REVISED SYLLABUS OF B.Sc. (ZOOLOGY)
UNDER CBCS FRAMEWORK WITH EFFECT FROM 2020-21

PROGRAMME: THREE-YEAR B.Sc.
(Zoology)

(With Learning Outcomes, Unit-wise Syllabus, References, Co-curricular Activities & Model Q.P.)
For Fifteen Courses of 1, 2, 3 & 4 Semesters)
(To be Implemented from 2020-21 Academic Year)
Structure of ZOOLOGY Syllabus

(Under CBCS for 3-year B.Sc. Programme)

(With domain subject covered during the first 4 Semesters with 5 Courses)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>SEM</th>
<th>PAPER</th>
<th>TITLE</th>
<th>MARKS (100)</th>
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PROGRAMME: THREE-YEAR B.Sc.
(With Chemistry, Botany and Zoology Disciplines)

As per the National Education Policy, 2019 the outcomes of Higher Education include increased critical thinking abilities, higher order thinking and deeper learning, mastery of content, problem solving, team work and communication skills besides general engagement and enjoyment of learning including systematic research in India.

The overall objectives of the learning outcomes-based curriculum framework are to:
- Help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;
- Enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values) or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study.

Programme Educational Objectives (PEOs):

**PEO1 Higher Education:** Empower students to pursue higher studies in various fields of Biology and Chemistry.

**PEO2 Career:** Enable students to pursue careers in Chemical, Biological and related fields as demonstrated by professional success at positions within industry, government, or academia.

**PEO3 Social responsibility:** Enable students to exhibit professionalism, ethical attitude, communication skills and team work in their profession.

Program Outcomes (POs):

The Learning Outcomes of the programme could be in consonance with the Bloom’s Taxonomy, which includes –

1. Remember (Lower order)
2. Understand (Lower Order)
3. Apply (Lower Order)
4. Analyze (Higher Order)
5. Evaluate & Problem Solving (Higher Order)
6. Create (Higher Order)

**PO1 Critical thinking**: Able to understand and utilize the principles of scientific enquiry, think analytically, clearly and evaluate critically while solving problems and making decisions during biological study.

**PO2 Effective communication**: Able to formally communicate scientific ideas and investigations of the biology discipline to others using both oral and written communication skills.

**PO3 Social interaction**: Able to develop individual behaviour and influence society and social structure.

**PO4 Effective citizenship**: Able to work with a sense of responsibility towards social awareness and follow the ethical standards in the society.

**PO5 Ethics**: Ability to demonstrate and discuss ethical conduct in scientific activities.

**PO6 Environment and Sustainability**: Able to understand the impact of biological science in societal and environmental contexts and demonstrate the knowledge for sustainable development.

**PO7 Self-directed and life-long learning**: Able to recognize the need of life-long learning and engage in research and self-education.
Domain Subject: ZOOLEGY
(Syllabus with Outcomes, Co-curricular Activities, References & Model Q.P
for Five Courses of 1, 2, 3, 4 & 5 Semesters)

“The domain subject “Zoology”, embracing the fields of Animal diversity, Cell biology, Genetics, evolution, Animal physiology, Biochemistry, Embryology, Immunology, Molecular biology and Ecology gives the student a broad understanding of faunal diversity, various life processes involved in the development of an animal, its functioning, its response to environmental stimuli, molecular basis of life, new technological approach towards life, an insight for the lecturer into research and responsibility of the student towards environment”.
GENERAL CURRICULAR ACTIVITIES

➢ **Lecturer-based:**

1) **Class-room activities:** Organization of Group discussions, question-answer sessions, scientific observations, use of audio-visual aids, guidance programmes, examination and evaluation work (scheduled and surprise tests), quizzes, preparation of question banks, student study material, material for PG entrance examinations etc.

2) **Library activities:** Reading books and magazines taking notes from prescribed and reference books and preparation of notes on lessons as per the syllabus; Reading journals and periodicals pertaining to different subjects of study; Making files of news-paper cuttings etc.

3) **Lab activities:** Organization of practicals, maintenance of lab attendance registers/log registers, maintenance of glassware and chemicals

4) **Activities in the Seminars, workshops and conferences:** Organization of at least one seminar/workshop/conference per academic year either on academic/research aspects and inculcate research spirit among students

5) **Research activities:** Student study projects (General / RBPT model), Minor or Major research projects, Research guidance to research scholars, Publication of research articles/papers (at least one in 2 years) in UGC-recognized journals, Registration in Vidwan/Orcid/Scopus/Web of Science

6) **Smart Classroom Activities:** Organization of Departmental WhatsApp groups, Ed Modo groups/Google Class Rooms/Adobe Spark groups for quick delivery of the subject; Preparation of Moocs content & presentation tube lessons by trained lecturers; Using smart/digital/e- class rooms (mandarory) wherever present; Utilization of youtube videos (subject to copy rights) etc.
➢ **Student-based:**

1) **Class-room activities:** Power point presentations, seminars, assignments
2) **Library activities:** Visit to library during library hour and preparation of notes
3) **Lab activities:** Maintenance of observation note book and record, keeping lab clean and tidy
4) **Activities in the Seminars, workshops and conferences:** Participation/presentation in seminar/workshop/conference

**CO-CURRICULAR ACTIVITIES**

**OBJECTIVES:**

The co-curricular activities are aimed at strengthening the theoretical knowledge with an activity related to the content taught in the classroom. The aesthetic development, character building, spiritual growth, physical growth, moral values, creativity of the student.

