



**ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM**  
**Single Major B.Sc. Zoology (w.e.f:2023-24A.B)**

**Programme: B.Sc. Honours in Zoology (Major)**

w.e.f. AY 2023-24

**COURSE STRUCTURE**

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Introduction to Classical Biology	3+2	4
	I	2	Introduction to Applied Biology	3+2	4
	II	3	Animal Diversity-I Biology of Non-Chordates	3	3
			Animal Diversity-I Biology of Non-Chordates Practical Course	2	1
	II	4	Cell and Molecular Biology	3	3
			Cell and Molecular Biology Practical Course	2	1
II	III	5	Animal Diversity-II Biology of Chordates	3	3
			Animal Diversity-II Biology of Chordates Practical Course	2	1
		6	Principles of Genetics	3	3
			Principles of Genetics Practical Course	2	1
		7	Animal Biotechnology	3	3
			Animal Biotechnology Practical Course	2	1
		8	Evolution and Zoogeography	3	3
			Evolution and Zoogeography Practical course	2	1
	IV	9	Embryology	3	3
			Embryology Practical Course	2	1
		10	Animal Physiology: Life Sustaining Systems	3	3
			Animal Physiology: Life Sustaining Systems Practical Course	2	1
		11	Immunology	3	3
			Immunology Practical Course	2	1



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Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
III	V	12	Poultry Management-I (Poultry Farming)	3	3
			Poultry Management-I (Poultry Farming) Practical Course	2	1
		13	Poultry Management-II (Poultry Production and Management)	3	3
			Poultry Management-II (Poultry Production and Management) Practical Course	2	1
		14 A	Sustainable Aquaculture Management	3	3
			Sustainable Aquaculture Management Practical Course	2	1
		<b>OR</b>			
		14 B	Live Stock Management- I (Biology of Dairy Animals)	3	3
			Live Stock Management- I (Biology of Dairy Animals) Practical Course	2	1
		15 A	Post-Harvest Technology of Fish and Fisheries	3	3
			Post-Harvest Technology of Fish and Fisheries Practical Course	2	1
		<b>OR</b>			
		15 B	Live Stock Management-II (Dairy Production and Management)	3	3
			Live Stock Management-II (Dairy Production and Management) Practical Course	2	1
	VI	Internship			
	VII		Courses will be available in due course of time		
	VIII		Courses will be available in due course of time		



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**SEMESTER-I**

**COURSE 1: INTRODUCTION TO CLASSICAL BIOLOGY**

Theory

Credits: 4

5 hrs/week

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**Learning objectives**

The student will be able to learn the diversity and classification of living organisms and understand their chemical, cytological, evolutionary and genetic principles.

**Learning Outcomes**

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

**Unit 1:** Introduction to systematics, taxonomy and ecology.

- 1.1. Systematics – Definition and concept, Taxonomy – Definition and hierarchy.
- 1.2. Nomenclature – ICBN and ICZN, Binomial and trinomial nomenclature.
- 1.3. Ecology – Concept of ecosystem, Biodiversity and conservation.
- 1.4. Pollution and climate change.

**Unit 2:** Essentials of Botany.

- 2.1. The classification of plant kingdom.
- 2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).
- 2.3. Structure of flower – Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.
- 2.4 Mushroom cultivation, floriculture and landscaping.

**Unit 3:** Essentials of Zoology

- 3.1. The classification of Kingdom Animalia and Chordata.
- 3.2 Animal Physiology – Basics of Organ Systems & their functions, Hormones and Disorders
- 3.3 Developmental Biology – Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)
- 3.4 Economic Zoology – Sericulture, Apiculture, Aquaculture



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**Unit 4:** Cell biology, Genetics and Evolution

- 4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.
- 4.2. Chromosomes and heredity – Structure of chromosomes, concept of gene.
- 4.3. Central Dogma of Molecular Biology.
- 4.4. Origin of life

**Unit 5:** Essentials of chemistry

- 5.1. Definition and scope of chemistry, applications of chemistry in daily life.
- 5.2. Branches of chemistry
- 5.3. Chemical bonds – ionic, covalent, noncovalent – Vander Waals, hydrophobic, hydrogen bonds.
- 5.4. Green chemistry

**References**

1. Sharma O.P., 1993. Plant taxonomy. 2<sup>nd</sup> Edition. McGraw Hill publishers.
2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4<sup>th</sup> edition. S. Chand publishers, New Delhi, India.
3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.
4. Rastogi, S.C., 2019. Essentials of animal physiology. 4<sup>th</sup> Edition. New Age International Publishers.
5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.
6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4<sup>th</sup> Edition. Elsevier publishers.
7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5<sup>th</sup> Edition. Pearson publishers.
9. Subrata Sen Gupta, 2014. Organic chemistry. 1<sup>st</sup> Edition. Oxford publishers.



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**ACTIVITIES:**

1. Make a display chart of life cycle of nonflowering plants.
2. Make a display chart of life cycle of flowering plants.
3. Study of stomata
4. Activity to prove that chlorophyll is essential for photosynthesis
5. Study of pollen grains.
6. Observation of pollen germination.
7. Ikebana.
8. Differentiate between edible and poisonous mushrooms.
9. Visit a nearby mushroom cultivation unit and know the economics of mushroom cultivation.
10. Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell
11. Visit to Zoology Lab and observe different types of preservation of specimens
12. Hands-on experience of various equipment – Microscopes, Centrifuge, pH Meter, Electronic Weighing Balance, Laminar Air Flow
13. Visit to Zoo / Sericulture / Apiculture / Aquaculture unit
14. List out different hormonal, genetic and physiological disorders from the society



**COURSE 2: INTRODUCTION TO APPLIED BIOLOGY**

Theory

Credits: 4

5 hrs/week

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**Learning objectives**

The student will be able to learn the foundations and principles of microbiology, immunology, biochemistry, biotechnology, analytical tools, quantitative methods, and bioinformatics.

**Learning Outcomes**

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules.
3. Knowledge on biotechnology principles and its applications in food and medicine.
4. Outline the techniques, tools and their uses in diagnosis and therapy.
5. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

**Unit 1: Essentials of Microbiology and Immunology**

- 1.1. History and Major Milestones of Microbiology; Contributions of Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.
- 1.2. Groups of Microorganisms – Structure and characteristics of Bacteria, Fungi, Archaea and Virus.
- 1.3. Applications of microorganisms in – Food, Agriculture, Environment, and Industry.
- 1.4. Immune system – Immunity, types of immunity, cells and organs of immune system.

**Unit 2: Essentials of Biochemistry**

- 2.1. Biomolecules I – Carbohydrates, Lipids.
- 2.2. Biomolecules II – Amino acids & Proteins.
- 2.3. Biomolecules III – Nucleic acids -DNA and RNA.
- 2.4. Basics of Metabolism – Anabolism and catabolism.

**Unit 3: Essentials of Biotechnology**

- 3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.
- 3.2. Environmental Biotechnology – Bioremediation and Biofuels, Bio fertilizers and Bio pesticides.
- 3.3. Genetic engineering – Gene manipulation using restriction enzymes and cloning vectors; Physical, chemical, and biological methods of gene transfer.
- 3.4. Transgenic plants – Stress tolerant plants (biotic stress – BT cotton, abiotic stress – salt tolerance). Transgenic animals – Animal and disease models.



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**Unit 4: Analytical Tools and techniques in biology – Applications**

- 4.1. Applications in forensics – PCR and DNA fingerprinting
- 4.2. Immunological techniques – Immunoblotting and ELISA.
- 4.3. Monoclonal antibodies – Applications in diagnosis and therapy.
- 4.4. Eugenics and Gene therapy

**Unit 5: Biostatistics and Bioinformatics**

- 5.1. Data collection and sampling. Measures of central tendency – Mean, Median, Mode.
- 5.2. Measures of dispersion – range, standard deviation and variance. Probability and tests of significance.
- 5.3. Introduction, Genomics, Proteomics, types of Biological data, biological databases- NCBI, EBI, Gen Bank; Protein 3D structures, Sequence alignment
- 5.4. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

**REFERENCES**

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11<sup>th</sup> Edition. Pearson publications, London, England.
2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5<sup>th</sup> Edition. McGraw Education, New York, USA.
3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4<sup>th</sup> Edition. Elsevier publishers.
4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.
6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3<sup>rd</sup> Edition. Cambridge Publishers.
7. U. Sathyanarayana, 2005. Biotechnology. 1<sup>st</sup> Edition. Books and Allied Publishers pvt. ltd., Kolkata.
8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
9. Arthur M. Lesk. Introduction to Bioinformatics. 5<sup>th</sup> Edition. Oxford publishers.
10. AP Kulkarni, 2020. Basics of Biostatistics. 2<sup>nd</sup> Edition. CBS publishers.

**ACTIVITIES**

1. Identification of given organism as harmful or beneficial.
2. Observation of microorganisms from house dust under microscope.
3. Finding microorganism from pond water.



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4. Visit to a microbiology industry or biotech company.
5. Visit to a waste water treatment plant.
6. Retrieving a DNA or protein sequence of a gene'
7. Performing a BLAST analysis for DNA and protein.
8. Problems on biostatistics.
9. Field trip and awareness programs on environmental pollution by different types of wastes and hazardous materials.
10. Demonstration on basic biotechnology lab equipment.
11. Preparation of 3D models of genetic engineering techniques.
12. Preparation of 3D models of transgenic plants and animals.

[**NOTE:** In the colleges where there is availability of faculty for microbiology and biotechnology, those chapters need to be handled by microbiology and biotechnology faculty. In other colleges, the above topics shall be dealt by Botany and Zoology faculty]





## ***Course – I & II Model Paper (70 Marks)***

### ***SECTION A (Multiple Choice Questions)***

***30 x 1 = 30 M***

***30 Multiple Choice Questions (Each Unit 6 Questions)***

### ***SECTION B (Fill in the blanks)***

***10 x 1 = 10 M***

***10 Fill in the Blanks (Each Unit 2 Questions)***

### ***SECTION C (Very short answer questions)***

***10 x 1 = 10 M***

***10 Very short answer questions (Each Unit 2 Questions)***

### ***SECTION D (Matching) (From 5 Units)***

***2 x 5 = 10 M***

- 1 A***  
***B***  
***C***  
***D***  
***E***

- 2 A***  
***B***  
***C***  
***D***  
***E***

### ***SECTION E (True or False)***

***10 x 1 = 10 M***

***10 True or False (Each Unit 2 Questions)***



**SEMESTER-II**

**COURSE 3: ANIMAL DIVERSITY-I BIOLOGY OF NON-CHORDATES**

Theory

Credits: 3

3 hrs/week

**LEARNING OBJECTIVES:**

- To understand the taxonomic position of protozoa to helminthes.
- To understand the general characteristics of animals belonging to protozoa to hemichordata.
- To understand the structural organization of animals phylum from protozoa to hemi chordata.
- To understand the origin and evolutionary relationship of different phyla from protozoa to hemi chordata.
- To understand the origin and evolutionary relationship of different phylum from annelids to hemichordates.

