

# SYLLABUS OF ZOOLOGY (MAJOR)

For 4-Year Undergraduate Programme Under  
NCCF, 2023



**Cooch Behar Panchanan Barma University**

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**1<sup>st</sup> Semester**

**SUBJECT ZOOLOGY**  
**4 YEAR UG SYLLABUS\_CBPBU**  
**MAJOR-1**  
**Animal Diversity: Non-Chordates and Chordates**

**OBJECTIVES:**

- Study the detailed scheme of classification of the animal world to gain deep insight regarding the unique characteristic features representing each phylum.
- To study some of the unique features of each taxonomic group of non-chordate and chordates for better understanding of the structural and functional patterns based on their evolutionary relationship.

**DIFFICULTY LEVEL: 100    MODE OF INSTRUCTION: LPT**

**THEORY**  
**(CREDITS 4)**

**Group A: Non chordates**

1. Body symmetry in invertebrates; Coelom: origin and types.
2. Classification with reasons and examples- Protozoa: up to phyla, other non-chordates (upto Phylum Echinodermata): from phyla to living sub-classes.  
[*Classification of invertebrates to be followed from Invertebrate Zoology by Ruppert and Barnes VI edition (1987, 1994) Saunders College Pub, except for Protozoa (American Association of Protozoologist ref: Levine 1980) and Porifera (Brusca and Brusca 2002; IV edition. Invertebrate Zoology)*].
3. Reproduction in *Paramoecium* sp. with special reference to conjugation.
4. Canal system in Porifera.
5. Coral reef: Types, coral reef formation, distribution, importance, and conservation of coral reefs.
6. Respiration in Arthropoda: Structure and mechanism of respiration through gills, book lungs and trachea.
7. Onychophora: Affinities, systematic position and evolutionary significance.
8. Nervous system in *Pila* and the significance of torsion on it. Nervous system in *Aplysia* and the significance of detorsion on it.

9. Water vascular system in *Asterias* sp.

### **Group B: Chordates**

1. Basic body plan in chordates.
2. Basic concept of chordate classification. Classification up to living subclasses of Fish, up to living orders of Amphibia and Reptilia; up to infra-classes of Mammals [according to J. Z. Young 1981 except fish (Talwar and Jhingran,1991)]
3. Salient features of *Balanoglossus* sp. and its affinities.
4. Retrogressive metamorphosis in *Ascidia* – justification in the light of survival of the species.
5. Structure of pharynx and feeding mechanism in *Branchiostoma* sp.
6. Agnatha: General characteristics and classification of cyclostomes up to classes.
7. Accessory respiratory organs in fishes.
8. Neoteny and pedomorphosis with special reference to Axolotl larva.
9. Non-poisonous and poisonous snakes; Poison apparatus and biting mechanism of poisonous snake; Dos and don'ts after snake bite; types of venom; antivenom-Indian perspective.
10. Feather of birds-types; Principles of aerodynamics in bird flight.
11. Dentition in mammals-types, structure, and cycle of replacement; Echolocation in bats.

### **PRACTICAL (CREDITS 2)**

**1. Identification with reasons following specimens** (Preserved specimens/models/photographs as available to be used):

**Non-Chordates:** *Amoeba, Paramoecium, Euglena, Scypha, Hydra, Obelia, Aurelia, Metridium, Taenia solium, Fasciola, Ascaris lumbricoides, Nereis, Pheretima, Chaetopterus, Hirudinaria, Macrobrachium, Squilla, Hippa, Balanus, Lepas, Cyclops, Daphnia, Periplaneta, Locust, Leptocoriza, Scorpion, Limulus, Julus, Scolopendra, Peripatus, Chiton, Aplysia, Pila, Achatina, Lamellidens, Loligo, Sepia, Octopus, Asterias, Echinus, Cucumaria.*

**Chordates:** *Balanoglossus, Branchiostoma, Ascidia, Petromyzon, Myxine, Scoliodon, Trygon, Narchine, Labeo, Catla, Cirrhina, Channa, Anabus, Heteropneustes, Clarias, Ichthyophis, Necturus, Bufo, Hyla, Tylotriton, Hemidactylus, Chamaeleo, Draco, Naja, Columba, Ornithorhynchus, Cavia.*

**2. Study of following Permanent Slides** (Permanent slides/photographs as available to be used):

CS of sponges (syconoid and leuconoid), LS of *Metridium*, CS of *Ascaris* (male &female) through gonadal region, CS of *Pheretima*.

