

# **MSc Zoology**

(Choice Based Credit System)

For the students admitted in the academic year  
2020 - 2021



**PG AND RESEARCH DEPARTMENT OF ZOOLOGY**  
**Bishop Heber College (Autonomous)**  
**(Nationally Reaccredited at the A+ level by NAAC)**  
**(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC &**  
**Identified as College of Excellence by the UGC)**  
**TIRUCHIRAPPALLI – 620017**  
**TAMIL NADU, INDIA**  
**2019 - 2020**

## **Vision**

**Envisage quality higher education and research in the field of animal sciences with global perspectives by promoting discovery and learning contemporary fields in Zoology inculcating social values for the holistic development and to conserve nature thus contributing for nation building.**

## **Mission**

- **Bestow quality education emphasizing the cognitive learning and concern towards the animal kingdom.**
- **Promulgate biodiversity conservation, field training skills, and entrepreneurship in the applied zoological sciences**
- **Enhance highest level of academic accomplishment with interdisciplinary approach through research, industrial collaboration and amalgamate with reputed national and international universities**
- **Foster globally competent individuals with interpersonal skills and environmental consciousness for the betterment of the world.**

## **Programme Outcomes**

On successful completion of the programme the Post graduate of Zoology will be able to

### **Knowledge**

**PO1** - Comprehend and apply accurately and creatively the principles and applications from the core areas in Zoology and its allied field.

**PO2** - Develop a holistic approach on the phylogeny with the rich diversity of organisms and their adaptations in ecology and evolutionary significance

**PO3**-Exhibit academic excellence in research and intellect in the areas of advanced Biological Research and Biodiversity Conservation

### **Skills**

**PO4** - Formulate an appropriate solution for complex research problem and publishing the new findings in innovative research

**PO5** –Demonstrate diversified professional proficiency gained through various laboratory technical training, field census, internships, industrial and research projects.

**PO6** –Exhibit transferable and entrepreneurial skills in collaboration with research institutes and undertake interdisciplinary research.

### **Attitudes**

**PO7** - Build trust and blend complementary strengths through communicative competence, encourage healthy risk-taking, and promote wider sense of ownership.

### **Ethical & Social Values**

**PO8**-Exhibit ethical and social values commit to professional ethics, liability and widen the empathy and love towards the animals

**PO9** - Develop methods towards protection of endangered species, pollution control, waste management and pave way for a sustainable environment.

## **Programme Specific Outcomes**

### **Knowledge and Skills**

**PSO1**-Illustrate the comprehensive knowledge of origin, salient features and functional aspects in system grade of organizations from lower invertebrates to higher chordates

**PSO2** -Comprehend the functions of organisms at the level of gene, genome, cell, tissue, organ and development, reproduction and behaviour of different lifeforms and their interrelationships with the environment.

**PSO3**-Analyze the biochemical, microbiological, Immunological processes and Bioinformatics databases to track evolution and predictions of biomolecules and to test the hypothesis by using statistical tools

**PSO4**- Identify appropriate resources like animal handling techniques and model organisms required to carry out the projects and apply the technical skills to contribute new scientific discoveries and inventions.

## Structure of the Curriculum

<b>Parts of the Curriculum</b>	<b>No. of Courses</b>	<b>Credits</b>
Core Course (Theory)	10	50
Core Course (Practical)	5	15
Elective	5	18
Project	1	5
VLOC	1	2
<b>-Total</b>	<b>22</b>	<b>90</b>

**M.Sc., Zoology – Programme Description**  
(For the candidates admitted from the academic year 2020 - 2021)

Sem.	Course	Course Code	Course Title	Pre requisites	Hours Per Week	Credits	Marks		
							CI A	ESA	Total
I	Core I	P19ZY101	Functional Morphology of Invertebrates and Chordates		5	5	25	75	100
	Core II	P19ZY102	Cell Biology		5	5	25	75	100
	Core III	P19ZY103	Molecular Biology and Bioinformatics	P19ZY102	5	5	25	75	100
	Core Prac. I	P20ZY1P1	Lab in cell biology and Molecular biology		5	3	40	60	100
	Core Prac. II	P19ZY1P2	Lab in microbiology/ Parasitology		5	3	40	60	100
	Elective I	P20ZY1:1 / P19ZY1:A	Microbiology/Parasitology	P19ZY101	5	4	25	75	100
II	Core IV	P20ZY204	Animal Physiology	P19ZY101	5	5	25	75	100
	Core V	P19ZY205	Biochemistry	P19ZY102	5	5	25	75	100
	Core Prac. III	P19ZY2P3	Lab in Animal Physiology and Immunology / Endocrinology		5	3	40	60	100
	Core Prac. IV	P19ZY2P4	Lab in biochemistry		5	3	40	60	100
	Elective II	P19ZY2:2/ P19ZY2:A	Immunology/ Endocrinology		4	4	25	75	100
	Elective	P19ZY2:3	Biostatistics		4	4	25/	75/ 60	100

	III						40		
	VLOC	P17VL2:1 / P17VL2:2	RI / MI		2	2	25	75	100
<b>III</b>	Core VI	P19ZY306	Environmental Biology		5	5	25	75	100
	Core VII	P19ZY307	Developmental Biology	P19ZY101	5	5	25	75	100
	Core VIII	P19ZY308	Genetics		5	5	25	75	100
	Core IX	P19ZY309	Research Methodology and Biotechniques		5	5	25	75	100
	Core Prac. V	P19ZY3P5	Lab in Environmental Biology, Developmental Biology and Genetics		5	3	40	60	100
	Elective IV	P19ZY3:4/ P19ZY3:A	Animal Biotechnology/ Genomics and Proteomics	P19ZY1:1	5	4	25	75	100
<b>IV</b>	Core X	P19ZY410	Evolution and Animal Behaviour		5	4	25	75	100
	Elective V	P19ZY4:1/ P19ZY4:A	Applied Entomology/ Bioinformatics	P19ZY 101	5	4	25	75	100
	Project	P19ZY4PJ	Project		--	5	--	--	100
<b>Total</b>						<b>90</b>			<b>2200</b>

CI A- Continuous Internal Assessment

ESA- End Semester Assessment

VLOC- Value added Life Oriented Course

**CORE I: FUNCTIONAL MORPHOLOGY OF INVERTEBRATES AND CHORDATES**

**Semester: I**  
**CREDITS: 5**

**Code: P19ZY101**  
**Total Hrs: 75 (Total Hrs per week: 5)**

**1. COURSE OUTCOMES:**

On completion of the course, the students will be able to:

CO No.	COURSE OUTCOME	LEVEL	UNIT
CO1	Identify the basics of systematics and compare the hierarchy of various animals	K3	I
CO2	Analyze the diversity in structure, function and habits of invertebrates	K4	I
CO3	Explain the diagnostic characters of different phyla through detailed studies of the various systems and organizations with examples	K5	II
CO4	Identify the evolutionary significance of the lower order invertebrates by comparing their larval forms	K3	III
CO5	Classify the morphological and functional characters of Chordates	K4	IV
CO6	Explain the structure and functions of integumentary system and compare the anatomy of nervous and urino-genital system	K5	V

**2. A. Syllabus:**

**UNIT I - CLASSIFICATION OF ANIMAL KINGDOM**

**15Hrs**

**Broad classification of Animal kingdom** - International code of Zoological nomenclature – Symmetry and its significance in animal organization - **Organization of coelom:** Acoelomates - Pseudocoelomates – Coelomate groups (schizocoel, enterocoel, and mesenchyme). **Locomotion:** Amoeboid, flagellar and ciliary movement in Protozoa– **Hydrostatic movement in Coelenterata and Echinodermata.**

**UNIT II - DIGESTION, RESPIRATION AND EXCRETION IN THE INVERTEBRATES**

**15Hrs**



**Nutrition and Digestion:** Patterns of feeding and digestion in lower metazoan, Mollusca and Echinodermata- Filter feeding in Polychaeta. **Organs of respiration:** Gills, book lungs, and trachea – Mechanism of respiration. **Organs of excretion:** Coelomoducts, Nephridia and Malpighian tubules – Mechanism of excretion.

### UNIT III-NERVOUS SYSTEM AND LARVAL FORMS OF INVERTEBRATES

15Hrs

**Nervous system:** Primitive nervous system in Coelenterata and Echinodermata- Advanced nervous system in Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda) –**Larval forms** of Trematoda, Cestoda, Crustacea, Mollusca, Echinodermata and their evolutionary significance.

### UNIT IV- FUNCTIONAL MORPHOLOGY OF CHORDATES

- 15Hrs

**Classification of chordates** – Origin and evolution of elasmobranchs – **Adaptive radiation of elasmobranchs and bony fishes** – **Migration in fishes** – **Origin and evolution of Amphibia** – Adaptive radiation in Amphibia – Terrestrialization

### UNIT V - STRUCTURE AND FUNCTIONS OF VARIOUS ORGANS IN MAMMALS

- 15Hrs

**Connecting links between reptiles and birds** – **Mammals:** Structural peculiarities of prototheria, metatheria and eutheria. – Structure and functions of integument and its derivatives - Origin and evolution of paired fins and limbs. **Evolution of urinogenital system in vertebrates**– Comparative anatomy of brain in vertebrates.

#### B. Topics for Self-Study:

Sl.No.	TOPICS	WEB LINKS
1.	Conjugation in Paramecium	<a href="https://www.allamaiqbalcollege.edu.in/uploads/download_2004051131.pdf">https://www.allamaiqbalcollege.edu.in/uploads/download_2004051131.pdf</a>
2.	Canal system in sponges	<a href="https://www.studyandscore.com/studymaterial-detail/phylum-porifera-canal-system-in-sponges-types-of-canal-systems-in-sponges-functions-of-water-current">https://www.studyandscore.com/studymaterial-detail/phylum-porifera-canal-system-in-sponges-types-of-canal-systems-in-sponges-functions-of-water-current</a>
3	Water vascular system in Echinodermata	<a href="https://www.biologydiscussion.com/invertebrate-zoology/phylum-echinodermata/water-vascular-system-of-echinoderms/33754">https://www.biologydiscussion.com/invertebrate-zoology/phylum-echinodermata/water-vascular-system-of-echinoderms/33754</a>
4.	Parental care in Amphibians	<a href="https://www.amu.ac.in/emp/studym/100007686.pdf">https://www.amu.ac.in/emp/studym/100007686.pdf</a>
5.	Migration in fishes	<a href="https://www.onlinebiologynotes.com/migration-in-fishes/">https://www.onlinebiologynotes.com/migration-in-fishes/</a>

### **C. Text Books:**

1. Ruppert E.E., Fox, R.S. and Barnes, R.D. Invertebrate Zoology. 7<sup>th</sup> Ed., Cenage Learning, Singapore, 2004.
2. Jordan E.L. and Verma P.S., Invertebrate Zoology, 12<sup>th</sup> edn. Schand & Co. 1995.
3. Kotpal R.L., Agarwal, R.P.R., Khertarpa, Modern text book of Zoology-I –Rastogi Publications. 1989.
4. Jordan E.L, Verma P.S, Chordate Zoology -S.Chand & Company Ltd. 2008
5. Kotpal R.L.A, Modern text book of Zoology Vertebrates, Rastogi publications, 2009.

### **D. References Books:**

1. Linzey, D., Vertebrate Biology, McGraw-Hill, Singapore, 2001.
2. Waterman A.J., Chordate Structure and Function, The Macmillan Publishing Co., 1971.
3. Pough H., Heisher J.B. and McFarland W.N., Vertebrate Life. Macmillan Publishing Co., New York, 1990.
4. Hyman L.H., The Invertebrates, Vol. 1 to 7, McGraw Hill Book Co., Inc., New York, 1940.
5. Barrington E.J.W., Invertebrate Structure and Functions, 2<sup>nd</sup> Ed., Thomas Nelson & Sons Ltd., Middlesex, United Kingdom, 1979.
6. Colbert H. E., Evolution of the Vertebrates, New Delhi, New Age International, 2000.
7. Jollie M, Chordate Morphology, Reinholt Publishing Corporation, New York, 1962.
8. Romer A.S., Hyman's Comparative Vertebrate Anatomy, 3<sup>rd</sup> Ed., The University of Chicago Press, London, 1979.
9. Young J.Z., Life of Vertebrates, Clarendon Press, Oxford, 1950.
10. Sinha, Adhikari, Ganguly, Bharati Goswami, Biology of animals Vol.II., New central book agency (p) ltd., 2004.

### **E. Web link:**

<https://courses.lumenlearning.com/wm-biology2/chapter/invertebrate-chordates/>

<http://www.opentextbooks.org.hk/ditatopic/35145>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit /section	Contents	Specific Learning Outcomes	Highest Bloom's taxonomic Level of transaction
<b>I</b>	<b>CLASSIFICATION OF ANIMAL KINGDOM</b>		
<b>1.1</b>	<p><b>Broad classification of Animal kingdom</b></p> <p>International code of Zoological nomenclature</p>	<ul style="list-style-type: none"> <li>➤ Classify the various phylum on the basis of their characters</li> <li>➤ List out the rules of zoological nomenclature</li> </ul>	<b>K4</b>
<b>1.2</b>	<p><b>Symmetry and its significance</b> in animal organization</p>	<ul style="list-style-type: none"> <li>➤ Explain the different types of symmetry and its importance</li> </ul>	<b>K5</b>
<b>1.3</b>	<p><b>Organization of coelom:</b> Acoelomates – Pseudocoelomates – Coelomate groups (schizocoel, enterocoel, and mesenchyme).</p>	<ul style="list-style-type: none"> <li>➤ Compare and classify the animals based on their coelomic organization</li> </ul>	<b>K5</b>
<b>1.4</b>	<p><b>Locomotion:</b> Amoeboid, flagellar and ciliary movement in Protozoa</p>	<ul style="list-style-type: none"> <li>➤ Illustrate the mechanism of locomotion in lower order invertebrates with examples</li> </ul>	<b>K2</b>
<b>1.5</b>	<p><b>Hydrostatic movement</b> in Coelenterata and Echinodermata.</p>	<ul style="list-style-type: none"> <li>➤ Elaborate the type of locomotion in higher order invertebrates</li> </ul>	<b>K6</b>
<b>II</b>	<b>DIGESTION, RESPIRATION AND EXCRETION IN THE INVERTEBRATES</b>		
<b>2.1</b>	<p><b>Nutrition and Digestion:</b> Patterns of feeding and digestion in lower metazoan, Mollusca and Echinodermata</p>	<ul style="list-style-type: none"> <li>➤ Explain the mechanism and pattern of digestion in various phyla</li> </ul>	<b>K5</b>
<b>2.2</b>	<p><b>Filter feeding</b> in Polychaeta</p>	<ul style="list-style-type: none"> <li>➤ Interpret the mechanism of feeding in Polychaeta</li> </ul>	<b>K5</b>

2.3	<b>Organs of respiration:</b> Gills, book lungs, and trachea	➤ Distinguish the role of respiratory organs in various phylum	<b>K4</b>
2.4	<b>Mechanism of respiration</b>	➤ Elaborate the respiratory mechanism in higher order invertebrates	<b>K6</b>
2.5	<b>Organs of excretion:</b> Coelomoducts, Nephridia and Malphigian tubules	➤ List out the different excretory organs and its significance	<b>K4</b>
2.6	<b>Mechanism of excretion.</b>	➤ Explain the mechanism of excretion	<b>K5</b>
<b>III</b>	<b>NERVOUS SYSTEM AND LARVAL FORMS OF INVERTEBRATES</b>		
3.1	<b>Primitive nervous system</b> in Coelenterata and Echinodermata	➤ Identify the grade of nervous system in Coelenterates and Echinoderms	<b>K3</b>
3.2	<b>Advanced nervous system</b> in Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda)	➤ Justify that Annelids has an advanced type of nervous system	<b>K5</b>
3.3	<b>Larval forms</b> of Trematoda, Cestoda, Crustacea, Mollusca, Echinodermata and their evolutionary significance.	➤ List out the various larval forms and its evolutionary significance	<b>K4</b>
<b>IV</b>	<b>FUNCTIONAL MORPHOLOGY OF CHORDATES</b>		
4.1	<b>Origin and evolution of elasmobranchs</b>  <b>Adaptive radiation</b> of elasmobranchs and bony fishes	➤ Explain the origin and evolution of elasmobranchs and the mechanism of adaptive radiation	<b>K5</b>
4.2	<b>Migration in fishes</b>	➤ Illustrate the process of migration in fishes with examples	<b>K2</b>
4.3	<b>Origin and evolution of</b>	➤ Summarize the origin, evolution and adaptive	<b>K2</b>

	<b>Amphibia</b> <b>Adaptive radiation in Amphibia–</b> Terrestrialization	radiation mechanism in amphibians	
<b>V</b>	<b>STRUCTURE AND FUNCTIONS OF VARIOUS ORGANS IN CHORDATES</b>		
<b>5.1</b>	<b>Connecting links between reptiles and birds</b>	➤ Categorize the animals which serves as the connecting link between the birds and reptiles	<b>K4</b>
<b>5.2</b>	<b>Mammals:</b> Structural peculiarities of prototheria, metatheria and eutheria.	➤ Classify the mammals based on their structural similarities	<b>K4</b>
<b>5.3</b>	<b>Structure and functions of integument</b> and its derivatives	➤ Explain the structure and functions of integumentary system with examples	<b>K5</b>
<b>5.4</b>	<b>Origin and evolution of paired fins and limbs</b>	➤ Examine the evolutionary pattern of fins and limbs	<b>K4</b>
<b>5.5</b>	<b>Evolution of urinogenital system in vertebrates</b>	➤ Interpret the evolutionary significance of urinogenital system in mammals	<b>K5</b>
<b>5.6</b>	<b>Comparative anatomy of brain</b> in vertebrates	➤ Compare the anatomy of brain and its functions in mammals	<b>K4</b>

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P15ZY101	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
<b>CO1</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	-	-	<b>H</b>	<b>M</b>	<b>M</b>	<b>H</b>
<b>CO2</b>	<b>M</b>	-	-	-	-	<b>M</b>	<b>H</b>	<b>H</b>	-	<b>M</b>	<b>M</b>	<b>H</b>	<b>H</b>
<b>CO3</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>M</b>	-	<b>H</b>	<b>M</b>	-	<b>H</b>	<b>H</b>	-	<b>M</b>
<b>CO4</b>	-	<b>M</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>H</b>	-	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	-
<b>CO5</b>	-	<b>M</b>	<b>H</b>	<b>M</b>	-	<b>M</b>	<b>M</b>	-	<b>H</b>	-	-	<b>M</b>	<b>M</b>
<b>CO6</b>	<b>H</b>	<b>M</b>	-	<b>H</b>	<b>H</b>	<b>M</b>	-	<b>M</b>	-	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>

**L-Low M-Moderate H- High**

## **5. COURSE ASSESSMENT METHODS:**

Direct
<ol style="list-style-type: none"><li>1. Continuous Assessment Test I, II</li><li>2. Assignment, Group Presentation, Poster preparation</li><li>3. End Semester Examination</li></ol>
Indirect
<ol style="list-style-type: none"><li>1. Course-end survey</li></ol>

## Core Course: II CELL BIOLOGY

Semester: I  
CREDITS: 5

Code: P19ZY102  
Total Hrs: 75 (Total Hrs per week: 5)

### 1. Course Outcomes:

On completion of the course, the students will be able to:

CO No.	COURSE OUTCOMES	LEVEL	UNIT
CO1	Distinguish prokaryotic and eukaryotic cells through basic structural organizations. Analyzing membrane structures and protein transport.	K4	I
CO2	Examine the functional significance of mitochondria, NPC, Intra cellular traffic and cytoskeleton structure	K4	II
CO3	Analyze cell-cell interaction, receptor based signal transduction, cell cycle and its control systems with check points	K4	III
CO4	Identify the mode of cell growth, death through apoptosis and tissue maintenance.	K4	III
CO5	Explain the significance of stem cells, types and its mechanism of self renewal and potency, stem cell characterization and IPS generation with application	K5	IV
CO6	Evaluate the molecular pathogenesis of cancer, role of oncogene/ tumor viruses, survival and death pathways and recent treatment strategies.	K5	V

### 2. A. Syllabus:

#### Unit – I

15 Hrs

#### PROKARYOTIC & EUKARYOTIC CELLS

Prokaryotic and eukaryotic cells. **Membrane structure:** lipid composition-protein components-principles of Membrane transport-carrier proteins-Ion channels and membrane potential - Cell junctions-Extra cellular matrix. **Intracellular compartments:** Endoplasmic reticulum, Golgi complex and lysosomes- Transport and sorting of proteins-vesicular transport-secretory pathways.

