Syllabus

Third Semester Courses in Zoology

2024 – 2025

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MUMBAI - 400 001.

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APPROVED SYLLABUS

20 JAN 2024

S.Y.B.Sc. ZOOLOGY Course Code: USZOO5001CR1

COMPARATIVE ANATOMY

Credits 4: **Theory 3 = 45 hrs and Practical 1 = 30 hrs**

Prerequisite: **The student should have done two core courses in Zoology in Semesters I and II**

Course Objectives:

1. To enable students to understand the complexity and differences of systems in different animals from lower organisms to higher organisms.
2. To bring an awareness of the different parts of the various anatomical systems from unicellular to multicellular and higher organisms with respect to digestive, excretory, respiratory and circulatory systems.
3. To understand the progressive complexity of the nervous and reproductive systems from lower to higher organisms.

Course Outcomes:

On completion of the course the learner should be able to:

CO	Course Outcomes	Bloom's Taxonomy Level
1	Students should be able to describe the various modes of locomotion in different animals.	Remembering
2	Students should understand the various anatomical features associated with the physiological working of a biological system from lower to higher organisms	Understanding
3	Relate the evolution of various anatomical systems in living organisms with respect to changing habitats	Applying
4	Students should be able to correlate the concepts with their own biological system	Applying

UNIT 1 (15 lectures)

- **Locomotion:**
  - Revisit the concept of Pseudopodia, cilia and flagella (done in FY)
  - Structure of parapodia and setae in Annelids
  - Tube feet in Echinoderms.
  - Types of muscles – striated, un-striated and cardiac muscles
  - Skeletal system in vertebrates (Cartilage and bone) [appendicular and axial]
- **Nutrition:**
  - Food vacuole in Protozoans - Paramoecium
  - Gastrovascular cavity - Hydra and Incomplete Digestive system in Platyhelminthes
  - Canal system - Poriferans
  - Invertebrates with complete alimentary canal - Cockroach, Earthworm, (gizzard and typhlosolar region of earthworm)
  - Vertebrate alimentary canal - Mammals and Bird
  - Symbiotic digestion - Ruminant Stomach - Gut brain axis
- **Excretion:**
  - Types of excretory organs – Contractile Vacuole, Flame cells in helminths, green gland in Crabs, Malpighian tubules in insects, Nephridia in Annelids.
  - Structure of Nephron - Functional unit of the Mammalian Kidney

UNIT 2 (15 lectures)

- **Respiration:**
  - Types of respiratory organs in different organisms: Plasma membrane, Tracheal system in insects, Gills (Unio, Crab, Cartilaginous and Bony Fish, amphibia), Swim bladder, Book lungs, Air sacs of birds, Lungs of Mammal
- **Circulation**:
  - Open and closed circulatory systems.
  - Single and double circulation – fish, frog, and mammal
  - Different types of hearts – Neurogenic heart (daphnia, cockroach and earthworm), Myogenic heart [Molluscan and Vertebrates (fish, frog, reptile and mammal)].

UNIT 3 (15 lectures)

- **Nervous system:**
  - Nervous systems in Hydra (Nerve net), Platyhelminthes, Cockroach, Earthworm (Giant nerve in Earthworm), Unio, and Vertebrates (Central and Peripheral [sympathetic and parasympathetic]).
  - Comparative brain anatomy of vertebrates - fish (shark and bony fish), frog, reptile, bird and mammal
  - Sensory receptors - (tactile, auditory, gustatory, olfactory and optic)
- **Reproduction:**

  Different modes of Reproduction - Asexual (Fission, Budding and Parthenogenesis), Sexual, Oviparity, Viviparity, Ovoviviparity
  - Reproductive system in Invertebrates - Taenia, Earthworm and Cockroach.
  - Male and Female reproductive system in Vertebrates - Mammals

List Of Recommended Reference Books:

1. Tortora, G. J., & Derrickson, B.H. (2020). Principles of Anatomy and Physiology (16th ed.). Wiley
2. Dhami, P.S., & Dhami, J.K. (2021). Vertebrate Zoology (5th ed.). R. Chand & Co.
3. Dhami, P.S., & Dhami, J.K. (2021). Invertebrate Zoology(5th ed.). R. Chand & Co.
4. Withers, P. C. (1992). Comparative Animal Physiology. Cengage Learning
5. Arora, M.P. (2022). Animal Physiology. Himalaya Publishing House
6. Hall, J.E. (2020). Guyton & Hall Textbook of Medical Physiologyl, Elsevier Publication
7. Kent, G. & Carr, R. (2000). Comparative Anatomy of the Vertebrates (9th ed.). McGraw-Hill

Practical Course:

1. Identification of the types of hearts - Cockroach, Frog, Fish, Bird and Mammal
2. Identification of Gills of fish (cartilaginous and bony fish), gills of crab, lungs of frog and mammal.
3. Study of Nutritional apparatus – Food vacuole of amoeba/ paramecium, Gastrovascular cavity of hydra, incomplete digestive system of planaria, digestive system of earthworm, cockroach, bird and ruminant stomach.
4. Observation of T.S. Giant nerve fibre and T.S. of spinal cord
5. Mounting of Septal Nephridia and setae of Earthworm

6. Identification of Proglottid of tapeworm, mammalian kidney (entire, L.S. and T.S.), T.S. of testis and ovary.
7. Identification and mounting of striated and smooth muscle.
8. Observation of ciliary movement, food vacuole, contractile vacuole and trichosis in paramecium
9. Identification of exoskeleton in Vertebrates and Integumentary Derivatives - Scales, Hair, feathers, claws, nails, hooves, horn and antlers.

Evaluation (Theory): Total marks per course - 100

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).

CIA Exam – 40 marks

- CIA 1: Written Test – 20 marks.
- CIA 2: Multiple choice questions/Assignment/Presentation – 20 marks

II. Summative Assessment 'of' Learning

End Semester Examination – 60 marks.

- One question from each unit for 20 marks, with internal choice. Total marks per question with choice – 30 to 32.

Evaluation of (Practical:) Total marks Practical course – 50 marks

- End Semester Practical Examination (Identification and performance of experiments) and Journal – 50 marks.

Template for End Semester examination in Semester III for the Core course in Comparative Anatomy.

UNITS	REMEMBERING	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS Per unit
1	12	8	-	20
2	12	8	-	20
3	8	8	4	20
TOTAL	32	24	4	60
% WEIGHTAGE	53	40	7	100%

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S.Y.B.Sc. ZOOLOGY Course Code: USZOO5002CR1

COMPARATIVE PHYSIOLOGY

Credits 4: **Theory 3 = 45 hrs and Practical 1 = 30 hrs**

Prerequisite: **Should have done Zoology in Semesters I and II**

Course Objectives:

1. Students understand the complexity of physiology in different animals.
2. To bring an awareness of the process of digestion, circulation, respiration, excretion, reproduction and nervous coordination in different organisms.

Course Outcomes:

On completion of the course the learner should be able to:

CO	Course Outcomes	Bloom's Taxonomy Level
1	Students should be able to understand the mechanism of muscle contraction for locomotion.	Understanding
2	Students should be able to understand how the physiological processes change from lower to higher organisms	Understanding
3	Relate the evolution of physiological processes in living organisms with respect to changing habitats.	Applying
4	Students should be able to correlate the physiological processes between animals and human physiology.	Analysing

UNIT 1 (15 lectures)

- **Movement and locomotion:**
  - Pseudopodia and Sol-gel theory
  - Flagella and Ciliary movement
  - Working of Tube feet in echinoderms and canal system
  - Water jet propulsion in cephalopods
  - Sliding filament theory
- **Digestion:**
  - Process of circumfluence and circumvellation in Amoeba
  - Cyclosis in Paramoecium
  - Intracellular, extracellular
  - Filter feeders
  - Digestion in Insects (Solid feeders and fluid feeders)
  - Process of symbiotic digestion
  - Process of digestion in a Mammals
- **Excretion and Osmoregulation:**
  - Physiology of Contractile Vacuole, Flame cells, Malpighian tubules, green gland of crab, Nephridia
  - Functions of Kidney and the process of Urine formation and acid base balance in Mammals.
  - Categorization of animals on the basis of principal nitrogenous excretory products.
  - Osmoregulation in aquatic and terrestrial environments