Larvae: trochophore, glochidium, nauplius, echinopluteus, axolotl.

**3. Staining/slide Preparation/dissection/mounting:**

*Hydra*, *Obelia* colony, *Cyclops*, *Daphnia*, *Tubifex*, digestive system of cockroach, mouth parts of cockroach, cycloid and ctenoid scales, hyoid apparatus and pecten of fowl.

4. Key for Identification of poisonous and non-poisonous snakes.

**PROJECT**

Suggestion: Students can submit insect box or bone box (disarticulated)- It can be assigned as a group activity.

# **2<sup>nd</sup> Semester**

**SUBJECT ZOOLOGY**  
**4 YEAR UG SYLLABUS\_CBPBU**

**MAJOR-2 - FUNDAMENTALS OF CELL BIOLOGY**

**(Difficulty Level-100)**

**Objectives:**

- To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
- To understand the functioning of cellular components to generate and utilize energy in cells.
- To list the distinguishing properties of cell adhesion molecules and cytoskeletons.
- To describe the major events of cell division that enable the genome of one cell to be passed on to two daughter cells.
- To understand the signalling pathways in cellular communication.

**Mode of Teaching:** LPT (L = Lecture, P = Practical, T = Tutorial)

**THEORY**  
**(CREDITS 4)**

1. Structural organisation of Prokaryotic and Eukaryotic cells; Fluid-mosaic model of plasma membrane structure; Cell junctions (Tight junctions, Desmosomes, Plasmodesmata, Gap junctions).
2. Structure and Function of intra-cellular organelle: Nucleus, Mitochondria, Lysosome, Peroxisome, Endoplasmic Reticulum, Golgi Apparatus & Ribosome.
3. Concept of: Chemi-Osmotic Hypothesis, Nuclear Pore Complex, Vesicular transport mechanism, Nucleosome & Membrane Transport (Active & Passive).
4. Cell Adhesion molecules (CAMs): Cadherins, Integrins, Immunoglobulin Superfamily & Selectins.
5. Cell Division: Mitosis, Meiosis, Cell cycle and its regulation.
6. Cytoskeleton: Microtubules, Microfilaments and Intermediate filaments.
7. Cell Signalling: Pathways (Membrane receptor & Nuclear receptor).

**PRACTICAL**  
**(CREDITS 2)**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis in Grasshopper testis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Study of human karyotype (normal and abnormal).

**SUGGESTED READINGS**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
  2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. Sinauer Associates, MA.
  3. 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.
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# **3<sup>rd</sup> Semester**



**SUBJECT ZOOLOGY**  
**4 YEAR UG SYLLABUS\_CBPBU**

**MAJOR-3: Biochemistry**

**About the Course:** The course affords an introduction to the structure of biomolecules with importance on the techniques used for structure determination and analysis. The course covers basic aspects of sample preparation for analysis and aims to enlighten the students how structural information can be utilized for better understanding of biological processes.

**Learning Outcomes:** - After successfully completing this course, the students will be able to

- Understand major biomolecules namely carbohydrates, lipids, proteins and nucleic acids which are imperative for the structural organization and functions of the cells.
- Learn about enzymes, the mechanism of catalysis and enzyme kinetics.
- Accomplish biochemical tests for identification of sugars and amino acids.

**Difficulty Level: 200, Mode of Instruction: Lecture, Practical and Tutorial**

**Theory (Credit-4)**

**Unit 1: Molecules and Their Interactions**

Basic concepts of pH; Buffers; Biological buffer systems; Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.)

**Unit-2: Carbohydrates**

Definition and Classification of carbohydrates, Isomerism and mutarotation, Formation of Glycosidic bonds, Carbohydrate metabolism (pathways): Glycolysis, TCA Cycle, Electron Transport Chain, Gluconeogenesis, Glycogenesis, Glycogenolysis

**Unit-3: Lipids**

Definition and classification of fatty acids, Physiologically important saturated and unsaturated fatty acids, tri-acylglycerols, phospholipids, glycolipids, sphingolipids, steroids, eicosanoids; Beta-oxidation of saturated fatty acids, Brief idea of alpha-oxidation and omega-oxidation.

