices: Fidelity Level (FL), Relative Importance (RI), Use Value (UV) or Cultural Importance Index (CI), the 'Cultural Value Index (CV) and the Relative Frequency of Citation (RFC).

### **Unit-IV Fundamental of basic and clinical research**

**10L**

1. Basic of Clinical research: Fundamental of Allopathy, Ayurveda, Siddha, Unani and Yoga, Naturopathy and Homoeopathy, placebo and nocebo effect, 2. Basic and clinical research, phases of clinical research. 3. Research model: choosing a good model for research, Mouse, birds, zebra fish, drosophila.

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### **Practical:**

**(Credit-1)**

8. Literature review and domain wise listing using different databases.
9. Reference writing, formatting and managing software.
10. Guidelines for keeping a laboratory notebook.
11. Review writing on the given topic and report submission.
12. Statistical analysis of given biological data using different software packages.
13. Project writing, hypothesis design, framing research objectives
14. Online tools for plagiarism checking.

### **Suggested Readings:**

14. Research Methodology (2018): A Step-by-Step Guide for Beginners by Ranjit Kumar



15. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (2016) by John W. Creswell and J. David Creswell
16. Social Research Methods: Qualitative and Quantitative Approaches (2018) by W. Lawrence Neuman
17. Research Methodology: Methods and Techniques (1982) by C.R. Kothari
18. The Craft of Research (2020) by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
19. Qualitative Inquiry and Research Design (2018): Choosing Among Five Approaches" by John W. Creswell
20. Research Methodology: A Step-by-Step Guide (2017) by Mugenda and Mugenda
21. Experimental and Quasi-Experimental Designs for Generalized Causal Inference (2020) by Donald T. Campbell and Julian C. Stanley
22. Designing Clinical Research (2020) by Stephen B. Hulley, Steven R. Cummings, Warren S. Browner, Deborah G. Grady, and Thomas B. Newman
23. Clinical Trials: A Practical Guide to Design, Analysis, and Reporting (2010) by Duolao Wang, Ameet Bakhai, and S. (Mitch) H. Gail
24. Ayurvedic Pharmacology and Therapeutics (2005), by: Author: Vaidya V. M. Gogte
25. Healing: A Practical Guide (2007), by: Author: Dr. Vasant Lad
26. Textbook of Ayurveda (2012), by: Vasant D. Lad, David Frawley.

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# **SEMESTER VIII**

**Course: Zoology Core**  
**Paper Code: ZOO23C801**  
**Paper Title: Environment Science and Fish Biology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Objective:**

**CO1:** Identity the different aspects of Environment that we live in

**CO2:** Understand the environment issues that will make students more scientific in their approach for monitoring and implementing action plans at all scales.

**CO3**Apply the knowledge for effective environmental decision-making, management, and sustainable development.

**CO4:** Understand the diversity in relation to identification and classification of species.

**CO5:** Comprehend the basic anatomy and structures of various fish fauna along with its physiological phenomenon.

**Theory**

**Credit:3**

**UNIT 1: Fundamental of Environment Science**

**12L**

Definition, Principles and Scope of Environmental Science. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Laws of thermodynamics, heat transfer processes, mass and energy transfer across various interfaces, material balance. Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, radiation and wind velocity, adiabatic lapse rate, environmental lapse rate. Wind roses. Interaction between Earth, Man and Environment. Biogeographic provinces of the world and agro-climatic zones of India. Concept of sustainable development.

**UNIT - 2: Environmental Monitoring, Education and Organizations**

**13L**

Environmental monitoring; Biological monitoring programme; Bioindicators and Environmental Monitoring; Remote sensing and Geographic Information Centre; Environmental Impact Assessment; Environmental Management; Indian Environmental Laws; National Environmental Policy (Draft), 2004.

Need of environmental education; Goals and Objectives; Environmental education; Environmental organizations and Agencies; Ministry of Environment, Forests and Climate Change, Govt. Of

India, Important acronyms.

### **Unit 3 Fish Taxonomy**

**8L**

Taxonomic characterization, taxonomic keys, taxonomic methods for identification of freshwater teleosts, Molecular taxonomy in fishes.

