


**B.Sc. Honours in Zoology**  
**(Major)**  
**Syllabus**

# SEMESTER-I

Introduction to Classical biology  
Introduction to Applied biology

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-I			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 1: INTRODUCTION TO CLASSICAL BIOLOGY</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Zoology	3	1	-	3

### Course Objectives:

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

### Course Outcomes:

On Completion of the course, the students will be able to-

CO1	1. Learn the principles of classification and preservation of biodiversity
CO2	2. Understand the plant anatomical, physiological and reproductive processes.
CO3	3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
CO4	4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
CO5	5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

### Course with focus on employability / entrepreneurship / Skill Development modules

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### Syllabus

**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

#### **Activities :**

- Visit to Zoology Lab and observe different types of preservation of specimens
- List out different hormonal, genetic and physiological disorders from the society

### **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

#### **Activities:**

- Draw the Ultrastructure of Prokaryotic and Eukaryotic Cell.
- Hands-on experience of various equipment – Microscopes
- Visit to Zoo / Sericulture / Apiculture / Aquaculture unit

### **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 bond

5.4. Green chemistry

### **1. Reference books:**

2. Sharma O.P., 1993. Plant taxonomy. 2<sup>nd</sup> Edition. McGraw Hill publishers.

3. Pandey B.P., 2001. The textbook of botany Angiosperms. 4<sup>th</sup> edition. S. Chand publishers, New Delhi, India.

4. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.

5. Rastogi, S.C., 2019. Essentials of animal physiology. 4<sup>th</sup> Edition. New Age International

Publishers.

6. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.
7. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4<sup>th</sup> Edition. Elsevier publishers.
8. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
9. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5<sup>th</sup> Edition. Pearson publishers.
10. Subrata Sen Gupta, 2014. Organic chemistry. 1<sup>st</sup> Edition. Oxford publishers.


#### Web Links:

1. <https://www.ignfa.gov.in/document/biodiversity-cell-ntfp-related-issues4.pdf>.
2. <https://www.fao.org/3/cb5353en/cb5353en.pdf>
3. [https://bio.libretexts.org/Bookshelves/Introductory\\_and\\_General\\_Biology/Introductory\\_Biology\\_\(CK-12\)/04%3A\\_Molecular\\_Biology/4.01%3A\\_Central\\_Dogma\\_of\\_Molecular\\_Biology](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Introductory_Biology_(CK-12)/04%3A_Molecular_Biology/4.01%3A_Central_Dogma_of_Molecular_Biology)

#### CO-PO Mapping:

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-I			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 2: INTRODUCTION TO APPLIED BIOLOGY</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Zoology	3	1	-	3

### Course Objectives:

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

On Completion of the course, the students will be able to-	
CO1	Learn the history, ultrastructure, diversity and importance of microorganisms.
CO2	Understand the structure and functions of macromolecules.
CO3	Knowledge on biotechnology principles and its applications in food and medicine.
CO4	Outline the techniques, tools and their uses in diagnosis and therapy.
CO5	Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

## Syllabus

### 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.

### **Activities: Biomolecules charts preparation**

#### **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, Biofertilizers and Biopesticides.

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.

#### **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

#### **Activities :**

#### **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**

#### **Reference books:**

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.

#### Web Links:

1. <https://microbiologynote.com/dna-fingerprinting-definition-steps-methods-applications/>
2. <https://egyankosh.ac.in/bitstream/123456789/41406/1/Unit-4.pdf>

#### CO-PO Mapping:


( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

# **SEMESTER-II**

Course 3: Animal diversity-I Biology of Non-chordates

Course 4: Cell & Molecular Biology

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-II			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 3: ANIMAL DIVERSITY-I BIOLOGY OF</b> <b>NON-CHORDATES</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Zoology	3	1	-	3

### Course 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.

On Completion of the course, the students will be able to-

CO1	● Describe concept of animal kingdom classification and general characters of Protozoa
CO2	● Classify Porifera and Coelenterata with taxonomic keys
CO3	● Classify Phylum Platy & Nematelminthes using examples, parasitic adaptation
CO4	● Describe Phylum Annelida & Arthropoda using examples and economic importance of vermicomposting & economic importance of insects.
CO5	● Describe Mollusca, Echinodermata & Hemi chordata with suitable examples in relation to the phylogeny

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### 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*

**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 phylogenetic 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”