**LEARNING OUTCOMES:** By the completion of the course the graduate should able to –

- Describe concept of animal kingdom classification and general characters of Protozoa
- Classify Porifera and Coelenterata with taxonomic keys
- Classify Phylum Platy & Nematelminthes using examples, parasitic adaptation
- Describe Phylum Annelida & Arthropoda using examples and economic importance of vermicomposting & economic importance of insects.
- Describe Mollusca, Echinodermata & Hemi chordata with suitable examples in relation to the phylogeny

**SYLLABUS:**

**UNIT-I**

- 1.1 Whittakers five kingdom concept and classification of Animal Kingdom.
- 1.2 Protozoa General Characters and classification up to classes with suitable examples
- 1.3 Protozoa Locomotion & nutrition
- 1.4 Protozoa reproduction

**Activity:** Assignment /Seminar on the above

**Evaluation:** Marks to be awarded for written and oral presentations

**UNIT –II**

- 2.1 Porifera General characters and classification up to classes with suitable examples
- 2.2 Canal system in sponges
- 2.3 Coelenterata General characters and classification up to classes with suitable examples
- 2.4 Polymorphism in coelenterates & Corals and coral reefs

**Activity:** Assignment /Seminar /Quiz/Project on the above

**Evaluation:** Evaluation of Written part + Evaluation of oral Presentation, Assessment of students in Quiz participation and Ranking - Evaluation of Project Report and oral presentation

**UNIT – III**

- 3.1 Platyhelminthes General characters and classification up to classes with suitable examples
- 3.2 Parasitic Adaptations in helminthes
- 3.3 Nematelminthes General characters and classification up to classes with suitable examples
- 3.4 Life cycle and pathogenicity of *Ascaris lumbricoides*



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**Activity: Assignment /Seminar /Quiz/Project/Peer teaching on the above**

**Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity**

**UNIT – IV**

4.1 Annelida General characters and classification up to classes with suitable examples

4.2 Vermiculture - Scope, significance, earthworm species, processing, Vermicompost, economic importance of vermicompost

4.3 Arthropoda General characters and classification up to classes with suitable examples

4.4 *Peripatus* - Structure and affinities

**Activity: Assignment /Seminar /Quiz/Project/Peer teaching on the above**

**Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity**

**UNIT – V**

5.1 Mollusca General characters and classification up to classes with suitable examples

5.2 Pearl formation in Pelecypoda

5.3 Echinodermata General characters and classification up to classes with suitable examples  
Water vascular system in star fish

5.4 Hemichordata General characters and classification up to classes with suitable examples  
*Balanoglossus* - Structure and affinities

**Activity: Assignment /Seminar /Quiz/Project/Peer teaching on the above**

**Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity**

**Co-curricular activities (suggested)**

- Preparation of chart/model of phylogenic tree of life, 5-kingdom classification
- Visit to Zoology Museum or Coral Island as part of Zoological tour
- Charts on polymorphism
- Clay models of canal system in sponges
- Plaster-of-paris model of *Peripatus*
- Construction of a vermicompost in each college, manufacture of manure by students and donating to local farmers
- Chart on pearl forming layers using clay
- Visit to a pearl culture rearing industry/institute
- Live model of water vascular system
- Observation of *Balanoglossus* for its tubicolous habit

**REFERENCE BOOKS:**

- L.H. Hyman „*The Invertebrates*’ Vol I, II and V. – M.C. Graw Hill Company Ltd.
- Kotpal, R.L. 1988 - 1992 Protozoa, Porifera, Coelenterata, Helminthes, Arthropoda, Mollusca, Echinodermata. Rastogi Publications, Meerut.
- E.L. Jordan and P.S. Verma „*Invertebrate Zoology*’ S. Chand and Company.
- R.D. Barnes „*Invertebrate Zoology*’ by: W.B. Saunders CO., 1986.
- Barrington. E.J.W., „*Invertebrate structure and Function*’ by ELBS.
- P.S. Dhami and J.K. Dhami. *Invertebrate Zoology*. S. Chand and Co. New Delhi.
- Parker, T.J. and Haswell, A *text book of Zoology*’ by, W.A., Mac Millan Co. London.
- Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”

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SEMESTER-II

COURSE 3: ANIMAL DIVERSITY-I BIOLOGY OF NON-CHORDATES

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

- 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, labelled record of identified museum specimens

**SYLLABUS:**

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

- Protozoa: Amoeba, *Paramoecium*, *Paramoecium* Binary fission and Conjugation, *Vorticella*, *Entamoeba histolytica*, *Plasmodium vivax*
- Porifera: *Sycon*, *Spongilla*, *Euspongia*, *Sycon*- T.S & L.S, Spicules, Gemmule
- Coelenterata: *Obelia* – Colony & Medusa, *Aurelia*, *Physalia*, *Velella*, *Corallium*, *Gorgonia*, *Pennatula*
- Platyhelminthes: *Planaria*, *Fasciola hepatica*, *Fasciola* larval forms – Miracidium, Redia, Cercaria, *Echinococcus granulosus*, *Taenia solium*, *Schistosoma haematobium*
- Nematelminths: *Ascaris* (Male & Female), *Dracunculus*, *Ancylostoma*, *Wuchereria*
- Annelida: *Nereis*, *Aphrodite*, *Chaetopterus*, *Hirudinaria*, Trochophore larva
- Arthropoda: Cancer, *Palaemon*, Scorpion, *Scolopendra*, *Sacculina*, *Limulus*, *Peripatus*, Larvae - Nauplius, Mysis, Zoea, Mouth parts of male & female *Anopheles* and *Culex*, Mouthparts of Housefly and Butterfly.
- Mollusca: *Chiton*, *Pila*, *Unio*, *Pterido*, *Murex*, *Sepia*, *Loligo*, *Octopus*, *Nautilus*, Glochidium larva
- Echinodermata: *Asterias*, *Ophiothrix*, *Echinus*, *Clypeaster*, *Cucumaria*, *Antedon*, Bipinnaria larva
- Hemichordata: *Balanoglossus*, Tornaria larva

**Dissections:**

Computer - aided techniques should be adopted or show virtual dissections Dissection of edible (Prawn/Pila) invertebrate as per UGC guidelines

An “Animal album” containing photographs, cut outs, with appropriate write up about the above-mentioned taxa. Different taxa/ topics may be given to different set of students for this purpose

**REFERENCE WEB LINKS:**

- <https://virtualmicroscopy.peabody.yale.edu/>
- <https://tnhm.in/category/assorted-gallery-for-vertebrates-and-invertebrates/invertebrates/>
- <http://www.nhc.ed.ac.uk/index.php?page=24.25.312>
- <https://biologyjunction.com/invertebrate-notes/>
- <https://lanwebs.lander.edu/faculty/rsfox/invertebrates/>
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>

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SEMESTER-II

COURSE 4: CELL & MOLECULAR BIOLOGY

Theory

Credits: 3

3 hrs/week

LEARNING OBJECTIVES

- To understand the cell and distinguish between prokaryotic and eukaryotic cell
- To understand the role of different cell organelles in maintenance of life activities
- To acquaint the students with the concepts of cell division and cell cycle
- 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 acquaint the students on the biological importance of biomolecules.

LEARNING 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 and molecular biology by the completion of the course the graduate shall be able to –

- Understand the basic unit of the living organisms and to differentiate the organisms by their cell structure.
- Describe fine structure and function of plasma membrane and different cell organelles of eukaryotic cell.
- Explain the cell cycle and bioenergetics of the cell
- Understand the central dogma of molecular biology and flow of genetic information from DNA to proteins
- Understand the gene expression phenomenon and biological importance of biomolecules

SYLLABUS:

UNIT – I Cell Biology-I

- 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 Fluid mosaic model
- 1.4 Transport functions of plasma membrane-Active – passive- facilitated.

**Activity:** Model preparation of cell/Assignment /Students Seminar /Quiz/Project/Peer teaching on the above

**Evaluation:** Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity

UNIT – II Cell Biology-II

- 2.1 Structure and functions of Golgi complex & Endoplasmic Reticulum
- 2.2 Structure and functions of Lysosomes & Ribosomes
- 2.3 Structure and functions of Mitochondria & Centriole
- 2.4 Structure and functions of Nucleus & Chromosomes

**Activity:** Model preparation of cell organelles/Assignment /Students Seminar /Quiz/Project/Peer teaching on the above

**Evaluation:** Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity



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**UNIT – III Cell Biology-III**

- 3.1 Cell Division- mitosis, meiosis
- 3.2 Cell cycle – stages- check points- regulation
- 3.3 Abnormal cell growth- cancer- apoptosis
- 3.4 Bio energetics- Glycolysis-Krebs cycle-ETS

**Activity:** *Model preparation cell division /Assignment /Students Seminar /Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT IV: Molecular Biology-I**

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

**Activity:** *Model preparation of DNA/Assignment /Students Seminar /Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT V: Molecular Biology-II**

- 5.1 Gene Expression in prokaryotes (Lac Operon); Gene Expression in eukaryotes
- 5.2 Biomolecules- Carbohydrates (Glucose- structure-properties- biological importance only)
- 5.3 Biomolecules- Protein (Amino acid- structure- properties- biological importance only)
- 5.4 Biomolecules- Lipids (Fatty acid- structure - properties- biological importance only)

**Activity:** *Assignment /Students Seminar /Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**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
- Charts on central dogma/lac operon/genetic code
- Model of semi-conservative model of DNA replication
- Power point presentation of any of the above topics by students

**REFERENCES:**

- Lodish, Berk, Zipursky, Matsudaria, Baltimore, Darnell „Molecular Cell Biology“ W.H. Freeman and company New York.
- Cell Biology by De Robertis
- Bruce Alberts, Molecular Biology of the Cell
- Rastogi, Cytology
- Varma & Aggarwal, Cell Biology
- C.B. Pawar, Cell Biology
- Molecular Biology by Frei fielder
- Instant Notes in Molecular Biology by Bios scientific publishers and Viva Books Private Limited
- James D. Watson, Nancy H. Hopkins „Molecular Biology of the Gene“



**SEMESTER-II**  
**COURSE 4: CELL & MOLECULAR BIOLOGY**

Practical

Credits: 1

2 hrs/week

**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

**SYLLABUS:**

1. Preparation of temporary slides of Mitotic divisions with onion root tips
2. Observation of various stages of Mitosis with prepared slides
3. Observation of various stages of Meiosis with prepared slides
4. Mounting of salivary gland chromosomes of Chironomus
5. Test for carbohydrate in given biological sample (Benedict's test)
6. Test for Protein in given biological sample (Nitric acid test -white ring)
7. Test for lipid in the given biological sample (Saponification test)

**REFERENCE WEB LINKS:**

- <https://cbi-au.vlabs.ac.in/>
- <https://www.youtube.com/watch?v=xhnUZAyNdQk>
- [https://www.youtube.com/watch?v=l8LXQq5\\_VL0](https://www.youtube.com/watch?v=l8LXQq5_VL0)
- <https://www.labster.com/simulations>
- <https://www.sciencecourseware.org/BiologyLabsOnline/protected/TranslationLab/index.php>
- <https://virtual-labs.github.io/exp-analysis-of-carbohydrates-au/procedure.html>
- [https://www.labxchange.org/library/items/lb:LabXchange:f10fd7ad:lx\\_simulation:1](https://www.labxchange.org/library/items/lb:LabXchange:f10fd7ad:lx_simulation:1)
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>

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**Single Major**  
**Model Question Paper**  
**SEMESTER-II**  
**ZOOLOGY**

**Paper: III-Animal Diversity-I Biology of Non-Chordates**

**Time:3hrs**

**MAX MARKS: 70 M**

**Answer any 5 questions. Each question carries 4 marks (5 X 4 = 20M)**  
(Total 8 questions, questions 1-5 from Units 1-5 & questions 6-8 from any of the units)

1. Briefly describe the nutrition in protozoa
2. Write a note on the general characters of Phylum Porifera
3. Write a note on the pathogenicity of *Ascaris*
4. Write a short note on the Affinities of *Peripatus*
5. With suitable examples write the general characters of the class Cephalopoda.
6. Brief the affinities of *Balanoglossus*
7. Write a short note on the coral formation
8. With suitable examples write the general characters of the class Polychaeta

**SECTION – B**

**Answer all the questions. Each question carries 10 marks. (5 X 10 = 50M)**  
(Each question (both 'A' or 'B') from each Unit.