UNIT 2 (15 lectures)

- **Respiration:**
  - Physiology of respiration cockroach, unio, crabs and fish (Counter-current mechanism)
  - Mechanism of exchange of gases in Vertebrate lungs and tissue respiration.
- **Circulation**:
  - Types of circulating fluids and blood cells
  - Mechanism of circulation in lower invertebrates (open) and earthworm (closed)
  - Working of a Neurogenic and a Myogenic heart

UNIT 3 (15 lectures)

- **Neurophysiology:**
  - Nervous coordination in invertebrates and Vertebrates
  - Structure and function of Neuron.
  - Generation and conduction of a nerve impulse
  - Motor and Sensory pathways
  - Reflex action and the reflex arc
- **Reproduction**
  - Types of Sexual modes of reproduction - Syngamy and Conjugation
  - Gametogenesis in mammals and its hormonal regulation
  - Menstrual and Estrous cycle
  - Fertilization in invertebrates and vertebrates - types and mechanisms
  - Sex-determination (XX and XY) and its social issues
  - Introduction to infertility, IVF and Contraception, Surrogacy, Invitro fertilisation

List Of Recommended Reference Books:

1. Tortora, G. J., & Derrickson, B.H. (2020). Principles of Anatomy and Physiology (16th ed.). Wiley
2. Dhami, P.S., & Dhami, J.K. (2021). Vertebrate Zoology (5th ed.). R. Chand & Co.
3. Dhami, P.S., & Dhami, J.K. (2021). Invertebrate Zoology (5th ed.). R. Chand & Co.
4. Withers, P. C. (1992). Comparative Animal Physiology. Cengage Learning
5. Arora, M.P. (2022). Animal Physiology. Himalaya Publishing House
6. Hall, J.E. (2020). Guyton & Hall Textbook of Medical Physiology, Elsevier Publication
7. Schmidt-Neilsen, K (2002). Animal Physiology: Adaptation and Environment (5th ed). Cambridge University Press

Practical Course:

1. Measurement of Heartbeat in Daphnia
2. Study of Osmosis using RBC's
3. Urine analysis – detection of normal and abnormal constituents
4. Identification of blood cells in vertebrates
5. Digestion in Drosophila larvae to show differential gut pH.

6. Identification of organisms with different feeding mechanisms: Herdmania, Amphioxus, sponge, sponging mouthparts, butterfly and bed bug (fluid feeders).
7. Mounting of haemocytes of Cockroach
8. Differential WBC count
9. Total WBC count using a haemocytometer.
10. Estimation of haemoglobin by Sahli's method
11. Demonstration of CBC using haemat analyzer

Evaluation (Theory): Total marks per course - 100

I. Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).

CIA Exam – 40 marks

- CIA 1: Written Test – 20 marks
- CIA 2: Multiple choice questions / Assignments / Presentations - 20 marks

II. Summative Assessment 'of' Learning

End Semester Examination – 60 marks.

- One question from each unit for 20 marks, with internal choice. Total marks per question with choice - 30 to 32.

Evaluation of (Practical:) Total marks Practical course – 50 marks

- End Semester Practical Examination (Identification and performance of experiments) and Journal – 50 marks.

Template for the End Semester examination in Semester III for the Core course in Comparative Physiology.