### **Unit 4 Anatomy, Physiology and Osteology**

**12L**

External and internal fish anatomy, Major anatomical features of different types of fishes, 2. Skin, Scale and Fins of freshwater fishes, 3. Digestion: digestive system and feeding types in fish, 4. Respiration: Structure and function of gills, accessory respiratory organs, 5. Excretion: Kidney: structure and function, osmoregulation in freshwater and marine teleost, 6. Reproduction and development of teleost, 7. Osteological study of freshwater teleost.

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### **Practical:**

**(Credit-1)**

1. Morphometric and meristic analysis of teleost.
2. Identification of ornamental fishes of freshwater with reasons up to order.
3. Identification of freshwater exotic fishes with reasons upto order.
4. Identification of fishes of the river Brahmaputra with reasons upto order.
5. Identification of marine water fishes.
6. Determination of DO, BOD, pH, FCO<sub>2</sub>, TA, TH of freshwater water.
7. Study plankton diversity in an aquatic habitat.
8. Estimation of density, frequency and abundance of animals/ plants in a community using transect/quadrant methods.
9. Visit to fish farm, wetlands within Assam.

### **Suggested Readings:**

1. Odum: Fundamental of Ecology(5th edition), Thomas Brooks/Cole, 2005.
2. Pawlosuske: Physico-chemical methods for water and wastewater treatment (vol19) Elsevier,1982.
3. Wetzel: Limnology Lake and River Ecosystem (3rd edition) Academicpress2001.
4. Arora: Fundamentals of environmental biology

5. S.S. Khanna & H.R. Singh, A textbook of Fish Biology and Fisheries, 3rd Ed. 2024.
6. Pandey and Shukla, Fish and Fisheries, 4th Ed. 2022.
7. Srivastava and Srivastava, A textbook of Fishery Science and Indian fisheries, 4th Ed. Kitap Mahal.
8. Jhringran, Fish & Fisheries of India, Hindustan Publication Corporation.

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**Course: Zoology Core**  
**Paper Code: ZOO23C802**  
**Paper Title: Entomology and Cellular Dynamics**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** To develop understanding about the basics of insects and their identification

**CO2:** To learn and understand various characters of insects and its modifications.

**CO3:** To learn and develop the understanding of molecular biology of insects.

**CO4:** To understand and apply the concepts of molecular biochemistry.

**CO5:** To create a comprehensive grasp of cell culture techniques, applications, and ethical considerations in various field of biology where stem cell research is used.

**Theory**

**Credit:3**

**Unit 1 Insect Classification and General structure**

**11 L**

Modern scheme of classification of insects along with key characteristics of insect orders, distinguishing characters, Body divisions-head (general structure and types), types of mouthparts, thorax (and its appendages, types of legs), abdomen (its appendages),

**Unit 2 Insect Anatomy, Physiology and Molecular Biology**

**11L**

Digestive system, nervous system, sensory system, respiratory system, circulatory system, excretory system , reproductive system, Insect miRNAs-mechanism of action of miRNA miRNAs function, Insect transposons- diversity and characteristics of insect transposons, Application of insect TEs

**UNIT - 3: Molecular Biochemistry**

**11 L**

1. Supercoiling of DNA, Topoisomerase I and II, C-value paradox 2. DNA replication (inhibition, elongation& termination) in eukaryotic and prokaryotic cells 3. Telomere shortening and its replication, 4. Transcription factors-RNA binding motif and proteins, 5. Post transcriptional processing: Capping, Tailoring, splicing and alternate splicing, mRNA Stability, RNA degradation, RNA editing, 6. Protein folding: enzymes for protein folding, 7. Ramachandran plot, 8. Molecular chaperonin and chaperones 9. Prion structure and function.

#### **UNIT-4: Cell and tissue culture**

**12 L**

1. Cell culture media properties and preparation, 2. Primary and secondary cell culture, continuous cell lines-lymphocytes and fibroblast cell culture, cell separation by FACS, 3. Properties and types of stem cells (embryonic, umbilical, adult), 4. Haemopoietic stem cells and formation of blood cells, bone marrow transplantations, 5. Stem cell disorders - Stem cell therapy, Stem cell and cancer, 6. Stem cells and tissue engineering –ethical, legal and social implications (ELSI) of stem cell technology.