The different types of co-curricular activities relevant to Zoology domain are listed below:

➢ **Academic - based**
  - Preparation of Charts/Clay or Thermocol Models
  - Debates, Essay Writing Competitions
  - Group Discussions
  - Departmental (Zoology) magazine
  - Formation of Book clubs
  - Animal album-making
  - Viva-Voce

➢ **Lab/Research –based**
  - Digital dissections
  - Field Visit/Excursions/Zoological Tours and submission of report
  - Training at research centres (aquaculture/apiculture/sericulture etc.)
  - Exposure to scientific instruments and hands-on experience

➢ **Value - based**
  - Organization of first-aid camp, swachh Bharat, cleanliness week, girl-child importance, Nutrition and health awareness etc.
### Observation of Days of National/International Importance

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<th>Day</th>
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<tr>
<td>World Cancer Day</td>
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<td>Darwin Day</td>
<td>February 12&lt;sup&gt;th&lt;/sup&gt;</td>
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<td>National Science Day</td>
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<td>World Wildlife day</td>
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<td>National Vaccination Day</td>
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<td>World Hepatitis Day</td>
<td>May 19&lt;sup&gt;th&lt;/sup&gt;</td>
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<td>International Biological Diversity Day</td>
<td>May 22&lt;sup&gt;nd&lt;/sup&gt;</td>
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<td>World Turtle Day</td>
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<td>World blood Donor Day</td>
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<td>World Zoonoses Day</td>
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<td>World Mosquito Day</td>
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<td>World Animal day</td>
<td>October 4&lt;sup&gt;th&lt;/sup&gt;</td>
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<td>World Immunization Day</td>
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Course Outcomes: By the completion of the course the graduate should able to –

CO1 Describe general taxonomic rules on animal classification

CO2 Classify Protozoa to Coelenterata with taxonomic keys

CO3 Classify Phylum Platy helminthes to Annelida phylum using examples from parasitic adaptation and vermin composting

CO4 Describe Phylum Arthropoda to Mollusca using examples and importance of insects and Molluscsans

CO5 Describe Echinodermata to Hemi chordata with suitable examples and larval stages in relation to the phylogeny

Learning objectives

1. To understand the taxonomic position of protozoa to helminthes.
2. To understand the general characteristics of animals belonging to protozoa to hemichordata.
3. To understand the structural organization of animals phylum from protozoa to hemichordata.
4. To understand the origin and evolutionary relationship of different phyla from protozoa to hemichordata.
5. To understand the origin and evolutionary relationship of different phylum from annelids to hemichordates.
### ZOOLOGY SYLLABUS FOR I SEMESTER

**PAPER – I: ANIMAL DIVERSITY – BIOLOGY OF NONCHORDATES**

**HOURS: 60 (5X12)**

Max. Marks: 100

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**UNIT I**

1.1 Principles of Taxonomy – Binomial nomenclature – Rules of nomenclature

1.2 Whittaker’s five kingdom concept and classification of Animal Kingdom.

**Phylum Protozoa**

1.3 General Characters and classification of protozoa up to classes with suitable examples

1.4 Locomotion, nutrition and reproduction in Protozoans

1.5 *Elphidium* (type study)

**UNIT II**

**Phylum Porifera**

2.1 General characters and classification up to classes with suitable examples

2.2 Skelton in Sponges

2.3 Canal system in sponges

**Phylum Coelenterata**

2.4 General characters and classification up to classes with suitable examples

2.5 Metagenesisis *Obelia*

2.6 Polymorphism in coelenterates

2.7 Corals and coral reefs

**Phylum Ctenophora**

2.8 General Characters and Evolutionary significance(affinities)

**Unit – III**

**Phylum Platyhelminthes**

3.1 General characters and classification up to classes with suitable examples

3.2 Life cycle and pathogenecity of *Fasciola hepatica*
3.3 Parasitic Adaptations in helminthes

**Phylum Nemathelminthes**

3.4 General characters and classification up to classes with suitable examples

3.5 Life cycle and pathogenecity of *Ascaris lumbricoides*

**Unit – IV**

**Phylum Annelida**

4.1 General characters and classification up to classes with suitable examples

4.2 Evolution of Coelom and Coelomoducts

4.3 Vermiculture - Scope, significance, earthworm species, processing,

Vermicompost, economic importance of vermicompost

**Phylum Arthropoda**

4.4 General characters and classification up to classes with suitable examples

4.5 Vision and respiration in Arthropoda

4.6 Metamorphosis in Insects

4.7 *Peripatus* - Structure and affinities

4.8 Social Life in Bees and Termites

**Unit – V**

**Phylum Mollusca**

5.1 General characters and classification up to classes with suitable examples

5.2 Pearl formation in Pelecypoda

5.3 Sense organs in Mollusca

**Phylum Echinodermata**

5.4 General characters and classification up to classes with suitable examples

5.5 Water vascular system in star fish

5.6 Larval forms of Echinodermata

**Phylum Hemichordata**

5.7 General characters and classification up to classes with suitable examples
5.8  *Balanoglossus* - Structure and affinities