#### Unit – II

15 Hrs

#### STRUCTURE & FUNCTION OF CELLULAR ORGANELLES

Structure and functional significance of Mitochondria. Structure of Nucleus - Nuclear pore complexes – Transport of molecules between the nucleus and cytosol. **Cytoskeleton:** Centriole - Dynamic structure of microfilaments, intermediate filaments and microtubules - molecular motors-cytoskeleton and cell behavior.

**Unit – III****15 Hrs****CELL COMMUNICATION & CELL CYCLE**

**Cell communication:** General principles- G-protein linked receptors–enzyme linked receptors-pathways of intracellular signal transduction.**Cell cycle control and cell death:** overview of cell cycle-control system – apoptosis-extracellular control of cell growth- Tissue maintenance and renewal.

**Unit – IV****15 Hrs****STEM CELLS**

**Stem cells:** Types- Molecular Basis of Pluripotency - Stem Cell Niches - Mechanisms of Stem Cell Self-Renewal - Generation of Induced Pluripotent Stem Cells -Characteristics and Characterization of Pluripotent stem Cells- Application of Embryonic stem Cells.

**Unit – V****15 Hrs****CANCER BIOLOGY**

**Biology of cancer:** Development and causes of cancer-properties of cancer cells- Tumor viruses–Oncogenes - Tumor suppressor genes- Molecular basis of cancer- Cell behavior- Molecular Approaches to Cancer Treatment - Apoptosis

**B. Topics for Self -Study:**

Sl.No.	TOPICS	WEBLINKS
1.	Senescence	<a href="https://www.ncbi.nlm.nih.gov/books/?term=Senescence">https://www.ncbi.nlm.nih.gov/books/?term=Senescence</a>
2.	SiRNA	<a href="https://www.ncbi.nlm.nih.gov/books/?term=SiRNA">https://www.ncbi.nlm.nih.gov/books/?term=SiRNA</a>
3.	Cell adhesion	<a href="https://www.ncbi.nlm.nih.gov/books/?term=Cell+adhesion">https://www.ncbi.nlm.nih.gov/books/?term=Cell+adhesion</a>
4.	Molecular chaperons	<a href="https://www.ncbi.nlm.nih.gov/books/?term=Molecular+chaperons">https://www.ncbi.nlm.nih.gov/books/?term=Molecular+chaperons</a>
5.	Protein folding	<a href="https://www.ncbi.nlm.nih.gov/books/?term=Protein+folding">https://www.ncbi.nlm.nih.gov/books/?term=Protein+folding</a>

**C. Text Books:**

1. Alberts, B., Johnson, A. and Lewis, J. Molecular Biology of the Cell. 4th Ed., 2002 New York: Garland,.
2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology, 8th Ed., 2001 Lippincott Williams & Wilkins, A Wolter Kluwer Business, Philadelphia,

**D. References Books:**

1. Lodish H., Berr, A. and Paul, M. Molecular Cell Biology, 2003. New York: W.H. Freeman,
2. Cooper G.M. and Hausman, R.E., The Cell - A Molecular Approach. 4th Ed., 2007 Sinauer Associates Inc. USA.



- 3.KarpG. Cell and Molecular Biology,2008 G. John Wiley & Sons,.
- 4.SheelerP. andBianchi, D.E., Cell and Molecular Biology, 3rd Ed., 2009.JohnWiley Indian Edition, New Delhi,
- 5.Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P.,The World of Cell, 6th Ed., 2007Pearson Education

**E. Web Links:**

1. [file:///C:/Users/welcome/Downloads/Molecular\\_Biology\\_of\\_the\\_Cell\\_6th\\_Editio.pdf](file:///C:/Users/welcome/Downloads/Molecular_Biology_of_the_Cell_6th_Editio.pdf)
2. <https://nptel.ac.in/courses/102/103/102103012/>
3. [https://onlinecourses.swayam2.ac.in/cec20\\_ma13/preview](https://onlinecourses.swayam2.ac.in/cec20_ma13/preview)

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Unit/ Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomy Levels of Transaction
<b>I</b>	<b>PROKARYOTIC &amp; EUKARYOTIC CELLS</b>		
1.1	Prokaryotic and eukaryotic cells Organizations	➤ Classify different cell types	K2
1.2	<b>Membrane structure:</b> lipid composition-protein components	➤ Compare membrane structure of different cells	K2
1.3	Principles of Membrane transport-carrier proteins-Ion channels and membrane potential - Cell junctions-Extra cellular matrix.	<ul style="list-style-type: none"> <li>➤ Explain the principle of transport molecules between the membranes,</li> <li>➤ Carrier protein, Ion channels, cell junctions and its functions</li> </ul>	K4
1.4	<b>Intracellular compartments:</b> Endoplasmic reticulum, Golgi complex and lysosomes- Transport and sorting of proteins-vesicular transport-secretory pathways.	➤ Explain the structure, function and biochemical properties of each of the cell organelles. Intra cellular movements of molecules and within EMS	K2

II	<b>STRUCTURE &amp; FUNCTION OF CELLUAR ORGANELLES</b>		
2.1	Structure and functional significance of Mitochondria. Structure of Nucleus - Nuclear pore complexes – Transport of molecules between the nucleus and cytosol.	➤ Explain structural and functional properties of mitochondria, nucleus and transport between cytoplasm and nucleus.	K2
2.2	<b>Cytoskeleton:</b> Centriole - Dynamic structure of microfilaments, intermediate filaments and microtubules - molecular motors- cytoskeleton and cell behavior.	➤ Explain structure and function of CSKs and motor proteins in relation to cell behavior	K4
III	<b>CELL COMMUNICATION &amp; CELL CYCLE</b>		
3.1	<b>Cell communication:</b> General principles- G-protein linked receptors–enzyme linked receptors- pathways of intracellular signal transduction.	➤ Explain receptors and its role in signal transduction pathways and cell communication.	K3
3.2	<b>Cell cycle control and cell death:</b> overview of cell cycle-control system – apoptosis- extracellular control of cell growth- Tissue maintenance and renewal.	➤ Explain cell cycle events, control systems, check points and cell cycle regulation. Understanding the significance of apoptosis in tissue maintenance and renewal.	K4
IV	<b>STEM CELLS</b>		
4.1	<b>Stem cells:</b> Types- Molecular Basis of	➤ Classify the types of stem cells and its niches. Illustrate	K2

	Pluripotency - Stem Cell Niches - Mechanisms of Stem Cell Self-Renewal -	the mechanism of self renewal and potency.	
4.2	Generation of Induced Pluripotent Stem Cells - Characteristics and Characterization of Pluripotent stem Cells- Application of Embryonic stem Cells	➤ Explain the importance of IPS & stem cell therapy	K5
V	<b>CANCER BIOLOGY</b>		
5.1	<b>Biology of cancer:</b> Development and causes of cancer- properties of cancer cells- Tumor viruses- Oncogenes - Tumor suppressor genes- Molecular basis of cancer- Cell behavior-	➤ Analyse the Biology of cancer cells, pathogenesis, properties, genes and factors involved,	K4
5.2	Molecular Approaches to Cancer Treatment - Apoptosis	➤ Develop novel strategies for cancer treatment	K5

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY102	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	H	L	M	H	H	M	H	H	H	M
CO2	H	H	H	M	L	M	H	H	M	H	H	H	L
CO3	H	H	H	H	L	M	H	H	M	H	H	H	L
CO4	H	H	H	L	L	M	H	H	M	H	H	H	L
CO5	H	H	M	M	L	M	H	H	M	H	H	H	M
CO6	H	H	H	H	L	M	H	H	M	H	H	H	M

**L-Low      M-Moderate      H- High**

**5. COURSE ASSESSMENT METHODS:**

Direct
<ol style="list-style-type: none"><li>1. Continuous Assessment Test I, II</li><li>2. Assignment, Group Presentation, Poster preparation</li><li>3. End Semester Examination</li></ol>
Indirect
<ol style="list-style-type: none"><li>1. Course-end survey</li></ol>

## CORE – III: MOLECULAR BIOLOGY AND BIOINFORMATICS

Semester: I  
CREDITS: 5

Code: P19ZY103  
Total Hrs: 75 (Total Hrs per week: 5)

### 1. COURSE OUTCOMES

After completing this course, the students will be able to:

CO. No.	COURSE OUTCOMES	LEVEL	UNIT
CO1.	Explain the structure, synthesis and function of biomolecules.	K5	1
CO2.	Interpret the C-value paradox and its importance.	K5	I
CO3.	Compare the process of DNA replication in both Prokaryotes and in Eukaryotes	K5	II
CO4.	Analyze the process of transcription and gene expression in eukaryotes.	K4	III
CO5.	Distinguish the types of various biological databases and tools used for protein structure visualization.	K5	IV
CO6.	Compare and relate the alignment tools used in evolution and in drug designing.	K5	V

### 2. A. Syllabus:

#### Unit – I

15 Hrs

#### STRUCTURE AND FORMS OF DNA

Structure of DNA, tRNA, micro -RNA. **Forms of DNA:** A, B and Z DNA - Mitochondrial DNA - structure of eukaryotic chromosome- nucleosome model- heterochromatin and euchromatin - Genome size and C value paradox. Unique and Repetitive nucleotide sequences in eukaryotic genome (LINEs, SINEs). Kinetics of renaturation: Cot curve.

#### Unit – II

15 Hrs

#### DNA REPLICATION AND CENTRAL DOGMA IN PROKARYOTIC CELLS

**DNA replication:** semi conservative, rolling circle, Q, D, Eye-models- Mechanism of replication –DNA damage and its repair mechanisms. **Genetic code:** Properties- Wobble hypothesis. **Transcription in Prokaryotes:** enzymes and proteins involved – mechanism –promoters- enhancers . **Protein synthesis in Prokaryotes:** Ribosomes - factors involved in protein synthesis - process of translation-post translational modifications and signal hypothesis - inhibitors.

#### Unit – III

15 Hrs

#### REGULATION OF GENE EXPRESSION IN PROKARYOTES

**Transcription in Eukaryotes:** RNA polymerases - promoters- enhancers and silencers - effects of chromatin structure. Post-transcriptional modifications -**Regulation of gene expression:** concepts of enzyme induction and repression- positive and negative control. Regulation of gene expression in Prokaryotes: lac-operon, trp-operon, ara-operon and gal-operon. Catabolite repression. Regulation of gene expression in eukaryotes.

**Unit – IV****15 Hrs****BIOINFORMATICS DATABASES**

Overview of Bioinformatics – Literature, sequence and structure databases – Pattern and motif searches: PROSITE, BLOCKS, PRINTS, PFAM – Structural classification: SCOP, CATH – Metabolic pathway databases: KEGG and Biocyc - Protein structure visualization tools: RasMol, Swiss PDB Viewer Molecular sequence alignment: Pair wise alignment - Local and Global alignment concepts – FASTA and BLAST - Multiple sequence alignment – CLUSTALW and TCOFFEE.

**Unit – V****15 Hrs****GENOMICS AND PROTEOMICS**

**Gene and Genome analysis:** Genome projects - Genome Mapping, Sequencing, Assembly and Annotation - comparative genomics. **Protein and proteome analysis:** – Protein secondary structure prediction - protein identification tools - Chou- Fasman /GOR method. Transcriptomics: Genome expression analysis using microarray techniques - Applications of Microarray- Modern drug discovery – CADD (Computer Aided Drug Discovery) - impact of structural bioinformatics in drug discovery.

**B. Topics for Self-Study:**

Sl. No.	TOPICS	WEB-LINKS
1.	<b>DNA Replication: Eukaryotic Origins and the Origin Recognition Complex</b>	<a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3779782/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3779782/</a>
2.	<b>Histone Modifications</b>	<a href="https://www.nature.com/articles/cr201122">https://www.nature.com/articles/cr201122</a>
3.	<b>DNA Repair and Cancer</b>	<a href="https://www.ncbi.nlm.nih.gov/books/NBK21554/">https://www.ncbi.nlm.nih.gov/books/NBK21554/</a>
4.	<b>Metabolite profiling and Biomarkers analysis</b>	<a href="https://www.nature.com/articles/s41598-017-01735-y">https://www.nature.com/articles/s41598-017-01735-y</a>
5.	<b>Modeling and simulation in drug development</b>	<a href="https://www.pharmafocusasia.com/foreword/modeling-simulation-drug-development">https://www.pharmafocusasia.com/foreword/modeling-simulation-drug-development</a>

**C. Text Books:**

1. Malacinski G.M., Freifelder's Essential of Molecular Biology, Narosa Publishing House, New Delhi, 2003.
2. Jeyanthi G.P, Molecular Biology, MJP Publishers, Chennai. 2009.
3. Ignacimuthu S, Basic Bioinformatics, Narosa Publishing House, Chennai, 2008

**D. References Books:**

1. Alberts, B., Johnson A and Lewis J, Molecular Biology of the Cell, 4<sup>th</sup> Ed., New York: Garland, 2002.
2. Weaver R, Molecular Biology, 5<sup>th</sup> Ed., McGraw-Hill, NY, 2012.
3. Lodish H, Berr A and Paul M, Molecular Cell Biology, New York, W.H. Freeman, 2003.
4. Epstein R.J, Human Molecular biology, An Introduction to the molecular basis of health

and  
disease, Cambridge University Press, 2003.

5. Colladovides J., Magasanik B and Smith, T.F. Integrative approaches to Molecular Biology. Ane Books, New Delhi. 2004.
  6. Lewin B, Genes IX, Jones and Bartlett Publishers, Boston, 2008.
  7. Bates A. D. and Maxwell A, DNA Topology, Oxford University Press Inc., New York, Indian Edition, 2005.
  8. David H.R., Genetics and Molecular Biology, Tata McGraw, New Delhi, 2009.
  9. Lewin B., Krebs J. E., Kilpatrick S.T. and Goldstein, E.S. Lewin's GENES X. John and Barlett Publishers, Sudbury Massachusetts, 2011.
  10. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losick R, Molecular Biology of the Gene, 5th Ed., Pearson Education Inc, 2004.
  11. Teresa K. Attwood, David Parry-Smith., Introduction to Bioinformatics. Pearson Education. 2001
- Highest level of Blooms Taxonomy

### E. Web Links:

1. [https://bio.libretexts.org/Bookshelves/Introductory\\_and\\_General\\_Biology/Book%3AGeneral\\_Biology\\_\(OpenStax\)/3%3AGenetics/15%3AGenes\\_and\\_Proteins/15.3%3AEukaryotic\\_Transcription](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Book%3AGeneral_Biology_(OpenStax)/3%3AGenetics/15%3AGenes_and_Proteins/15.3%3AEukaryotic_Transcription)
2. <https://www.sciencedirect.com/science/article/pii/S2352873717300653>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC186575/>

### 3. SPECIFIC LEARNING OUTCOME (SLO):

Unit /section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomy Level of Transaction
<b>1</b>	<b>STRUCTURE AND FORMS OF DNA</b>		
1.1	Structure of DNA	➤ Explain the Watson & Crick model of DNA	K2
		➤ Analyse the backbone of DNA	K4
		➤ Explain the X-ray diffraction studies of DNA	K5
1.2	Structure of t-RNA	➤ Analyse the clover leaf model structure of t-RNA	K4
		➤ Explain the functions of t-RNA	K2
	Structure of micro RNA	➤ Define and analyse the non-coding RNA	K4
		➤ Explain the functions of non-coding RNA	K6
1.3	Forms of DNA	➤ Explain the different forms of DNA	K4

		➤ Compare and Interpret the molecular basis of different forms of DNA	K5
1.4	Mitochondrial DNA	➤ Define and identify the components of Mitochondrial DNA.	K3
		➤ ➤ Compare the functions of mitochondrial DNA and highlight its importance	K5
1.5	Structure of Eukaryotic chromosome	➤ Analyse the chromatin organization and nucleosomes.	K4
		➤ Explain the four motifs that play a major role in DNA binding	K5
1.6	Nucleosomes Model	➤ Compare the first order and second order DNA coiling.	K4
		➤ Explain the core structure of nucleosomes and histones	K5
1.7	Heterochromatin & Euchromatin	➤ Infer the structure of heterochromatin and euchromatin.	K4
		➤ Explains the solenoid model of chromosome.	K5
1.8	Genome size	➤ Compare the variation and genome size.	K5



		<ul style="list-style-type: none"> <li>➤ Explain the types of DNA sequences in Humans</li> </ul>	K5
1.9	C Value Paradox	<ul style="list-style-type: none"> <li>➤ Discover the variation of C-value paradox among species</li> <li>➤ Interpret the importance of C-value paradox in evolution</li> </ul>	K4 K5
1.10	Unique and Repetitive nucleotide sequences in eukaryotic genome (LINEs, SINEs)	<ul style="list-style-type: none"> <li>➤ Identify the repetitive nucleotide sequences</li> <li>➤ Explain the total repetitive nucleotide sequences in eukaryotic genome</li> </ul>	K4 K5
II	<b>DNA REPLICATION AND CENTRAL DOGMA IN PROKARYOTIC CELLS</b>		
2.1	Kinetics of renaturation: Cot curve	<ul style="list-style-type: none"> <li>➤ Analyse the Cot curve and infer the results</li> </ul>	K4
2.2	DNA replication	<ul style="list-style-type: none"> <li>➤ Explain the process of DNA replication.</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ List out the requisites of DNA replication.</li> </ul>	K4
		<ul style="list-style-type: none"> <li>➤ Analyse the models of replication in leading strand</li> </ul>	K4
		<ul style="list-style-type: none"> <li>➤ Compare the models of DNA replication</li> </ul>	K5
	Semi conservative replication	<ul style="list-style-type: none"> <li>➤ Explain and defend the Meselson &amp; Stahl's experiment on semi conservative model</li> <li>➤ Applications</li> </ul>	K5
2.3	Models of replication-Semi conservative, conservative and dispersive	<ul style="list-style-type: none"> <li>➤ Discuss and compare the different models of replication</li> </ul>	K6
		<ul style="list-style-type: none"> <li>➤ Explain the three types of models of DNA replication</li> </ul>	K5