#### **Practical:**

**(Credit-1)**

1. Insect collection, labeling and preservation techniques
2. Slide preparation of insect head, antennae and legs
3. Dissection/display of insect digestive system, nervous system and reproductive system
4. Designing of miRNA
5. Primer designing using different *p* element of insects
6. Isolation of genomic DNA from animal tissue and demonstration of Agarose Gel Electrophoresis
7. SDS-polyacrylamide Gel -Electrophoresis for protein and its visualization.
8. Preparation of different types of buffer and cell culture media used in molecular biology.

#### **Suggested readings**

1. Imms, A. D. A. General Text Book of Entomology.
2. Chapman & Hall, UK. The Insects: Structure and Function. Cambridge University Press, UK
3. Snodgrass, R. E. Principles of Insect Morphology. Cornell Univ. Press, USA
4. Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the Study of Insects. M Saunders College Publication, USA Suggested Readings: •
5. Gilbert, LI. Insect molecular biology and biochemistry. Academic Press
6. Gullan, P. J., and Cranston, P. S. The Insects, An outline of Entomology. Wiley Blackwell, UK
7. Nation, J. L. Insect Physiology and Biochemistry. CRC Press, US
8. Fenemore, P.G. and Prakash, A. 1992. Applied Entomology. Wiley Eastern Limited
9. T. A. Brown: Genomes 3 (2<sup>nd</sup> Ed.), Gerald publication, 2009.
10. J. D. Watson et al.: Molecular Biology of the Gene (4<sup>th</sup> Edn.) Benjamin/Cummings Pub Co.

(2010).

11. R. R. Sinden: DNA Structure and Function, Academic Press, 1998.

12. D. L. Hartl and E.W. Jones: Essential Genetics: A Genomic Perspective, Jones and Bartlett (2002).

13. B. Lewin: Genes VIII, Prentice Hall; Tch edition (2004).

14. B. Alberts et al. Molecular Biology of the Cell, 6<sup>th</sup> Edn. (2014).

15. J.F. Atkins et al.: RNA Worlds: From Life's Origins to Diversity in Gene Regulation Cold Spring Harbor Laboratory, Press, U.S; 1<sup>st</sup> Edn. (24 September 2010).

16. V. Ramamurthy and S. Raveendran, Fundamentals of Biochemistry, Aruna Publications, Koradacherry (2010).

17. J. L. Jain, Fundamentals of Biochemistry, S. Chand and Co. Ltd. New Delhi.

18. L. Stryer, Biochemistry, W.H. Freeman and Co. New York (1988)



**Course: Zoology Core**

**Paper Code: ZOO23C803**

**Paper Title: Advanced Approach to Ecology and Fish Biology**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1:** To know basic pattern of interaction between community variables and their relationships

**CO2:** To understand the different aspects of Bioremediation and Biodiversity conservation

**CO3:** Know the different culture practice along with fishing gears.

**CO4:** Know advanced techniques related to fish breeding

**CO5:** Understand different methods of fish preservation, about different by-products of fish

**Theory**

**Credit:3**

**UNIT -1: Community ecology**

**10L**

Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, proto cooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, climax community concepts, examples of succession. ecological niche; types of niches: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche, impacts of biological invasion on ecosystem and communities, case studies.

**UNIT-2: Bioremediation and Biodiversity**

**10L**

Basic concept, need, merits and scope of Bioremediation, approaches to Bioremediation, Ecotechnology of Bioremediation, FOCI of R&D for Bioremediation, Phytoremediation, Current status Biodiversity; Measuring Biodiversity; Global Biodiversity; Conservation of Biodiversity; Ecology vs Economy; The Biological Biodiversity Act (2002 in force); Biodiversity and Biopiracy; International Efforts for Conservation of Biodiversity; CBD Milestones.