9. (a) Write an essay on the General characters and classification up to classes of the phylum Protozoa  
(OR)  
(b) Describe the locomotion in Protozoa.
10. (a) What is canal system? Explain different types of Canal systems in Phylum porifera, with a note on its significance  
(OR)  
(b) Write an essay on the Polymorphism seen in Coelenterates, add a note on the significance of Polymorphism.
11. (a) Write an essay on the parasitic adaptations seen in Helminthes  
(OR)  
(b) with a neat labelled diagram explain the Life History of *Ascaris lumbricoides*
12. (a) Define Vermiculture. Explain the earthworm species, processing, economic importance of vermicompost  
(OR).  
(b) Write an essay on the general characters of the phylum Arthropoda.
13. (a) In detail explain the pearl formation in Pelecypoda  
(OR)  
(b) With a neat labelled diagram explain the structure and function of water vascular system in Echinoderms





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**Single Major**  
**Model Question Paper**  
**SEMESTER-II**  
**ZOOLOGY**

**Paper: IV- CELL & MOLECULAR BIOLOGY**

**Time:3hrs**

**MAX MARKS: 70 M**

**SECTION - A**

**Answer any 5 questions. Each question carries 4 marks (5 X 4 = 20M)**  
(Total 8 questions, questions 1-5 from Units 1-5 & questions 6-8 from any of the units)

1. Write notes on the structure of Virus
2. Write a note on structure and function of Centriole
3. Write a short note on the Apoptosis
4. Write a short note on Propagation of replication fork
5. Brief the biological importance of Carbohydrates.
6. Write a shote note on the types of Chromosomes.
7. Differentiate between prokaryotic and eukaryotic cells.
8. What is Cytokinesis? Why it is important in Cell Division?

**SECTION – B**

**Answer all the questions. Each question carries 10 marks. (5 X 10 = 50M)**  
(Each question (both 'A' or 'B') from each Unit.

9. (a) In detail explain the Fluid Mosaic Model of plasma membrane  
(OR)  
(b) Describe Ultra Structure of the Animal cell with a neat labelled diagram.
10. (a) In detail explain the structure and functions of the Endoplasmic reticulum  
(OR)  
(b) Write an essay on the structure and functions of the Mitochondria, with a note on its biological significance
11. (a) What is cell cycle? Explain different stages of Cell Cycle in detail.  
(OR)  
(b) In detail explain the Krebs cycle.
12. (a) Write an essay on the Semi conservative method of DNA replication.  
(OR).  
(b) Write an essay on Transcription in eukaryotes.
13. (a) In detail explain the gene expression in prokaryotes with Lac Operon.  
(OR)  
(b) Write an essay on the structure, properties and biological importance of Amino Acids.



SEMESTER-III

COURSE 5: ANIMAL DIVERSITY-II BIOLOGY OF CHORDATES

Theory

Credits: 3

3 hrs/week

LEARNING OBJECTIVES

- To understand the animal kingdom.
- To understand the taxonomic position of Protochordata to Mammalia.
- To understand the general characteristics of animals belonging to Fishes to Reptilians.
- To understand the body organization of Chordata.
- To understand the taxonomic position of Protherian mammals.

**LEARNING OUTCOMES:** By the completion of the course the graduate should be able to –

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

SYLLABUS:

UNIT - I

- 1.1 General characters and classification of Chordata up to classes
- 1.2 Salient features of Cephalochordata, Salient features of Urochordata
- 1.3 Structure and life history of *Herdmania*, Retrogressive metamorphosis –Process and Significance
- 1.4 Cyclostomata, General characters, Comparison of Petromyzon and Myxine

**Activity:** *Model preparation /Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

UNIT - II

- 2.1 General characters of Fishes, Salient features Dipnoi
- 2.2 *Scoliodon*: External features, Digestive system, Respiratory system
- 2.3 *Scoliodon* Structure and function of Heart, Structure and functions of the Brain.
- 2.4 Migration in Fishes, Types of Scales

**Activity:** *Model preparation /Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*



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**UNIT - III**

- 3.1 General characters of Amphibia, General characters of Reptilia
- 3.2 *Rana hexadactyla*: External features, Respiratory system, Structure and function of Heart
- 3.3 *Rana hexadactyla* structure and functions of the Brain
- 3.4 *Calotes*: External features, Digestive system, structure and function of Brain
- 3.5 Identification of Poisonous snakes

**Activity:** *Model preparation /Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT - IV**

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

**Activity:** *Model preparation/Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT - V**

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

**Activity:** *Model preparation/Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**Co-curricular activities (suggested)**

- Preparation of charts on Chordate classification (with representative animal photos) and retrogressive metamorphosis
- Clay models of Herdmania and Amphioxus
- Visit to local fish market and identification of local cartilaginous and bony fishes
- Maintaining of aquarium by students
- 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



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- 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**

- J.Z. Young, 2006. The life of vertebrates. (The Oxford University Press, New Delhi). 646 pages. Reprinted
- Arumugam, N. Chordate Zoology, Vol. 2. Saras Publication. 278 pages. 200 figs.
- A.J. Marshall, 1995. Textbook of zoology, Vertebrates. (The McMillan Press Ltd., UK). 852 pages. (Revised edition of Parker & Haswell, 1961).
- M. Ekambaranatha Ayyar, 1973. A manual of zoology. Part II. (S. Viswanathan Pvt. Ltd., Madras).
- P.S. Dhami & J.K. Dhami, 1981. Chordate zoology. (R. Chand & Co.). 550 pages.
- Gurdarshan Singh & H. Bhaskar, 2002. Advanced Chordate Zoology. Campus Books, 6 Vols., 1573 pp., tables, figs.
- A.K. Sinha, S. Adhikari & B.B. Ganguly, 1978. Biology of animals. Vol. II. Chordates. (New Central Book Agency, Calcutta). 560 pages.
- R.L. Kotpal, 2022. Modern textbook of zoology, Vertebrates. (Rastogi Publ., Meerut). 632 pages.
- E.L. Jordan & P.S. Verma, 1998. Chordate zoology. (S. Chand & Co.). 1092 pages.
- G.S. Sandhu, 2005. Objective Chordate Zoology. Campus Books, vii, 169 pp.
- Sandhu, G.S. & H. Bhaskar, H. 2004. Textbook of Chordate Zoology. Campus Books, 2 vols., xx, 964 p., figs.
- Veena, 2008. Lower Chordata. (Sonali Publ.), 374 p., tables, 117 figs.

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SEMESTER-III

COURSE 5: ANIMAL DIVERSITY-II BIOLOGY OF CHORDATES

Practical

Credits: 1

2 hrs/week

LEARNING OBJECTIVES

- 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. Protochordata: *Herdmania*, *Amphioxus*, *Amphioxus* T.S through pharynx.
2. Cyclostomes: *Petromyzon* and *Myxine*.
3. Pisces: *Pristis*, *Torpedo*, *Hippocampus*, *Exocoetus*, *Echeneis*, *Labeo*, *Catla*, *Clarius*, *Channa*, *Anguilla*.
4. Amphibia: *Ichthyophis*, *Amblystoma*, *Axolotl* larva, *Hyla*,
5. Reptilia: *Draco*, *Chamaeleon*, *Uromastix*, *Testudo*, *Trionyx*, *Russels viper*, *Naja*, *Krait*, *Hydrophis*, *Crocodile*.
6. Aves: *Psittacula*, *Eudynamis*, *Bubo*, *Alcedo*.
7. Mammalia: *Ornithorhynchus*, *Pteropus*, *Funambulus*.
8. **Dissections**-As per UGC guidelines  
*Scoliodon* IX and X, Cranial nerves  
*Scoliodon* Brain  
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 WEB LINKS:

- <https://nt7-mhe-complex-assets.mheducation.com/nt7-mhe-complex-assets/Upload-20190715/InspireScience6-8CA/LS15/index.html>
- <https://themammallab.com/>
- <http://abacus.bates.edu/acad/depts/biobook/LabConCh.htm>
- <https://virtualzoology.wordpress.com/scoliodon/>
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>

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SEMESTER-III

**COURSE 6: PRINCIPLES OF GENETICS**

Theory

Credits: 3

3 hrs/week

**LEARNING OBJECTIVES**

- To provide the background knowledge on the history of genetics and the importance of Mendelian principles.
- To provide the required knowledge on the gene interactions
- To acquaint the students, distinguish between polygenic, sex-linked, and multiple allelic modes of inheritance and extrachromosomal inheritance.
- To understand the principles of sex determination in animals with a reference to human being, and sex-linked inheritance
- To understand the human karyotyping and the concept of pedigree analysis basics.

**LEARNING OUTCOMES:** By the completion of the course the graduate should be able to –

- To understand the history of genetics, gain knowledge basic terminology of genetics
- To acquire knowledge on interaction of genes, various types of inheritance patterns existing in animals with reference to non-Mendelian inheritance.
- To acquire knowledge on chromosomal inheritance
- Acquiring in-depth knowledge on various aspects of genetics involved in sex determination,
- Acquiring in-depth knowledge on human karyotyping, pedigree analysis and chromosomal disorders concepts of proteomics and genomics

**SYLLABUS:**

**UNIT-I:**

- 1.1 History of Genetics- Concepts of Phenotype, Genotype, Heredity, Variation, Pure lines and Inbred Lines
- 1.2 Mendelian Principles on Monohybrid cross, back cross and Test cross
- 1.3 Mendelian Principles on Dihybrid cross

**Activity:** Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Problem solving on Mendelian principles

**Evaluation:** Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity

**UNIT-II:**

- 2.1 Linkage - Definition, Types of linkage-complete linkage and incomplete linkage, Significance of linkage.
- 2.2 Crossing over - definition; Mechanism of crossing over: Chiasma Interference and coincidence
- 2.4 Gene Interactions: Incomplete dominance, codominance, Pleiotropy
- 2.5 Gene Interactions: Lethal alleles, Epistasis, Non- Epistasis

**Activity:** Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Model preparation of linkage/crossing over



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***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**UNIT-III:**

- 3.1 Polygenes (General Characteristics & examples)
- 3.2 Multiple Alleles (General Characteristics and Blood group inheritance)
- 3.3 Rh inheritance erythroblastosis foetalis
- 3.4 Extra chromosomal inheritance- Kappa particles in Paramecium and Shell coiling in snails

***Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Case study on Rh/Erythroblastosis foetalis***

***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**UNIT-IV:**

- 4.1 Sex determination- Chromosomal theory and Genic Balance theory
- 4.2 Sex determination- Hormonal, Environmental and Haplo-diploidy types
- 4.3 Sex linked inheritance: X-linked inheritance
- 4.4 Sex linked inheritance: Y-linked & XY-linked inheritance

***Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/ Preparation of animated model /chart on sex determination methods***

***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**UNIT-V:**

- 5.1 Human karyotyping, Pedigree Analysis(basics)
- 5.2 Autosomal Recessive disorder-Sickle cell anaemia – causes, treatment, inheritance pattern, modes of testing and prevention
- 5.3 Autosomal Dominant disorder- Huntington disease
- 5.4 Basics on Genomics and Proteomic

***Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/ Case study of a family for pedigree analysis***

***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**Co-curricular activities (Suggested)**

- 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 grandparents
- Karyotyping and preparation of pedigree charts for identifying diseases in family history
- Charts on chromosomal disorders

**REFERENCE BOOKS:**

- Harper, P. (2010). Practical genetic counselling. CRC Press.