#### **Unit-4: Proteins**

Structure, classification and general Properties of  $\alpha$  - amino acids, Concept of pKa and pI, Bond stabilizing protein structure, levels of organization in Proteins, Introduction of simple and conjugate proteins; Protein metabolism: Transamination, Deamination and Urea Cycle.

#### **Unit-5: Nucleic Acids**

Structure of Purine and Pyrimidines, Nucleosides, Nucleotides, Types of Nucleic acids; cot curves: base pairing, denaturation and renaturation of DNA, Hypo and Hyperchromicity of DNA.

#### **Unit-6: Enzymes**

Nomenclature & Classification, Co-factors; Isozymes, Enzyme Kinetics: Derivation of Michaelis Menten Equation, significance of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition – Competitive, Non-competitive, Uncompetitive; Concept of Allosteric enzymes; Regulation of enzyme action.

#### **Practical (Credit-2)**

1. Qualitative Test of Carbohydrate, Proteins (Biuret) and lipids.
2. Quantitative estimation of Protein using Lowry's method.
3. Estimation of Glucose by GPD-POD method.
4. Action of Salivary amylase under optimum condition and effect of Temperature on enzyme activity.
5. Paper Chromatography
6. Demonstration of hyper chromic or Hypo chromic effect of DNA sample.

#### **Suggested Readings:-**

- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K
- Paul F Cook & W.W. Cleland. *Enzyme Kinetics & Mechanism*, 2007. Garland Science.

**SUBJECT ZOOLOGY**  
**4 YEAR UG SYLLABUS\_CBPBU**  
**Major-4: ANIMAL PHYSIOLOGY**

Difficulty level: 200

Mode of instruction: LPT

### **Course Objective**

**Theory:**

1. To become familiar with the structure of different organs of the body
2. To form the concept of the functional mechanism of different systems
3. Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.

**Practical:**

1. To expose students to the histology of different glands/organs of the body
2. To provide students hands-on training on the use of various instruments/apparatus used in the physiological examinations
3. To measure various physiological aspects of the body and understand their biological reference ranges

### **Syllabus**

**THEORY (Credit: 4)**

**Unit 1: Tissues**

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

**Unit 2: Bone and Cartilage**

Structure and types of bones and cartilages; Bone growth and resorption

**Unit 3: Nervous System**

Structure of neuron, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Synaptic transmission; Physiology of vision.

**Unit 4: Muscle**

Types of muscles; Ultrastructure of skeletal muscle; Molecular basis of muscle contraction

**Unit 5: Digestive system**

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins.

**Unit 6: Physiology of Respiration**

Mechanism of respiration with pulmonary ventilation; Respiratory volumes

and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning.

### **Unit 7: Circulatory System**

Components of blood and their functions; Structure of Haemoglobin; Blood coagulation pathways, Structure of mammalian heart; Origin and conduction of cardiac impulses; Cardiac Cycle; Cardiac output, Frank-Starling Law

### **Unit 8: Excretion and Osmoregulation**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance; Concept of osmoregulator and osmoconformer; Osmoregulation with special reference to freshwater and marine animals.

### **Unit 9: Thermoregulation**

Definition and examples of endotherm, ectotherm, homeotherm, poikilotherm, heterotherm; Brief idea of adaptive hypothermia, adaptive hyperthermia, thermal neutral zone and evaporative cooling; Desert adaptation in camel; Thermoregulation of whales with special reference to blubber and counter-current heat exchanger

### **PRACTICAL (Credit: 2)**

1. Estimation of haemoglobin using Sahli's haemoglobinometer
2. Determination of clotting & bleeding time
3. Histological study of transverse sections of the mammalian spinal cord, stomach, duodenum, ileum, liver, lung, and kidney from permanent slides (preferable)/ photomicrograph
4. Recording of human blood pressure using a sphygmomanometer (Demonstration)
5. Preparation of temporary mounts of Squamous epithelium.
6. Microtomy: Permanent slide preparation of any two mammalian (goat/white rat) tissue sections by double staining (H/E Staining)