### UNIT 3. Fish Farming

11L

1. Scopes of aquaculture including fisheries, 2. Types of aquaculture (warm and cold water), aquaculture systems (monoculture, polyculture, semi-intensive, intensive culture, monosex culture), 3. Fish breeding technology and its importance, 4. Integrated fish farming (paddy cum fish, duck cum fish, pig cum fish, fish cum livestock), 5. Composite fish farming: methods and importance, 6. Culture of ornamental fishes (exotic and indigenous) and their importance., 7. Aquatic weeds, 8. Larvivorous fishes, 9. Threatened and endemic fishes of Northeast India with special reference to Assam, conservation methods and strategies.

### UNIT4. Aquaculture

12L

Types of capture fishery resources, 2. Fishery resources in major river systems of India with special reference to Brahmaputra and Barak river system, 3. Hill stream fisheries: Mahaseer fisheries, 4. Floodplain wetland (beel) fisheries of Assam, their problems and management, 5. Marine fisheries (Sardine and Mackerels), 6. Fishing gears in inland fisheries and fishing crafts in marine fisheries., 7. Migration of fish, 8. Sewage fed fisheries, 9. By-products of fish, 10. Transportation of fish seed and fishes, 11. Principle and practice of fish preservation.

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### PRACTICAL:

Credit 1

1. Ecological sampling and census techniques.
2. Estimation of primary productivity of water body.
3. Field equipment's on population study and analysis, camera trapping, GIS, GPS and RS technology. Study of fishing gears used in Assam.
4. Study of skeletal system of freshwater fishes.
5. Dissections: Accessory respiratory system of *Anabas sp.*, *Channa sp.* and *Heteropneustes fossilis*. Urino-genital system of carp, Weberian ossicles of carp, IX<sup>th</sup> and X<sup>th</sup> cranial nerves in carps.
6. Submission of fish specimens representing different groups (at least 10 numbers).
7. Submission of fish skeleton representing different groups.
8. Field visit to agricultural station/institution, entomology/Fishery related lab/fish

farm/wetland and report submission.

**Suggested Readings:**

1. Anathakrishnan: Bioresources ecology, Taylor and Francis, 1982
2. Bouhey: Ecology of populations (2nd edition) Macmillan,1973.
3. Dowdoswell: An introduction to animal ecology, Methien, 1967.
4. Kormondy: Concepts of ecology, Prentice-Hill, 1984
5. May: Stability and Complexity in Model ecosystems (Vol.6th). Princeton university press, 1974
6. Odum: Fundamental of Ecology(5thedition), Thomas Brooks/Cole, 2005.
7. Pawlosuske: Physico- chemical methods for water and wastewater treatment (vol19) Elsvier,1982.
8. Wetzal: Limnology: Lake and River Ecosystem (3rd edition) Academicpress2001.
9. Arora: Fundamentals of environmental biology.
10. S.S. Khanna & H.R. Singh, A textbook of Fish Biology and Fisheries, 3rd Ed. 2024.
11. Pandey and Shukla, Fish and Fisheries, 4th Ed. 2022.
12. Srivastava and Srivastava, A textbook of Fishery Science and Indian fisheries, 4th Ed. Kitap Mahal.
13. Jhringran, Fish & Fisheries of India, Hindustan Publication Corporation.

**Course: Zoology Core**  
**Paper Code: ZOO23C804**

**Paper Title: Advance Approach to Entomology and Cellular Dynamics**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1: Learn** insect communication patterns and immunological responses to pathogens

**CO2: Learn, understand and apply** the knowledge of pests and pest ecology in IPM.

**CO3: Application** of entomology in stored grain pests as well as forensic field.

**CO4:** To develop understanding of the intricacies genetic information is organized and expressed in organism. Through a blend of theoretical understanding the techniques in molecular biology, students will develop the skills to analyze, evaluate, and creatively apply this knowledge, fostering a comprehensive understanding of the applicability of molecular techniques in unraveling the complexities of genome organization and gene expression.

**CO45** The course focuses on students acquiring proficiency in applying various molecular biology techniques. By the end of the course, students should be able to know a theoretical and practical understanding of the advance molecular techniques, apply, evaluate and create them with the good knowledge in molecular biology.