### Web Links:

1. [Elphidium: Structure and Life History \(With Diagram\) \(notesonzooology.com\).pdf](https://www.notesonzooology.com/pdf/Elphidium-Structure-and-Life-History-With-Diagram.pdf)
2. [WATER VASCULAR SYSTEM IN STARFISH \(bioscience.com.pk\)](https://www.bioscience.com.pk/WATER-VASCULAR-SYSTEM-IN-STARFISH)

### CO-PO Mapping:

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	3	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-II			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 3: ANIMAL DIVERSITY-I BIOLOGY OF NON-CHORDATES</b>				
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### 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*, *Verella*, *Corallium*, *Gorgonia*, *Pennatula*
- Platyhelminthes: *Planaria*, *Fasciola hepatica*, *Fasciola larval forms – Miracidium*, *Redia*, *Cercaria*, *Echinococcus granulosus*, *Taenia solium*, *Schistosoma haematobium*
- Nematelminths: *Ascaris (Male & Female)*, *Drancunculus*, *Ancylostoma*, *Wuchereria*
- Annelida: *Nereis*, *Aphrodite*, *Chaetopteurs*, *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*, *Pteredo*, *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 books:


- Practical Zoology- Invertebrates S.S. Lal
- Practical Zoology - Invertebrates P.S. Verma
- Practical Zoology - Invertebrates K.P. Kurl
- Ruppert and Barnes (2006) Invertebrate Zoology, 8<sup>th</sup> Edition, Holt Saunders International Edition

### ➤ Virtual Lab Links:

#### 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>

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-II			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 4: CELL &amp; MOLECULAR BIOLOGY</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Zoology	3	1	-	3

### Course 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.

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 –

CO1	<ul style="list-style-type: none"> <li>• Understand the basic unit of the living organisms and to differentiate the organisms by their cell structure.</li> </ul>
CO2	<ul style="list-style-type: none"> <li>• Describe fine structure and function of plasma membrane and different cell organelles of eukaryotic cell.</li> </ul>
CO3	<ul style="list-style-type: none"> <li>• Explain the cell cycle and bioenergetics of the cell</li> </ul>
CO4	<ul style="list-style-type: none"> <li>• Understand the central dogma of molecular biology and flow of genetic information from DNA to proteins</li> </ul>

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### 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*

## **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
- Powerpoint presentation of any of the above topics by students

### ● Reference books:

- 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“

### Web Links:


1. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3197541/>
2. [https://bio.libretexts.org/Bookshelves/Introductory\\_and\\_General\\_Biology/Book%3A\\_General\\_Biology\\_\(Boundless\)/16%3A\\_Gene\\_Expression/16.02%3A\\_Regulation\\_of\\_Gene\\_Expression\\_-\\_Prokaryotic\\_versus\\_Eukaryotic\\_Gene\\_Expression](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3A_General_Biology_(Boundless)/16%3A_Gene_Expression/16.02%3A_Regulation_of_Gene_Expression_-_Prokaryotic_versus_Eukaryotic_Gene_Expression)

### CO-PO Mapping:

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-II			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 4: CELL &amp; MOLECULAR BIOLOGY</b>				
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### ● 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>

\*\*\*\*\*


# **SEMESTER-III**

COURSE 5: ANIMAL DIVERISTY-II BIOLOGY OF CHORDATES

COURSE 6: PRINCIPLES OF GENETICS.

COURSE7 : ANIMAL BIOTECHNOLOGY

COURSE 8: EVOLUTION AND ZOOGEOGRAPHY

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-III			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 5: ANIMAL DIVERSITY-II BIOLOGY OF CHORDATES</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Zoology	3	1	-	3

### ● Course 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 able to –

CO1	● Describe general taxonomic rules on animal classification of chordates
CO2	● Classify Protochordata to Mammalia with taxonomic keys
CO3	● Understand Mammals with specific structural adaptations
CO4	● Understand the significance of dentition and evolutionary significance

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### 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*

## **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

- 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.