**Co-curricular activities (suggested)**

- Preparation of chart/model of phylogenetic tree of life, 5-kingdom classification, *Elphidium* life cycle etc.
- Visit to Zoology museum or Coral island as part of Zoological tour
- Charts on life cycle of *Obelia*, polymorphism, sponge spicules
- Clay models of canal system in sponges
- Preparation of charts on life cycles of *Fasciola* and *Ascaris*
- Visit to adopted village and conducting awareness campaign on diseases, to people as part of Social Responsibility.
- Plaster-of-paris or Thermocol model of *Peripatus*
- Construction of a vermicompost in each college, manufacture of manure by students and donating to local farmers
- Models of compound eye, bee hive and terminarium (termitaria) by students
- Visit to apiculture centre and short-term training as part of apprenticeship programme of the govt. Of Andhra Pradesh
- Chart on pearl forming layers using clay or Thermocol
- Visit to a pearl culture rearing industry/institute
- Live model of water vascular system
- Phylogeny chart on echinoderm larvae and their evolutionary significance
- Preparation of charts depicting the feeding mechanism, 3 coeloms, tornaria larva etc., of *Balanoglossus*
REFERENCE BOOKS

5. Barrington. E.J.W., ‘Invertebrate structure and Function’ by ELBS.
I. Answer any FIVE of the following:  
5x5=25

Draw labeled diagrams wherever necessary

1.
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II. Answer any FIVE of the following:  
5x10=50

Draw labeled diagrams wherever necessary

9.

OR

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OR

11.

OR

12.
13.

OR
ZOOLOGY PRACTICAL SYLLABUS FOR I SEMESTER
ZOOLOGY - PAPER - I
ANIMAL DIVERSITY - BIOLOGY OF NONCHORDATES

Periods: 24 Max. Marks: 50

Learning Outcomes:

- To understand the importance of preservation of museum specimens
- To identify animals based on special identifying characters
- To understand different organ systems through demo or virtual dissections
- To maintain a neat, labeled record of identified museum specimens

Syllabus:

1. Study of museum slides / specimens / models (Classification of animals up to orders)

**Protozoa:** Amoeba, Paramoecium, Paramoecium Binary fission and Conjugation, Vorticella, Entamoebahistolytica, Plasmodium vivax

**Porifera:** Sycon, Spongilla, Euspongia, Sycon- T.S & L.S, Spicules, Gemmule

**Coelenterata:** Obelia – Colony & Medusa, Aurelia, Physalia, Velella, Corallium, Gorgonia, Pennatulav.

**Platyhelminthes:** Planaria, Fasciola hepatica, Fasciolalarval forms – Miracidium, Redia, Cercaria, Echinococcusgranulosus, Taeniasolium, Schistosomahaematobiumvii.

**Nemathelminthes:** Ascaris(Male & Female), Drancunculus, Ancylostoma, Wuchereria

**Annelida:** Nereis, Aphrodite, Chaetopteurs, Hirudinaria, Trochophore larva

**Arthropoda:** Cancer, Palaemon, Scorpion, Scolopendra, Sacculina, Limulus, Peripatus, Larvae - Nauplius, Mysis, Zoa, Mouth parts of male &female Anopheles and Culex, Mouthparts of Housefly and Butterfly. xiii.

**Mollusca:** Chiton, Pila, Unio, Ptered, Murex, Sepia, Loligo, Octopus, Nautilus, Glochidium larva
**Echinodermata:** Asterias, Ophiothrix, Echinus, Clypeaster, Cucumaria, Antedon, Bipinnaria larva

**Hemichordata:** Balanoglossus, Tornaria larva

2. **Dissections:**
   1. **Prawn:** Appendages, Digestive system, Nervous system, Mounting of Statocyst
   2. **Insect** Mouth Parts
   3. **Laboratory Record work shall be submitted at the time of practical examination**
   4. An “Animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose
   5. **Computer - aided techniques should be adopted or show virtual dissections**

**REFERENCE MANUALS:**

1. Practical Zoology- Invertebrates S.S. Lal
2. Practical Zoology - Invertebrates P.S. Verma
3. Practical Zoology - Invertebrates K.P. Kurl
   International Edition
Course Outcomes:

By the completion of the course the graduate should able to -

CO1 Describe general taxonomic rules on animal classification of chordates
CO2 Classify Protochordata to Mammalia with taxonomic keys
CO3 Understand Mammals with specific structural adaptations
CO4 Understand the significance of dentition and evolutionary significance
CO5 Understand the origin and evolutionary relationship of different phyla from Prochordata to mammalia.