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS Per unit
1	6	10	4	20
2	6	10	4	20
3	5	8	7	20
TOTAL	17	28	15	60
% WEIGHTAGE	28	47	25	100%

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S.Y.B.Sc. ZOOLOGY Course Code: USZOO5001MN1

ECONOMIC ENTOMOLOGY

Credits 4: **Theory 3 = 45 hrs and Practical 1 = 30 hrs**

Prerequisite: **Should have done Zoology in Semesters I and II**

Course Objectives:

1. To emphasize the commercial aspect of the pure science of zoology
2. To learn the various commercial applications of zoology
3. To investigate some commercial applications of entomology
4. To understand the scope and prospects in zoology

Course Outcomes:

On completing the course, the learner will be able to:

CO	Course Outcomes	Bloom's Taxonomy Level
1	Gain knowledge on the various fields of applications in zoology. Know the different types of honeybees, their nesting habits, apiculture methods, harvest of commercial products of honeybees and role of honeybees in pollination service. Understand the life cycle and culturing of mulberry silk moth, lac insect, cochineal bug and blister beetle along with their associated products of commercial importance.	Remembering
2	Understand the technicalities, conditioning factors and environmental impacts on various cultures of living organisms.	Understanding
3	Students should be able to become a small-scale entrepreneur.	Applying
4	Be aware of broad areas of career options in applied zoology (Aquaculture and Dairy Science).	Analysing

UNIT 1 (15 lectures)

- Introduction to importance of zoology and its commercial aspect

AQUACULTURE

- Introduction to fisheries – Edible and ornamental fishes: freshwater, estuarine and marine fisheries, aquaria for ornamental fish, economics of fisheries and aquaria, fish diseases and their control
- Fish processing: for human consumption, animal feeds, industry
- Crustacean and Molluscan culture: Culturing prawns, lobsters and oysters

UNIT 2 (15 lectures)

INSECTS OF COMMERCIAL IMPORTANCE

- Honeybee (Apiculture): Economics of apiculture, scale of developing apiculture (small scale to industrial scale), products of apiculture and their uses in industry and basic research, diseases of honeybees and their management.
- Silk Moth (Sericulture): Economics of sericulture and silk industry, introduction to mulberry culture, scales, and levels of sericulture (small scale to industry scale), types of silk and silk products, diseases of silk moth and their management
- Insects used in biological pest control: introduction to parasitoids, their cultures and biological pest control, economics of parasitoid culture.

UNIT 3

DAIRY AND POULTRY (15 lectures)

- Dairy Science:
  - Introduction to animal breeds
  - Maintenance of a dairy farm and farm animals (cattle, goat and sheep), animal diseases and their control.
  - Processing and Economics of Dairy products, wool and meat for human consumption and commercial use.
- Poultry:
  - Introduction to poultry breeds and Emu farming
  - Maintenance of a poultry farm, poultry diseases and their control.
  - Processing and Economics of Poultry products and meat for human consumption and commercial use.

List of Recommended Reference Books:

1. Banerjee, G. C. (2019). A textbook of Animal Husbandry (8th ed). Oxford Publishers.
2. Deb, R., Chakraborty, S., Singh, U., Kumar, S., & Sharma, A. (2012). Infectious Diseases of Cattle. Serial Publication House
3. Gupta, S. K., & Gupta, P. C. (2006). General and Applied Ichthyology: Fish and Fisheries. S. Chand Publishers
4. Chaudhari, S. (2017). Economic Zoology. NCBA Publishers
5. Ninawe, A. S., & Rathnakumar, K. (2008). Fish Processing Technology & Product Development. Narendra Publishing House
6. Snodgrass, R. E. (1993). Principles of Insect Morphology. Tata McGraw Hill
7. Textbook of Entomology – Ross – John Wiley publication
8. David, B. V., & Ananthakrishnan, T. N. (2003). General and Applied Entomology (2nd ed). McGraw Hill publication
9. Textbook of Entomology – Awasthi
10. Chapman, R. F. (2013). The Insects – Structure and Function Chapman. Cambridge University Press.