### Web Links:


[Migration In Fishes - Definition, Types, Significance, Examples \(microbiologynote.com\)](https://www.microbiologynote.com/migration-in-fishes-definition-types-significance-examples/)  
[Morphological Adaptations to Migration in Birds | SpringerLink](https://www.springerlink.com/lookup/10.1007/978-93-325-2000-0_10)

### CO-PO Mapping:

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-III			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 5: ANIMAL DIVERSITY-II BIOLOGY OF CHORDATES</b>				
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### ● Course 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>

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b>			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 6: PRINCIPLES OF GENETICS</b>	B.Sc. Honours in Zoology (Major) Semester-III			
Teaching	Hours Allocated: 60 (THEORY)	L	T	P	C
Pre-requisites:	Basics of Genetics	3	1	-	3

### ● Course 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 able to –

CO1	● To understand the history of genetics, gain knowledge basic terminology of genetics
CO2	● To acquire knowledge on interaction of genes, various types of inheritance patterns existing in animals with reference to non-Mendelian inheritance.
CO3	● To acquire knowledge on chromosomal inheritance
CO4	● Acquiring in-depth knowledge on various of aspects of genetics involved in sex determination,

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### SYLLABUS:

#### UNIT-I:

- 1.1 History of Genetics- Concepts of Phenotype, Genotype, Heredity, Variation, Pure lines and Inbreed 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*

**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.
- 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, 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

**Web Links:**


1. [Polygene Definition and Examples - Biology Online Dictionary](#)
2. [17.5: Genomics and Proteomics - Biology LibreTexts](#)
3. [18.6 Blood Typing - Anatomy and Physiology 2e | OpenStax](#)

**CO-PO Mapping:**

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b>			
Course Code	<b>TITLE OF THE COURSE COURSE 6: PRINCIPLES OF GENETICS</b>	B.Sc. Honours in Zoology (Major) Semester-III			
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

**SEMESTER-III**

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.rlbcu.ac.in/pdf/Agriculture/AGP%20113%20%20Fundamentals%20of%20Genetics.pdf>
- [https://coabnau.in/uploads/1610707528\\_GPB3.2PracticalManual-Final.pdf](https://coabnau.in/uploads/1610707528_GPB3.2PracticalManual-Final.pdf)

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-II			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE7 : ANIMAL BIOTECHNOLOGY</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Animal biotechnology	3	1	-	3

### ● 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 –

CO1	● Get knowledge of the Vectors and Restriction enzymes used in biotechnology
CO2	● Describe the gene delivery mechanism and PCR technique
CO3	● Acquire basic knowledge on media preparation and cell culture techniques
CO4	● 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.

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### 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.

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*

### ● Reference 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)

### Web Links:


1. [1.4: DNA Modifying Enzymes - Biology LibreTexts https://core.ac.uk/download/pdf/11017224.pdf](https://core.ac.uk/download/pdf/11017224.pdf)
2. [Bioinformatics- Introduction and Applications \(microbenotes.com\)](http://microbenotes.com)

### CO-PO Mapping:

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-III			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 7: ANIMAL BIOTECHNOLOGY</b>				
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### ● Learning Objectives:

This course will provide students with a practical knowledge in animal biotechnology, by the completion of the course the graduate shall 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)

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b>			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 8: EVOLUTION AND ZOOGEOGRAPHY</b>	B.Sc. Honours in Zoology (Major) Semester-III			
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of evolution and zoogeography	3	1	-	3

### ● 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 zoogeography, by the completion of the course the graduate shall able to –

CO1	● 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
CO2	● Explain the different evidences of evolution
CO3	● Understand the theories of evolution
CO4	● Explain the various tools for evolution
	● Map the distribution of animals according to zoological realms

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### 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

***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.

**Reference books:**

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

**Web Links:**


1. [1.4: Prebiotic Earth and the origin of life - Chemistry LibreTexts](#)
2. [4.3.1: The Hardy-Weinberg Equilibrium - Biology LibreTexts](#)

**CO-PO Mapping:**

( 1: Slight [Low]; 2: Moderate [Medium]; 3: Substantial [High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-III			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 8: EVOLUTION AND ZOOGEOGRAPHY</b>				
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### ● 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/>

# **SEMESTER-IV**

COURSE 9: EMBRYOLOGY

COURSE 10: ANIMAL PHYSIOLOGY: LIFE  
SUSTAINING SYSTEMS

COURSE 11: IMMUNOLOGY

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-IV			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 9: EMBRYOLOGY</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Embryology	3	1	-	3

### ● 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 –

CO1	● Understand the historical perspective and concepts of embryology
CO2	● Acquire knowledge on gametogenesis, fertilization and cleavage patterns
CO3	● Understand the fate of germinal layers and extraembryonic membranes
CO4	● Explain the process of regeneration in certain animals
	● Examine the process of organogenesis

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### SYLLA

#### BUS: UNIT-

#### I:

- 11.1 Historical perspective and basic concepts: Phases of development
- 11.2 Cell-Cell interaction, Pattern formation, Differentiation and growth
- 11.3 Differential gene expression,
- 11.4 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*