2.4	Mechanism of replication- Initiation, Elongation and Termination	➤ Illustrate the steps in replication in formation of new strands	K6
		➤ Explain replisome and its mo components with its functio	K5
2.5	DNA damage	➤ Transfer the causes of DNA damage	K4
		➤ ➤ List out the types of DNA damage	K4
2.6	DNA repair mechanism- Types of DNA repair systems- Mismatch repair, Base-excision, Nucleotide excision, Direct repair, Post replication & Error -prone	➤ Explain the mechanism of DNA repair mechanism	K5
		➤ List out the types of DNA repair mechanism	K4
2.7	Genetic code	➤ Explain the Wobble hypothesis with examples	K5
		➤ List out the features of genetic code	K4
2.8	Transcription in prokaryotes	➤ Explain the structure of RNA polymerase	K5
		➤ Prioritise the process of transcription in Prokaryotes	K5
2.9	Protein synthesis in Prokaryotes	➤ Identify the factors involved in protein synthesis	K4
		➤ Analyse the components of protein machinery of prokaryotes	K4
		➤ Explain the steps	K5

		involved in protein synthesis	
2.10	Post translational modifications	➤ Transfer the post translational modifications.	K4
		➤ List out the types of post translational modifications.	K4
2.11	Signal hypothesis	➤ Analyse the process of binding & release of the signal peptides	K4
		➤ Predict the importance of signal hypothesis in biomolecules	K6
III	<b>REGULATION OF GENE EXPRESSION IN PROKARYOTES</b>		
3.1	Inhibitors	➤ Identify the inhibitors of protein synthesis in prokaryotes.	K4
		➤ List out the inhibitors of protein synthesis	K4
3.2	Transcription in Eukaryotes: RNA Polymerases	➤ Explain the structure & function of RNA polymerase.	K5
		➤ Explains the types and functions of RNA polymerase	K5
3.3	Effects of chromatin structure	➤ Identify and explain the effects of chromatin structure	K5
		➤ Distinguish the types of chromatin and its role in cell division	K4
	Post transcriptional modifications	➤ Interpret the post transcriptional modifications.	K5

3.4		<ul style="list-style-type: none"> <li>➤ List out the types of post translational modifications</li> </ul>	K4
3.5	Regulation of gene expression- concepts of enzyme induction and repression- positive and negative control	<ul style="list-style-type: none"> <li>➤ Analyze the process of regulation of gene expression.</li> </ul>	K4
		<ul style="list-style-type: none"> <li>➤ Distinguish the types of repression- positive and negative control</li> </ul>	K4
3.6	Regulation of gene expression in prokaryotes- Lac operon, Trp Operon, Ara operon, Gal operon	<ul style="list-style-type: none"> <li>➤ Interpret the positive and negative control of gene expression.</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ List out the types of operons in prokaryotes</li> </ul>	K4
3.7	Regulation of gene expression in eukaryotes	<ul style="list-style-type: none"> <li>➤ Justify the gene expression in Eukaryotes and its feedback control</li> </ul>	K5
IV	<b>BIOINFORMATICS DATABASES</b>		
4.1	Overview of Bioinformatics	<ul style="list-style-type: none"> <li>➤ Explain the scope of bioinformatics</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ Elaborate the importance of bioinformatics in various fields</li> </ul>	K6
	Literature, sequence and structure databases	<ul style="list-style-type: none"> <li>➤ Identify the different sequence &amp; structure database.</li> </ul>	K3
		<ul style="list-style-type: none"> <li>➤ List out the types of sequence and structural databases</li> </ul>	K4
4.2	Pattern and motif Searches	<ul style="list-style-type: none"> <li>➤ Apply the secondary database for assessing pattern &amp; motifs in proteins.</li> </ul>	K3
		<ul style="list-style-type: none"> <li>➤ List out the types of pattern and motifs databases in secondary structure</li> </ul>	K4
4.3	Structural classification	<ul style="list-style-type: none"> <li>➤ Classify &amp; compare the structure of proteins</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ Identify the databases applied in predicting the protein structure</li> </ul>	K3
4.4	Metabolic pathway databases	<ul style="list-style-type: none"> <li>➤ Analyze the metabolic pathways.</li> </ul>	K4

		➤ List out the types of metabolic databases	K4
4.5	Protein structure visualization tools	➤ Interpret the 3D structure of proteins by using visualization tools	K5
		➤ List out the types of 3D structure of proteins visualization tools	K4
4.6	Molecular sequence alignment	➤ Apply the alignment tools for finding homology	K3
		➤ List out the tools applied for molecular sequence alignment	K3
<b>V</b>	<b>GENOME AND PROTEOME ANALYSIS</b>		
5.1	Gene and Genome analysis	➤ Infer the importance of human genome sequencing & mapping	K3
		➤ Apply the methods used for genome analysis	K3
5.2	Comparitive genomics	➤ Discuss the importance of comparative genomics in tracking evolution	K6
5.3	Protein and proteome analysis	➤ apply the concepts of proteomics in various fields	K3
5.4	Protein structure prediction methods	➤ Analyse the structure of proteins by prediction method	K4
		➤ Infer the secondary structure of proteins by structure prediction methods	K4
5.5	Transcriptomics	➤ Apply the micro array techniques for studying gene expressions	K3
		➤ Analyse the tools used for gene and mRNA expression	K4
5.6	Modern drug discovery	➤ Apply the CADD methods in drug designing.	K3
		➤ Explain the methods and tools used for modern drug discovery	K5

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY103	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
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<b>CO1</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>
<b>CO2</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>
<b>CO3</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>
<b>CO4</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>
<b>CO5</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>H</b>	<b>M</b>
<b>CO6</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>H</b>	<b>M</b>

**L-Low**

**M-Moderate**

**H- High**

### **5. COURSE ASSESSMENT METHODS:**

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment, Presentation, Project report, Poster preparation.</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE PRACTICAL-I: LAB IN CELL AND MOLECULAR BIOLOGY

Semester: I

Code: P20ZY1P1

CREDITS: 3

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

After completing this course, the students will be able to:

CO No.	COURSE OUTCOME	LEVEL	Experiments
CO1	Examine the stages of mitotic cell division	K4	I
CO2	Analyze various events in cell division and cell cycle.	K4	I
CO3	Develop permanent slides and perform various staining procedures.	K6	I
CO4	Estimate protein/DNA using gel electrophoresis and analyze their molecular mass	K6	II
CO5	Test gene amplification using PCR	K5	II
CO6	Explain the significance of concentrating biomolecules	K5	II

### 2. A. Syllabus:

#### I CELL BIOLOGY

45Hrs

1. Effect of Colchicine on Mitosis using onion root tip.
2. Study of giant chromosomes in chironomous larva and micrometric measurements of Puffs.
3. Methyl Green Pyronin staining of DNA and RNA in buccal smear
4. Histology: Fixation, dehydration, embedding, sectioning, staining and permanent mounting of tissues - Submission of 5 best slides for Exam evaluation
5. Histochemistry: Feulgen Reaction for DNA, Periodic Acid – Schiff (PAS) reaction for carbohydrates, Mercuric Bromophenol Blue staining for Proteins.

**Spotters:** Giant chromosome, Mitotic stages of onion root tip, T.S of Heart, T.S of Kidney, T.S of Pancreas, T.S of Liver

#### II MOLECULAR BIOLOGY

35Hrs

1. Isolation of genomic DNA from PBMC.
2. PAGE - separation and molecular weight determination of proteins.
3. Agarose gel electrophoresis of DNA and calculation of molecular weight.
4. Amplification of gene by PCR.
5. Demonstration of Protein precipitation and purification.

**Spotters:** PCR, PAGE and Agarose gel electrophoresis

## B. Topics for Self-Study:

Sl.No.	TOPICS	WEB LINKS
1.	FACS	<a href="https://www.labome.com/method/Flow-Cytometry-and-Cell-Sorting-A-Practical-Guide.html">https://www.labome.com/method/Flow-Cytometry-and-Cell-Sorting-A-Practical-Guide.html</a>
2.	Cryopreservation	<a href="https://assets.thermofisher.com/TFS-Assets/LSG/manuals/D21111.pdf">https://assets.thermofisher.com/TFS-Assets/LSG/manuals/D21111.pdf</a>
3.	Immunohistochemistry	<a href="https://link.springer.com/book/10.1007/978-1-4939-1578-1">https://link.springer.com/book/10.1007/978-1-4939-1578-1</a>
4.	Western Blotting	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=187&amp;sim=1331&amp;cnt=1">https://vlab.amrita.edu/?sub=3&amp;brch=187&amp;sim=1331&amp;cnt=1</a>
5.	Cell Culture	<a href="https://atecentral.net/downloads/1163/Basics_of_Cell_Culture_students_manualv7.pdf">https://atecentral.net/downloads/1163/Basics_of_Cell_Culture_students_manualv7.pdf</a>

## C. Text Books:

1. Cell Biology: Practical Manual. Dr. Renu Gupta (Author), Dr. Seema Makhija (Author), Dr. Ravi. Prestige Publishers (2018)
2. Freshney, R. I. (2005). Culture of specific cell types. John Wiley & Sons, Inc.
3. Razdan, M. K. (2003). Introduction to plant tissue culture. Science Publishers. Reference book

## D. Reference Books:

1. Essential Cell Biology: A Practical Approach Volume 1: Cell Structure (Practical Approach Series) 1st Edition. John Davey and J. Michael Lord. Oxford University Press; 1 edition (August 7, 2003) 2003
2. Sambrook, J., Russell, D. W., & Russell, D. W. (2001). Molecular cloning: a laboratory manual (3-volume set).
3. Cell and Molecular Biology: A Lab Manual. Chaitanya K.V. January 2013. Prentice Hall India Learning Private Limited

## E. Weblinks:

1. <https://b-ok.asia/book/5925611/120ff0>
2. <https://www.amrita.edu/school/biotechnology/academics/pg/cell-molecular-biology-lab-bio588>



### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Sl.No.	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomy Levels of Transaction
<b>I</b>	<b>Cell biology</b>		
1	Effect of Colchicine on Mitosis using onion root tip.	Explain the stages of mitosis	K5
2.	Study of giant chromosomes in chironomous larva and micrometric measurements of Puffs.	Examine Giant chromosomes in chironomous larva	K5
3	Methyl Green Pyronin staining of DNA and RNA in buccal smear	Distinguish DNA and RNA using Methyl Green Pyronin staining	K5
4	Histology: Fixation, dehydration, embedding, sectioning, staining and permanent mounting of tissues - Submission of 5 best slides for Exam evaluation.	Explain the importance of histology	K5
5	Histochemistry: Feulgen Reaction for DNA, Periodic Acid Schiff(PAS) reaction for carbohydrates, Mercuric Bromophenol Blue staining for Proteins.	Estimate the presence of various biomolecules in the tissue using dyes.	K5
6	<b>Spotters:</b> Giant chromosome, Mitotic stages of onion root tip, T.S of Heart, T.S of Kidney, T.S of Pancreas, T.S of Liver	Classify the various stages of cell division, DNA forms and histo-architecture of tissues	K2
<b>II</b>	<b>Molecular Biology</b>		
1	Isolation of genomic DNA from PBMC	Examine isolation of DNA from White Blood cells	K5
2	PAGE - separation and molecular weight determination of proteins.	Interpret tissue proteins through gel electrophoresis	,K5
3	Agarose gel electrophoresis of DNA and calculation of molecular weight.	Interpret DNA using agarose gel electrophoresis	K5
4	Amplification of gene by PCR.	Test gene amplification in the given sample	K5

5	Demonstration of Protein precipitation and purification.	Explain concentrating protein in a given sample.	K5
6	<b>Spotters:</b> PCR, PAGE and Agarose gel electrophoresis	Summarize the principle and applications of instrument used in molecular biology.	K2

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY1P 1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	H	H	H	H	H	H	M	H	H	H	L
CO2	H	H	H	H	H	M	L	H	M	H	H	H	L
CO3	H	H	H	H	H	M	M	H	L	H	H	H	L
CO4	H	H	H	H	H	L	H	H	L	H	H	H	L
CO5	H	H	H	H	H	M	L	H	M	H	H	H	M
CO6	H	H	H	H	H	L	L	H	L	H	H	H	M

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE PRACTICAL -II LAB IN MICROBIOLOGY AND BIOINFORMATICS

Semester: I

Code: P19ZY1P2

Credits: 3

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

After completing this course, the students will be able to:

CO.No.	COURSE OUTCOMES	LEVEL	UNIT
CO1	Categorise and determine the bacteria based on colony morphology	K4	I
CO2	Assess the different bacterial culture techniques applied for isolating pure culture.	K5	I
CO3	Determine the growth of bacteria in four stages by Spectrophotometry method.	K5	I
CO4	Evaluate the antibiotic sensitivity of bacteria by Disc Diffusion method.	K5	I
CO5	Justify the similarities between multiple sequences & to track the evolution.	K5	II
CO6	Determine the 3D structure of protein and to assess the phylogenetic relationship between the organisms.	K5	II

### 2. A. Syllabus:

#### I Microbiology

45Hrs

1. Sterilization procedures and maintenance of laboratory.
2. Media preparation and bacterial culture inoculation.
3. Identification of bacteria based on colony morphology and colony counting.
4. Serial dilution and pour plate method and determination of colony number/gram.
5. Culture techniques :Broth culture, Spread plate, Streak plate, Slant culture &Swab culture
6. Identification of bacteria by gram staining method..
7. Determination of bacterial growth by spectrophotometry.
8. Antibiotic sensitivity test.
9. MPN technique for the identification of coliforms in water samples.
10. Bio- Chemical tests for bacterial identification. (IMVIC)

**Spotters:** Fungi and culture plates

Instruments: Laminar air flow and Colony counter

## II-Bioinformatics

35Hrs

1. Basic local Alignment methods – BLAST, FASTA
2. Multiple Alignment methods–Clustal X
3. Structural Data Base -3D structure of proteins– PDB, Swiss Prot
4. Phylogenetic tree relationship- Distance tree results and neighbor joining tree method

### B. Topic for Self-Study:

Sl.No.	TOPICS	WEB-LINKS
1.	Introduction to the use of practical laboratory microscopes	<a href="https://www.pdfdrive.com/practical-microbiology-e12040951.html">https://www.pdfdrive.com/practical-microbiology-e12040951.html</a>
2.	Basic bacterial cultivation techniques	<a href="https://www.pdfdrive.com/practical-microbiology-e12040951.html">https://www.pdfdrive.com/practical-microbiology-e12040951.html</a>
3.	Transfer, maintenance and storage of pure cultures	<a href="https://www.pdfdrive.com/practical-microbiology-e12040951.html">https://www.pdfdrive.com/practical-microbiology-e12040951.html</a>
4.	Schaeffer-fulton spore staining	<a href="https://www.pdfdrive.com/practical-microbiology-e12040951.html">https://www.pdfdrive.com/practical-microbiology-e12040951.html</a>

### C. Text Book:

1. Laboratory Manual in Microbiology. P.Gunasekaran . New Age International, 2007 .

### D. Reference Books:

1. Laboratory Manual: Microbiology Principles and Applications. Stephen A. Norrell Prentice Hall, 1990 - Medical microbiology.
2. Microbiology: A Laboratory Manual- James G. Cappuccino, Natalie Sherman Pearson Education, 20-Feb-2013
3. Bioinformatics Practical Manual . Mohammed Iftexhar · Createspace Independent Publishing Platform 2015.
4. Introduction to Bioinformatics Using Action Labs- Jean-Louis Lassez, Ryan Rossi, Stephen Sheel · Published by Lulu.com2016

### E. Web links:

1. [https://bio.libretexts.org/Bookshelves/Ancillary\\_Materials/Laboratory\\_Experiments/Microbiology\\_Labs/Microbiology\\_Labs\\_I/03%3A\\_Dilution\\_Techniques\\_and\\_Pipetting](https://bio.libretexts.org/Bookshelves/Ancillary_Materials/Laboratory_Experiments/Microbiology_Labs/Microbiology_Labs_I/03%3A_Dilution_Techniques_and_Pipetting)
2. <https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf>
3. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0211962>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit/ Section	Contents	Specific Learning Outcomes (SLO)	Highest Bloom's taxonomy Level of transaction
	<b>MICROBIOLOGY</b>		
1	Sterilization procedures and maintenance of laboratory	➤ Apply the sterilization procedures and lab maintenance	K3
2	Media preparation and bacterial culture inoculation	➤ Assess the types of media prepare for bacterial culture	K5
3	Identification of bacteria based on colony morphology.	➤ Identify the bacteria based on colony morphology	K3
4	Serial dilution and pour plate method and determination of colony number/gram.	➤ Analyse the process of serial dilution to isolate pure culture	K4
		➤ Determine the process of pour culture method	K5
		➤ Predict the total number of bacterial colony count /gram.	K6
5	Culture techniques :Broth culture, Spread plate, Streak plate, Slant culture &Swab culture	➤ Evaluate and analyse the strains of bacteria using different culture techniques.	K6
6	Identification of bacteria by gram staining method	➤ Identify the bacteria based on gram staining.	K3

		➤ Assess the bacterial strain type based on grams staining.	K5
7	Determination of bacterial growth by spectrophotometry -	➤ Determine the growth of bacteria by Spectrophotometry method.	K5
		➤ Evaluate the stages of bacterial growth	K5
8	Antibiotic sensitivity test.-	➤ Evaluate the antibiotic sensitivity of bacteria by Disc Diffusion method.	K5
		➤ Determine the antibiotic sensitivity in bacteria using different concentration of antibiotics.	K5
9	MPN technique for the identification of coliforms in water samples	➤ Analyse the Coliform bacteria in the drinking water by MPN method.	K4
		➤ Analyse the water portability test.	K4
10	Biochemical test for bacterial identification- IMViC	➤ Identify the gram negative bacteria by biochemical test.	K3
		➤ Analyse the bacterial strains for identification at genus level by IMViC tests	K4
	<b>SPOTTERS</b>		

11	Spotters- Fungi and culture plates	➤ Analyse & compare the bacteria based on its morphology.	K4
		➤ Analyse & compare the fungi based on its morphology	K4
12	Instruments-Laminar air flow, Colony counter	➤ Explain the principle & applications of the instruments.	K5
<b>BIOINFORMATICS</b>			
1	Basic Local Alignment <b>methods- BLAST &amp; FASTA</b>	➤ Compare & determine the similarities between the two local sequences using BLAST.	K5
		➤ Compare & determine the similarities between the two local sequences using FASTA.	K5
2	Multiple alignment methods- Clustal X	➤ Identify similarities between multiple sequences & to track the evolution	K5
		➤ Predict and apply the multiple alignment between the sequences using CLUSTAL X	K6
3.	Structural database-3D structure of proteins- PDB,SwissProt	➤ Determine the 3D structure of proteins	K5
		➤ Apply the 3D structure of protein to predict the annotations of	K3

		the protein	
4.	Phylogenetic relationship- Distance tree results and neighbor joining tree method	➤ Assess the phylogenetic relationship between the organisms.	K5
		➤ Apply the phylogenetic relationship between the organisms to track evolution	K3

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY1P2	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	M	H	H	H	H	M	H	M	M	M	H	H
CO2	H	H	H	H	H	H	M	H	M	M	H	H	H
CO3	H	M	H	H	H	H	L	H	M	M	H	H	H
CO4	H	M	H	H	H	H	L	H	M	M	H	H	H
CO5	H	H	H	H	H	H	L	H	H	M	M	H	H
CO6	H	H	H	H	H	H	L	H	H	M	M	H	H

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

<b>Direct</b>
1. Continuous Assessment Test I,II
2. ,
3. End Semester Examination
<b>Indirect</b>
1. Course-end survey



Direct
1. Continuous Assessment Test I, II 2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation 3. End Semester Examination
Indirect
1. Course-end survey

### ELECTIVE – I: MICROBIOLOGY

**Semester: I**

**Code: P20ZY1:1**

**Credits : 4**

**Total hrs: 75 (Total hrs per week: 5)**

#### 1. COURSEOUTCOMES:

After completing this course, the students will be able to:

CO. No.	COURSE OUTCOME	LEVEL	UNIT
CO1	Explain the structure, function, diversity, metabolism, and the genetics of metabolic regulation microorganisms.	K5	I
CO2	Explain the nutrient types essential for the microbial growth	K5	II
CO3	Discuss about the multiplication and the physical factors influencing the growth of microbes.	K6	III
CO4	Identify and assess the various accessory pigments and their functions for major metabolic processes	K2	IV
CO5	Explain the functional role of microbes in large scale industries	K5	V
CO6	Categorize the diverse threat of microorganisms causing deadliest diseases	K2	VI

#### 2. A. Syllabus:

**Unit – I      MICROBES : CLASSIFICATION AND STRUCTURE**

**15Hrs**

**Microbial diversity:** Whitakers system of classification. **Bacteria:** Structure of *E.coli*- Cytoplasmic membrane – cell wall – gram positive and gram negative bacterial cell surface structures- cell inclusions– gas vesicles- endospores - locomotion – nutrition types in bacteria. **Virus:** Structure and life cycle of Bacteriophage.