Learning objectives

1. To understand the animal kingdom.
2. To understand the taxonomic position of Protochordata to Mammalia.
3. To understand the general characteristics of animals belonging to Fishes to Reptilians.
4. To understand the body organization of Chordata.
5. To understand the taxonomic position of Protherian mammals.
ZOOLOGY SYLLABUS FOR II SEMESTER
PAPER – II: ANIMAL DIVERSITY – BIOLOGY OF CHORDATES

HOURS: 60 (5X12)  Max. Marks: 100

Unit - I

1.1 General characters and classification of Chordata upto classes
1.2 Protochordata- Salient features of Cephalochordata , Affinities of Cephalochordata.
1.3 Salient features of Urochordata
1.4 Structure and life history of Herdmania
1.5 Retrogressive metamorphosis –Process and Significance

Unit - II

2.1 Cyclostomata, General characters, Comparison of Petromyzon and Myxine
2.2 Pisces : General characters of Fishes
2.3 Scoliodon: External features, Digestive system, Respiratory system, Structure and function of Heart, Structure and functions of the Brain.
2.4 Migration in Fishes
2.5 Types of Scales
2.6 Dipnoi

Unit - III

3.1 General characters of Amphibia
3.2 Classification of Amphibia up to orders with examples.
3.3 Ranahexadactyla: External features, Digestive system, Respiratory system, Structure and function of Heart, structure and functions of the Brain
3.4 Reptilia: General characters of Reptilia, Classification of Reptilia upto orders with examples
3.5 Calotes:External features, Digestive system, Respiratory system, Structure and function of Heart, structure and function of Brain
3.6 Identification of Poisonous snakes and Skull in reptiles
Unit - IV

4.1 Aves General characters of Aves
4.2 *Columba livia*: External features, Digestive system, Respiratory system, Structure and function of Heart, structure and function of Brain
4.3 Migration in Birds
4.4 Flight adaptation in birds

Unit - V

5.1 General characters of Mammalia
5.2 Classification of Mammalia upto sub - classes with examples
5.3 Comparison of Prototherians, Metatherians and Eutherians
5.4 Dentition in mammals

Co-curricular activities (suggested)

- Preparation of charts on Chordate classification (with representative animal photos) and retrogressive metamorphosis
- Thermocol or Clay models of Herdmania and Amphioxus
- Visit to local fish market and identification of local cartilaginous and bony fishes
- Maintaining of aquarium by students
- Thermocol model of fish heart and brain
- Preparation of slides of scales of fishes
- Visit to local/nearby river to identify migratory fishes and prepare study notes
- Preparation of Charts on above topics by students (Eg: comparative account of vertebrate heart/brain/lungs, identification of snakes etc.)
- Collecting and preparation of Museum specimens with dead frogs/snakes/lizards etc., and/or their skeletons
- Additional input on types of snake poisons and their antidotes (student activity).
- Collection of bird feathers and submission of report on Plumology
- Taxidermic preparation of dead birds for Zoology museum
- Map pointing of prototherian and metatherian mammals
- Chart preparation for dentition in mammals
REFERENCE BOOKS

I. Answer any FIVE of the following:  
Draw labeled diagrams wherever necessary  
1. Amphioxus  
2. Placoid scale  
3. Quill feather  
4. Prototheria  
5. Anadromous migration  
6. Draco  
7. Emu  
8. Apoda  

II. Answer any FIVE of the following:  
Draw labeled diagrams wherever necessary  
9. Explain the life history of Herdmania  
OR  
Explain the origin and general characters of chordates  
10. Compare the characters of Petromyzon and Myxine  
OR  
Describe the structure of heart of Scoliodon  
11. Describe the brain of Ranahexadactyla  
OR  
Explain the external features of Calotes  
12. Write an essay on flight adaptations in birds  
OR  
Explain the respiratory system of Columba livia  
13. Compare the characters of Metatheria and Eutheria
OR
Write an essay on dentition in mammals
Learning Outcomes:

- To understand the taxidermic and other methods of preservation of chordates
- To identify chordates based on special identifying characters
- To understand internal anatomy of animals through demo or virtual dissections, thus directing the student for “empathy towards the fellow living beings”
- To maintain a neat, labeled record of identified museum specimens

OBSERVATION OF THE FOLLOWING SLIDES / SPOTTERS / MODELS

2. Cyclostomata: *Petromyzon and Myxine*.
5. Reptilia: *Draco, Chamaeleon, Uromastix, Testudo, Trionyx, Russels viper, Naja, Krait, Hydrophis, Crocodile*.
6. Aves: *Psittacula, Eudynamis, Bubo, Alcedo*.
7. Mammalia: *Ornithorhynchus, Pteropus, Funambulus*.