Practical Course:

1. Identification of: Fish, Crustaceans and Molluscs.
2. Estimation of reducing sugars from the given milk sample.
3. Estimation of calcium content in milk.
4. Lipid content in milk
5. Protein content in milk
6. Paneer making
7. Study of cattle and poultry breeds
8. Biometric study in Fish
9. Identification of apiculture equipment and insect products
10. Life cycle of honeybees and Silkmoth

Evaluation (Theory): Total marks per course - 100

I. **Formative Assessment 'for' Learning (continuous internal assessment - CIA to improve learning).**

CIA- 40 marks

- CIA 1: Written Test – 20 marks
- CIA 2: Multiple choice questions / Field report / Assignment / Presentation - 20 marks

II. **Summative Assessment 'of' Learning**

End Semester Examination – 60 marks.

- One question from each unit for 20 marks, with internal choice. Total marks per question with choice -30 to 32.

Evaluation of (Practical:) Total marks Practical course - 50

- End Semester Practical Examination (Identification and performance of experiments) and submission of Certified Journal – 50 marks.

Template for the End Semester examination in Semester III for the Minor course in Economic Entomology.

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS Per unit
1	7	5	8	20
2	6	4	10	20
3	6	4	10	20
TOTAL	19	13	28	60
% WEIGHTAGE	31.6	21.6	46.6	100

Field Trip:

- Visit to Sasoon docks/CIFE, fishing villages and aquarium shops in Mumbai to understand the economics involved in fisheries and aquaria.
- Visit to KKV Dapoli and nearby Fish landing sites/Dr. Nikam's Bee Institute in Nashik.

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S.Y.B.Sc. ZOOLOGY Course Code: USZOO5001VS1

BIOSTATISTICS

Credits 2: **Theory 1 = 15 hrs and Practical 1 = 30 hrs**

Prerequisite: **None**

Course Objectives:

1. This course will make students understand the fundamentals of statistics and its applicability in the field of biology.

Course Outcomes:

On completing the course, the learner will be able to:

CO	Course Outcomes	Bloom's Taxonomy Level
1	Collect data using appropriate sampling techniques	Understanding
2	Choosing the appropriate methods for describing data.	Applying
3	Formulate hypothesis and choose an appropriate statistical test and perform it using manual and digital methods.	Applying

(Descriptive and Inferential Statistics: Will be done using manual methods as well as digital methods such as using commonly used and/or open-source software's.)

UNIT 1 (15 lectures)

Introduction to Biostatistics

- Applicatory significance of statistics in biological fields
- Basic concepts of Descriptive Statistics
    - What is Data? Types of Data.
    - Sources of Data
    - What is Variable? Types of Variables
    - Population and Sample, Types of sampling methods
    - Types of measurement scales
    - Measures of central tendencies
    - Data Dispersion: Variance and Standard deviation
    - Percentile and quartile
- Statistical graphs: Bar graph, Frequency polygon, histogram, scatter plot, line graph, pie chart, box and whisker graph, stem and leaf graph
- Introduction to probability and types of probability distribution
    - Normal
    - Binomial
    - Poison
- Central limit theorem
- Confidence interval
- Hypothesis testing
    - General framework
    - Type I and II errors.
    - Idea of Significant difference

UNIT 2 (15 lectures)

- Parametric tests:
    - Z-test
    - T-test
    - Regression
- ANOVA:
    - Assumptions and related statistical design
    - One-way and Two-way ANOVA model
    - ANOVA table and F-test.
    - Post-hoc comparisons

- Non-parametric tests:
    - Chi-square tests
    - Wilcoxon test
    - Man-Whitney U test.
    - Correlation
- Introduction to R and Python

List of Recommended Reference Books:

1. Wayne, W., Daniel, Cross, C.L. Biostatistics: Basic Concepts and Methodology for the Health Sciences.
2. Rowntree, D. Statistics without tears.
3. Kempthorne, O. (2007). Design and Analysis of Experiments (2^{nd} ed). Vol I-II, Wiley
4. Paradise, E. R for Beginners.

Evaluation (Theory and Practical): Total marks per course - 50

- Periodic internal assessments totalling to 50 marks.

Template for the End Semester examination in Semester III for the Vocational Skill Course in Biostatistics

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS Per unit
1	15	6	4	25
2	6	15	4	25
TOTAL	21	21	8	50
% WEIGHTAGE	**42**	**42**	**16**	**100**

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