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- Kessler, S. (Ed.). (2013). Genetic counselling: psychological dimensions. Academic Press. 3.
- Stevenson, A. C., & Davison, B. C. (2016). Genetic counselling. Elsevier.
- Evans, C. (2006). Genetic counselling: a psychological approach. Cambridge University Press.
- References:
- Atlas of Inherited Metabolic Diseases.
- Mendelian Inheritance in Man: A Catalog of Human Genes and Genetic Disorders, Victor A. McKusick, 2 Vol I & II
- Stacy L Blachford (Editor) 2001. The Gale Encyclopedia of Genetic Disorders. Gale Group Publishers, Vol.1 (A-L), Vol.II (M-Z).
- Limoine, W.R. and Cooper, D.NB. 1996: Gene Trophy, Bios Scientific Pub.Oxford.
- REFERENCES:
- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
- James D. Watson, Nancy H. Hopkins 'Molecular Biology of the Gene'
- Gupta P.K., 'Genetics

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**SEMESTER-III**

**COURSE 6: PRINCIPLES OF GENETICS**

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

- To acquire practical knowledge on the importance of Mendelian principles by solving the problems.
- To provide the required knowledge on the gene interactions
- To acquaint the students on Human karyotype & pedigree analysis basics
- To understand the various genetic concepts through Virtual labs

**SYLLABUS:**

1. Study of Mendelian inheritance using suitable examples/Problems
2. Study of linkage recombination, gene mapping using the data
3. Study of human karyotypes
4. Blood grouping and Rh in humans
5. Demonstration of prenatal diagnosis (Virtual lab).
6. Amniocentesis demo or virtual lab
7. Demonstration of Ultrasonography (Virtual lab).
8. Scoring dysmorphic features in syndromic patients
9. Genetic Counselling methods based on case history
10. Construction and analysis of Pedigree

**REFERENCE WEB LINKS:**

- <https://www.iitg.ac.in/cseweb/vlab/anthropology/Experiments/Mendels%20law/index.html>
- <https://learn.genetics.utah.edu/content/labs/>
- [https://virtuallabs.merlot.org/vl\\_biology.html](https://virtuallabs.merlot.org/vl_biology.html)
- <https://blog.praxilabs.com/2020/06/30/dna-extraction-virtual-lab/>
- <https://jru.edu.in/studentcorner/lab-manual/agriculture/Fundamentals%20of%20Genetics.pdf>
- [https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1008&context=ny\\_oers](https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1008&context=ny_oers)
- <https://sjce.ac.in/wp-content/uploads/2018/04/Cell-Biology-Genetics-Laboratory-Manual-17-18.pdf>
- <https://www.rlbcau.ac.in/pdf/Agriculture/AGP%20113%20Fundamentals%20of%20Genetics.pdf>
- [https://coabnau.in/uploads/1610707528\\_GPB3.2PracticalManual-Final.pdf](https://coabnau.in/uploads/1610707528_GPB3.2PracticalManual-Final.pdf)

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SEMESTER-III  
COURSE 7: ANIMAL BIOTECHNOLOGY

Theory

Credits: 3

3 hrs/week

**LEARNING OBJECTIVES:**

- 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, hybridoma 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 therapeutic proteins.
- To understand principles of animal culture, media preparation.

**LEARNING OUTCOMES:**

This course will provide students with a deep knowledge in animal biotechnology, by the completion of the course the graduate shall able to –

- Get knowledge of the Vectors and Restriction enzymes used in biotechnology
- Describe the gene delivery mechanism and PCR technique
- Acquire basic knowledge on media preparation and cell culture techniques
- Understand the manipulation of reproduction with the application of biotechnology
- Understand the applications of Biotechnology in the fields of industry and agriculture including animal cell/tissue culture, stem cell technology and genetic engineering.

**SYLLABUS:**

**UNIT-I:**

1.1 Enzymes and Vectors Restriction modification systems: Types I, II and III.

1.2 Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering

1.3 DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

1.4 Cloning Vectors: Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs,

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/ Preparation of models of Cloning vectors with biodegradable material/*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT- II:**

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

2.2 PCR: Basics of PCR.



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2.3 DNA Sequencing: Sanger's method of DNA sequencing- traditional and automated sequencing

2.4 Hybridization techniques: Southern, Northern and Western blotting

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/ Visit to any clinical testing laboratory for hands on experience of PCR Use*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-III:**

3.1 Natural and Synthetic Cell cultures: primary culture, secondary culture, continuous cell lines

3.2 Organ culture; Cryopreservation of cultures.

3.3 Hybridoma Technology: Cell fusion, Production of Monoclonal antibodies (mAb), Applications of mAb

3.4 Stem cells: Types of stem cells, applications

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/ Visit to any clinical testing laboratory for observation of various cultures*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-IV:**

4.1 Manipulation of reproduction in animals: Artificial Insemination, In vitro fertilization

4.2 Manipulation of reproduction in animals: Super ovulation, Embryo transfer, Embryo cloning

4.3 Transgenic Animals: Strategies of Gene transfer;

4.4 Transgenic - sheep, - fish; applications

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/ Visit to laboratory for observation of Artificial Insemination, In vitro fertilization/model preparation of transgenic animal*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-V:**

5.1 DNA fingerprinting

5.2 Application of biotechnology in fisheries – monoculture in fishes, polyploidy in fishes

5.3 Gene therapy-application

5.4 Bio informatics- concept-definition-database types

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Case study*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*



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**REFERENCES BOOKS:**

- Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
- Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
- Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
- Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
- Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
- Brown TA. (2007). Genomes-3. Garland Science Publishers
- Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
- Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994. BIOS Scientific Publishers Limited.
- Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes, 1998. Animal Cell Culture Methods Academic Press.
- P.K. Gupta: Biotechnology and Genomics, Rastogi publishers (2003).
- B.D. Singh: Biotechnology, Kalyani publishers, 1998 (Reprint 2001)

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SEMESTER-III  
COURSE 7: ANIMAL BIOTECHNOLOGY

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

This course will provide students with a practical knowledge in animal biotechnology, by the completion of the course the graduate shall be able to –

- Acquire knowledge on Cloning vectors widely used in biotechnology
- Empower with the process of DNA quantification and amplification
- Explain purification of biological compounds by paper chromatography
- Get insight maintenance of laboratory apparatus
- Understand principles of animal culture, media preparation

**SYLLABUS:**

1. Cloning Vectors: Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs, (Charts/Images/Models)
2. DNA quantification using DPA Method.
3. Techniques: DNA Fingerprinting
4. Separation, Purification of biological compounds by paper chromatography
5. Cleaning and sterilization of glass and plastic wares for cell culture.
6. Preparation of culture media.
7. Amplification of DNA by PCR

*Note: above practical may be demonstrated in the lab or demonstrated by V- lab*

**REFERENCE WEB LINKS:**

- <https://vlab.amrita.edu/>
- <https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering>
- <https://blog.praxilabs.com/2020/06/30/dna-extraction-virtual-lab/>
- <http://mbvi-au.vlabs.ac.in/>
- [https://webstor.srmist.edu.in/web\\_assets/downloads/2021/18BTC203J-lab-manual.pdf](https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC203J-lab-manual.pdf)
- [https://webstor.srmist.edu.in/web\\_assets/srm\\_mainsite/files/files/BT%200312%20-%20ANIMAL%20CELL%20AND%20TISSUE%20CULTURE%20LABORATORY.pdf](https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/BT%200312%20-%20ANIMAL%20CELL%20AND%20TISSUE%20CULTURE%20LABORATORY.pdf)
- <https://davjalandhar.com/dbt/biotechnology/SOP/BSc%20Biotechnology%20Semester%20V%20%26%20VI.pdf>
- [https://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414\\_Lab%20Manual\\_Fall%202011.pdf](https://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414_Lab%20Manual_Fall%202011.pdf)

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SEMESTER-III

**COURSE 8: EVOLUTION AND ZOOGEOGRAPHY**

Theory

Credits: 3

3 hrs/week

**LEARNING OBJECTIVES**

- To provide knowledge on origin of life, theories and forces of evolution
- To explore the evidences of evolution
- To Explain the theories of evolution
- To understand the role of variations and mutations in evolution of organisms
- To understand the zoogeographical distribution of animals

**LEARNING 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 Evolution and zoo geography, by the completion of the course the graduate shall able to –

- 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
- Explain the different evidences of evolution
- Understand the theories of evolution
- Explain the various tools for evolution
- Map the distribution of animals according to zoological realms

**SYLLABUS:**

**UNIT-I**

- 1.1 Origin of life: different ancient concepts -Origin of Earth and Solar system: Big Bang theory, Primitive atmosphere, formation of macromolecules
- 1.2 Biological evolution: Coacervates, Microspheres, formation of Nucleic acids, Nucleoproteins
- 1.3 Formation of primary organisms, evolution of modes of nutrition, oxygen revolution, present day atmosphere, evolution of eukaryotes.
- 1.4 Experimental evidences in support of Biochemical origin of life (Miller and Urey experiment)

**Activity:** Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above

**Evaluation:** Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity

**UNIT-II**

- 2.1 Palaeontological and taxonomical evidences of evolution
- 2.2 Morphological and anatomical evidences of evolution
- 2.3 Embryological and physiological evidences of evolution
- 2.4 Evidences from connecting links, missing links and bio geographical distribution



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**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Visit to Archaeological Museum for observation of fossils*  
**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT -III**

- 3.1 Lamarckism-Neo Lamarckism
- 3.2 Germplasm theory-August Weismann
- 3.3 Darwinism-Theory of Natural selection
- 3.4 Modern synthetic theory of evolution (Neo Darwinism)

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*  
**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-IV**

- 4.1 Variations-types-sources of variations- importance in evolution
- 4.2 Mutations-classification-causes-significance in evolution
- 4.3 Isolation mechanisms-role in evolution
- 4.4 Sewall wright effect, Hardy Weinberg Principle

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*  
**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-V**

- 5.1 Animal distribution and barriers of distribution
- 5.2 Zoogeographical realms – Palearctic & Nearctic regions
- 5.3 Zoogeographical realms – Neotropical & Ethiopian regions
- 5.4 Zoogeographical realms – Oriental & Australian regions

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Case study on the observation of fauna in the college locality/in the residential area*  
**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**Co-curricular activities (Suggested)**

- 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 BOOKS:**

- Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
- Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.



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- Minkoff, E. (1983). *Evolutionary Biology*. Addison-Wesley.
- Organic evolution by Organic evolution by Dr. Veer Bala Rastogi, 2019 Kedar Nath Ramnath
- Palaeontology and Zoogeography Organic evolution by Dr. Veer Bala Rastogi, 2019 Kedarnath Ramnath
- Rastogi VB. 1991. *Organic Evolution*. Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.
- Stahl FW. 1965. *Mechanics of Inheritance*. Prentice-Hall.
- White MJD. 1973. *Animal Cytology and Evolution*. Cambridge Univ. Press

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**SEMESTER-III**  
**COURSE 8: EVOLUTION AND ZOOGEOGRAPHY**

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

- Acquainting and skill enhancement in the usage of laboratory equipment
- To apply the basic concept of inheritance for applied research
- To get familiar with phylogeny and geological history of origin & evolution of animals
- To understand the zoogeographical distribution of animals

**SYLLABUS:**

1. Study of fossil evidences
2. Study of homology and analogy from suitable specimens and pictures
3. Study of embryological evidences by charts/ pictures
4. Study of Lamarckism with images /animations
5. Study of Darwinism with images/ animation
6. Study of connecting links/missing links images/charts
7. Phylogeny of horse with pictures
8. Study of Genetic Drift by using examples of Darwin's finches (pictures)
9. Visit to Natural History Museum and submission of report
10. Mapping distribution of animals according to zoogeographical regions.
11. Mapping zoogeographical regions

**REFERENCE WEB LINKS:**

- <https://www.labster.com/course-packages/evolution-and-diversity>
- <https://www.biointeractive.org/classroom-resources/stickleback-evolution-virtual-lab>
- <https://www.youtube.com/watch?v=tXbmPhrS4eA>
- <https://www.studocu.com/en-us/document/temple-university/bioe-lab-2-biomaterials/1632834116536-zoogeography-assignment/17915777>
- <https://guides.library.tulsacc.edu/c.php?g=932434&p=6720765>
- [https://bio.libretexts.org/Courses/Butte\\_College/BC%3A\\_BIOL\\_2\\_-\\_Introduction\\_to\\_Human\\_Biology\\_%28Grewal%29/Text/09%3A\\_Biological\\_Evolution/9.3%3A\\_Evidence\\_for\\_Evolution](https://bio.libretexts.org/Courses/Butte_College/BC%3A_BIOL_2_-_Introduction_to_Human_Biology_%28Grewal%29/Text/09%3A_Biological_Evolution/9.3%3A_Evidence_for_Evolution)
- <https://www.coursehero.com/study-guides/boundless-biology/evidence-of-evolution/>

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SEMESTER-IV  
COURSE 9: EMBRYOLOGY

Theory

Credits: 3

3 hrs/week

**LEARNING OBJECTIVES**

- The objective of this course is to provide a comprehensive understanding of the concepts of early animal development.
- Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.
- In this course different concepts of animal development will be elaborated
- Students will be made familiar with different approaches that have been used to study embryology.
- Topics that will be discussed are organogenesis and regeneration.