**Fungi:** Structure and life cycle of *Penicillium*.

**Unit – II MICROBIAL CULTURE AND GROWTH 15Hrs**

**Microbial culture and growth:** Types of culture–culture media. Cell division - peptidoglycon synthesis-measurement of microbial growth - exponential growth- growth curves –growth kinetics –**Factors affecting growth:** temperature, pH and oxygen.

**Unit – III AEROBIC AND ANAEROBIC RESPIRATION 15Hrs**

**Phototrophy:** Structure of photosynthetic pigments – chlorophylls, bacteriochlorophyll, carotenoids and phycobilins **Chemolithotrophy:** inorganic electron donors - hydrogenoxidation- sulfur oxidation- iron oxidation- nitrification. **Anaerobic respiration:** nitrate reduction- sulfur reduction- acetogenesis - methanogenesis - organic electron acceptor.

**Unit – IV MICROBIAL PRODUCTS 15Hrs**

**Industrial Microbiology:** Microbial products -primary and secondary metabolites-characteristics of large-scale fermentations- Antibiotics isolation and characterization- Industrial production of vitamins-steroids - enzymes - alcohol-vinegar-citric acid.

**Unit – V MICROBIAL DISEASES 15Hrs**

**Medical microbiology:** Symptoms, prevention and control of **Air borne infections:** Tetanus - tuberculosis- respiratory viral infections – Polio - influenza. **Water borne infections:** - hepatitis. Helicobacter pylori and Gastric ulcer – Leprosy - Sexually Transmitted Diseases: Gonorrhea-Syphilis - AIDS.

**B. Topics for Self-Study:**

Sl.No.	TOPICS	WEB LINKS
1	Virtualization Proteins as Indicators of Phylogeny	<a href="https://academic.oup.com/peds/article/14/9/609/1551466">https://academic.oup.com/peds/article/14/9/609/1551466</a>
2	Quorum Sensing and Microbial Populations	<a href="https://elifesciences.org/articles/25773">https://elifesciences.org/articles/25773</a>
3	Specialty Compounds for Use in Medicine and Health	<a href="ftp://ftp.hpl.hp.com/wilkes/AutoRAID.TOCS.ps.Z">ftp://ftp.hpl.hp.com/wilkes/AutoRAID.TOCS.ps.Z</a>
4	Microbial Mechanisms for Escaping Host Défense	<a href="https://www.immunology.org/public-information/bitesized-immunology/pathogens-and-disease/host-%E2%88%92-pathogen-interactions-and">https://www.immunology.org/public-information/bitesized-immunology/pathogens-and-disease/host-%E2%88%92-pathogen-interactions-and</a>

**C. Text Books:**

1. Pelczar M.J and Reid, Microbiology, 1996. Tata Mc Graw Hill,
2. Prescott L.M., Harley J. P. and Klein D.A., Microbiology, 6th Ed., 2005. McGraw-Hill, New Delhi,

**D. References Books:**

1. Pomerville P.C., Alacamo's Fundamentals of Microbiology, 7th Ed., 2004. Boston: Jones and Bartlett,
2. Tartora G.J., Case C.L. and Funke B.R., Microbiology - An Introduction, 8th Ed., 2004. Pearson Benjamin Cummings, New York,
3. Hogg S, Essential Microbiology, 2005. John Wiley & Sons Ltd., England,
4. Madigan M.T. and Martinko J.M., Brock Biology of Microorganisms, 11th Ed., 2006. Prentice Hall, USA,
5. Percival S.L., Chalmers RM, Embrey M., Hunter PR, Sellwood J and Wyn-Jones P, Microbiology of Waterborne Diseases, 2004 Elsevier Academic Press, London,.
6. Schaechter M, The Desk Encyclopedia of Microbiology, 2004 Elsevier Academic Press, London.

**E. Web Links:**

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Unit/ Section	Contents	Specific Learning Outcomes	Highest Bloom's taxonomy level of transaction
<b>I</b>	<b>MICROBES : CLASSIFICATION AND STRUCTURE</b>		
1.1	Microbial diversity	➤ Classify the microorganisms with Whitaker's classification	K2
1.2	Bacteria	➤ Explain the structure and classification of bacteria	K5
1.3	Virus	➤ Explain the structure and life cycle of viruses	K5
1.4	Fungi	➤ Explain the structure and life cycle of Fungi	K5
<b>II</b>	<b>MICROBIAL CULTURE AND GROWTH</b>		
2.1	Microbial cultural growth	➤ Classify the various types of culture media for the growth of microbial	K2

		growth	
		➤ Determine the stages of cell division and their functions	K6
		➤ Explain about the growth curve and kinetics	K5
2.2	Factors affecting growth	➤ Assess the importance of physical factors essential for the growth	K5
III	<b>AEROBIC &amp; ANAEROBIC RESPIRATION</b>		
3.1	Phototrophy and Chemolithotrophy	➤ Explain the structure and importance of photosynthetic pigments	K5
		➤ Elaborate the process of metabolism occur in bacteria	K6
3.2	Respiration	➤ Explain the mechanism of anaerobic respiration in microorganisms	K5
IV	<b>MICROBIAL PRODUCTS</b>		
4	Industrial microbiology	➤ Classify the different microbial products and their metabolite characters	K2
		➤ Estimate about the large scale fermentations of essential needs of human beings	K5
V	<b>MICROBIAL DISEASES</b>		
5	Medical microbiology	➤ Interpret the symptoms of major infections	K5
		➤ Explain the prevention and control of deadly microbes	K2
		➤ Classify the various Airborne, water borne and sexually transmitted diseases with their symptoms	K2

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY1:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
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<b>CO1</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>
<b>CO2</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>
<b>CO3</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>
<b>CO4</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>
<b>CO5</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>
<b>CO6</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>	<b>H</b>

L-Low

M-Moderate

H- High

### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation,</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE – IV: ANIMAL PHYSIOLOGY

Semester: II

Code: P20ZY204

Credits: 5

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO.No.	COURSE OUTCOME	LEVEL	UNIT
CO1	Analyze the structural and functional aspects of digestive and respiratory systems in mammals.	K4	I
CO2	Evaluate the function of the blood and the process of circulation in mammals.	K5	II
CO3	Interpret the mechanism of excretion, regulation of water balance, acid-base balance, electrolyte balance, thermoregulation and stress adaptations	K5	III
CO4	Examine the transmission of nerve impulses and physiology of muscle contraction	K4	IV
CO5	Asses the role of hormones in the coordination of activities in the biological systems	K5	V
CO6	Explain the reproductive processes and disorders of ovary in mammals	K5	V

### 2. A. Syllabus:

#### Unit – I: DIGESTIVE & RESPIRATORY SYSTEM

15Hrs

Digestion-absorption- energy balance - BMR. **Respiratory system:** Internal and external respiration-Comparison of respiration in mammals -respiratory pigments-transport of gases - exchange of gases - neural and chemical regulation of respiration.

#### Unit – II : BLOOD AND CIRCULATION

15Hrs

Blood corpuscles - haemopoiesis and formed elements -plasma function-blood volume -blood volume regulation. **Cardiovascular System:** Anatomy of heart - myogenic heart - principle and significance of ECG - cardiac cycle - blood pressure and neural and chemical regulation.

#### Unit – III: EXCRETORY SYSTEM & THERMOREGULATION

15Hrs

**Excretory system:** kidney-urine formation- urine concentration-waste elimination-micturition-regulation of water balance - electrolyte balance- acid-base balance. **Thermoregulation:** Comfort zone - body temperature - physical, chemical, neural regulation- acclimatization- stress adaptation.

#### Unit – IV NERVOUS AND MUSCULAR SYSTEMS AND SENSE ORGANS 15Hrs

Nervous system :Central and Peripheral nervous system - Neurons - action potential–transmission of nerve impulse - neural control of muscle tone and posture.

Sense organs : Vision, hearing, gustation, olfaction and tactile.

Muscular system: Ultra structure of muscle - Physiology of muscle contraction

### Unit – V :ENDOCRINE GLANDS

15Hrs

Principles of Hormone action -Pituitary, Thyroid, Adrenal and Parathyroid: Hormones - mechanism of action, functions and diseases. - Neuroendocrine regulation. Hormonal control of female reproductive cycle: Menstrual cycle -pregnancy- parturition – lactation.Disorders of Ovary: Polycystic Ovarian Syndrome.

\*With reference to mammals

#### B. Topics for Self-Study:

S.No	TOPICS	WEB LINKS
1	Bioluminescence in animals	<a href="https://www.youtube.com/watch?reload=9&amp;v=9HXXQBz6Vv0">https://www.youtube.com/watch?reload=9&amp;v=9HXXQBz6Vv0</a> <a href="https://www.nationalgeographic.org/encyclopedia/bioluminescence/">https://www.nationalgeographic.org/encyclopedia/bioluminescence/</a>
2.	Physiology of stress	<a href="https://www.ncbi.nlm.nih.gov/books/NBK541120/">https://www.ncbi.nlm.nih.gov/books/NBK541120/</a> <a href="https://samples.jblearning.com/0763740411/Ch%20Seaward_Managing%20Stress_5e.pdf">https://samples.jblearning.com/0763740411/Ch%20Seaward_Managing%20Stress_5e.pdf</a>
3.	Adaptations to high altitude	<a href="https://www.coursera.org/lecture/mountains-101/4-3-adaptation-of-high-altitude-peoples-QqTLE">https://www.coursera.org/lecture/mountains-101/4-3-adaptation-of-high-altitude-peoples-QqTLE</a>
4.	Neuromuscular disorders	<a href="https://www.maxhealthcare.in/our-specialities/neurology/conditions-treatments/neuromuscular-diseases">https://www.maxhealthcare.in/our-specialities/neurology/conditions-treatments/neuromuscular-diseases</a>
5.	Hormone receptors	<a href="https://www.sciencedirect.com/topics/neuroscience/hormone-receptor">https://www.sciencedirect.com/topics/neuroscience/hormone-receptor</a>

#### C. Text Books:

Sherwood, L., Klandorf, H, and Yancey, P.H. Text Book of Animal Physiology 2008.Cengage Learning India Pvt., Ltd.

Hoar, W.S. General and Comparative Physiology,1968 Prentice Hall

#### D. Reference Books:

1. Hill R.W., Wyse G.A. and Anderson, M., Animal Physiology., 2nd Ed.,2008. Sinauer Associates, Inc Publisher, Massachusetts.
- 2 . Moyes, C.D. and Schulte, P.M. Principles of Animal Physiology. Pearson Education,

2007, Dorling Kindersley Publication. New Delhi.

3. Guyton, A.C. Textbook of Medical Physiology. 2000. W.B. Saunders Company, Philadelphia, London, Toronto and IgakuShoin/Saunders (Tokyo).

4. Prosser, C.L. Comparative Animal Physiology. 3rd Ed., 1973. W.B. Saunders & Co. Philadelphia

#### E. Weblinks:

1. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/animal-physiology>
2. <https://handwrittennotes.in/product/science-notes-anatomy-and-physiology-of-animal-anatomy-and-physiology/>
3. <https://nptel.ac.in/courses/102/104/102104042/>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit/ Section	Contents	Specific Learning Outcomes (SLO)	Highest Bloom's Taxonomic Level of Transaction
<b>I</b>	<b>DIGESTIVE &amp; RESPIRATORY SYSTEM</b>		
1.1	Digestion of food and absorption	<ul style="list-style-type: none"> <li>➤</li> <li>➤ Describe the process of digestion and absorption</li> <li>➤ Analyze the digestion &amp; absorption of food</li> </ul>	<b>K4</b>
1.2	Energy balance mechanism Intake of energy, Energy expenditure	<ul style="list-style-type: none"> <li>➤ Illustrate the mechanism of energy balance</li> <li>➤ Categorize the energy expenditure in animals</li> </ul>	<b>K4</b>
1.3	BMR	<ul style="list-style-type: none"> <li>➤ Analyze the basal metabolic rate in various animals</li> </ul>	<b>K4</b>
1.4	Internal and external respiration, Comparison of respiration in mammals	<ul style="list-style-type: none"> <li>➤ Demonstrate internal and external respiration in mammals</li> <li>➤ Compare the mechanism of respiration in mammals</li> </ul>	<b>K3</b>



1.5	Types of respiratory pigments	➤ Classify the respiratory pigments	<b>K4</b>
1.6	Transport and exchange of gaseous molecules Regulation (Neural, chemical)	➤ Analyse the transport of gaseous molecules ➤ Explain the regulation of respiration	<b>K4</b>
<b>II</b>	<b>BLOOD AND CIRCULATION</b>		
2.1	Types of blood corpuscles, haemopoiesis	➤ Classify the blood corpuscles ➤ Discuss the production of RBC	<b>K5</b>
2.2	Function of blood plasma	➤ List out the functions of blood plasma	<b>K5</b>
2.3	Blood volume and its regulation	➤ Examine blood volume and its regulation	<b>K4</b>
2.4	Heart – Anatomy	➤ Describe the structure of heart	<b>K2</b>
2.5	Myogenic heart, ECG	➤ Interpret the heart rate	<b>K5</b>
2.6	Cardiac cycle, blood pressure	➤ Infer the process of cardiac cycle ➤ Measure the blood pressure	<b>K5</b>
2.7	Neural and chemical regulation	➤ Conclude the regulation of circulation	<b>K5</b>
<b>III</b>	<b>EXCRETORY SYSTEM &amp; THERMOREGULATION</b>		
3.1	Kidney – anatomy	➤ Describe the structure of Kidney	<b>K2</b>
3.2	Formation and concentration of Urine	➤ Explain the process of urine formation in mammals	<b>K4</b>
3.3	Waste elimination, Micturition	➤ Interpret the process of micturition	<b>K5</b>
3.4	Water balance, Electrolyte, acid –base balance	➤ Relate water balance, Electrolyte, acid –base balance	<b>K2</b>
3.5	Thermoregulation: body temperature Regulation (physical, chemical, neural)	➤ Analyse the influence of body temperature in physiology of mammals ➤ Explain different types of regulation in Excretion	<b>K5</b>
3.6	Acclimatization, stress adaptation	➤ Assess acclimatization due to temperature	<b>K5</b>

<b>IV</b>	<b>NERVOUS AND MUSCULAR SYSTEMS AND SENSE ORGANS</b>		
4.1	CNS, PNS : types of neuron	➤ List out the type of neurons	<b>K4</b>
4.2	Action potential, impulse transmission	➤ Analyze the transmission of nerve impulse	<b>K4</b>
4.3	Optic, auditory, gestation, Olfactory, tactile	<ul style="list-style-type: none"> <li>➤ Explain the structure of sensory Organs</li> <li>➤ Analyse the functions of sensory organs</li> </ul>	<b>K5</b>
4.4	Neural control of muscle tone, posture, muscle structure, Physiology of muscle contraction	<ul style="list-style-type: none"> <li>➤ Identify and illustrate muscle tone and posture</li> <li>➤ Explain the physiology of muscle contraction</li> </ul>	<b>K5</b>
<b>V</b>	<b>ENDOCRINE GLANDS</b>		
5.1	Pituitary, Thyroid, Adrenal, Parathyroid  Action of hormones, functions and disorders	<ul style="list-style-type: none"> <li>➤ Summarize the different types of endocrine glands</li> <li>➤ Justify “pituitary gland is the master gland”</li> <li>➤ Identify and Interpret the hormonal disorders</li> </ul>	<b>K5</b>
5.2	Neuro endocrine regulation of hormones	➤ Explain the Neuro endocrine regulation	<b>K5</b>
5.3	Hormonal control of female reproductive cycle: Menstrual cycle, Ovulation, Pregnancy, Parturition	<ul style="list-style-type: none"> <li>➤ Explain the hormonal control of the menstrual cycle</li> <li>➤ Discuss the process of ovulation, Pregnancy and Parturition</li> </ul>	<b>K5</b>
5.4	Disorders of Ovary: PCO	➤ Explain the ovarian disorder, Polycystic Ovarian Syndrome	<b>K5</b>

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY204	P01	P02	P03	P04	P05	P06	P07	P08	P09	PS01	PSO 2	PSO3	PSO 4
C01	H	M	M	H	H	-	-	M	-	H	H	-	-
C02	H	-	M	L	L	-	-	-	-	H	H	-	-
C03	H	M	M	L	L	-	-	-	-	H	H	-	-
C04	H	M	M	L	L	-	-	-	-	H	H	-	-
C05	M	M	M	L	L	-	-	-	-	H	H	-	-
C06	H	M	M	L	L	-	-	-	-	H	H	-	-

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE – V: BIOCHEMISTRY

Semester: II

Code: P19ZY205

Credits: 5

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO.No.	COURSE OUTCOME	LEVEL	UNIT
CO1	Explain the basic concepts/functions of solutes, chemical bonding and organic compounds.	K2	I
CO2	Predict the structure of proteins and their biological active sites	K6	II
CO3	Assess quantitative and qualitative estimation of biomolecules	K5	III
CO4	Explain the importance of biochemical metabolism of carbohydrate	K5	IV
CO5	Evaluate the importance of biochemical metabolism of protein and lipid	K5	V
CO6	Analyze the importance of essential aminoacids	K4	V

### 2. A. Syllabus:

#### Unit – I CHEMICAL BONDS, BUFFERS AND CARBOHYDRATES 15Hrs

**Chemical bonds and interaction:** Hydrogen bond, ionic bond and covalent bonds - vanderwaals and hydrophobic interactions - Water as a solvent - **pH and buffers:** Acid-base reactions- dissociation constants ( $K_a$ ) for weak acids and weak bases - role of buffers in biological systems. **Carbohydrates:** monosaccharides: linear and heterocyclic structure - conformational structure- isomers - epimers. Disaccharides - oligosaccharides - polysaccharides- Glycoproteins and glycolipids.

#### Unit – II PROTEINS AND LIPIDS 15Hrs

**Proteins:** Primary structure–peptide bond. Secondary structure– $\alpha$ helix - $\beta$  pleated sheet and bends- Prediction of secondary structure: Ramachandran plot. Tertiary structure – Forces stabilizing tertiary structure - Domains and motifs. Quaternary structures-Molecular chaperones - prions. **Lipids:** Structure – Steroids – Cholesterol.