*Note: The use of animals should conform to the existing guidelines of UGC and other relevant bodies regarding the use of laboratory animals.*

### **SUGGESTED PROJECT:**

1. Preparation of a Project Report on various types of blood cells, their morphology and functions

### **Suggested reading:**

1. Ganong W.F. (2019). Review of Medical Physiology 26th ed McGraw-Hill
2. Guyton, A.C & Hall, J.E. (2006). Textbook of Medical Physiology, XI Edition. Herculat Asia PTE Ltd/W.B. Saunders Company
3. Mescher A.L., Junqueira's Basic Histology: Text and Atlas, 17th Edition. McGraw Hill LLC
4. Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition. John Wiley & Sons

# **4<sup>th</sup> Semester**

**SUBJECT ZOOLOGY**  
**4 YEAR UG SYLLABUS\_CBPBU**  
**MAJOR-5: Ecology & Animal Behaviour**

**Difficulty: 200**

**Mode of Instruction: LPT**

**Objective:**

1. To form an understanding about the different ecological levels, components, and their functioning through the study of basic concepts, experiments, and laws.
2. To sensitize students about biodiversity and conservation of wildlife resources.
3. To form a preliminary idea about animal behaviour through the study of different modes of behaviour including behavioural patterns, social behaviour, communication, and biological rhythms.
4. To train students to perform calculations of selected biodiversity indices, identification of zooplanktons and determination of selected parameters from water samples.
5. To give a cursory idea of the selected methods of the study of animal behaviour.

**Theory (Credit-4)**

**Group A: Ecology**

**Unit 1: Introduction to Ecology**

Definition; Scope; Levels of organization; Laws of limiting factors: Liebig's Law of Minimum, Shelford's Law of Tolerance, Blackman's Law of Limiting factors; Basic concept of phenotypic plasticity; Ecological Niche: Definition and types; Faunal make up of major biomes: Savannah, Tropical Rainforest, Desert biome.

**Unit 2: Biogeochemical cycles**

Carbon cycle and Nitrogen cycle.

**Unit 3: Population**

Population attributes: Density, natality, doubling time, mortality, life tables, survivorship curves, age pyramids, exponential and logistic growth, r and k strategies, density dependent and density independent population regulation; Population interactions; Gause's Principle of competitive exclusion.

**Unit 4: Community**

Community characteristics: Species richness, dominance, diversity, abundance; Ecotone and Edge effect; Ecotype; Concept of ecological succession with hydrosere as example; Theories pertaining to climax community- monoclimax, polyclimax and climax pattern theory.

## **Unit 5: Ecosystem**

Definition of ecosystem; Food chain: Detritus and Grazing food chains; Food web; Energy flow models: Single channel, Y shaped and Universal; Ecological pyramids-pyramid of number, biomass and energy.

## **Unit 6: Biodiversity & Wildlife Conservation**

Definition of biodiversity; Levels of biodiversity (genetic diversity, species diversity and ecosystem diversity); Values of biodiversity; Biodiversity Hotspots, India as a mega-diversity country; Wildlife conservation (ideas of in-situ and ex-situ conservation): National Park, Wildlife sanctuary, Biosphere reserve; Project Tiger; Wildlife Protection Act, 1972.

## **Group B: Animal Behaviour**

### **Unit 1: Introduction to Animal Behaviour**

Origin, history, and scope of ethology; Proximate and ultimate causes of behaviour; Analysis of behavior (Ethogram).

### **Unit 2: Patterns of Behaviour**

Innate behaviour: Concept of sign stimulus, Fixed action pattern, Innate releasing mechanism; Study of egg rolling behaviour of greylag geese; Learnt behaviour: Classical conditioning (Pavlov's experiment), Operant conditioning, Habituation, Imprinting (Lorenz's experiment).

### **Unit 3: Social Behaviour**

Altruism and kin selection, Hamilton's rule; Eusociality in honey bees; Territoriality.

### **Unit 4: Animal Communication**

Signals and their roles in communication; Brief idea of channels of communication (Vision, audition, chemical touch and electric field); Round dance and waggle dance in honey bees; Communication by pheromones in insects; Echolocation in marine mammals.