**LEARNING OUTCOMES:**

The overall course outcome is that the student shall develop deeper understanding of concepts of embryology. This course will provide students with a deep knowledge in embryology by the completion of the course the graduate shall able to –

- Understand the historical perspective and concepts of embryology
- Acquire knowledge on gametogenesis, fertilization and cleavage patterns
- Understand the fate of germinal layers and extraembryonic membranes
- Explain the process of regeneration in certain animals
- Examine the process of organogenesis

**SYLLABUS:**

**UNIT-I:**

- 1.1 Historical perspective and basic concepts: Phases of development
- 1.2 Cell-Cell interaction, Pattern formation, Differentiation and growth
- 1.3 Differential gene expression,
- 1.4 Cytoplasmic determinants and asymmetric cell division

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-II:**

- 2.1 Gametogenesis, Spermatogenesis, Oogenesis;
- 2.2 Types of eggs, Egg membranes; Fertilization (External and Internal)
- 2.3 Planes and patterns of cleavage; Types of Blastulae; Fate maps
- 2.4 Early development of frog and chick up to gastrulation

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Model preparation on cleavage planes*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*



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**UNIT-III:**

- 3.1 Fate of Germ Layers
- 3.2 Extra-embryonic membranes
- 3.3 Placenta (Structure, types and functions of placenta)
- 3.4 Amniocentesis

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Chart preparation on the placenta*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-IV:**

- 4.1 Metamorphosis: Changes, hormonal regulations in amphibians
- 4.2 Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (in Turbellarians)
- 4.3 Ageing: Concepts and Theories
- 4.4 Teratogenic agents and their effects on embryonic development

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Flow chart preparation on the process of metamorphosis highlighting the periodical changes vs hormone activity*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT-V:**

- 5.1 Organogenesis of Central Nervous system
- 5.2 Organogenesis of Eye, Ear
- 5.3 Organogenesis of Skin
- 5.3 Organogenesis of Circulatory system
- (\* Organogenesis in Human need to be explained)

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Flow chart preparation on the process of organogenesis highlighting the gradual developments of organ systems*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**Co-curricular activities (Suggested)**

- Preparation of models of different types of eggs in animals
- Chart on frog embryonic development, fate map of frog blastula, cleavage etc.
- Chart on the organogenesis
- RBPT on the Placenta
- Model of extra embryonic membrane
- Laboratory observation of chick embryonic development

**REFERENCES BOOKS:**

- Developmental Biology by Balinsky
- Developmental Biology by Gerard Karp
- Chordate embryology by Varma and Agarwal
- Embryology by V.B. Rastogi



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- Austen CR and Short RV. 1980. *Reproduction in Mammals*. Cambridge University Press.
- Gilbert SF. 2006. *Developmental Biology*, 8<sup>th</sup> Edition. Sinauer Associates Inc., Publishers, Sunderland, USA.
- Longo FJ. 1987. *Fertilization*. Chapman & Hall, London.
- Rastogi VB and Jayaraj MS. 1989. *Developmental Biology*. KedaraNath Ram Nath Publishers, Meerut, Uttar Pradesh.
- Schatten H and Schatten G. 1989. *Molecular Biology of Fertilization*. Academic Press, New York.

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SEMESTER-IV  
COURSE 9: EMBRYOLOGY

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

- The objective of this course is to provide a comprehensive practical knowledge on the embryology
- Must develop a critical understanding of the early embryological events
- Acquire knowledge on the developmental stages of chick
- Understand the histology of placenta

**SYLLABUS:**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: 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: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of different sections of placenta (photomicrograph/ slides)
4. Project report on chick embryo development

**REFERENCE WEB LINKS:**

- <https://praxilabs.com/en/3d-simulations/cultivation-and-preparation-of-the-virus-in-chick-embryo-virtual-lab>
- <https://vlab.amrita.edu/>
- <https://www.vlab.co.in/>
- [https://www.youtube.com/watch?v=p\\_tx88He8Pk](https://www.youtube.com/watch?v=p_tx88He8Pk)
- <https://core.ac.uk/download/143957972.pdf>
- <https://egyankosh.ac.in/bitstream/123456789/57549/1/Exercise%207%20Chick%20Embryo.pdf>
- [http://www.macollege.in/app/webroot/uploads/departement\\_materials/doc\\_501.pdf](http://www.macollege.in/app/webroot/uploads/departement_materials/doc_501.pdf)
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>

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### LEARNING OBJECTIVES

- To acquire knowledge of organ systems function.
- To develop the ability to integrate physiology from the cellular and molecular level to the organ system and organismic level of organization.
- To Effectively read, evaluate and communicate scientific information related to physiological processes in the body.
- To gain a deep knowledge of current topics in physiology.

### LEARNING OUTCOMES:

The overall course outcome is that the student shall develop deeper understanding of concepts of Physiology. This course will provide students with a deep knowledge in physiology by the completion of the course the graduate shall able to –

- Understand the physiology of digestion and hormonal control of digestion
- Develop a comprehensive picture of respiratory physiology
- Acquire knowledge on the Renal physiology
- Understand the physiology of Nerve and muscle
- Understand the physiology of heart

### SYLLABUS:

#### UNIT-I: Physiology of Digestion

- 1.1 Structural organization and functions of gastrointestinal tract and associated glands;
- 1.2 Vitamins & Mineral composition of food & Mechanical and chemical digestion of food;
- 1.3 Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins;
- 1.4 Hormonal control of secretion of enzymes in Gastrointestinal tract.

**Activity:** Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Chart preparation on the hormonal control of secretion of enzymes

**Evaluation:** Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity

#### UNIT-II: Physiology of Respiration

- 2.1 Structural organization of Respiratory system, Mechanism of respiration, Control of respiration
- 2.2 Pulmonary ventilation; Respiratory volumes and capacities;
- 2.3 Transport of oxygen in blood and dissociation curves and the factors influencing it
- 2.4 Transport of Carbon dioxide in blood; dissociation curves and the factors influencing it, Carbon monoxide poisoning

**Activity:** Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Group discussion on the CO poisoning/Debate on the dissociation curves



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***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**UNIT-III: Renal Physiology**

- 3.1 Structure of kidney and its functional unit
- 3.2 Mechanism of urine formation
- 3.3 Regulation of water balance
- 3.4 Regulation of acid-base balance

***Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Group discussion on the Urine formation/Working model of Kidney***

***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**UNIT-IV: Physiology of exciting tissues**

- 4.1 Neuron structure and types
- 4.2 Nerve impulse transmission-(Myelinated, Non-myelinated, synaptic)
- 4.3 Ultra structure of muscle
- 4.4 Molecular and chemical basis of muscle contraction

***Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Group discussion on the impulse trasnmission/Debate on the dissociation curves***

***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**UNIT- V: Physiology of Heart**

- 5.1 Structure of mammalian heart, Coronary circulation;
- 5.2 Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses
- 5.3 Cardiac Cycle-Cardiac output and its regulation
- 5.4 Nervous and chemical regulation of heart rate. Blood pressure and its regulation

***Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above /Group discussion on the phases of Cardiac output /case study on the Blood Pressure***

***Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity***

**Co-curricular activities (Suggested)**

- Chart on cardiac cycle, human lung, kidney/nephron structure etc.
- Working model of human / any mammalian heart.
- Working model of human / any mammalian urine formation
- Chart/model of sarcomere
- Chart/model on nerve impulse transmission



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**REFERENCES BOOKS:**

- Eckert H. *Animal Physiology: Mechanisms and Adaptation*. W.H. Freeman & Company.
- Floray E. *An Introduction to General and Comparative Animal Physiology*. W.B. Saunders Co., Philadelphia.
- Goel KA and Satish KV. 1989. *A Text Book of Animal Physiology*, Rastogi Publications, Meerut, U.P.
- Hoar WS. *General and Comparative Physiology*. Prentice Hall of India, New Delhi.
- Lehninger AL. Nelson and Cox. *Principles of Biochemistry*. Lange Medical Publications, New Delhi.
- Prosser CL and Brown FA. *Comparative Animal Physiology*. W.B. Saunders Company, Philadelphia.

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**SEMESTER-IV**

**COURSE 10: ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

- To acquire knowledge of anatomy of certain important organs.
- To develop the ability to test the biological sample like saliva and urine.
- To Effectively estimate the blood haemoglobin.
- To Acquire skill to use the sphygmomanometer in recording blood pressure.
- To observe the ECG

**SYLLABUS:**

1. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney
2. Study of activity of Salivary amylase under optimum condition
3. Qualitative tests for identification of Carbohydrates
4. Qualitative tests for identification of Proteins
5. Qualitative tests for identification of Fats
6. Urine test for sugar, albumin
7. Estimation of haemoglobin using Sahli's haemoglobinometer
8. Recording of blood pressure using a sphygmomanometer
9. Recording of frog's heart beat under in situ and perfused conditions
10. ECG observation- Spotting/identification of curves from the given ECG

**REFERENCE WEB LINKS:**

- <https://www.vlab.co.in/participating-institute-amrita-vishwa-vidyapeetham>
- <https://library.csi.cuny.edu/oer/virtuallabs-simulations#anatomy>
- <https://www.labster.com/simulations?course-packages=animal-physiology>
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>
- [https://physiology.elte.hu/gyakorlat/jegyzet/Physiology\\_Pactical\\_\(2013\).pdf](https://physiology.elte.hu/gyakorlat/jegyzet/Physiology_Pactical_(2013).pdf)

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SEMESTER-IV  
COURSE 11: IMMUNOLOGY

Theory

Credits: 3

3 hrs/week

**LEARNING OBJECTIVES**

- To promote critical thinking among students.
- To provide students with a foundation in immunological processes
- To provide students with knowledge on how the immune system works building on their previous knowledge
- To clearly state the role of the immune system.
- To compare and contrast the innate versus adaptive immune systems.
- To provide an overview of the interaction between the immune system and pathogens.

**LEARNING OUTCOMES:**

The overall course outcome is that the student shall develop deeper understanding of concepts of immunology. This course will provide students with a deep knowledge in immunology by the completion of the course the graduate shall able to –

- Articulate the roles of innate recognition receptors in immune responses
- Compare and contrast humoral versus cell-mediated immune responses
- Distinguish various cell types involved in immune responses and associated functions;
- Distinguish and characterize antibody isotypes, development, and functions
- Understand the role of cytokines in immunity and immune cell activation;
- Understand the significance the Major Histocompatibility Complex in terms of immune response and transplantation

**SYLLABUS:**

**UNIT – I: Overview of Immune system**

- 1.1 Introduction to basic concepts in Immunology
- 1.2 Innate and adaptive immunity
- 1.3 Cells of immune system
- 1.4 Organs of immune system

*Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/Report writing after watching any video on the above/Model chart preparation of cells/organs of immune system*

*Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT – II : Antigens**

- 2.1 Basic properties of antigens
- 2.2 B and T cell epitopes, paratopes
- 2.3 Haptens and adjuvants
- 2.4 Factors influencing immunogenicity

*Activity: Assignment /Students Seminar/Quiz/Project/Peer teaching/ Model chart preparation of organogenesis*

*Evaluation: Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*



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**UNIT – III: Antibodies**

- 3.1 Structure of antibody
- 3.2 Classes of antibodies
- 3.3 Functions of antibodies
- 3.4 Monoclonal antibodies

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/ Model chart preparation of antibodies*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT – IV: Working of Immune system**

- 4.1 Structure and functions of major histocompatibility complexes
- 4.2 Exogenous pathway of antigen presentation and processing
- 4.3 Endogenous pathway of antigen presentation and processing
- 4.4. Basic properties and functions of cytokines

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/ Model chart preparation of MHC*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**UNIT – V: Immune system in health and disease**

- 5.1 Gell and Coombs' classification and brief description of various types of hypersensitivities
- 5.2 Introduction to concepts of autoimmunity and immunodeficiency
- 5.3 General introduction to vaccines Types of vaccines, Immunization programme
- 5.4 Organ transplantation- Graft rejection, immune suppressors

**Activity:** *Assignment /Students Seminar/Quiz/Project/Peer teaching/ Model chart preparation of classification of Hypersensitivity*

**Evaluation:** *Instructor supposed to prepare a detailed Rubrics for the evaluation of the above activity*

**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

**REFERENCES BOOKS:**

- Judy Owen, Jenni Punt, Sharon Stranford 2013 Kuby Immunology: International Edition W. H. Freeman
- Abbas AK, 2011, Cellular and Molecular Immunology 7th Ed. Elsevier Health Sciences – India.
- Delves P, Martin S, Burton D, Roitt IM 2011 Roitt's Essential Immunology. 12th Ed. Wiley-Blackwell Scientific Publication, Oxford.
- Murphy K, 2011 Janeway's Immunobiology. 8th Ed. Garland Science Publishers, New York.