#### Unit – III ENZYMES 15Hrs

**Enzymes:** Classification of enzymes - co-enzymes- iso-enzymes- ribozyme - abzymes. Enzyme specificity: Mode of action of enzymes - Formation of enzyme substrate complex. **Enzyme kinetics:** Equilibrium and steady - state assumptions - Michaelis - Menten equation - significance of  $K_m$  Value- MM & LB plots - Enzyme regulation

#### Unit – IV CARBOHYDRATE METABOLISM 15Hrs

**Carbohydrate metabolism:** Glycolysis - Pentose phosphate pathway - citric acid cycle-oxidative phosphorylation. Gluconeogenesis - Cori cycle. Glycogen metabolism: Glycogenesis - Glycogenolysis - Adenylate cascade system- Regulation of glycogen synthesis – Intermediate metabolism.

**Unit – V PROTEIN AND LIPID METABOLISM**

**15Hrs**

**Metabolism of Proteins:** Deamination, transamination and transdeamination. **Metabolism of lipids:**  $\beta$  oxidation – alpha oxidation - omega oxidation -synthesis of triacylglycerols - **Synthesis of essential amino acids:** methionine and valine - synthesis of purine and pyrimidine nucleotides.

**B. Topics for Self -Study:**

Sl.No.	TOPICS	WEB LINKS
1.	Entropy	<a href="http://guweb2.gonzaga.edu/faculty/cronk/CHEM245pub/entropy.html">http://guweb2.gonzaga.edu/faculty/cronk/CHEM245pub/entropy.html</a>
2.	Enthalpy	<a href="http://guweb2.gonzaga.edu/faculty/cronk/CHEM245pub/enthalpy.html">http://guweb2.gonzaga.edu/faculty/cronk/CHEM245pub/enthalpy.html</a>
3.	Electron Transport Chain	<a href="https://microbenotes.com/electron-transport-chain-etc-components-and-steps/">https://microbenotes.com/electron-transport-chain-etc-components-and-steps/</a>
4.	Action Potential	<a href="https://teachmephysiology.com/nervous-system/synapses/action-potential/">https://teachmephysiology.com/nervous-system/synapses/action-potential/</a>
5.	Metabolic acidosis	<a href="https://litfl.com/metabolic-acidosis/">https://litfl.com/metabolic-acidosis/</a>

**C. Text Books:**

1. Cox M.M. and Nelson D.L. Lehninger’s Principles of Biochemistry, 4th Ed., 2005 New York: W.H. Freeman
2. Ambika Shanmugam, Fundamentals of Biochemistry for Medical Students, Revised Ed., 2001.

**D. References Books:**

1. Voet D. and Voet, J.G., Biochemistry, 4th Ed., 2011 John Wiley & Sons,
2. BergJ.M., Tymoczko J.L. and Stryer L. Biochemistry, 6th Ed., 2007 W.H Freeman and Company, New York.
3. Zubay G.L., Principles of Biochemistry, 2000Dubuque, Williams C, Brown Publishers.
4. Murray R.K., Granner D.K. and Mayer P.A., Harper’s Illustrated Biochemistry: A Lange Medical Book, 26th Ed., 2003 New Delhi, McGraw-Hill.
5. Bayens J.W. and Marek D, Medical Biochemistry, 2nd Ed., 2005 Elsevier.
6. Mathews C.K., Van holde, K.E. and AHERNK.G., Biochemistry, 3rd Ed., 2004 New Delhi, Pearson Education.

7. Elliott W. H. and Elliott D. C., Biochemistry and Molecular Biology, 3<sup>rd</sup> Ed., 2005 Oxford University Press, Indian Edition.
8. Devlin T. M., Text book of Biochemistry with Clinical Correlation, 2002 John Wiley & Sons.
9. Price N.C. and Stevens L., Fundamentals of Enzymology, 3rd Ed., 2006 Oxford University Press.
10. Conn E.E., Stump P.K., Bruening G. and DOI R.H., Outlines of Biochemistry, 5th Ed., 2007 John Wiley & Sons, Indian Edition.

#### E. Weblinks:

1. [https://nptel.ac.in/content/syllabus\\_pdf/104105076.pdf](https://nptel.ac.in/content/syllabus_pdf/104105076.pdf)
2. <https://www.classcentral.com/course/swayam-experimental-biochemistry-12909>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit/ Section	Contents	Specific Learning Outcomes	Highest Blooms Taxonomical level of Transaction
<b>I</b>	<b>CHEMICAL BONDS, BUFFERS &amp; CARBOHYDRATES</b>		
<b>1.1</b>	<b>Chemical bonds and interaction:</b> Hydrogen bond, ionic bond and covalent bonds - vanderwaals and hydrophobic interactions - Water as a solvent	➤ Define interaction of atoms, ions and molecules in biochemical process	K1
<b>1.2</b>	<b>pH and buffers:</b> Acid-base reactions- dissociation constants (Ka) for weak acids and weak bases - role of buffers in biological systems.	➤ Demonstrate different acid base interaction and role of buffers in biological system	K2
<b>1.3</b>	<b>Carbohydrates:</b> monosaccharides: linear and heterocyclic structure - conformational structure- isomers - epimers. Disaccharides - oligosaccharides – polysaccharides - Glycoproteins and glycolipids.	➤ Interpret the structure and conformational changes of different carbohydrates	K2
<b>II</b>	<b>PROTEINS &amp; LIPIDS</b>		
<b>2.1</b>	<b>Proteins:</b> Primary structure–peptide	➤ Predict the	K6

	bond. Secondary structure— $\alpha$ helix - $\beta$ pleated sheet and bends - Prediction of secondary structure: Ramachandran plot. Tertiary structure - Forces stabilizing tertiary structure - Domains and motifs. Quaternary structures-Molecular chaperones - prions.	conformational changes of protein structures	
2.2	<b>Lipids:</b> Structure – Steroids – Cholesterol.	➤ Explain the structure and properties of lipids	K2
<b>III</b>	<b>ENZYMES</b>		
3.1	<b>Enzymes:</b> Classification of enzymes - co-enzymes- iso-enzymes-ribozyme - abzymes. Enzyme specificity: Mode of action of enzymes - Formation of enzyme substrate complex.	➤ Classify enzymes and their properties and Examine the interaction of enzyme substrates complex	K4
3.2	<b>Enzyme kinetics:</b> Equilibrium and steady-state assumptions- Michaelis -Menten equation-significance of $K_m$ Value- MM & LB plots - Enzyme regulation.	➤ Determine the chemical reaction catalyzed by enzymes.	K5
<b>IV</b>	<b>CARBOHYDRATE METABOLISM</b>		
4.1	<b>Carbohydrate metabolism:</b> Glycolysis – Pentose phosphate pathway - citric acid cycle-oxidative phosphorylation. Gluconeogenesis - Cori cycle. Glycogen metabolism: Glycogenesis - Glycogenolysis - Adenylate cascade system-Regulation of glycogen synthesis – Intermediate metabolism.	➤ Explain the fundamental biochemical process that ensures constant supply of energy to living cells	K2
<b>V</b>	<b>PROTEIN AND LIPID METABOLISM</b>		

<b>5.1</b>	<b>Metabolism of Proteins:</b> Deamination, transamination and trans-deamination.	➤ Determine the biochemical process responsible for the synthesis of proteins	K5
<b>5.2</b>	<b>Metabolism of lipids:</b> β oxidation – alpha oxidation - omega oxidation - synthesis of triacylglycerols -	➤ Determine the synthesis and degradation of lipids in cells, involving the breakdown or storage of fats for energy.	K5
<b>5.3</b>	<b>Synthesis of essential amino acids:</b> methionine and valine - synthesis of purine and pyrimidine nucleotides.	➤ Analyze the pathways involved in the synthesis of essential amino acids.	K4

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY205	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	-	L	-	-	M	-	-	-	L	-	-	M
CO2	-	M	-	M	-	-	-	H	-	-	-	M	-
CO3	L	-	-	-	L	-	-	-	M	-	-	-	H
CO4	-	-	M	-	-	-	-	L	-	-	M	-	M
CO5	H	-	-	-	M	-	H	-	-	L	-	-	-
CO6	-	M	-	H	-	L	-	-	M	-	-	H	-

L - Low                                  M - Medium                                  H - High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation</li> <li>3. End Semester Examination</li> </ol>



Indirect
1. Course-end survey

## ELECTIVE – II: IMMUNOLOGY

**Semester: II**

**Code: P19ZY2:2**

**Credits : 4**

**Total hrs: 60 (Total hrs per week: 4)**

### 1. COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO.No.	COURSE OUTCOME	LEVEL	UNIT
CO1	Interpret the structure and functions of lymphoid organs.	K5	I
CO2	Explains the functions of Complements and its mechanism to form Membrane attack complex.	K5	II
CO3	Interpret the types and functions of MHC complex	K5	III
CO4	Explains about tumor antigens and its immune response.	K5	IV
CO5	Appraise the role of vaccines in treating diseases	K5	IV
CO6	Elaborate the importance of immunotechniques	K6	V

### 2. A. Syllabus:

#### Unit – I IMMUNITY AND ITS TYPES

**12Hrs**

**Immunity:** Innate and Acquired immunity- Ultra structure and functions of primary and secondary lymphoid organs. Cell types - origin and specific functions. Antigens and Immunogens - characteristics - epitopes. **Immunoglobulins:** 3D structure-classes- antigenic determinants- class switching-generation of antibody diversity.

#### Unit – II CELL MEDIATED IMMUNITY AND COMPLEMENTS PATHWAY

**12Hrs**

**Immune response:** antigen recognition- processing and presentation-interaction of T and B cells – cell mediated and humoral immunity - cytokines and immune response – immunological memory – agglutination - antigen-antibody interactions – complements - classical and alternative pathway and immunological significance.

**Unit – III MAJOR HISTOCOMPATIBILITY COMPLEX AND TRANSPLANTATION IMMUNOLOGY**

**12Hrs**

**Major Histocompatibility Complex:** structure of MHC molecules –types - MHC and antigens presentation. **Transplantation immunology:** HLA typing-immunology of graft rejection- Hypersensitivity reactions -immunotolerance and autoimmune diseases

**Unit – IV CANCER IMMUNOLOGY AND IMMUNODEFICIENCY DISEASES**

**12Hrs**

**Immunology of cancer:** tumor antigens- immune response to tumor antigens - immuno therapy.

**Primary immunodeficiency:** SCID **-Secondary immunodeficiency:** Immunological abnormalities associated with AIDS – CD4 and CD8 cells. **Vaccines:** Vaccination schedule - Polysaccharide vaccines-toxoids- vaccines from recombinants vectors- DNA vaccines.

**Unit – V IMMUNOTECHNIQUES**

**12Hrs**

**Immunotechniques: Precipitin reactions:** immunodiffusion and immunoelectrophoresis RIA–ELISA-Western blotting- Complement fixation -Flow cytometry - Monoclonal antibody production -principles of immunohistochemistry- Fluorescent immunoassay (FIA).

**B. Topics for Self-Study:**

Sl. No.	TOPICS	WEB-LINKS
1.	Lymphocyte antigen Receptor	<a href="https://www.sciencedirect.com/topics/neuroscience/lymphocyte-antigen-receptor">https://www.sciencedirect.com/topics/neuroscience/lymphocyte-antigen-receptor</a>
2.	. Generation of T cell receptor ligands.	<a href="https://www.pnas.org/content/109/45/E3111">https://www.pnas.org/content/109/45/E3111</a>
3.	The immune response in health and disease.	<a href="https://www.sciencedirect.com/science/article/abs/pii/S0950355205800033">https://www.sciencedirect.com/science/article/abs/pii/S0950355205800033</a>
4.	Immunity at mucosal surfaces.	<a href="https://www.sciencedirect.com/science/article/pii/B9780128119242000067">https://www.sciencedirect.com/science/article/pii/B9780128119242000067</a>

**C. Text Book:**

Roitt, I.M., and Delves, P.J. Roitt's Essential Immunology. 10th Ed., Oxford: Blackwell Science, 2000

**D. Reference Books:**

1. Goldsby, R.A., Kindt, T. J. and Osborne, B. A. Kuby's Immunology. 5th Ed., WH Freeman & Co., 2003.
2. Abbas, A.K. and Lichtman, A.H. Cellular and Molecular Immunology. 6th Ed., Saunders Elsevier, 2007.
3. Janeway, C. Immunobiology. 5th Ed., Garland Publications, 2001.
4. Benjamin, E., Richard, C., and Sunshine, G. Immunology: A Short Course. 4th Ed., John Wiley, New York, 2000.
5. Tizard, I.R. Immunology 4th Ed., Thomson, Singapore, 2004.
6. Chakravarty, A.K. Immunology and Immunotechnology. Oxford University Press. New Delhi, 2000.

#### E. Weblinks

1. <https://www.niaid.nih.gov/research/immune-system-overview>
2. [https://www.cell.com/immunity/comments/S1074-7613\(00\)80641-X](https://www.cell.com/immunity/comments/S1074-7613(00)80641-X)
3. <https://www.ncbi.nlm.nih.gov/books/NBK27156/>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit/Section	Contents	Specific Learning Outcomes	Highest Bloom's taxonomy Level of transaction
<b>1</b>	<b>IMMUNITY AND ITS TYPES</b>		
1.1	Immunity –Introduction- History of Immunology Types- Innate immunity- barriers-First line of defense, Second line of defense, Third line of defense	➤ Explain immunity and its types	K5
	Acquired immunity – Natural active, Artificial active, Natural passive, Artificial passive	➤ Distinguish the types of barriers and the types of defenses	K4
1.2	Ultra-structure and functions of primary and secondary lymphoid organs	➤ Explain the structure of lymphoid organs and its functions.	K5

1.2	Cell types Lymphoid & Myeloid lineage	➤ Explain the types of cell lineages	K5
	Functions of Lymphoid & Myeloid lineage	➤ Compare the types of lymphoid and myeloid lineages	K5
1.3	Antigens and Immunogens	➤ Classify the types of antigens	K4
	Types of antigens Properties of antigens	➤ ➤ Compare the difference between antigens and immunogens.	K4 K5 K4
	Difference between antigens & immunogens Epitopes	➤ Explain the properties of antigens  ➤ Distinguish the epitopes and its types.	
1.4	Immunoglobulins- types- Ig G,A,M,D,E Class switching	➤ Interpret the basic structure of immunoglobulin	K5
		➤ Explain the types of Immunoglobulins structure and its functions	K6
1.5	Generation of Antibody diversity Heavy chain & light chain rearrangements	➤ Analyse the process of class switching and its types	K4
		➤ Elaborate the mechanism of generation of antibody diversity and Heavy chain & light chain rearrangements	K6
<b>II</b>	<b>CELL MEDIATED IMMUNITY AND COMPLEMENTS PATHWAY</b>		
2.1	Immune response antigen recognition- processing and presentation. Antigen processing and presenting cells –MHC Class I & MHC Class II	➤ Analyse the immune response	K4
		➤ Elaborate the process of antigen recognition and processing and presentation.	K6
		➤ Explain the antigen processing and presentation	K5

2.2	Interaction of T and B cells T Helper cells & T cytotoxic cells in antigen processing	<ul style="list-style-type: none"> <li>➤ Compare the process of interaction of T cells and B cells in antigen processing.</li> </ul>	K5
2.3	Cell mediated and humoral immunity Cell mediated immunity- cytotoxic cells – Dendritic cells, TC CD8 cells,ADCC- perforated channels- antigen degradation. Humoral immunity- Activation of B cells-	<ul style="list-style-type: none"> <li>➤ Explain the process of cell mediated immunity in antigen degradation.</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤</li> <li>➤ Elaborate the process of humoral immunity and activation of B cells.</li> </ul>	K6
2.4	Cytokines and immune response Types and its functions	<ul style="list-style-type: none"> <li>➤ Categorise the types of cytokines .</li> </ul>	K4
		<ul style="list-style-type: none"> <li>➤</li> <li>➤ Explain the process of immune response induced by cytokines</li> </ul>	K5
2.5	Immunological memory Clonal expansion & clonal differentiation of B cells	<ul style="list-style-type: none"> <li>➤ Explain the process of immunological memory</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ Elaborate the process of Clonal expansion &amp; clonal differentiation of B cells</li> </ul>	K6
2.5	Agglutination reaction Antigen antibody interactions	<ul style="list-style-type: none"> <li>➤ 1.Explain the process of agglutination reaction</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ 2.Examine the process of antigen antibody interaction</li> </ul>	K4
2.6	Complements - classical and alternative pathway- Opsonisation - immunological significance.	<ul style="list-style-type: none"> <li>➤ Explain the process of activation of complement pathway</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤</li> <li>➤ Explain the classical pathway and its functions</li> </ul>	K5
		<ul style="list-style-type: none"> <li>➤ Describe the alternative pathway and its functions</li> </ul>	
<b>III</b>	<b>MAJOR HISTOCOMPATIBILITY COMPLEX AND TRANSPLANTATION IMMUNOLOGY</b>		

3.1	Major Histocompatibility Complex Structure of MHC molecules Types – Class I, Class II, Class III	➤ explain the structure and functions of Major histocompatibility complex.	K5
		➤ classify and determine the types of MHC involved in antigen processing and presentation	K5
	MHC and antigens presentation APCs and Antigens processing & presentation	➤ explain the process of antigen processing and presentation to T helper cells through MHC complex	K5
3.2	Transplantation immunology HLA – introduction	➤ classify the types of grafts used in transplantation processes	K4
	HLA typing Immunology of graft rejection –Kidney transplantation & Eye transplantation	➤ explain the process of HLA typing ➤ explain the process of graft rejection in kidney transplantation and in eye transplantation	K5
3.3	Hypersensitivity reactions Types- I,II,III,IV,V	➤ distinguish the types of hypersensitivity reaction and the diseases associated to it.	K4
		➤ list out the various pharmacological mediators involved in hypersensitivity reaction.	K4
3.4	Immunotolerance Central tolerance Peripheral tolerance	➤ classify the types of immunological tolerance	K4
	Autoimmune diseases Types- systemic	➤ compile the significance of	K6

3.5	& organ specific	auto immune diseases.	
		➤ list out the types of auto immune diseases	
<b>IV</b>	<b>CANCER IMMUNOLOGY AND IMMUNODEFICIENCY DISEASES</b>		
4.1	Immunology of cancer Tumor antigens- Types 1. Tumor antigens recognised by T-lymphocytes 2. Tumor antigens identified by xenogeneic antibodies	➤ list out the types of tumor antigens	K4
		➤ interpret the significance of tumor antigens recognised by xenogeneic antibodies	K5
4.2	Immune response to tumor antigens Immune response by T & B cells	➤ explain the mechanism of cell mediated and humoral immune response to tumor cells.	K5
4.3	Immuno therapy. Active immunization Passive therapy	➤ interpret the process of immune therapy to tumors.	K5
		➤ compare the types of immune therapy to tumors.	K5
4.4	Cytokines	➤ explain the role of cytokines in immune response.	K5
		➤ list out the types of cytokines.	K4
4.5	Primary immunodeficiency SCID- symptoms & deficiency of immune cells	➤ define SCID	K5
		➤ ➤ explain the types of immunodeficiency	K5
		➤ analyse the symptoms of primary immunodeficiency	K6