Dissections:

1. *Scoliodon IX and X, Cranial nerves*
2. *Scoliodon Brain*
3. *Mounting of fish scales*

Note: 1. Dissections are to be demonstrated only by the faculty or virtual.
2. Laboratory Record work shall be submitted at the time of practical examination.
REFERENCE BOOKS:

1. S.S.Lal, Practical Zoology – Vertebrata
2. P.S.Verma, A manual of Practical Zoology – Chordata
Course Outcomes:

The overall course outcome is that the student shall develop deeper understanding of what life is and how it functions at cellular level. This course will provide students with a deep knowledge in Cell Biology, Animal Biotechnology and Evolution and by the completion of the course the graduate shall able to –

CO1 To understand the basic unit of the living organisms and to differentiate the organisms by their cell structure.

CO2 Describe fine structure and function of plasma membrane and different cell organelles of eukaryotic cell.

CO3 To understand the history of origin of branch of genetics, gain knowledge on heredity, interaction of genes, various types of inheritance patterns existing in animals

CO4 Acquiring in-depth knowledge on various of aspects of genetics involved in sex determination, human karyotyping and mutations of chromosomes resulting in various disorders

CO5 Understand the central dogma of molecular biology and flow of genetic information from DNA to proteins.

CO6 Understand the principles and forces of evolution of life on earth, the process of evolution of new species and apply the same to develop new and advanced varieties of animals for the benefit of the society
Learning Objectives

- To understand the origin of cell and distinguish between prokaryotic and eukaryotic cell
- To understand the role of different cell organelles in maintenance of life activities
- To provide the history and basic concepts of heredity, variations and gene interaction
- To enable the students distinguish between polygenic, sex-linked, and multiple allelic modes of inheritance.
- To acquaint student with basic concepts of molecular biology as to how characters are expressed with a coordinated functioning of replication, transcription and translation in all living beings
- To provide knowledge on origin of life, theories and forces of evolution
- To understand the role of variations and mutations in evolution of organisms
ZOOLOGY SYLLABUS FOR III SEMESTER

PAPER – III: CELL BIOLOGY, GENETICS, MOLECULAR BIOLOGY AND EVOLUTION

HOURS: 60 (5X12)  Max. Marks: 100

Unit – I  Cell Biology
1.1 Definition, history, prokaryotic and eukaryotic cells, virus, viroids, mycoplasma
1.2 Electron microscopic structure of animal cell.
1.3 Plasma membrane – Models and transport functions of plasma membrane.
1.4 Structure and functions of Golgi complex, Endoplasmic Reticulum and Lysosomes
1.5 Structure and functions of Ribosomes, Mitochondria, Nucleus, Chromosomes

(Note: 1. General pattern of study of each cell organelle – Discovery, Occurrence, Number, Origin, Structure and Functions with suitable diagrams)
2. Need not study cellular respiration under mitochondrial functions)

Unit – II  Genetics - I
2. 1 Mendel’s work on transmission of traits
2. 2 Gene Interaction – Incomplete Dominance, Codominance, Lethal Genes
2. 3 Polygenes (General Characteristics & examples); Multiple Alleles (General Characteristics and Blood group inheritance
2. 4 Sex determination (Chromosomal, Genic Balance, Hormonal, Environmental and Haplo-diploidy types of sex determination)
2. 5 Sex linked inheritance (X-linked, Y-linked & XY-linked inheritance)

Unit – III  Genetics - II
3.1 Mutations & Mutagenesis
3.2 Chromosomal Disorders (Autosomal and Allosomal)
3.3 Human Genetics – Karyotyping, Pedigree Analysis (basics)
3.4 Basics on Genomics and Proteomics

UNIT IV:  Molecular Biology
4.1 Central Dogma of Molecular Biology
4.2 Basic concepts of -
   a. DNA replication – Overview (Semi-conservative mechanism, Semi-discontinuous mode, Origin & Propagation of replication fork)
   b. Transcription in prokaryotes – Initiation, Elongation and Termination, Post-transcriptional modifications (basics)
   c. Translation – Initiation, Elongation and Termination

4.3 Gene Expression in prokaryotes (Lac Operon); Gene Expression in eukaryotes

Unit - V

5.1 Origin of life
5.2 Theories of Evolution: Lamarckism, Darwinism, Germ Plasm Theory, Mutation Theory
5.3 Neo-Darwinism: Modern Synthetic Theory of Evolution, Hardy-Weinberg Equilibrium
5.4 Forces of Evolution: Isolating mechanisms, Genetic Drift, Natural Selection, Speciation

Co-curricular activities (Suggested)