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**Single Major B.Sc. Zoology (w.e.f:2023-24A.B)**

- Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
- Richard Coico, Geoffrey Sunshine 2008 Immunology: A Short Course, 6th Edition Wiley-Blackwell
- Sudha Gangal 2013 Textbook of Basic and Clinical Immunology Orient Blackswan Private Limited - New Delhi

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SEMESTER-IV  
COURSE 11: IMMUNOLOGY

Practical

Credits: 1

2 hrs/week

**LEARNING OBJECTIVES**

- To acquire knowledge on the distribution of lymphoid organs
- To study the histology of lymphoid organs
- To acquaint with the process of blood grouping with kit
- To acquaint with the ELISA test
- To acquaint with the Widal test

**SYLLABUS:**

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 ELISA
5. Demonstration of Immunoelectrophoresis
6. Testing for Typhoid antigens by Widal test.
7. Differential Leukocyte Count
8. Isolation of monocytes from blood.
9. Rapid Plasma Reagin (RPR) Test

**REFERENCE WEB LINKS:**

- <https://vlab.amrita.edu/?sub=3&brch=69>
- <https://iv11-au.vlabs.ac.in/List%20of%20experiments.html>
- <https://iv12-au.vlabs.ac.in/List%20of%20experiments.html>
- <https://www.medicine.mcgill.ca/physio/vlab/immun/vlabmenuimmun.htm>
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>
- <http://www.lucp.net/books-pdf/Lab%20Manual%20Dr.%20Idris%20Adewale%20Ahmed/15.%20BASIC%20IMMUNOLOGY.pdf>
- [https://www.avit.ac.in/lab/immunology\\_bioprocess\\_engineering\\_lab/download/17BTCC89/lab\\_manual.pdf](https://www.avit.ac.in/lab/immunology_bioprocess_engineering_lab/download/17BTCC89/lab_manual.pdf)
- <https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/labs/frelinger-lab/documents/Immunology-Lab-Manual.pdf>
- [https://webstor.srmist.edu.in/web\\_assets/downloads/2021/18BTC106J-lab-manual.pdf](https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab-manual.pdf)

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**SEMESTER-V**  
**COURSE 12: POULTRY MANAGEMENT-I (POULTRY FARMING)**

Theory Credits: 3 3 hrs/week

**LEARNING OUTCOMES:**

Students at the successful completion of the course will be able to

- Evaluate the status of Indian Poultry Industry
- Explain the Scientific Poultry keeping
- Compare the diversified Poultry practices
- Inspect the different breeds of chicken

**SYLLABUS:**

**Unit 1 Indian poultry Industry**

- 1.1 Importance of poultry farming and poultry development in India.
- 1.2 Present status and future prospectus of poultry Industry
- 1.3 Classification of poultry based on genetics Utility

**Unit -2 Scientific Poultry Keeping**

- 2.1 Modern breeds of Chicken
- 2.2 Present day egg production lines- meat production lines
- 2.3 Mini breeds- dwarfism in mini-Leghorns

**Unit-3 Diversified Poultry**

- 3.1 Ducks and Geese-classification- rearing system-classification-advantages
- 3.2 Guinea fowls - guinea fowl farming in India-Production-varieties
- 3.3 Emu-rearing- Economical aspects-commercial products

**Unit-4 Desi Chickens:**

- 4.1 Indigenous breeds and economical aspects of desi chicken
- 4.2 Indigenous breeds-Aseel-Chittagong-Kadakhnath-Bursa
- 4.3 Improved varieties in India – Giriraja-Vanaraja-Girirani-Kalinga brown, Gramapriya,Swarnandhra

**Unit -5 Breeds from Central Avian Research Institute – Izatnagar**

- 5.1 CARI Nirbheek - CARI- Shyama-HITCARI (Naked Neck Cross)
- 5.2 CARI- Priya Layer, CARI- Sonali Layer,
- 5.3 CARIBRO-VISHAL, CARI-RAINBRO,
- 5.4 Nandanam chicken-I, Nandanam Chicken-II, Nandanm-Quail

**REFERENCES:**

1. Text Book of Poultry Science, P V Sreenivasaiiah, Write and Print Publications, ISBN No. 9788192970592, 8192970590
2. Poultry Science Practices, Nilothpal Ghosh, CBS Publication & Distributions, 2015
3. Principles of Poultry Science, 1996, CAB Publishers, ISBN 9780851991221
4. A Text Book of Animal Husbandry, C. C. Banerjee, Oxford and IBH, Publish Co, ISBN: 9788120412606

**Web sources:**

5. <https://www.drvt.in/p/e-books.html>
6. <https://byjus.com/biology/animal-husbandry-poultry-farming/>
7. [https://www.helpforag.app/2018/02/livestock-production-and-management-lpm\\_14.html?m=1](https://www.helpforag.app/2018/02/livestock-production-and-management-lpm_14.html?m=1)

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SEMESTER-V  
COURSE 12: POULTRY MANAGEMENT-I (POULTRY FARMING)

Practical

Credits: 1

2 hrs/week

**LEARNING OUTCOMES:**

On successful completion of this practical course, student shall be able to:

- Identify different types of Poultry rearing practices
- Evaluate the efficacy of different types of poultry practices in maximizing yield
- Understand the importance of different hybrid breeds in poultry

**SYLLABUS:**

1. Different types of Poultry rearing (Students has to observe and draw the different types of poultry rearing systems)
2. Different types of poultry Housing - Models / Images/charts
3. Different layer breeds images/charts/ Models (Observation of characters)
4. Types of broilers images/charts/ Models (Identification of important Characters)
5. CARI breeds characters –images/charts
6. Nandanam breeds- images/charts (Identification of characters)  
\*\*\* (This practical is 70 % (Web based /virtual) 30% physical: student and teachers must browse the web for the specimens models – write down the important characters based on the web resources)

**REFERENCES:**

1. A Text Book of Animal Husbandry, C. C. Banerjee, Oxford and IBH, Publish Co, ISBN: 9788120412606
2. [http://www.agritech.tnau.ac.in/expert\\_system/poultry/Poultry%20House%20Construction.html](http://www.agritech.tnau.ac.in/expert_system/poultry/Poultry%20House%20Construction.html)
3. <https://petkeen.com/best-chicken-breeds-for-eggs/>
4. <https://garden.decorexpro.com/en/hozyajstvo/ptitsevodstvo/porody-brojlernyh-kur-s-foto-i-opisaniem.html>

**Co-Curricular Activities:**

a) **Mandatory:**

1. For Teacher: Training of students by the teacher in laboratory and field on the techniques of identification of layers, broilers and management practices in poultry.
2. For Student: Students shall Individually visit a Poultry farm, make observations and report on the Rearing, Housing, Brooding, Feeding and water management activities. The student shall submit a handwritten Fieldwork/Project work Report on the observations along with pictures in the given format not exceeding 10 pages to teacher.
3. Max marks for Fieldwork/Project work Report: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, detailsof place visited, observations made, findings and acknowledgements.*
5. Unit tests. (IE)

b) **Suggested Co-Curricular Activities**

1. Web resources – visiting the web sites of CARI-IZATNAGA <https://cari.icar.gov.in> procuring additional information on the poultry breeds
2. Web resources- visiting the web site of NANADANAM [http://www.tanuv.ac.in/ipmmadhavaram\\_tech.html](http://www.tanuv.ac.in/ipmmadhavaram_tech.html)
3. Collection of additional data on different types of Poultry breeds
4. Seminar, Assignment, Group discussion. Quiz, Collection of Material, Invited Lecture, Video preparation etc.

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**SEMESTER-V**  
**COURSE 13: POULTRY MANAGEMENT-II**  
**(POULTRY PRODUCTION AND MANAGEMENT)**

Theory

Credits: 3

3 hrs/week

**LEARNING OUTCOMES:**

Students at the successful completion of the course will be able to

- Suggest measure for Health care in Poultry
- Evaluate the economics of poultry production
- Elaborate the poultry Breeder flock management
- Differentiate the poultry hatchery practices

**SYLLABUS:**

**Unit-1 HEALTH CARE**

- 1.1 Common poultry diseases: bacterial, viral, fungal, parasitic and nutritional deficiencies.
- 1.2 Vaccination schedule for commercial layers and broilers: factors that govern vaccination schedule; vaccination principles type, methods, pre and post vaccination care.
- 1.3 Disinfection: Types of disinfectants; mode of action; recommended procedure; precaution and handling.

**Unit-2 ECONOMICS**

- 2.1 Economics of layer and broiler production
- 2.2 Projects reports in different systems of rearing for layer & broilers.
- 2.3 Feasibility studies on poultry rearing- in context of small units and their profitability.
- 2.4 Export/import of poultry and poultry products.

**Unit-3 BREEDER FLOCK MANAGEMENT**

- 3.1 Layer and broiler breeder flock management housing & space requirements
- 3.2 Different stage of management during life cycle; Light management during growing and laying period, Artificial insemination.
- 3.3 Feeding: Feed restriction, separate male feeding. Nutrient requirement of layer and broiler breeders of different age groups.

**Unit-4 BREEDER HEALTHCARE**

- 4.1 Vaccination of breeder flock; difference between vaccination schedule of broilers and commercial birds.
- 4.2 Common diseases of breeders (Infectious and metabolic disorders)-prevention.
- 4.3 Fertility disorder- etiology, diagnosis and corrective measures. Selection and culling of breeder flocks

**Unit-5 HATCHERY PRACTICES**

- 5.1 Management principles of incubation.
- 5.2 Factors affecting fertility and hatchability. Selection, care and incubation of hatching eggs. Fumigation; sanitation and hatchery hygiene.
- 5.3 Importance of hatchery records, break even analysis of unhatched eggs.
- 5.4 Computer applications for hatchery management





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**REFERENCES:**

1. HVS Chauhan, S. Roy, Poultry Diseases, Diagnosis and Treatment, New Age International Publishers-2018

**Web resources:**

2. <https://www.drivet.in/p/e-books.html>
3. <https://byjus.com/biology/animal-husbandry-poultry-farming/>
4. [https://www.helpforag.app/2018/02/livestock-production-and-management-lpm\\_14.html?m=1](https://www.helpforag.app/2018/02/livestock-production-and-management-lpm_14.html?m=1)

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**LEARNING OUTCOMES:**

On successful completion of this practical course, student shall be able to:

- Identify Poultry diseases by observation
- Analyze Poultry establishment feasibility
- Understand the Poultry Records

**SYLLABUS:**

1. Poultry Viral diseases – Observation of histopathological slides
2. Poultry Fungal Diseases- Observation of histopathological slides
3. Poultry Bacterial Diseases-Observation of histopathological slides
4. Feasibility study of Poultry establishment: (Preparation of feasibility study report with given parameters )
5. Rearing of Layers – (Preparation of Flow chart
6. Rearing of broiler- Flow chart
7. Hatchery records- Model study/analysis- Report with modified data

**REFERENCES:**

1. HVS Chauhan, S. Roy, Poultry Diseases, Diagnosis and Treatment, New Age International Publishers-2018
2. Flow chart hatchery : <http://lms.tanuv.ac.in/mod/resource/view.php?id=45106>
3. Feasibility report:  
<https://www.manage.gov.in/stry&fcac/content/19.%20Project%20Report%20on%20Layer%20Poultry.pdf>

**Co-Curricular Activities**

**a) Mandatory:**

1. For Teacher: Training of students by the teacher laboratory and field on skills in different practices employed in poultry with regard to the disease management – analysis of poultry project- preparation of flow chart – Observation of Poultry records – computerization activities
2. For Student: students shall (individually) visit a Layer/ Broiler Poultry farming places (small scale/corporate), make observations on practices- resources – management and marketing - analysis and submit a handwritten Fieldwork/Project work Report of 10 pages with necessary images.
3. Max marks for Fieldwork/Project work Report: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, detailsof place visited, observations made, findings and acknowledgements.*
6. (IE): Unit tests.