4.6	Secondary immunodeficiency Immunological abnormalities associated with AIDS – CD4 and CD8 cells Symptoms- Immune cells Vaccines Vaccination schedule	➤ Elaborate the process of secondary immunodeficiency with immunological abnormalities	K6
		➤ Interpret the role of CD4 and CD8 cells in AIDS	K5
4.5	Polysaccharide vaccines Types – Hib, Meningococcal vaccines Outer membrane protein vaccines Conjugate vaccines Toxoids      Tetanus Toxoids	➤ Explain the Types of vaccines	K5
	Vaccines from recombinants vectors Multivalent subunit vaccine DNA Vaccines DNA as adjuvant - Mucosal adjuvant	➤ Explain the role of polysaccharide vaccines, ➤ Conjugate vaccines, toxoid vaccines and recombinant vaccines.	K5
		➤ ➤ Compare the role of the different vaccines and its significance	K5
V	<b>IMMUNOTECHNIQUES</b>		
5.1	Immunotechniques Introduction to immunotechniques Precipitin reactions Agglutination reaction Agglutination Vs. Precipitation reactions	➤ Compare the process of precipitin reactions and agglutination reactions.	K5
		➤ Explain the mechanism of antigen antibody interaction	K5



5.2	Immunodiffusion techniques Ouchterlony Gel Diffusion	➤ Explain the significance of immunodiffusion techniques.	K5
5.3	Immunoelectrophoresis- Two step double diffusion technique.	➤ List out its applications.	K4
		➤ Describe the importance of immunoelectrophoresis techniques.	K3
5.4	RIA Principle & Applications	➤ Elaborate the principle and applications of RIA	K5
5.5	ELISA Types – Direct, Indirect, Sandwich	➤ Define ELISA	K3
		➤ Describe the types of ELISA and its role in detecting the presence of antigen and antibody	K3
5.6	Western blotting Principle & Applications	➤ Explain the principle and applications of Western blotting technique	K6
5.7	Complement fixation Antibody detection test – Principle & Applications	➤ Elaborate the process of complement fixation in antibody detection	K5
		➤ List out the applications of Complement fixation test	K4
5.8	Flow cytometry Principle, Procedure & Applications	➤ Explain the process of flow cytometry and list out its applications.	K5
5.9	Monoclonal antibody production Establishment of Hybridoma Production of monoclonal antibodies	➤ Elaborate the process of production of monoclonal antibody	K6
		➤ Explain the process of establishment of Hybridoma ➤ Define the media used for Hybridoma technology	K5
		➤ Analyse the role of immunohistochemistry in antibody detection	K4
5.10	FIA -Fluorescent immunoassay	➤ Explain the principle and applications of Fluorescent immunoassay	K5

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY2:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	L	M	M	H	H	M	H	M	M	H	H	H
CO2	H	M	M	M	H	H	M	H	M	M	H	H	H
CO3	H	H	H	H	H	H	H	H	M	M	H	H	H
CO4	H	-	H	H	H	H	H	H	M	M	H	H	H
CO5	H	-	H	H	H	H	H	H	M	M	H	H	H
CO6	H	-	H	M	H	H	H	H	M	M	H	H	H

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation,</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

### ELECTIVE – III: BIOSTATISTICS

Semester: II

Code: P19ZY2:3

Credits: 2

Total hrs: 60 (Total hrs per week: 4)

#### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO. No.	COURSE OUTCOME	LEVEL	UNIT
CO1	Explain the methods of data collection in biological research	K5	I
CO2	Compare and interpret results by chi-square and ANOVA among two or more populations	K4	II
CO3	Compare and interpret the various distribution methods	K4,K3	III
CO4	Examine the hypotheses and compare the data using student 't' test.	K4	IV
CO5	Verify and evaluate the basic concepts of statistics using SPSS.	K6,K4	V
CO6	Analyse the statistical inference by correlation and regression	K4	V

#### 2. A. Syllabus:

##### Unit I COLLECTION OF DATA

12Hrs

Collection of Data: Primary and Secondary data – Classification and tabulation of Data – Diagrams and Graphs – Frequency Distribution

##### Unit – II MEASURES OF CENTRAL TENDENCY

12Hrs

Measures of Central tendency – Averages – Measures and Dispersion – Probability: Types of Probability-Application of Principles of Probability to Biological Problems – Chi-square test

##### Unit- III STATISTICAL DISTRIBUTIONS

12Hrs

Binomial Distribution – Poisson Distribution – Normal Distribution and their applications.

**Unit – IV SAMPLING METHODS****12Hrs**

Inference about population – sampling methods – Hypothesis testing – student’s t-Test

**Unit – V STATISTICAL ANALYSIS****12Hrs**

ANOVA – Correlation – Regression - Applications of SPSS package.

**B. Topics for Self- Study:**

S.No.	TOPICS	WEB LINKS
1.	Sampling methods	<a href="https://towardsdatascience.com/sampling-techniques-a4e34111d808">https://towardsdatascience.com/sampling-techniques-a4e34111d808</a>
2.	Probability	<a href="https://www.statisticshowto.com/probability-sampling/">https://www.statisticshowto.com/probability-sampling/</a> <a href="https://research-methodology.net/sampling-in-primary-data-collection/probability-sampling/">https://research-methodology.net/sampling-in-primary-data-collection/probability-sampling/</a>
3.	New statistical packages	<a href="https://en.wikipedia.org/wiki/List_of_statistical_software">https://en.wikipedia.org/wiki/List_of_statistical_software</a>
4.	Statistical distributions	<a href="http://www.stat.rice.edu/~dobelman/textfiles/DistributionsHandbook.pdf">http://www.stat.rice.edu/~dobelman/textfiles/DistributionsHandbook.pdf</a>

**C. Text Books:**

1. An Introduction to Biostatistics, Gurumani.N Second Revised Edition,2008 www. MJP
2. publishers, Chennai,
3. Palanichamy S and M. Manoharan,- Statistical methods for Biologists, , Paramount
4. Publications, 2009
5. Pranab Kumar Banerjee Revised Edition, Introduction to Biostatistics, S. Chand
6. Publishers, 2011

**D. Reference Books:**

1. McCleery, R.H. and WATT, T.A., Introduction to Statistics for Biology, 3rd Ed., 2007 Chapman & Hall/CRC,
2. Gupta S P, Statistical Methods S.Chand & Sons, 2008.
3. Zar, J.H, Biostatistical analysis – Prentice Hall Inc., New Jersey, USA, 1974.

**E. Weblinks:**

1. <https://statisticsbyjim.com/basics/measures-central-tendency-mean-median-mode/>
2. <https://www.survevsystem.com/correlation.htm>
3. <https://www.statisticshowto.com/probability-and-statistics/regression-analysis/>
4. <https://www.statisticshowto.com/probability-and-statistics/chi-square/>

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Sl.No.	Content	Specific Learning outcome	Highest Bloom’s Taxonomic Level of

			<b>Transaction</b>
<b>1</b>	<b>Collection of data</b>		
1.1	Collection of data	<ul style="list-style-type: none"> <li>➤ Explain the collection of data</li> <li>➤ Classify the data.</li> </ul>	K2 K3
1.2	Graphical representation	<ul style="list-style-type: none"> <li>➤ Compare and Interpret the data using graphs</li> </ul>	K4 K2
1.3	Frequency distribution	<ul style="list-style-type: none"> <li>➤ Construct the diagram/graph using the data</li> </ul>	K5
<b>II</b>	<b>Measures of Central tendency</b>		
2.1	Measures of Central tendency- Mean	<ul style="list-style-type: none"> <li>➤ Examine the length or width of the given molluscan shell and calculate the mean value</li> </ul>	K3
52.2	Measures of Central tendency- Median	<ul style="list-style-type: none"> <li>➤ Justify the length or width of the given molluscan shell and calculate the mean value</li> </ul>	K4
2.3	Measures of Central tendency- Mode	<ul style="list-style-type: none"> <li>➤ Justify the length or width of the given molluscan shell and calculate the mean value</li> </ul>	K4
2.4	Measures of Dispersion	<ul style="list-style-type: none"> <li>➤ Justify the length or width of the given molluscan shell and calculate the mean value</li> </ul>	K4
2.5	Probability & Types	<ul style="list-style-type: none"> <li>➤ Assess the degree of uncertainty numerically using probability</li> </ul>	K6
2.6	Chi square test	<ul style="list-style-type: none"> <li>➤ Find out degree of discrepancy between observed and expected frequency using the chi square test .</li> </ul>	K1
<b>III</b>	<b>Statistical Distributions</b>		
3.1	Binomial Distribution	<ul style="list-style-type: none"> <li>➤ Examine the statistical data using binomial distribution</li> </ul>	K4
3.2	Poisson Distribution	<ul style="list-style-type: none"> <li>➤ Analyse the statistical quality of the data using Poisson distribution</li> </ul>	K4
3.3	Normal Distribution	<ul style="list-style-type: none"> <li>➤ Design the statistical quality control experiment using normal</li> </ul>	K5

		distribution	
IV	<b>SAMPLING METHODS</b>		
4.1	Sampling methods	➤ Catogorise the different types of sampling methods	K4
4.2	Student's t-Test	➤ Verify the test the significance of a single mean when the population variance is unknown	K6
V	<b>Statistical Analysis</b>		
5.1	ANOVA	➤ Analyse the significance of differences in means and the variance by using ANOVA method	K3
5.2	Correlation	➤ Compare two different types of data using correlation analysis	K4
5.3	Regression	➤ Examine the average between two or more variables.	K4
5.4	Applications of SPSS package	➤ Analyse the data using SPSS software	K4

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY2:3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	M	H	H	L	M	-	-	L	H	L	H	H
CO2	H	M	H	H	L	M	-	-	L	H	L	H	L
CO3	H	-	M	M	-	M	-	-	-	L	L	H	L
CO4	H	M	M	M	-	M	-	-	-	L	L	H	L
CO5	H	-	M	M	-	M	-	-	-	L	-	H	L
CO6	H	M	M	H	-	M	-	-	-	L	-	H	L

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
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- |  |
|--|
| <ol style="list-style-type: none"><li>1. Continuous Assessment Test I, II</li><li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation</li><li>3. End Semester Examination</li></ol> |
| Indirect   |
| <ol style="list-style-type: none"><li>1. Course-end survey</li></ol>   |

**CORE PRACTICAL – III : LAB IN ANIMAL PHYSIOLOGY AND  
IMMUNOLOGY/ENDOCRINOLOGY**

**Semester: II**

**Code: P19ZY2P3**

**Credits : 3**

**Total hrs: 75 (Total hrs per week: 5)**

**1. COURSE OUTCOMES**

On completion of this course, the students will be able to:

<b>CO.No.</b>	<b>COURSE OUTCOME</b>	<b>LEVEL</b>	<b>PRACTICALS</b>
CO1	Apply the physiological concepts in experiments	K3	<b>I</b>
CO2	Interpret the results in physiological experiments.	K5	<b>I</b>
CO3	Identify the tissues of different endocrine organs	K3	<b>I</b>
CO4	Apply the immunological techniques in biology	K3	<b>II</b>
CO5	Analyze the various immunological disorders.	K4	<b>II</b>
CO6	Identify the tissues of lymphoid organs and Lymphocytes	K3	<b>II</b>

**2. A. Syllabus:**

**I ANIMAL PHYSIOLOGY**

**40Hrs**

1. Survey of digestive enzymes in Cockroach (Invertase, Amylase, Maltase, Protease and Lipase)
2. The rate of oxygen consumption in fish with reference to body weight.
3. Rate of salt loss and salt gain in crab.
4. Estimation of urea in the blood and urine by DAM method.
5. Effect of Humulin on blood glucose level (Demonstration)
6. ECG (Demonstration).
7. **Prepared Slides:** T.S of endocrine organs: Pituitary, thyroid, parathyroid, pancreas, adrenal, ovary and testis.

**II IMMUNOLOGY**

**35Hrs**

1. Differential counting of WBCs.
2. Blood grouping and Rh factor analysis.
3. Quantitative estimation of Thyroid hormone by ELISA (Demonstration).
4. Double immune-diffusion
5. WIDAL test
6. **Prepared Slides:** T.S of lymphoid organs: Thymus, Bone marrow, lymph node, spleen, T cells and B cells.



**B. Topics for Self-Study:**

Sl.No	TOPICS	WEB LINKS
1	Osmoionic regulation in Tilapia fish	<a href="https://www.slideshare.net/mndp_slide/osmo-regulation-in-fish-by-mndp-poonia">https://www.slideshare.net/mndp_slide/osmo-regulation-in-fish-by-mndp-poonia</a>
2.	Analysis of heat shock response	<a href="https://www.cell.com/molecular-cell/pdf/S1097-2765(16)00136-2.pdf">https://www.cell.com/molecular-cell/pdf/S1097-2765(16)00136-2.pdf</a>
3.	Immuno electrophoresis	<a href="https://www2.slideshare.net/SaajidaSultaana/immuno electrophoresis-169939054?from_action=save">https://www2.slideshare.net/SaajidaSultaana/immuno electrophoresis-169939054?from_action=save</a>
4.	Immuno precipitation	<a href="https://www2.slideshare.net/masumaactersani5/immunoprecipitation-84426921">https://www2.slideshare.net/masumaactersani5/immunoprecipitation-84426921</a>
5.	Monoclonal antibodies production	<a href="https://www2.slideshare.net/SrilaxmiMenon/monoclonal-antibody-production-and-hybridoma-technology">https://www2.slideshare.net/SrilaxmiMenon/monoclonal-antibody-production-and-hybridoma-technology</a>

**C. Text Books:**

1. Ghai. C.L, A Textbook of Practical Physiology, 6<sup>th</sup> Edition,2005, Jaypee Brothers, Medical Publishers, New Delhi.
2. Rajan. S and Selvi Christy. R, Experimental procedures in Life Sciences,1<sup>st</sup> Edition 2010, Anjanaa Book House, Chennai.

**D. Weblink:**

1. [https://laney.edu/rebecca\\_bailey/wp-content/uploads/sites/10/2017/07/Human-Physiology-Lab-Exercises-update-2017.pdf](https://laney.edu/rebecca_bailey/wp-content/uploads/sites/10/2017/07/Human-Physiology-Lab-Exercises-update-2017.pdf)

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Experiment	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomic level of Transaction
I	ANIMAL PHYSIOLOGY		

1.	Survey of digestive enzymes in Cockroach (Invertase, Amylase, Maltase, Protease and Lipase)	<ul style="list-style-type: none"> <li>➤ Examine the digestive system present in the Cockroach</li> <li>➤ Analyse the digestive enzymes present in Cockroach</li> </ul>	<b>K4</b>
2.	Rate of oxygen consumption in fish with reference to body weight.	<ul style="list-style-type: none"> <li>➤ Apply the concepts of respiration in fish.</li> <li>➤ Evaluate the rate of oxygen consumption in fish</li> <li>➤ Interpret the results with reference to body weight.</li> </ul>	<b>K5</b>
3.	Rate of salt loss and salt gain in crab.	<ul style="list-style-type: none"> <li>➤ Apply the concepts of osmo-ionic regulation in crab</li> <li>➤ Analyse the rate of salt loss and salt gain in different media</li> </ul>	<b>K4</b>
4.	Estimation of urea in the blood and urine(DAM method)	<ul style="list-style-type: none"> <li>➤ Compare the quantity of urea present in the blood and urine</li> <li>➤ Evaluate the normal level of urea in the samples.</li> <li>➤ Analyze the results and predict the diseases.</li> </ul>	<b>K5</b>
5.	Effect of Humulin on blood glucose level (Demo)	<ul style="list-style-type: none"> <li>➤ Estimate the blood glucose level with the effect of humulin</li> </ul>	<b>K5</b>
6.	ECG (Demo)	<ul style="list-style-type: none"> <li>➤ Interpret and read the ECG graph of a human heart.</li> <li>➤ Assess the heart rate of a human being.</li> </ul>	<b>K5</b>
7.	<b>Slides:</b> T.S of endocrine organs: Pituitary, thyroid, parathyroid, pancreas, adrenal, ovary and testis.	<ul style="list-style-type: none"> <li>➤ Identify the tissues of different endocrine organs</li> <li>➤ Distinguish the cells of various endocrine organs</li> </ul>	<b>K4</b>
<b>II</b>	<b>IMMUNOLOGY</b>		
1.	Differential counting of WBCs.	<ul style="list-style-type: none"> <li>➤ Identify the different types of WBCs in the blood smear.</li> <li>➤ Distinguish the types of WBCs by the structure of nucleus.</li> </ul>	<b>K4</b>
2.	Blood grouping and Rh factor analysis.	<ul style="list-style-type: none"> <li>➤ Apply the concepts of multiple allele to find out the blood group.</li> <li>➤ Identify the blood group and Rh factor.</li> </ul>	<b>K3</b>
3.	Quantitative estimation of Thyroid hormone by ELISA(Demo)	<ul style="list-style-type: none"> <li>➤ Estimate Thyroid <ul style="list-style-type: none"> <li>○ hormones by immunological</li> <li>○ techniques.</li> </ul> </li> </ul>	<b>K5</b>

4.	Double immune-diffusion	➤ Demonstrate the immunological technique Double immune diffusion	<b>K2</b>
5.	WIDAL test	➤ Detect typhoid by Widal test	<b>K5</b>
6.	<b>Slides:</b> T.S of lymphoid organs: Thymus, Bone marrow, lymph node , spleen, T cells and B cells	➤ Identify the tissues of lymphoid organs ➤ Distinguish the cells of lymphoid organs.	<b>K3</b>

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY2P3	P01	P02	P03	P04	P05	P06	P07	P08	P09	PSO 1	PSO 2	PSO 3	PSO 4
C01	H	M	H	H	H	H	M	H	-	H	H	M	M
C02	H	M	H	H	H	H	M	H	-	H	H	M	M
C03	H	M	H	H	H	H	M	H	-	H	H	M	M
C04	H	M	H	H	H	H	M	H	-	H	H	M	M
C05	H	M	H	H	H	H	M	H	-	H	H	M	M
C06	H	M	H	H	H	M	M	H	-	H	H	M	M

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
1. Continuous Assessment Test I, II  2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation.  3. End Semester Examination
Indirect
1. Course-end survey

## CORE PRACTICAL - IV: LAB IN BIOCHEMISTRY

Semester: II

Code: P19ZY2P4

Credits: 3

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO. No.	COURSE OUTCOMES	LEVEL	EXPERIMENTS
CO1	Evaluate the experiments based on biochemical calculations.	K5	1
CO2	Design & prepare the Acetate & Phosphate buffers.	K6	3
CO3	Evaluate the acid-base titration for pKa determination.	K5	3
CO4	Develop knowledge in structure, reactions and energy metabolism of the cellular biomolecules.	K6	4,5
CO5	Categorize & classify the micro molecules by TLC method	K5	8
CO6	Classify & separate the amino acids by Paper Chromatography method.	K5	9

### 2. A. Syllabus:

#### BIOCHEMISTRY

75Hrs

1. Preparation of solutions: i) Molarity ii) Normality iii) Percentage solution
2. Calculation of moles, millimoles and nanomoles
3. Basic and Standardization procedures
  - i) Preparation and testing of buffers: Acetate and Phosphate buffers.
  - ii) Acid-base titration and determination of pKa value.
  - iii) Measuring pH of different solutions.
4. Quantitative estimation of reducing sugars by Anthrone method.
5. Quantitative estimation of amino acids by ninhydrin method.
6. Quantitative estimation of protein by Lowry *et al.* method.
7. Quantitative estimation of nucleic acids.
8. Separation of micromolecules by Thin layer Chromatography: Sugars and drugs
9. Separation of micromolecules by Paper chromatography: Amino acids