**Theory**

**Credit:3**

**Unit 1: Insect biochemistry and immunology**

**11L**

Biochemistry of pheromones, insect chemical communication, insect moulting and metamorphosis, Insect cuticle- protein, sclerotization and tanning, Chitin metabolism in insects, digestive enzymes in insects, developmental insect immunity-Mechanism of innate immunity, signalling pathways pathway, antibacterial immunity; anti-viral immunity.

**Unit2: Insect Ecology and Applied Entomology**

**11L**

Insect population and pest outbreak, Insect communication-honeybee dance, ant colony optimization, vibrational communication, concept of pests and its types, insect plant interaction, host plant selection by phytophagous insects, principles of pests control, types of pest control, concepts of IPM, Understanding bionomics of agricultural pests- pests of paddy, cotton, vegetable and pulses, stored grain pest (*Sitophilus oryzae*, *Callosobruchus* sp.), Forensic entomology.

**Unit 3: Genome organization and gene expression**

**13L**

1. Organization of genome in prokaryotic and eukaryotic cells, organelle genome organization -

mitochondria and chloroplast, virus genome, 2. mobile genetic element (Transposable element, IS element, P element, retrovirus and retro-transposome). 3. Mapping of genome –physical and genetic mapping. 4. Genome sequencing and High-throughput screening and next generation sequencing, 5. Genetic markers, Genome analysis technique: RFLP, AFLP, RAPD, ISSR. 6. Gene silencing: DNA methylation and acetylation, doses compensation, RNA Interference and CRIPR-Cas9.

#### **Unit 4: Application of Molecular Biology**

**10L**

1. Concept of System biology - Transcriptomics, proteomics, metabolomics, lipidomics, glycomics, and phosphoproteomics. 2. Antisense and ribozyme technology 4. Hybridization techniques –Northern-, Southern hybridization, Chromosome painting, FISH, DNA chip technology. 5. Gene therapy and application - Gene therapy for inherited immune deficiency syndromes, Cystic fibrosis and HIV, 6. Retroviral mediated gene transfer.

#### **Practical:**

**(Credit-1)**

1. Study of Pests of Cotton, vegetables, pulses and stored grain pests- *Sitophilus oryzae*, *Callosobruchus* sp.
2. Submitting insect life-cycles (any two)
3. Preparation and identification of hemocytes
4. Detection of chitin
5. Field visits-agricultural/horticultural farm/institutes related to insect vector
6. Isolation of mitochondria by ultracentrifugation technique from suitable animal tissue material.
7. In-silico designing of primer for COI and 18sRNA degenerate and specific primer.
8. Chromosome preparation from *Drosophila*, bone marrow or other sources.

#### **Suggested Reading**

1. Wigglesworth, V.B. Insect Physiology, Methuen & Co. Ltd, London
2. Gilbert, LI. Insect molecular biology and biochemistry. Academic Press
3. Wilson, E. O. The Insect Societies. Harvard Univ. Press, UK
4. Gullan, P. J., and Cranston, P. S. The Insects, An outline of Entomology. Wiley Blackwell, UK

5. Nation, J. L. Insect Physiology and Biochemistry. CRC Press, US
6. Fenemore, P.G. and Prakash, A. 1992. Applied Entomology. Wiley Eastern Limited.
7. T. A. Brown: Genomes 3 (2<sup>nd</sup> Ed.), Gerald publication, 2009.
8. J. D. Watson et al.: Molecular Biology of the Gene (4<sup>th</sup> Edn.) Benjamin/Cummings Pub Co. (2010)
9. R. R. Sinden: DNA Structure and Function, Academic Press, 1998.
10. D. L. Hartl and E.W. Jones: Essential Genetics: A Genomic Perspective, Jones and Bartlett (2002).
11. B. Lewin: Genes VIII, Prentice Hall; Tch edition (2004)
12. B. Alberts et al. Gerald Publications; 6<sup>th</sup> Edn. (2014).
13. J.F. Atkins et al.: RNA Worlds: From Life's Origins to Diversity in Gene Regulation Cold Spring Harbor Laboratory, Press, U.S;1<sup>st</sup>Edn. (24 September2010).
14. V. Ramamurthy and S. Raveendran, Fundamentals of Biochemistry, Aruna Publications, Koradacherry (2010) J. L
15. Jain, Fundamentals of Biochemistry, S. Chand and Co. Ltd. New Delhi.
16. L. Stryer, Biochemistry, W.H.Freeman and Co.NewYork.(1988).