**b) Suggested Co-Curricular Activities**

1. Preparation of Poultry diseases charts
  2. Preparation of feasibility report poultry establishment with different variables
  3. Seminar, Assignment, Group discussion. Quiz, Collection of Material, Invited Lecture, Video preparation etc.
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### LEARNING OUTCOMES:

Students at the successful completion of this course will be able to

- Evaluate the present status of aquaculture at the Global level and National level
- Classify different types of ponds used in aquaculture
- Demonstrate induced breeding of carps
- Acquire critical knowledge on commercial importance of shrimps
- Identify fin and shell fish diseases

### SYLLABUS:

#### Unit: 1

- 1.1 Present status of Aquaculture – Global and National scenario
- 1.2 Major cultivable species for aquaculture: freshwater, brackish water and marine.
- 1.3 Traditional, extensive, modified extensive, semi-intensive and intensive cultures of fish and shrimp.
- 1.4 Design and construction of fish and shrimp farms

#### Unit: 2

- 2.1 Functional classification of ponds – head pond, hatchery, nursery ponds
- 2.2 Functional classification of ponds -rearing, production, stocking and quarantine ponds
- 2.3 Need of fertilizer and manure application in culture ponds
- 2.4 Physio-chemical conditions of soil and water optimum for culture (Temperature, depth, turbidity, light, water, PH, BOD, CO<sub>2</sub> and nutrients)

#### Unit: 3

- 3.1. Induced breeding in fishes
- 3.2. Culture of Indian major carps: Pre-stocking management (Dewatering, drying, ploughing / desilting; Predators, weeds and algal blooms and their control, Liming and fertilization)
- 3.3. Culture of Indian major carps - Stocking management
- 3.4. Culture of Indian major carps - post-stocking management

#### Unit: 4

- 4.1 Commercial importance of shrimp & prawn
- 4.2 *Macrobrachium rosenbergii*- biology, seed production.
- 4.3 Culture of *L. vannamei* – hatchery technology and culture practices
- 4.4 Mixed culture of fish and prawns

#### Unit: 5

- 5.1 Viral diseases of Fin Fish & shell fish
- 5.2 Fungal diseases of Fin & Shell fish
- 5.3 Bacterial diseases of Finfish & Shell fish
- 5.4 Prophylaxis in aquaculture



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**REFERENCES:**

1. Pillay TVR & M.A.Dill, 1979. Advances in Aquaculture. Fishing News Books Ltd., London
2. Stickney RR 1979. Principles of Warm Water Aquaculture. John Wiley & Sons Inc.1981
3. Boyd CE 1982. Water Quality Management for Pond Fish Culture. Elsevier ScientificPublishing Company.
4. Bose AN et.al. 1991. Costal Aquaculture Engineering. Oxford & IBH Publishing CompanyPvt. Ltd.

**Web resources:**

5. [http://www.fao.org/fishery/docs/CDrom/FAO\\_Training/FAO\\_Training/General/x6708e/x6708e06.htm](http://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6708e/x6708e06.htm)
6. [http://aquaticcommons.org/1666/1/Better-Practice3\\_opt.pdf](http://aquaticcommons.org/1666/1/Better-Practice3_opt.pdf)
7. <https://www.notesonzooology.com/india/fishery/fish-diseases-symptoms-and-control-fishery/871>

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SEMESTER-V

COURSE 14 A: SUSTAINABLE AQUACULTURE MANAGEMENT

Practical

Credits: 1

2 hrs/week

**LEARNING OUTCOMES:**

On successful completion of this practical course, student shall be able to:

- Identify the characters of Fresh water cultivable species
- Estimate physico chemical characteristics of water used for aquaculture
- Examine the diseases of fin and shell fish
- Suggest measures to prevent diseases in aquaculture

**SYLLABUS:**

- a. Fresh water Cultivable species any (Fin & Shell Fish Specimens – Observation of morphological characters by observation and drawings)-5
- b. Brackish water cultivable species (Fin & Shell fish- Specimens- Observation of Morphological Character by observing drawing) -5
- c. Hands on training on the use of kits for determination of water quality in aquaculture (DO, Salinity, pH, Turbidity- Testing kits to be used for the estimation of various parameters/ Standard procedure can be demonstrated for the same)
- d. Demonstration of Hypophysation(Procedure of hypophysation to be demonstrated in the practical lab with any edible fish as model)
- e. Viral diseases of Fin & Shell Fish (Observation of his to pathological slides / Charts/ Models of viral pathogens in fin/ shell fish – one edible specimen can be used for observation of same in the laboratory)
- f. Bacterial diseases of Fin & Shell Fish (Observation of his to pathological slides / Charts/ Models of Bacterial pathogens in fin/ shell fish – One edible specimen can be used for observation of same in the laboratory)
- g. Fungal diseases of Fin & Shell Fish (Observation of his to pathological slides / Charts/ Models of Bacterial pathogens in fin/ shell fish – One edible specimen can be used for observation of same in the laboratory)

**REFERENCES:**

- h. Boyd CE 1982. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company
- i. [http://www.fao.org/fishery/docs/CDrom/FAO\\_Training/FAO\\_Training/General/x6708e/x6708e06.htm](http://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6708e/x6708e06.htm)
- j. [http://aquaticcommons.org/1666/1/Better-Practice3\\_opt.pdf](http://aquaticcommons.org/1666/1/Better-Practice3_opt.pdf)
- k. <https://www.notesonzooology.com/india/fishery/fish-diseases-symptoms-and-control-fishery/871>

**Co-Curricular Activities**

**a. Mandatory:**

1. For Teacher: Training of students by the teacher in laboratory/field on Breeding- Induced breeding in carps -hatchery technology of *L. Vennami*- Farming techniques- disease diagnostic techniques— concepts –Demonstration @ any aqua laboratory
2. For Student: Students shall (individually) visit a Hatchery/Farm/ Aqua diagnostic center and make careful observations of the process method and implements- protocols and report on the same in 10 pages hand written Fieldwork/Project work Report.
3. Max marks for Fieldwork/Project work Report: 05.



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4. Suggested Format for Fieldwork/Project work: Title page, student details, index page, details of place visited, observations made, findings and acknowledgements.
5. (IE). Unit tests.

**b. Suggested Co-Curricular Activities**

1. Preparation of Model/Charts of Cultivable species of fin fish shell fish
2. Preparation of Model/Chart of Ideal fish Pond- with the standards prescribed.
3. Observation of aquaculture activities in their area (Observation of any activity related to aquaculture in the vicinity of the college/village)
4. Preparation of Model – charts of Fin /Shell fish Diseases with eco-friendly material.
5. Assignments, Group discussion, Seminar, Quiz, Collection of Material, Video preparation etc.,  
Invited lecture

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SEMESTER-V

COURSE 14 B: LIVE STOCK MANAGEMENT -I  
(BIOLOGY OF DAIRY ANIMALS)

Theory

Credits: 3

3 hrs/week

**LEARNING OUTCOMES:**

Students at the successful completion of the course will be able to

- Select the suitable breeds of livestock for rearing
- Relate the anatomy of udder with let-down of milk
- Identify and manipulate the reproductive behaviour of cattle
- Inspect economics of dairy farming
- Apprise the various breeding techniques employed in live stock

**SYLLABUS:**

**Unit 1:**

Livestock census; Breeds of Dairy cattle, Buffaloes and Goats. Indigenous, Exotic and Crossbred Cattle breeds

**Unit 2:**

Anatomy of Udder; Development of udder; Lactogenesis and Galactopoiesis; let-down of milk.

**Unit 3:**

Artificial insemination; Oestrous cycle; Symptoms of heat in cows and buffaloes. Conception, Pregnancy diagnosis in cattle. Multi ovulation and embryo transfer technique. Cloning.

**Unit 4:**

Economic traits of Dairy cattle. Methods of selection of dairy animals.

**Unit 5:**

Systems of Dairy cattle breeding. Inbreeding, out breeding, Cross breeding, grading up. Breeding systems (Cross breeding of cattle and grading up of buffaloes).

**REFERENCES:**

1. Textbook of Animal Husbandry-GC Benarjee
2. Handbook of Animal Husbandry –ICAR Edition
3. Principles and practices of Dairy Farm–Jagdish Prasad

**Web resources:**

4. <http://ecoursesonline.iasri.res.in/course/index.php?categoryid=42>
5. <https://vetsebooks.blogspot.com/p/e-books.html>
6. <https://www.basu.org.in/study-materials/veterinary-science/>
7. <https://vikaspedia.in/agriculture/livestock/cattle-buffalo/breeds-of-cattle-buffalo>

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SEMESTER-V  
COURSE 14 B: LIVE STOCK MANAGEMENT -I  
(BIOLOGY OF DAIRY ANIMALS)

Practical

Credits: 1

2 hrs/week

**LEARNING OUTCOMES:**

On successful completion of this practical course, student shall be able to

- Examine the points of dairy cow
- Understand the behavioral changes of cow during the reproductive period
- Differentiate the merits and demerits of cross breeds in cattle

**SYLLABUS:**

1. Points dairy cow. (Explanation with observation of charts- Model evaluation to be performed by the student in the laboratory)
2. Identification of different breeds of dairy cattle and buffaloes. (Observation of Charts of breeds in the laboratory- at least 3 breeds should be identified by the students in their locality with video, photo)
3. Male and female reproductive systems of cow – Model/ Chart (Student has to draw a labeled diagram of the male and female reproductive systems of cow – acquire skill to identify the parts).
4. Symptoms of heat in cow (Study and Understanding the physiological symptoms during heat).
5. Artificial in semi nation (Flow chart of implements – Procedure- precautions)
6. Pregnancy diagnosis in cattle.
7. Study comparative merits of cows and buffaloes; zebu and cross bred cows (Examination of merits)

**REFERENCES:**

1. Principles and practices of Dairy Farm–Jadish Prasad
2. Dairy cow points: <https://www.icar.org/Guidelines/05-Conformation-Recording.pdf>
3. Pregnancy test protocol:  
<https://cgspace.cgiar.org/bitstream/handle/10568/109408/Milk%20testing%20lab%20protocol.pdf?sequence=1&isAllowed=y>

**Co-Curricular Activities**

**a) Mandatory:**

- i. For Teacher: Training of students by the teacher in laboratory/field for not less than 15 hours on principles and practices of dairy industry- breeds –artificial insemination- reproductive behavior of cows etc. as per the syllabus above.
- ii. For Student: Students shall individually visit to any of the nearby cattle rearing centers/ veterinary hospital/Raithu Bharosa Kendra and make observations of the procedure and quality enhancement activities and submit a handwritten Fieldwork/Project work Report in 10 pages.
- iii. Max marks for Fieldwork/Project work Report: 05.
- iv. Suggested Format for Fieldwork/Project work Report: Title page, student details, index page, details of place visited, observations made, findings and acknowledgements
- v. (IE)Unit tests,

**b) Suggested Co-Curricular Activities:**

1. Collection of various cattle breed images from the web to prepare a album
2. Visit the sites of Veterinary colleges in India and preparation of brief report on the videos and content/ employment details
3. Sketch a model dairy farm with details
4. Invited lecture and presentation on related topics by experts
5. Seminar, Assignment, Group discussion. Quiz, Collection of Material, invited lectures, Video preparation etc.