**B. Topics for Self-Study:**

Sl.No	TOPICS	WEB-LINKS
1.	Estimation of Reducing Sugar by Dinitro Salicylic Method	<a href="https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry">https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry</a>
2.	Determination of Micro nutrients by colorimetric method	<a href="https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry">https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry</a>
3.	Estimation of Total soluble solids	<a href="https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry">https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry</a>
4.	Estimation of Total Phenolic compounds	<a href="https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry">https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry</a>
5.	Estimation of Flavanols	<a href="https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry">https://www.researchgate.net/publication/306034920_Laboratory_Manual_of_Biochemistry</a>

**C. Text Book:**

1. Laboratory Manual in Biochemistry: J.Jayaraman. Published by Wiley Eastern. 1981.

**D. Reference Books:**

1. Fundamentals of Biochemistry: A Practical Approach .Naren Kumar Dutta – 2005
2. Experimental Approaches in Biochemistry and Molecular Biology Henry M. Zeidan, William V. Dashek - 199

**E. Weblinks:**

1. [https://biolympiads.com/wp-content/uploads/2014/08/metodich\\_1.pdf](https://biolympiads.com/wp-content/uploads/2014/08/metodich_1.pdf)
2. <https://courses.lumenlearning.com/introchem/chapter/acid-base-titrations/>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit /Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
<b>BIOCHEMISTRY</b>			
1	Preparation of solutions: i) Molarity ii) Normality iii) Percentage solution	➤ Construct the experiments based on biochemical calculations.	K3
2.	Calculation of moles, millimoles and nanomoles	➤ Construct the experiments based on moles, millimoles and nanomoles.	K3
3	Basic and Standardization procedures	➤	
3.1	i) Preparation and testing of buffers: Acetate and Phosphate buffers.	➤ Apply the procedure to prepare the Acetate & Phosphate buffers.	K3
3.2	ii) Acid-base titration and determination of pKa value.	➤ Evaluate the acid-base titration for pKa determination.	K5
3.3	iii) Measuring pH of different solutions.	➤ Evaluate pH of different solutions	K5
4.	Quantitative estimation of reducing sugars by Anthrone method.	➤ Appraise the amount of reducing sugars in the biological samples.  ➤ Appraise the amount of reducing sugar in clinical samples	K5  K5
5.	Quantitative estimation of amino acids by ninhydrin method.	➤ Evaluate the amount of amino acids in the biological samples.  ➤ Appraise the amount of reducing sugar in clinical samples	K5  K5
6.	Quantitative estimation of protein by Lowry et al. method.	➤ Evaluate the amount of protein in the biological samples  ➤ Appraise the amount of protein in	K5  K5

		clinical samples	
7.	Quantitative estimation of nucleic acids.	<ul style="list-style-type: none"> <li>➤ Evaluate the amount of nucleic acids in the biological samples.</li> <li>➤ Appraise the amount of nucleic acid in clinical samples</li> </ul>	K5  K5
8.	Separation of micro molecules by Thin layer Chromatography: Sugars and drugs	<ul style="list-style-type: none"> <li>➤ Categorize &amp; classify the micro molecules by TLC method.</li> </ul>	K4
9.	Separation of micro molecules by Paper chromatography: Amino acids	<ul style="list-style-type: none"> <li>➤ Classify &amp; separate the amino acids by Paper Chromatography method.</li> </ul>	K4

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY2P4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	L	H	H	H	M	L	M	M	M	L	H	H
CO2	H	L	H	M	H	M	M	M	M	L	L	H	H
CO3	H	L	H	M	H	H	M	M	M	L	L	H	H
CO4	H	M	H	H	H	H	M	M	L	M	M	H	H
CO5	H	L	H	H	H	H	M	M	L	L	L	H	H
CO6	H	L	H	H	H	H	M	M	L	L	L	H	H

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation.</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE –VI: ENVIRONMENTAL BIOLOGY

Semester: III

Code: P19ZY306

Credits: 5

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO.No.	COURSE OUTCOMES	LEVEL	UNIT
CO1	Analyse the interrelation between abiotic and biotic environment and scope of Ecology	K4	I
CO2	Explain the characteristics of ecosystem.	K5	II
CO3	Explain the characteristics of population, Niche, Niche parameter.	K4	III
CO4	Compare ecological succession, equivalents and indicators.	K4	IV
CO5	Classify freshwater and marine habitats. List the characters of terrestrial habitat.	K2	V
CO6	Discuss the importance of biodiversity and its conservation.	K6	V

### 2. A. Syllabus:

#### UNIT-I ENVIRONMENTAL FACTORS & ECOSYSTEM 15Hrs

Importance and scope of ecology –**Environmental factors:** light – temperature – humidity – edaphic (soil) and biotic factors. Ecosystems: Characteristics of ecosystems - food chain – herbivorous and detritus food chains and food web - bio-magnification - Energy flow in an ecosystem– productivity - trophic levels.

#### Unit – II POPULATION ECOLOGY 15Hrs

**Population Ecology:** Definition, Characteristics of Population: Density - Natality–Mortality– Age distribution – Growth form–Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation – r and K strategists. Niche concept – Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche.

#### Unit – III COMMUNITY ECOLOGY 15Hrs

**Community Ecology:** Characteristics of a Community - Ecological succession–Primary andSecondary succession –Natural and man-influenced succession - Hydrarch and Xerarch -



Ecotone and Edge effect - Ecological equivalents - Ecotypes and Ecophenes - Ecological indicators.

**Unit – IV HABITAT ECOLOGY**

**15Hrs**

**Habitat Ecology:** Characteristics and types of fresh water and estuarine habitat. Marine habitat: Characteristics and types – Ecology of benthic zone, intertidal zone and deep sea. Physico -chemical characteristics of terrestrial habitat – Tundra, Forest, Desert and mountain biomes - Biogeographical zones of India.

**Unit-V BIODIVERSITY AND CONSERVATION**

**15Hrs**

**Biodiversity and its conservation**-global environmental change – biodiversity-status, monitoring and documentation-Megadiversity and hotspots - biodiversity management approaches. Conservation biology: Principles of conservation, major approaches to management, Indian initiatives for conservation (Project Tiger, Project Elephant Biosphere reserves).IUCN, Red Listed animals, Endangered animals, WWF and Wildlife Institutes in India.

**B. Topics for Self-Study:**

Sl.No.	TOPICS	WEB LINKS
1	Biogeochemical cycles, N C P	<a href="https://byjus.com/biology/biogeochemical-cycles/#:~:text=Biogeochemical%20cycles%20are%20basically%20divided,Phosphorus%2C%20Rock%20cycle%2C%20etc.">https://byjus.com/biology/biogeochemical-cycles/#:~:text=Biogeochemical%20cycles%20are%20basically%20divided,Phosphorus%2C%20Rock%20cycle%2C%20etc.</a>
2	Ecotoxicology	<a href="https://library.um.edu.mo/ebooks/b28113652.pdf">https://library.um.edu.mo/ebooks/b28113652.pdf</a>
3	Waste Treatment Technology	<a href="https://www.pseau.org/outils/ouvrages/wrc_wastewater_treatment_technologies_a_basic_guide_2016.pdf">https://www.pseau.org/outils/ouvrages/wrc_wastewater_treatment_technologies_a_basic_guide_2016.pdf</a>
4	Environmental Laws	<a href="https://en.wikipedia.org/wiki/Environmental_law">https://en.wikipedia.org/wiki/Environmental_law</a>
5	Types of biodiversity	<a href="https://www.vedantu.com/biology/biodiversity">https://www.vedantu.com/biology/biodiversity</a>

**C. Text Book:**

Odum, E.P. and Barrett, G.W. Fundamental of Ecology. 5th Ed.,2005 Cengage Learning India. New Delhi,

**D. Reference Books:**

1. PeterJ.R., Stephan, L.W., PauleH., Ceche S. and Bevlerly, M. Ecology,2008 Cengage learning India, New Delhi,
2. Wright, R.T., Environmental Science, 10th Ed., 2008 Pearson Education, New Delhi,
3. Smith T.M. and SmithR.L.,Elements of Ecology, 6th Ed., 2008 Pearson Education, New Delhi,
4. Kormondy E.J, Concepts of Ecology, 4th Ed.,1996 PHI Cengage Learning India, New Delhi,
5. Turk A. and Turk J., Environmental Science., 4th Ed., 1993 Saunders, Primark R.B., A Primer of Conservation Biology, 2nd Ed., 2000 Sinauer Associates

**E. Weblink:**

1. <https://nptel.ac.in/courses/127/106/127106004/>

**3.SPECIFIC LEARNING OUTCOMES (SLO):**

Unit/ Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomic Levels of Transaction
<b>I</b>	<b>ENVIRONMENTAL FACTORS AND ECOSYSTEM</b>		
1.1	Abiotic factors: Light, temperature, soil, water	➤ List out the abiotic factors	K4
		➤ Identify the role of light,soil,water ect...	K3
1.2	Biotic factors: symbiosis, commensalism, mutualism,predation, parasitism and competition	➤ Explain the animal interaction	K4
		➤ Justify the animal behaviours	K5
1.3	Biogeochemical cycles: Nitrogen, phosphorous.	➤ Examine the Biogeochemical cycles ➤ Analyse the importance of chemical cycles	K4 K5
1.4	Trophic levels: Food chain, Food web	➤ Assess the food habits	K5
1.5	Ecological Pyramids: Pyramid of biomass, number, and energy.	➤ Measure the classification of energy	K4
		➤ Measure the energy level	K5

		➤ Analyze the level of consumers	K5
II	<b>POPULATION ECOLOGY</b>		
2.1	Population : Definition - natality- mortality- age pyramids- population equilibrium- fluctuation- regulation	➤ Measure and classify the population characteristics	K5
2.2	Carrying capacity	➤ Explain the concept of CC	K5
2.3	Niche concept	➤ Classify the Niche concept	K4
3	<b>COMMUNITY ECOLOGY</b>		
3.1	<b>Community Ecology:</b> Types of community - characteristics of community – stratification – Carrying capacity	➤ Assess the types of community – characteristics	K5
3.2	Ecotone edge effect - ecological Niche - ecological succession.	➤ Compare and contrast the each aspect	K5
3.3	Ecosystem: Structure of Pond ecosystem.	➤ Analyze the pond ecosystem..	K5
3.4	Ecological indicators.	➤ explain the different level indicators ➤ survey the flora and fauna communities	K5
IV	<b>HABITAT ECOLOGY</b>		

4.1	Fresh water characteristics	➤ Estimate the distribution level	K5
4.2	Estuary	➤ Survey the flora and fauna communities	K4
4.3	Marine	➤ Survey the flora and fauna communities	K4
4.4	Concepts and levels of biodiversity	➤ Elaborate the concept and levels of biodiversity	K5
<b>V</b>	<b>BIODIVERSITY AND CONSERVATION</b>		
5.1	Biodiversity	➤ Elaborate the concept and levels of biodiversity	K3
5.2	– biodiversity-status, monitoring and documentation	➤ Elaborate and to develop the documentation skill	K3
5.3	Conservation biology	➤ Plan to conserve the endangered species	K6
5.4	Project Tiger, Project Elephant Biosphere reserves	➤ Plan to conserve the key stone species	K3
5.5	IUCN, Red Listed animals, Endangered animals, WWF and Wildlife Institutes in India	➤ Take part in conservatory aspects	K4

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P15ZY306	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	H	H	H	H	H	H	-	H	-	H	H
CO2	H	H	H	H	H	M	H	H	-	H	-	H	M

<b>CO3</b>	H	H	H	H	H	-	H	H	-	H	-	H	-
<b>CO4</b>	H	H	H	H	H	H	H	H	H	H	-	H	H
<b>CO5</b>	H	H	M	H	H	H	M	H	H	H	-	-	H
<b>CO6</b>	H	H	H	H	H	M	H	H	-	H	-	H	H

L-Low

M-Moderate

H- High

## 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE-VII: DEVELOPMENTAL BIOLOGY

Semester: III

Code: P19ZY307

Credits : 5

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO.No	COURSE OUTCOMES	LEVEL	UNIT
CO1	Illustrate the basic principles of growth and development in animals.	K2	I
CO2	Interpret the axis and pattern formation in <i>Drosophila</i> .	K5	II
CO3	Explain the environmental regulation of animal development	K5	III
CO4	Examine the metamorphosis in amphibia and regeneration in salamander.	K4	IV
CO5	Justify the concepts of organiser in determining the fate of developing embryos	K5	IV
CO6	Identify the role of genes in the embryonic development.	K3	V

### 2. A. Syllabus:

#### Unit – I FERTILIZATION IN MAMMALS

15Hrs

Introduction to Developmental Biology- spermatogenesis and oogenesis in mammals - **Fertilization in mammals:** translocation and capacitation of sperm - cell surface interactions between egg and sperm -gamete fusion- cleavage and formation of blastula- gastrulation and formation of germ layers.

#### Unit – II CELL DIFFERENTIATION

15Hrs

Concepts of induction, competence, totipotency, cell specification, commitment, determination and morphogenetic gradients - cell lineages – cell differentiation and cell aggregation in *Dictyostelium* -axis and pattern formation in *drosophila* – gradient and polarity.

#### Unit – III ORGANOGENESIS

15Hrs

**Organogenesis:** Development and differentiation in *Caenorhabditis elegans*–development of vertebrate eye – development of tetrapod limb. **Environmental regulation of animal development:** developmental symbiosis - nutritional and seasonal polyphenism. **Abnormal development:** Teratoma and teratogens.

**Unit – IV ORGANISER****15Hrs**

**Organiser:** Spemann’s experiment- functions of organiser–mechanism of noggin, chordin, Follistatin, BMP4, Wnt, FGF and retinoic acid for the action of organiser. **Metamorphosis in amphibia:** morphological changes associated with metamorphosis. **Regeneration:** Mechanism of regeneration in salamander. **Ageing:** The biology of senescence.

**Unit – V GENES IN DEVELOPMENT****15Hrs**

**Genes in Gonad development:** Function of SF1, WNT4, SRY, SOX genes. **Genes in embryonic development:** Role of Homeobox genes in Drosophila and Hox genes in Mouse. Concepts of GeneKnock out, Genomic imprinting and Genomic equivalence.

**B. Topics for Self-Study:**

Sl.No.	TOPICS	WEB LINKS
1.	Zebrafish early and Late development	<a href="https://embryology.med.unsw.edu.au/embryology/index.php/Zebrafish_Development">https://embryology.med.unsw.edu.au/embryology/index.php/Zebrafish_Development</a>
2.	Development of central nervous system in vertebrates	<a href="https://www.britannica.com/science/nervous-system/The-vertebrate-system">https://www.britannica.com/science/nervous-system/The-vertebrate-system</a>
3.	Germ cell specification and migration	<a href="https://link.springer.com/article/10.1007/s12522-014-0184-2">https://link.springer.com/article/10.1007/s12522-014-0184-2</a>
4.	Model organism in developmental Biology	<a href="https://blog.addgene.org/plasmids-101-five-popular-model-organisms">https://blog.addgene.org/plasmids-101-five-popular-model-organisms</a>
5.	Medical implications of Developmental Biology.	<a href="https://www2.slideshare.net/AYSHA007/medical-implication-of-developmental-biology?from_action=save">https://www2.slideshare.net/AYSHA007/medical-implication-of-developmental-biology?from_action=save</a>

**C. Text Books:**

1. Gilbert B.F., Developmental Biology, 8th Ed., 2006 Sinaur Associates Inc. Publishers, Sunderland, Massachusetts, USA,
2. Veer Bala Rastogi, Chordate Embryology, 2016, Kedar Nath Ram Nath

**D. Reference Books:**

1. Wolpert L, Principles of Development, 2nd Ed., 2002 Oxford University Press,
2. Twyman R.M. Developmental Biology, 2008 Viva, New Delhi,
3. Balinsky B.I., An Introduction to Embryology, 5th Ed., 2004 Thomas Asia Pvt. Ltd.,
4. Russo V.E.A, Brody S., Cove D and Ottolenghi S, Development: The Molecular Genetic Approach, 1992 Springer Verlag, Berlin,
5. Rao.V, Developmental Biology: A Modern Synthesis, 1994 Oxford IBH New Delhi.

### E. Weblinks:

1. <https://nptel.ac.in/courses/102/106/102106084/>
2. <http://mcb.berkeley.edu/courses/mcb141/lecturetopics/Levine/engrailed.pdf>
3. <https://plato.stanford.edu/entries/biology-developmental/notes.html>

### 3 SPECIFIC LEARNING OUTCOMES (SLO):

Unit/ Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomic Levels of Transaction
<b>I</b>	<b>FERTILIZATION IN MAMMALS</b>		
1.1	Introduction: Spermatogenesis and Oogenesis	<ul style="list-style-type: none"> <li>➤ Recall the formation of gametes</li> <li>➤ Relate the structure and functions of egg and ova</li> </ul>	<b>K1</b>
1.2	Fertilization in mammals Translocation and Capacitation of sperm, cell surface interactions between egg and sperm , gamete fusion	<ul style="list-style-type: none"> <li>➤ Explain the process of fertilization in mammals.</li> <li>➤ Examine cell surface interactions</li> </ul>	<b>K4</b>
1.3	Cleavage formation of blastula, gastrulation, formation of germ layers	<ul style="list-style-type: none"> <li>➤ Explain the process of cleavage</li> <li>➤ Evaluate the formation of blastula and gastrula</li> </ul>	<b>K5</b>
<b>II</b>	<b>CELL DIFFERENTIATION</b>		
2.1	Concepts of induction, competence, totipotency, cell specification, commitment	<ul style="list-style-type: none"> <li>➤ Relate induction, competence and totipotency</li> <li>➤ Illustrate cell specification and commitment</li> </ul>	<b>K2</b>
2.2	Cell lineages, cell differentiation and cell aggregation in <i>Dictyostelium</i>	<ul style="list-style-type: none"> <li>➤ Determine cell lineages</li> <li>➤ Summarize the cell differentiation and aggregation in <i>Dictyostelium</i></li> </ul>	<b>K5</b>



2.3	Axis and pattern formation in <i>Drosophila</i> , Gradient and polarity	<ul style="list-style-type: none"> <li>➤ Examine Axis and pattern formation in <i>Drosophila</i></li> <li>➤ Illustrate Gradient and Polarity</li> </ul>	<b>K4</b>
<b>III</b>	<b>ORGANOGENESIS</b>		
<b>3.1</b>	<b>Organogenesis</b> Development and differentiation in <i>Caenorhabditis elegans</i> Development of vertebrate eye, Development of tetrapod limb	<ul style="list-style-type: none"> <li>➤ Explain the development and differentiation of <i>Caenorhabditis elegans</i></li> <li>➤ Influence of organizer in the development of vertebrate eye</li> <li>➤ Examine the Development of tetrapod limb</li> </ul>	<b>K5</b>
3.2	<b>Environmental regulation of animal development</b> Developmental symbiosis -nutritional and seasonal polyphenism	<ul style="list-style-type: none"> <li>➤ Explain the Environmental regulation of animal development</li> <li>➤ Illustrate Developmental Symbiosis</li> <li>➤ Relate the importance of nutritional and seasonal polyphenism</li> </ul>	<b>K5</b>
3.3	<b>Abnormal development:</b> Teratoma and teratogens.	<ul style="list-style-type: none"> <li>➤ Analyse the causes of Teratoma</li> <li>➤ Classify the types of teratogens</li> </ul>	<b>K4</b>
<b>IV</b>	<b>ORGANISER</b>		
<b>4.1</b>	<b>Organiser</b> Spemann's experiment, mechanism of noggin, chordin, Follistatin	<ul style="list-style-type: none"> <li>➤ Interpret Spemann's experiment of organiser</li> <li>➤ Examine the mechanism of noggin, chordin, Follistatin through Spemann's experiment</li> </ul>	<b>K4</b>
4.2	BMP4, Wnt, FGF and retinoic acid for the action of organizer	<ul style="list-style-type: none"> <li>➤ Distinguish BMP4, Wnt, FGF and retinoic acid for the action of organizer</li> </ul>	<b>K4</b>
4.3	<b>Metamorphosis in amphibian</b> Morphological changes associated with metamorphosis	<ul style="list-style-type: none"> <li>➤ Asses the morphological changes during metamorphosis in Amphibia.</li> </ul>	<b>K3</b>
4.4	<b>Regeneration:</b> Mechanism of regeneration in salamander.	<ul style="list-style-type: none"> <li>➤ Explain the Mechanism of regeneration in salamander</li> </ul>	<b>K5</b>