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**Course: Zoology Minor**  
**Paper Code: ZOO23M805**  
**Paper Title: Biomimicry and Science Communication**

**Total Lectures: 45**

**Credit: (L+T+P): 3+0+1=4**

**Course Outcome (CO):**

**CO1: To understand and appreciate** the pattern and processes in nature

**CO2: Application** of the knowledge gained in developing designs and technology

**CO3: Analyse** the nature inspired innovation for critical thinking

**CO4: Learn and understand** the importance of science communication and its various ways

**CO5: To be able to apply** the knowledge in creating awareness in science

**Theory**

**Credit: 3**

**Unit 1**

**11L**

(a) Introduction to biomimicry/biomimetics & its history-Janine Benyus; (b). Categories of natural objects & their functions (with respect to biomimicry)-bacteria, invertebrate, vertebrate, plants; (c) Importance of biomimicry; (d) Study of nature inspired innovations in biological/zoological field [any 5-6 case studies]

**Unit 2**

**12L**

a) Steps to develop design based on biomimicry (design process); b) understanding systems-properties and interconnections; c) Nature's unifying patterns- 10 patterns (explanations with examples); d) study of any 5 innovations through videos on biomimicry and their relevance.

**Unit 3**

**12L**

Basics of Communication; Functions of Mass Media, Grassroots Communication; Science Communication; Importance and use of Science Communication - Public Understanding of Science (PUS); Science popularization: programmes, organizations, individuals; Sources of scientific information- books, scientific reports, scientific journals, magazines, feature syndicates, leaflets, tabloids, wall magazines, speeches, seminars, press releases, databases, encyclopedias on science, etc.

**Unit 4**

**10L**

Ethical concerns and critical areas in Science Communication- healthcare, environment, diversity, and indigenous knowledge, etc.; Science Communication with reference to India, Northeast and

Assam; Science communication and policy formulation; Scientific content creation: Print, Electronic (audio and audio-video) and New Media content designing; creating scientific posters, pamphlets, short videos/documentaries, short films, Public Service Announcements (PSAs), etc.;; Relevant case studies

**Practical:** **(Credit-1)**

1. Visit to RSC & preparation of documents on biomimicry
2. Study of some invertebrate and vertebrate models commonly used in biomimicry (concept, principle. Design and application)
3. Field visits to understand indigenous practices and prepare reports
4. Making brochure, announcements and scientific posters
5. Making short video/ documentary on everyday science or on any scientific news or event
6. To report about any 2 new scientific development in the recent times.

**Suggested Readings:**

1. Benyus, J. B. 2002. Biomimicry- Innovations inspired by Nature.
2. Biomimicry.org
3. Sites.udel.edu/bioinspired
4. Graeff et al. (2001). Research in Engineering design.
5. Fayemi et al. (2017). Bioinspiration and biomimetics 12 (1).
6. Stem.org.uk/ resources
7. Poepsel, MA, Media, Society, Culture and You.
8. Turner, L.H. and West, R. 2019. An Introduction to Communication. Cambridge University Press
9. Peters HP. Gap between science and media revisited: scientists as public communicators. Proc National Academy of Science USA. 2013 Aug 20;110 Suppl 3(Suppl 3):14102-9.
10. Matthews JR., Matthews RW, (2008) “Successful Scientific Writing: A Step-By-step Guide for the Biological and Medical Sciences” 3 rd Edition, Cambridge University Press.
11. Yousuf A, Sidiq M, Acharya S, (2018) “Publish and Cherish – The Art and Craft of Publishing Scientific Research” 1st Edition, Sara Book Publication.

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