- Model of animal cell
- Working model of mitochondria to encourage creativity among students
- Photo album of scientists of cell biology
- Charts on plasma membrane models/cell organelles
- Observation of Mendelian / Non-Mendelian inheritance in the plants of college botanical garden or local village as a student study project activity
- Observation of blood group inheritance in students, from their parents and grand parents
- Karyotyping and preparation of pedigree charts for identifying diseases in family history
- Charts on chromosomal disorders
- Charts on central dogma/lac operon/genetic code
- Model of semi-conservative model of DNA replication
- Model of tRNA and translation mechanism
- Power point presentation of transcription or any other topic by students
- Draw geological time scale and highlight important events along the time line
• Chart on industrial melanism to teach directed selection, Darwin’s finches to teach genetic drift, collection of data on weight of children born in primary health centres to teach stabilizing selection etc.
REFERENCES:

1. Lodish, Berk, Zipursky, Matsudaria, Baltimore, Darnell ‘Molecular Cell Biology’
   W.H.Freeman and company New York.
2. Cell Biology by De Robertis
3. Bruce Alberts, Molecular Biology of the Cell
4. Rastogi, Cytology
5. Varma & Aggarwal, Cell Biology
6. C.B. Pawar, Cell Biology
   Edition. Wiley India.
   and Sons Inc.
   Benjamin Cummings.
    Cummings.
13. Molecular Biology by freifelder
14. Instant Notes in Molecular Biology by Bios scientific publishers and Viva Books
    Private Limited
    Publishers
    Cummings.
I. Answer any FIVE of the following:  
Draw labeled diagrams wherever necessary
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II. Answer any FIVE of the following: 
Draw labeled diagrams wherever necessary
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日本語
Learning Objectives:

- Acquainting and skill enhancement in the usage of laboratory microscope
- Hands-on experience of different phases of cell division by experimentation
- Develop skills on human karyotyping and identification of chromosomal disorders
- To apply the basic concept of inheritance for applied research
- To get familiar with phylogeny and geological history of origin & evolution of animals

I. Cell Biology

1. Preparation of temporary slides of Mitotic divisions with onion root tips
2. Observation of various stages of Mitosis and Meiosis with prepared slides
3. Mounting of salivary gland chromosomes of Chiranothirus

II. Genetics

1. Study of Mendelian inheritance using suitable examples and problems
2. Problems on blood group inheritance and sex linked inheritance

III. Evolution

1. Study of fossil evidences
2. Study of homology and analogy from suitable specimens and pictures
3. Phylogeny of horse with pictures
4. Study of Genetic Drift by using examples of Darwin’s finches (pictures)
5. Visit to Natural History Museum and submission of report
REFERENCE BOOKS


Course Outcomes:

This course will provide students with a deep knowledge in Physiology, Cellular metabolism and Molecular Biology and by the completion of the course the graduate shall able to –

CO1 Understand the functions of important animal physiological systems including digestion, cardio-respiratory and renal systems.

CO2 Understand the muscular system and the neuro-endocrine regulation of animal growth, development and metabolism with a special knowledge of hormonal control of human reproduction.

CO3 Describe the structure, classification and chemistry of biomolecules and enzymes responsible for sustenance of life in living organisms

CO4 Develop broad understanding the basic metabolic activities pertaining to the catabolism and anabolism of various biomolecules

CO5 Describe the key events in early embryonic development starting from the formation of gametes upto gastrulation and formation of primary germ layers.
Learning Objectives

- To achieve a thorough understanding of various aspects of physiological systems and their functioning in animals.
- To instil the concept of hormonal regulation of physiology, metabolism and reproduction in animals.
- To understand the disorders associated with the deficiency of hormones
- To demonstrate a thorough knowledge of the intersection between the disciplines of Biology and Chemistry.
- To provide insightful knowledge on the structure and classification of carbohydrates, proteins, lipids and enzymes
- To demonstrate an understanding of fundamental biochemical principles such as the function of biomolecules, metabolic pathways and the regulation of biochemical processes
- To make students gain proficiency in laboratory techniques in biochemistry and orient them to apply the scientific method to the processes of experimentation and hypothesis testing.
ZOOLOGY SYLLABUS FOR IV SEMESTER
PAPER – IV: ANIMAL PHYSIOLOGY, CELLULAR METABOLISM AND EMBRYOLOGY

HOURS: 60  (5X12)  Max. Marks: 100

UNIT I  Animal Physiology - I
1.1 Process of digestion and assimilation
1.2 Respiration - Pulmonary ventilation, transport of oxygen and CO₂
(Note: Need not study cellular respiration here)
1.3 Circulation - Structure and functioning of heart, Cardiac cycle
1.4 Excretion - Structure and functions of kidney urine formation, counter current Mechanism

UNIT II  Animal Physiology - II
2.1 Nerve impulse transmission - Resting membrane potential, origin and propagation of action potentials along myelinated and non-myelinated nerve fibers
2.2 Muscle contraction - Ultra structure of muscle, molecular and chemical basis of muscle contraction
2.3 Endocrine glands - Structure, functions of hormones of pituitary, thyroid, parathyroid, adrenal glands and pancreas
2.4 Hormonal control of reproduction in a mammal