## **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

#### ● Reference books:

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

#### Web Links:


1. [43.6A: Organogenesis - Biology LibreTexts https://core.ac.uk/download/pdf/11017224.pdf](https://core.ac.uk/download/pdf/11017224.pdf)
2. [Teratogens | The Embryo Project Encyclopedia \(asu.edu\)](#)

#### CO-PO Mapping:

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b>			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 9: EMBRYOLOGY</b>	B.Sc. Honours in Zoology (Major) Semester-IV			
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### ● 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/department\\_materials/doc\\_501.pdf](http://www.macollege.in/app/webroot/uploads/department_materials/doc_501.pdf)
- <http://www.zoologyresources.com/uploadfiles/books/dc64b77d8769325515d17c945e461b45.pdf>

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-IV			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 10: ANIMAL PHYSIOLOGY:</b> <b>LIFE SUSTAINING SYSTEMS</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Animal physiology	3	1	-	3

### ● 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 –

CO1	● Understand the physiology of digestion and hormonal control of digestion
CO2	● Develop a comprehensive picture of respiratory physiology
CO3	● Acquire knowledge on the Renal physiology
CO4	● Understand the physiology of Nerve and muscle
	● Understand the physiology of heart

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

### 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***

***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 transmission/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

**Reference books:**

- Eckert H. *Animal Physiology: Mechanisms and Adaptation*. W.H. Freeman & Company.
- Flory 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.

**Web Links:**

1. [Overview of the Digestive System - Anatomy and Physiology 2e | OpenStax](https://core.ac.uk/download/pdf/11017224.pdf)  
<https://core.ac.uk/download/pdf/11017224.pdf>
2. [Mammalian Heart and Blood Vessels - Structures of the Heart - Biology LibreTexts](#)


**CO-PO Mapping:**

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*



	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b>			
Course Code	<b>TITLE OF THE COURSE COURSE 10: ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS</b>	B.Sc. Honours in Zoology (Major) Semester-IV			
Teaching	Hours Allocated: 30 (Lab)	L	T	P	C
Pre-requisites:		0	0	3	2

### ● 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)

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-IV			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 11:</b> <b>IMMUNOLOGY</b>				
Teaching	Hours Allocated: 60 ( <b>THEORY</b> )	L	T	P	C
Pre-requisites:	Basics of Immunology	3	1	-	3

**● 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 –

CO1	● Articulate the roles of innate recognition receptors in immune responses
CO2	● Compare and contrast humoral versus cell-mediated immune responses
CO3	● Distinguish various cell types involved in immune responses and associated functions;
CO4	● 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

Skill Development		Employability		Entrepreneurship	
-------------------	--	---------------	--	------------------	--

**SYLLABUS:**

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

- 10.1 Introduction to basic concepts in Immunology
- 10.2 Innate and adaptive immunity
- 10.3 Cells of immune system
- 10.4 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*

## **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

**● Reference 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.
- 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

**Web Links:**


1. [Cells of Immune System- Types and Examples \(microbenotes.com\)](http://microbenotes.com)
2. [Major Histocompatibility Complex I- Structure, Mechanism, Functions \(microbenotes.com\)](http://microbenotes.com)
3. [19.3: Organ Transplantation and Rejection - Biology LibreTexts](http://LibreTexts.org)

**CO-PO Mapping:**

( 1: Slight [Low]; 2: Moderate[Medium]; 3: Substantial[High], '-' : No Correlation)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	3	2	3	2	1	2	2
CO2	2	1	3	2	1	1	2	3	1	1	2	2	2
CO3	1	1	2	3	3	1	1	1	2	3	1	2	1
CO4	2	2	3	2	2	2	1	2	1	2	2	1	2
CO5	1	2	1	1	1	2	2	1	1	1	1	1	2

\*\*\*\*\*

	<b>Government College (Autonomous) Rajahmundry</b>	<b>Program &amp; Semester</b> B.Sc. Honours in Zoology (Major) Semester-IV			
Course Code	<b>TITLE OF THE COURSE</b> <b>COURSE 11: IMMUNOLOGY</b>				
Teaching	Hours Allocated: 30 ( <b>Lab</b> )	L	T	P	C
Pre-requisites:		0	0	3	2

### ● 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://ivl1-au.vlabs.ac.in/List%20of%20experiments.html>
- <https://ivl2-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://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)

\*\*\*\*\*