### **Unit 5: Reproductive behaviour**

Definition and types of mating systems: Monogamy, polygyny, polyandry; Brief idea on sexual selection.

### **Unit 6: Biological Rhythms**

Types: Circadian rhythms, tidal rhythms, lunar rhythms, circannual rhythms; Hibernation and



aestivation(brief discussion); Biological clocks: concept of entrainment, *zeitgeber*, free running period, significance of biological clocks.

### **Practical (Credit-2)**

#### **Group A: Ecology**

1. Calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for a natural /hypothetical community.
2. Determination of population density in a natural/ hypothetical community by quadrat method.
3. Estimation of pH, dissolved oxygen content (Winkler's method) and free CO<sub>2</sub> of water sample.
4. Estimation of Primary productivity by light & Dark bottle method.
5. Report on field observations: Study at National Park/ Biodiversity Park/ Zoological Park/ Wildlife Sanctuary/ Sea Shore.

#### **Group B: Animal Behaviour**

1. Identification of different types of bird nests (from field study/photographs): Cup nest, cavity nest, pendant nest, platform nest, floating nest.
2. Study of aggressive behaviour in *Betta* sp. (live demonstration/videographs).
3. Study of learning behaviour in mice through T-maze (live demonstration/videographs).

#### **References:**

- Smith and Smith (2012) Elements of Ecology. Pearson
- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology, Harper and Row publisher
- Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres
- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

**SUBJECT ZOOLOGY**  
**4 YEAR UG SYLLABUS\_CBPBU**

**Major 6: Developmental Biology**

Difficulty: 200

Mode of Instruction: LPT

Objective:

- The syllabus aims in providing general concepts regarding the fundamental process and diversities of gametogenesis, fertilization and embryonic development.
- The syllabus also provides basic idea regarding the phenomenon supporting and modulating the embryonic development.
- The syllabus also provides basic idea for the modern concepts and technological applications in developmental biology.

**THEORY (Credit-4)**

**Unit 1: Early Embryonic Development**

Gametogenesis: Spermatogenesis and Oogenesis in mammals; Types of eggs, Egg membranes; Fertilization: External (in Sea Urchin) and Internal (in Mammals) fertilization with special reference to prevention of polyspermy, activation of egg metabolism; capacitation in mammals.

Planes and patterns of cleavage; Types of blastulae; Fate map in frog and chick, fate map construction techniques; Gastrulation in frog and chick; Embryonic induction and organizers in *Xenopus* (Spemann & Mangold's experiment).

**Unit 2: Late Embryonic Development**

Extra-embryonic membranes in Chick; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

**Unit 3: Organogenesis & Post Embryonic Development**

Development of eye in Chick. Molecular Induction in Eye development.

Metamorphosis: Changes, hormonal regulation in amphibians; Regeneration: modes of regeneration - epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and theories.

**Unit 4: Implications of Developmental Biology**

Stem cell: Concept of potency, types, markers and applications of stem cell therapy in bone marrow transplantation, Amniocentesis.

Teratogenesis: Teratogenic agents and their effects on embryonic development.

**Unit 5: Parthenogenesis**

Definition, types (Facultative, obligatory, cyclic and complete, arrhenotoky, thelytoky and artificial) and significance.

### **PRACTICAL (Credit-2)**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides/photomicrographs: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
2. Study of whole mounts of developmental stages of chick through permanent slides/photomicrographs: Primitive streak (13 and 18 hours), 24, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).
3. Preparation of whole mounts of chick embryo: 24, 48, 72 & 96 hrs (Demonstration Only)
4. Study of different sections of placenta (photomicrograph/slides) (based on histological classification).
5. Study of the developmental stages and life cycle of *Drosophila* from stock culture.

### **SUGGESTED PROJECT**

Project report on *Drosophila* culture/chick embryo development.

### **SUGGESTED READINGS**

- Gilbert S.F. 2010. Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers,
- Carlson BM. 2014. Human Embryology and Developmental Biology. 5th Edn. Elsevier.
- Das N. 2012. Fundamental Concept of Developmental Biology. New Central Book Agency
- Gardner DK. 2006. In Vitro Fertilization: a Practical Approach. CRC Press.
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press