UNIT III  Cellular Metabolism – I (Biomolecules)
3.1 Carbohydrates - Classification of carbohydrates. Structure of glucose
3.2 Proteins - Classification of proteins. General properties of amino acids
3.3 Lipids - Classification of lipids
3.4 Enzymes: Classification and Mechanism of Action

UNIT IV  Cellular Metabolism – II
4.1 Carbohydrate Metabolism - Glycolysis, Krebs cycle, Electron Transport Chain, Glycogen metabolism, Gluconeogenesis
4.2 Lipid Metabolism – β-oxidation of palmitic acid
4.3 Protein metabolism - Transamination, Deamination and Urea Cycle

Unit – V Embryology
5.1 Gametogenesis
5.2 Fertilization
5.3 Types of eggs
5.4 Types of cleavages
5.5 Development of Frog upto formation of primary germ layers

Co-curricular activities (Suggested)
- Chart on cardiac cycle, human lung, kidney/nephron structure etc.
- Working model of human / any mammalian heart.
- Chart of sarcomere/location of endocrine glands in human body
- Chart affixing of photos of people suffering from hormonal disorders
- Student study projects such as identification of incidence of hormonal disorders in the local primary health centre, studying the reasons thereof and measures to curb or any other as the lecturer feels good in nurturing health awareness among students
- Chart on structures of biomolecules/types of amino acids (essential and non-essential) Chart preparation by students on Glycolysis / kreb’s cycle/urea cycle etc.
- Model of electron transport chain
- Preparation of models of different types of eggs in animals
- Chart on frog embryonic development, fate map of frog blastula, cleavage etc.
REFERENCES

7. Developmental Biology by Balinksy
8. Developmental Biology by Gerard Karp
9. Chordate embryology by Varma and Agarwal
10. Embryology by V.B. Rastogi
I. Answer any FIVE of the following: \(5 \times 5 = 25\)

Draw labeled diagrams wherever necessary

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II. Answer any FIVE of the following: \(5 \times 10 = 50\)

Draw labeled diagrams wherever necessary

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केली नेपाल
Learning Objectives:

- Identification of an organ system with histological structure
- Deducing human health based on the information of composition of blood cells
- Demonstration of enzyme activity in vitro
- Identification of various biomolecules of tissues by simple colorimetric methods and also quantitative methods
- Identification of different stages of earl embryonic development in animals

I. ANIMAL PHYSIOLOGY

1. Qualitative tests for identification of carbohydrates, proteins and fats
2. Study of activity of salivary amylase under optimum conditions
3. T.S. of duodenum, liver, lung, kidney, spinal cord, bone and cartilage
4. Differential count of human blood

II. CELLULAR METABOLISM

1. Estimation of total proteins in given solutions by Lowry’s method.
2. Estimation of total carbohydrate by Anthrone method.
3. Qualitative tests for identification of ammonia, urea and uric acid
4. Protocol for Isolation of DNA in animal cells

III. EMBRYOLOGY

1. Study of T.S. of testis, ovary of a mammal
2. Study of different stages of cleavages (2, 4, 8 cell stages)
3. Construction of fate map of frog blastula

REFERENCE BOOKS:
- Harper’s Illustrated Biochemistry
- Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Co. Ltd.
- Laboratory techniques by Plummer
Course Outcomes:

This course will provide students with a deep knowledge in immunology, genetics, embryology and ecology and by the completion of the course the graduate shall able to –

**CO1** To get knowledge of the organs of Immune system, types of immunity, cells and organs of immunity.

**CO2** To describe immunological response as to how it is triggered (antigens) and regulated (antibodies)

**CO3** Understand the applications of Biotechnology in the fields of industry and agriculture including animal cell/tissue culture, stem cell technology and genetic engineering.

**CO4** Get familiar with the tools and techniques of animal biotechnology.

**Learning Objectives**

- To trace the history and development of immunology
- To provide students with a foundation in immunological processes
- To be able to compare and contrast the innate versus adaptive immune systems and humoral versus cell-mediated immune responses
- Understand the significance of the Major Histocompatibility Complex in terms of immune response and transplantation
- To provide knowledge on animal cell and tissue culture and their preservation
- To empower students with latest biotechnology techniques like stem cell technology, genetic engineering, hyridoma technology, transgenic technology and their application in medicine and industry for the benefit of living organisms
- To explain *in vitro* fertilization, embryo transfer technology and other reproduction manipulation methodologies.
- To get insight in applications or recombinant DNA technology in agriculture, production of therapeuti c proteins.
• To understand principles of animal culture, media preparation.
# ZOOLOGY SYLLABUS FOR SEMESTER - IV