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**SEMESTER-V**

**COURSE 15 A: POSTHARVEST TECHNOLOGY OF FISH AND FISHERIES**

Theory

Credits: 3

3 hrs/week

**LEARNING OUTCOMES:** Students at the successful completion of this course will be able to

- Identify the types of preservation methods employed in aquaculture
- Choose the suitable Processing methods in aquaculture
- Maintain the standard quality control protocols laid down in aqua industry
- Identify the best Seafood quality assurance system

**SYLLABUS:**

**Unit – I Handling and Principles of fish Preservation**

1.1 Handling of fresh fish, storage and transport of fresh fish, post mortem changes (rigor mortis and spoilage), spoilage in marine fish and freshwater fish.

1.2 Principles of preservation – cleaning, lowering of temperature, rising of temperature, denudation, use of salt, use of fish preservatives, exposure to low radiation of gamma rays.

**Unit – II Methods of fish Preservation**

2.1 Traditional methods - sun drying, salt curing, pickling and smoking.

2.2. Advanced methods – chilling or icing, refrigerated sea water, freezing, canning, irradiation and Accelerated Freeze drying (AFD).

**Unit – III Processing and preservation of fish and fish by-products**

3.1 Fish products – fish minced meat, fish meal, fish oil, fish liquid (ensilage), fish protein concentrate, fish chowder, fish cake, fish sauce, fish salads, fish powder, pet food from trash fish, fish manure.

3.2 Fish by-products – fish glue, Using glass, chitosan, pearl essence, shark fins, fish Leather and fish maws.

**Unit – IV Sanitation and Quality control**

4.1 Sanitation in processing plants - Environmental hygiene and Personal hygiene in processing plants.

4.2 Quality Control of fish and fishery products – pre-processing control, control during processing and control after processing.

**Unit – V Quality Assurance, Management and Certification**

5.1. Seafood Quality Assurance and Systems: Good Manufacturing Practices (GMPs); Good Laboratory Practices (GLPs); Standard Operating Procedures (SOPs); Concept of Hazard Analysis and Critical Control Points (HACCP) in seafood safety.

5.2 National and International standards – ISO 9000: 2000 Series of Quality Assurance System, *Codex Alimentarius*.

**REFERENCES:**

1. Santharam R, N Sukumaran and P Natarajan 1987. A manual of aquaculture, Oxford-IBH, New Delhi
2. Lakshmi Prasad's, Fish Processing Technology 2012, Arjun Publishing House
3. Dr Sunitha Rai, Fish Processing Technology, 2015, Random Publications
4. Safety and Quality Issues in Fish Processing (Woodhead Publishing Series in Food Science, Technology and Nutrition) by H A Bremner K.A Mahanthay, Innovations in Fishing and Fish Processing Technologies, January 2021

**Web resources:**

5. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=145743>
6. [https://ecourses.icar.gov.in/e-Learningdownload3\\_new.aspx?Degree\\_Id=03](https://ecourses.icar.gov.in/e-Learningdownload3_new.aspx?Degree_Id=03)

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**LEARNING OUTCOMES:**

On successful completion of this practical course, student shall be able to:

- Identify the quality of aqua processed products.
- Determine the quality of fishery products by observation
- Analyze the protocols of aqua processing methods

**SYLLABUS:**

1. Evaluation of fish/ fishery products for organoleptic, chemical and microbial quality.
2. Preparation of dried, cured and fermented fish products
3. Examination of salt, protein, moisture in dried / cured products
4. Examination of spoilage of dried / cured fish products, marinades, pickles, sauce.
5. Preparation of isinglass, collagen and chitosan from shrimp and crab shell.
6. Developing flow charts and exercises in identification of hazards – preparation of hazard analysis worksheet
7. Corrective action procedures in processing of fish- flow chart- work sheet preparation  
(\*Refer the following web sites for complete procedure method and estimations of above listed practical's)

**REFERENCES:**

1. Dr Sunitha Rai, Fish Processing Technology, 2015, Random Publications
2. [https://ecourses.icar.gov.in/e-Learningdownload3\\_new.aspx?Degree\\_Id=03](https://ecourses.icar.gov.in/e-Learningdownload3_new.aspx?Degree_Id=03)
3. <https://vikaspedia.in/agriculture/fisheries/post-harvest-and-marketing/processing-in-fisheries/fermented-products>
4. <https://krishi.icar.gov.in/jspui/bitstream/123456789/20500/1/Fermentation%20technology%20for%20fish.pdf>
5. <http://jebas.org/00200620122014/Abujam%20et%20al%20JEBAS.pdf>
6. [https://krishi.icar.gov.in/jspui/bitstream/123456789/20770/1/Training%20Manual\\_Hygienic%20drying%20and%20packing%20of%20fish.pdf](https://krishi.icar.gov.in/jspui/bitstream/123456789/20770/1/Training%20Manual_Hygienic%20drying%20and%20packing%20of%20fish.pdf)
7. [https://krishi.icar.gov.in/jspui/bitstream/123456789/20770/1/Training%20Manual\\_Hygienic%20drying%20and%20packing%20of%20fish.pdf](https://krishi.icar.gov.in/jspui/bitstream/123456789/20770/1/Training%20Manual_Hygienic%20drying%20and%20packing%20of%20fish.pdf)
8. [https://agritech.tnau.ac.in/fishery/fish\\_byproducts.html](https://agritech.tnau.ac.in/fishery/fish_byproducts.html)
9. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5352841/>
10. <http://www.fao.org/3/i1136e/i1136e.pdf>
11. <http://www.fao.org/3/x5989e/X5989e01.htm#What%20is%20sensory%20assessment>

**Co-Curricular Activities**

**a. Mandatory:**

1. For Teacher: Training of students by the teacher in laboratory/field in various steps of post-harvest techniques of fishes, on the advanced techniques in post-harvest technology – Training of students on other employability skills in the Post-harvest sector of Aquaculture Industry- like Processing, Packing, marketing of processed aqua products.
2. For Student: Students shall (individually) visit - Any fish/shrimp Processing Plant/Packing industry and make observations on post harvesting techniques and submit a brief handwritten Fieldwork/Project work Report with pictures and data /survey in 10 pages.
3. Max marks for Fieldwork/Project work Report: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations made, findings and acknowledgements*



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5. (IE): Unit tests,

**b. Suggested Co-Curricular Activities**

1. Observation of fish/shrimp processing plants – visit web sites of processing companies and record the details of that Unit
2. Interaction with local fishermen to know the method of preservation and details with the available traditional technology
3. Collection of web resources on the Quality assurance, quality control measures in Aqua Industries- cross checking the standards during the visit to any processing units.
4. Assignments, Seminar, Group discussion. Quiz, Collection of Material, invited lectures, Video preparation etc.,

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Single Major B.Sc. Zoology (w.e.f:2023-24A.B)  
SEMESTER-V

**COURSE 15 B: LIVE STOCK MANAGEMENT -II  
(DAIRY PRODUCTION AND MANAGEMENT)**

Theory

Credits: 3

3 hrs/week

**LEARNING OUTCOMES:**

Students at the successful completion of the course will be able to

- Identify and suggest the suitable housing system for the dairy farming
- Understand management practices for the dairy farming
- Learn the process of milk pasteurization
- Prepare cream from milk

**SYLLABUS:**

**Unit-1:** of Housing of Dairy cattle- Loose Housing and Conventional Dairy Barns. Drawing of layouts for dairy cattle dwellings; Criteria for selecting site for establishing Dairy farm buildings; Water requirement of dairy animals. Systems

**Unit-2:**

Management of different classes of Dairy animals- Milk producing animals, pregnant animals dry animals, heifers and calves. Management practices for Dairy farm; Identification, Dehorning, Castration, Deworming, Vaccination, Disinfection, and Milking.

**Unit-3:**

(a) Pasteurization of milk: Definition, objects of pasteurization, objections to pasteurization, Principles of heat exchange. Methods of pasteurization: LTLT, HTST and Uperization.  
(b) Sterilization of milk. Homogenization: Factors influencing homogenization

**Unit- 4:**

Market milk: Toned milk, double toned milk, Reconstituted milk, Standardized milk and fullcream milk—Standards and methods of manufacture.

**Unit- 5:**

Cream: Types of cream, composition, methods of cream separation, gravity and centrifugal methods, types of cream separators, factors affecting fat losses in skim milk and fat percentage in cream.

**REFERENCES:**

1. Textbook of Animal Husbandry-G C Benarjee
2. Handbook of Animal Husbandry –ICAR Edition
3. Principles and practices of Dairy Farm–Jagdish Prasad

**web resources:**

4. <http://ecoursesonline.iasri.res.in/course/index.php?categoryid=42>
5. <https://vetsebooks.blogspot.com/p/e-books.html>
6. <https://www.basu.org.in/study-materials/veterinary-science/>
7. <https://vikaspedia.in/agriculture/livestock/cattle-buffalo/breeds-of-cattle-buffalo>

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**SEMESTER-V**  
**COURSE 15 B: LIVE STOCK MANAGEMENT -II**  
**(DAIRY PRODUCTION AND MANAGEMENT)**

Practical

Credits: 1

2 hrs/week

**LEARNING OUTCOMES:**

On successful completion of this practical course, student shall be able to:

- Design a model dairy farm layout
- Understand procedure of milk pasteurization at milk processing centers
- Identify various important management practices in dairy farming

**SYLLABUS:**

1. Dairy Farm layout (In the laboratory student has to sketch a dairy farm with all its components )
2. Identification of cows (students have to identify the breeds of cows from the images/charts –have to identify any two breeds in the vicinity of the college/ their locality).
3. Dehorning of calves : (Method - protocol- precautions)
4. Castration of bulls (Method – Apparatus- Time-importance)
5. Deworming of dairy cattle: (Schedule – method- benefits )
6. Pasteurization of milk (Batch Method- procedure- Observation)
7. Sterilization of milk (In bottle sterilization- procedure – protocol)
8. Cream separation (By gravity method- procedure- hands on experiment)

**REFERENCES:**

1. Handbook of Animal Husbandry –ICAR Edition
2. Dairy farm layout : <https://www.youtube.com/watch?v=dmukHUEUvKc>
3. Dehorning procedure : <http://www.omafra.gov.on.ca/english/livestock/dairy/facts/09-003.htm>
4. Castration of bulls: <https://vikaspedia.in/agriculture/livestock/general-management-practices-of-livestock/castration-of-ruminants>
5. Deworming: [https://kvk.icar.gov.in/API/Content/PPupload/k0347\\_10.pdf](https://kvk.icar.gov.in/API/Content/PPupload/k0347_10.pdf)
6. Pasteurization of milk : <http://www.jnkvv.org/PDF/08042020170652part%203.pdf>
7. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1690>
8. Cream separation: <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=147910>

**Co-Curricular Activities**

**a) Mandatory:**

1. For Teacher: Training of students by the teacher in laboratory and field on skills of dairy management – housing-management of dairy animals of various stages- procedure of preparation of marketable milk with procedures like sterilization, pasteurization and other techniques.
2. For Student: Student shall (individually) visit a nearby dairy farm- house hold cattle rearing – make observations on aspects like housing – management – feed- milk- revenue- breed selection- qualities of breed –etc. A handwritten Fieldwork/Project work Report to be submitted in the given format.
3. Max marks for Fieldwork/Project work Report: 05.
4. Suggested Format for Fieldwork/Project work Report: *Title page, student details, index page, details of place visited, observations made, findings and acknowledgements.*
5. (IE)Unit tests.

**b) Suggested Co-Curricular Activities**

1. Sketch model dairy house with details
2. Web resources on Protocols in the management of stages of cattle
3. Properties of varieties of milk from the market observation
4. Assignment, Seminar, invited lecture, Group discussion. Quiz, Collection of Material, Video preparation etc.

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