## COURSE – 5: IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY

**HOURS : 60 (5X12)**  
Max. Marks: 100

<table>
<thead>
<tr>
<th>Unit – I</th>
<th>Immunology – I (Overview of Immune system)</th>
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</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Introduction to basic concepts in Immunology</td>
</tr>
<tr>
<td>1.2</td>
<td>Innate and adaptive immunity, Vaccines and Immunization programme</td>
</tr>
<tr>
<td>1.3</td>
<td>Cells of immune system</td>
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<tr>
<td>1.4</td>
<td>Organs of immune system</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit – II</th>
<th>Immunology – II (Antigens, Antibodies, MHC and Hypersensitivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Antigens: Basic properties of antigens, B and T cell epitopes, haptons and adjuvants; Factors influencing immunogenicity</td>
</tr>
<tr>
<td>2.2</td>
<td>Antibodies: Structure of antibody, Classes and functions of antibodies</td>
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<tr>
<td>2.3</td>
<td>Structure and functions of major histocompatibility complexes</td>
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<tr>
<td>2.4</td>
<td>Exogenous and Endogenous pathways of antigen presentation and processing</td>
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<td>2.5</td>
<td>Hypersensitivity – Classification and Types</td>
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<thead>
<tr>
<th>Unit – III</th>
<th>Techniques</th>
</tr>
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<tbody>
<tr>
<td>2.1</td>
<td>Animal Cell, Tissue and Organ culture media: Natural and Synthetic media,</td>
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<tr>
<td>2.2</td>
<td>Cell cultures: Establishment of cell culture (primary culture, secondary culture, types of cell lines; Protocols for Primary Cell Culture); Established Cell lines (common examples such as MRC, HeLa, CHO, BHK, Vero); Organ culture; Cryopreservation of cultures</td>
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<td>2.3</td>
<td>Stem cells: Types of stem cells and applications</td>
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<td>2.4</td>
<td>Hybridoma Technology: Production &amp; applications of Monoclonal antibodies (mAb)</td>
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<tr>
<th>Unit – IV</th>
<th>Applications of Animal Biotechnology</th>
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</table>
3.1 Genetic Engineering: Basic concept, Vectors, Restriction Endonucleases and Recombinant DNA technology

3.2 Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated gene delivery

3.3 Transgenic Animals: Strategies of Gene transfer; Transgenic - sheep, - fish; applications

3.4 Manipulation of reproduction in animals: Artificial Insemination, *In vitro* fertilization, super ovulation, Embryo transfer, Embryo cloning

**Unit - V**

4.1 PCR: Basics of PCR.

4.2 DNA Sequencing: Sanger’s method of DNA sequencing- traditional and automated sequencing (2 hrs)

4.3 Hybridization techniques: Southern, Northern and Western blotting

4.4 DNA fingerprinting: Procedure and applications

4.5 Applications in Industry and Agriculture: Fermentation: Different types of Fermentation and Downstream processing; Agriculture: Monoculture in fishes, polyploidy in fishes

**Co-curricular activities (suggested)**

- Organizing awareness on immunization importance in local village in association with NCC and NSS teams
- Charts on types of cells and organs of immune system
- Student study projects on aspects such as – identification of allergies among students (hypersensitivity), blood groups in the class (antigens and antibodies duly reported) etc., as per the creativity and vision of the lecturer and students
- Visit to research laboratory in any University as part of Zoological tour and exposure and/or hands-on training on animal cell culture.
- Visit to biotechnological laboratory in University or any central/state institutes and create awareness on PCR, DNA finger printing and blot techniques or Visit to a fermentation industry or Visit to a local culture pond and submit report on culture of fishes etc.
REFERENCE BOOKS

1. Immunology by Ivan M. Riott
2. Immunology by Kubey
I. Answer any FIVE of the following:  
5x5=25

Draw labeled diagrams wherever necessary

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II. Answer any FIVE of the following:  
5x10=50

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Learning Objectives:

- Acquainting student with immunological techniques vis-à-vis theory taught in the classroom
- Interconnect the theoretical and practical knowledge of immunity with the outer world for the development of a healthier life.
- Demonstrate basic laboratory skills necessary for Biotechnology research
- Promoting application of the lab techniques for taking up research in higher studies

I. IMMUNOLOGY

1. Demonstration of lymphoid organs (as per UGC guidelines)
2. Histological study of spleen, thymus and lymph nodes (through prepared slides)
3. Blood group determination
4. Demonstration of
   a. ELISA
   b. Immunoelectrophoresis

II. Animal biotechnology

1. DNA quantification using DPA Method.
2. Techniques: Western Blot, Southern Hybridization, DNA Fingerprinting
3. Separation, Purification of biological compounds by paper, Thin-layer and Column chromatography
4. Cleaning and sterilization of glass and plastic wares for cell culture.
5. Preparation of culture media.

REFERENCE BOOKS

1. Immunology Lab Biology 477 Lab Manual; Spring 2016 Dr. Julie Jameson
2. Practical Immunology A Laboratory Manual; LAP LAMBERT Academic Publishing
3. Manual of laboratory experiments in cell biology by Edward, G
4. Laboratory Techniques by Plummer
SUBJECT EXPERTS

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Nagarjuna Nagar

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Lecturer in Zoology
& Co ordinator JKC,
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