4.5	<b>Ageing:</b> The biology of senescence	<ul style="list-style-type: none"> <li>➤ Categorize the agents of senescence</li> <li>➤ Explain in detail the biology of aging</li> </ul>	<b>K5</b>
<b>V</b>	<b>GENES IN DEVELOPMENT</b>		
5.1	<b>Genes in Gonad development</b> Function of SF1, WNT4, SRY, SOX genes	<ul style="list-style-type: none"> <li>➤ Justify the function of Genes in Gonad development</li> <li>➤ Evaluate the function of SF1, WNT4, SRY, SOX genes in development</li> </ul>	<b>K5</b>
5.2	<b>Genes in embryonic development</b> Role of Homeobox genes in Drosophila and Hox genes in Mouse	<ul style="list-style-type: none"> <li>➤ Compare the role of Homeobox genes in Drosophila and Hox genes in mouse</li> </ul>	<b>K4</b>
5.3	Concepts of Gene Knock out, Genomic imprinting and Genomic equivalence.	<ul style="list-style-type: none"> <li>➤ Summarise the Concepts of Gene Knock out, Genomic imprinting and Genomic equivalence</li> <li>➤ Illustrate the concepts of Gene Knockout</li> <li>➤ Explain the importance of Genomic imprinting and Genomic equivalence</li> </ul>	<b>K2</b>

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY307	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	H	M	M	-	H	H	H	H	H	H	-
CO2	H	H	H	M	M	-	H	H	H	H	H	H	-
CO3	H	H	H	M	M	-	H	H	H	H	H	H	-
CO4	H	H	H	M	M	-	H	H	H	H	H	H	-
CO5	H	H	H	M	M	-	H	H	H	H	H	H	-
CO6	H	H	H	M	M	-	H	H	H	H	H	H	-

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1.Continuous Assessment Test I, II</li> <li>2.Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE-VIII: GENETICS

Semester: III

Code: P19ZY308

Credits: 5

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES:

On completion of this course, the students will be able to:

CO. No	COURSE OUTCOMES	LEVEL	UNIT
CO1	Interpret the Mendelian law of inheritance.	K4	I
CO2	Compare the nuclear and maternal inheritance of genes	K4	II
CO3	Elaborate the environmental effects and gene expression	K6	III
CO4	Analyze the concepts of Microbial genetics	K4	IV
CO5	Discuss the perception of Evolutionary and population genetics	K6	V
CO6	Assess the importance of human genetics and its related disorders	K5	V

### 2. A. Syllabus:

#### Unit I MENDELIAN GENETICS

15Hrs

**Mendelian Genetics:** Mendelian laws of inheritance–**Classical Genetics:** Linkage–crossing over–types and mechanics – chromosome mapping –Heterogametic and Homogametic – Haplodiploidy-Mosaics and Gynandromorphs. Human Y chromosome - evolution, structure, molecular organization and its role in sex determination- Dosage compensation.

#### Unit-II MATERNAL INHERITANCE AND GENE EXPRESSION

15Hrs

Extranuclear inheritance and maternal effects: Organelle heredity (mitochondria) - Infectious heredity (Cytoplasmic inheritance) in symbionts (Paramecium and Drosophila). **Maternal inheritance:** Ephestia pigmentation and snail coiling. **Environmental effects and gene expression**– Phenocopies- Twin studies and IQ- Concordance – Discordance- Penetrance and expressivity.

#### Unit-III MICROBIAL GENETICS:

15Hrs

**Microbial Genetics:** Evidence of genetic materials in Bacteria. **Bacterial transformation:** molecular mechanism- mapping by transformation. **Bacterial conjugation:** insertion of F into the bacterial chromosome- Hfr transfer- recombination in recipient cells. Transduction: DNA transfer by means of transduction- cotransduction and linkage. **Specialized transducing particles:** Phagemids, Cosmids -characteristics- role as cloning vectors.

#### Unit-IV EVOLUTIONARY POPULATION GENETICS:

15Hrs

**Evolutionary Genetics:** Genetics of races and species formation–genetic load–genetic polymorphism – X inactivation – genomic imprinting.

**Population Genetics:** Gene pool and gene frequencies–equilibrium of gene frequencies–Hardy-weinberg equilibrium – changes in gene frequencies- factors affecting Hardy-weinberg equilibrium.

**Unit-V HUMAN GENETICS**

**15Hrs**

**Human Genetics:** Pedigree construction, inheritance patterns (autosomal, sex -linked,sex -limited and sex-influenced)- Gene Mutation - Inborn errors of metabolism in man - Haemoglobin disorders – sickle cell anemia and thalassemia. Human karyotype preparation and chromosomal syndromes in man.

**B. Topics for Self-Study:**

Sl.No	TOPICS	WEB LINKS
1	Genetic Analysis of Inbreeding	<a href="https://www.ucl.ac.uk/~ucbhdjm/courses/b242/InbrDrift/InbrDrift.html">https://www.ucl.ac.uk/~ucbhdjm/courses/b242/InbrDrift/InbrDrift.html</a>
2	Parental Imprinting	<a href="http://atlasgeneticsoncology.org/Educ/GenomImprintID30027ES.html">http://atlasgeneticsoncology.org/Educ/GenomImprintID30027ES.html</a>
3	Mutant Genes in Bacteria	<a href="https://eujournal.org/index.php/esj/article/view/2518">https://eujournal.org/index.php/esj/article/view/2518</a>
4	Amniocentesis and Chorionic Biopsy	<a href="https://www.cdc.gov/mmwr/preview/mmwrhtml/00038393.htm#:~:text=CVS%20utilizes%20either%20a%20catheter,surrounds%20the%20fetus%20is%20removed">https://www.cdc.gov/mmwr/preview/mmwrhtml/00038393.htm#:~:text=CVS%20utilizes%20either%20a%20catheter,surrounds%20the%20fetus%20is%20removed</a>

**C. Text Book:**

1. Gardner E.J, Simmons, M.J. and Snustad D.P, Principles of Genetics, 7th Ed., 2007 John Wiley India,

**D. Reference Books:**

1. William K.S. and Cummings M. Concepts of Genetics, 7th Ed., 2011 Pearson Education Inc, Dorling Kindersley Publication,
2. Snustad D.P. and Simmons M.J. Genetics, VI Ed., 2012 John Wiley & Sons, Singapore,
3. Sudbery P, Human Molecular Genetics, 2nd Ed., 2009 Dorling Kindersley (India) Pvt. Ltd.,
4. Nancy T and Trempy J, Fundamental Bacterial Genetics, 2nd Ed., 2006 Malden MA; Blackwell Science,
5. Stent G.S. and Calendar R. Molecular Genetics: An Introductory Narrative, 2nd Ed., 2004 CBS Publishers and Distributors, New Delhi,
6. Klug W.S. and Cummings M.R. Concepts of Genetics. 7th Ed., 2003 Pearson Education,
7. Russell P.J. Genetics: A Molecular Approach, 2nd Ed., 2006 Pearson Education,

8. Maloy S.R., Cronan, J.E. and Freifelder, D. Microbial Genetics 2nd Ed., 2008 Narosa Publishing House, New Delhi,
9. Pasternak, J.J. An Introduction to Molecular Human Genetics. 2000 Fritzgerald Science Press, Bethesda
10. Hancock, J.T. Molecular Genetics. 2008 New Delhi.

**E. Weblinks:**

1. <https://nptel.ac.in/courses/102/104/102104052/>
2. [https://onlinecourses.swayam2.ac.in/cec20\\_bt03/preview](https://onlinecourses.swayam2.ac.in/cec20_bt03/preview)

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Unit/ Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
<b>I</b>	<b>MENDELIAN GENETICS</b>		
1.1	Mendelian genetics	➤ Define the laws of inheritance	<b>K1</b>
1.2	Classical genetics	➤ Elaborate the concepts of linkage and crossing over	<b>K6</b>
1.3	Chromosome mapping	➤ Explain the types and significance of chromosome mapping	<b>K6</b>
1.4	Human chromosomes	➤ Assess the evolutionary concepts of chromosome	<b>K5</b>
		➤ Determine the molecular level of organization	<b>K5</b>
		➤ Identify the concept behind sex determination and dose compensation	<b>K3</b>
<b>II</b>	<b>MATERNAL INHERITANCE AND GENE EXPRESSION</b>		
2.1	Extranuclear inheritance and maternal effects	➤ Explain the heredity of mitochondria	<b>K5</b>
		➤ Classify the various Cytoplasmic inheritance in Symbionts	<b>K2</b>
2.2	Maternal inheritance	➤ Elaborate about the Ephesian pigmentation	<b>K6</b>
		➤ explain about the coiling process occur in snail	
2.3	Environmental effects & gene expression	➤ Interpret the role of gene expression in phenotypes.	<b>K5</b>
<b>III</b>	<b>MICROBIAL GENETICS</b>		
3.1	Microbial Genetics	➤ Analyse the importance of genetic materials in bacteria	<b>K5</b>
3.2	Bacterial transformation	➤ Explain about molecular mechanism	<b>K2</b>
		➤ by transformation technique	
3.3	Bacterial Conjugation	➤ Explain about the Hfr transfer and recombination technique in bacterial cells	<b>K5</b>
		➤ Elaborate the process of DNA transduction and linkages	<b>K6</b>

3.4	Transducing particles	➤ Categorize and explain the specialized transducing vectors	<b>K4</b>
		➤ Explain the role of cloning vectors	<b>K5</b>
<b>IV</b>	<b>EVOLUTIONARY POPULATION GENETICS</b>		
4.1	Evolutionary Genetics	➤ Assess the genetics of races and species formation	<b>K5</b>
		➤ Explain the genetic polymorphism	<b>K5</b>
		➤ Elaborate the process of genomic imprinting	<b>K5</b>
4.2	Population Genetics	➤ Summarise the concepts of gene pool and gene frequencies	<b>K2</b>
		➤ Evaluate Hardy Weinberg equilibrium	<b>K5</b>
		➤ Estimate changes occur due to gene frequencies	<b>K5</b>
		➤ Analyze the factors affecting Hardy-Weinberg equilibrium.	<b>K2</b>
<b>V</b>	<b>HUMAN GENETICS</b>		
5	Human Genetics	➤ Evaluate the inheritance pattern through pedigree chart	<b>K5</b>
		➤ Explain the concept of gene mutations with examples	<b>K5</b>
		➤ Explain the concept of Human karyotype preparation	<b>K2</b>
		➤ Find out the various chromosomal syndromes in mam	<b>K1</b>

#### 4 MAPPING SCHEME FOR THE PO, PSOS AND COS:

<b>P19ZY308</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PSO 1</b>	<b>PSO 2</b>	<b>PSO 3</b>	<b>PSO 4</b>
<b>CO1</b>	H	H	H	M	M	M	M	M	H	M	H	M	H
<b>CO2</b>	H	M	H	H	H	H	M	H	M	H	H	H	H
<b>CO3</b>	H	H	H	H	H	-	H	H	H	H	H	H	H
<b>CO4</b>	H	H	H	H	H	-	H	H	M	H	H	H	H
<b>CO5</b>	H	H	H	H	M	H	-	H	H	H	H	H	H
<b>CO6</b>	H	H	H	H	H	H	H	H	H	H	H	H	H

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## Core IX Research Methodology and Biotechniques

Semester: III

Code: P19ZY309

Credit: 5

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO.No.	COURSEOUTCOMES	LEVEL	UNIT
CO1	Apply the Statistical principles and skills in biological research	K3	I
CO2	Analyse, review and assess critically scientific hypotheses and theories using scientific evidence and information	K6,K4	II
CO3	Design to the learning process of how to write thesis and how to publish papers in various journals	K5	II
CO4	Investigate the various chemical compounds using chromatographic technique	K4	III
CO5	Explain the principles and applications of spectrophotometry and electrophoresis	K4	IV
CO6	Select and use the animal cell culture technique	K3	V

### 2. A. Syllabus:

#### Unit – I COMPONENTS OF RESEARCH

15Hrs

**Research:** Objectives–types–significance–Components of research- Research process -  
**Research Design:** need-features of a good design–concepts-principles of Experimental design.Selection and Defining of a research problem- **Sources and retrieval of information:** journals, monographs, books –computer aided searches - Offline and Online journals -search engines- Formulating a research Hypothesis

#### Unit – II THESIS WRITING

15Hrs

**Thesis writing:** format of thesis- preparation of manuscript and editing - forms of presentation of results-components of Discussion- citing the references - Research papers for publication-writing a research proposal-Impact factor-citation index- manuscript preparation- IPR and patenting.

#### Unit – III CHROMATOGRAPHY & CENTRIFUGATION

15Hrs

**Chromatography:** Principle and methodology of column, ion exchange and affinity chromatography -GLC and HPLC-**Centrifugation:** Differential and gradient centrifugation-Ultra centrifuge-Principles and applications of Autoradiography and X-ray crystallography.

**Unit –IV      SPECTROPHOTOMETRY & ELELCTROPHORESIS      15Hrs**

**Spectrophotometry:** Principle, methodology and applications of Atomic absorbance spectrophotometer, Flame Photometer, UV-VIS spectrophotometer, Nuclear magnetic resonance spectrometry (NMR).**Electrophoresis:** Principle, types, procedure and applications. Cell lines-cell lines culture.

**Unit – V      ANIMAL CELL CULTURE TECHNIQUES      15Hrs**

**Animal Cell culture Techniques:** Design and functioning of tissue culture laboratory- Cell proliferation measurements- Cell viability testing- Culture media preparation. Types of culture: -Flask, Test tube, Organ and Embryo culture. Protoplast culture. Stem cell culture. Cryopreservation for cells, Tissues and organisms. Germplasm storage: Cryobank - Pollen bank and sperm bank.

**B. Topics for Self-Study:**

Sl.No	TOPICS	WEB LINKS
.		
1.	Patenting	<a href="https://www.government.nl/topics/intellectual-property/question-and-answer/what-are-the-criteria-for-patenting-my-invention">https://www.government.nl/topics/intellectual-property/question-and-answer/what-are-the-criteria-for-patenting-my-invention</a>
2.	Crystallography	<a href="https://en.wikipedia.org/wiki/Crystallography">https://en.wikipedia.org/wiki/Crystallography</a>
3.	cell line culture	<a href="file:///C:/Users/Dell/Downloads/2015_Bookmatter_TheImpactOfFoodBioactivesOnHea.pdf">file:///C:/Users/Dell/Downloads/2015_Bookmatter_TheImpactOfFoodBioactivesOnHea.pdf</a>
4	Stem cell culture	<a href="https://www.creative-bioarray.com/support/stem-cell-culture-guide.htm">https://www.creative-bioarray.com/support/stem-cell-culture-guide.htm</a> <a href="https://microbenotes.com/stem-cells/">https://microbenotes.com/stem-cells/</a>

**C. Text Book:**

1. Kothari, C.R. Research Methodology: Methods and Techniques. 2nd Ed.,2004 New Age International Publishers, New Delhi,

**D. Reference Books:**

1. Pingoud, A. Biochemical Methods. 2003 Wiley-VCH,
2. Venn, R.F. Principles and Practice of Bioanalysis. 2003 Taylor & Francis,
3. Holme, D.J. and Peck, H. Analytical Biochemistry. 3rd Ed.,1998 Pearson Education,
4. Wilson, K. and Walker, J. Practical Biochemistry: Principles and Techniques. 5th Ed.,2000 Cambridge University Press,
5. Wilson, K. and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed.,2010 Cambridge University Press,
6. Holmes, D., Moody, P., Dine, D., Moody, P. andHolmes, D.S. Research Methods for the Biosciences. 2006 Oxford University Press, New Delhi,



7. Ramadass, P. and Wilson Aruni, A. Research and Writing-across the Disciplines.2009  
MJP Publishers, Chennai.

**E. Weblinks:**

1. <https://www.mayoclinic.org/tests-procedures/in-vitro-fertilization/about/pac->
2. <https://microbenotes.com/polyacrylamide-gel-electrophoresis-page/>
3. <https://assets.thermofisher.com/TFS-Assets/LSG/manuals/D21111.pdf>
4. [https://atecentral.net/downloads/1163/Basics\\_of\\_Cell\\_Culture\\_students\\_manual\\_v7.pdf](https://atecentral.net/downloads/1163/Basics_of_Cell_Culture_students_manual_v7.pdf)

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Unit/ section	Content	Specific Learning Outcome	Highest Bloom's Taxonomic Level of Transaction
<b>I</b>	<b>COMPONENTS OF RESEARCH</b>		
1.1	Introduction	➤ Define research	K6
1.2	Types of research	➤ Classify and explain the types of research	K4
1.3	Sources & retrieval of information	➤ Compare the various methods in reteriving of information for research	K4
1.4	Research design	➤ Discuss in detail the important concepts related to research design	K6
		➤ Explain briefly the parts of research design	K2
<b>II</b>	<b>THESIS WRITING</b>		
2.1	Thesis writing	➤ Explain the structure of thesis	K4
2.2	Impact factor & citation index	➤ Compare and interpret the research publications	K4
2.3	IPR& Patent	➤ Create the IPR & patent for your indogeneous research findings	K5
<b>III</b>	<b>CHROMATOGRAPHY &amp; CENTRIFUGATION</b>		
3.1	Chromatography – Column, Ion	➤ Classify the types of chromatography	K3

	exchange, Affinity		
3.2	Centrifugation – GLC,HPLC  Differential &gradient,  Ultra centrifuge	<ul style="list-style-type: none"> <li>➤ Explain the principle of various centrifugation methods.</li> <li>➤ Justify centrifugation is a best separation method</li> </ul>	K4   K6
3.3	Autoradiography	<ul style="list-style-type: none"> <li>➤ Classify and compare the components present in the biological material using autoradiography</li> </ul>	K4
3.4	X-ray crystallography	<ul style="list-style-type: none"> <li>➤ Predict the molecular structure using X - ray crystallography</li> </ul>	K5
<b>IV</b>	<b>SPECTROPHOTOMETRY &amp; ELELCTROPHORESIS</b>		
4.1	Spectrophotometry  Atomic absorbance  Flame photometer  UV-VIS  NMR	<ul style="list-style-type: none"> <li>➤ Analyse and categorise the various molecules present in the biological sample using Spectrophotometry,Atomicabsorbance,Flame photometer</li> <li>➤ UV-VIS,NMR</li> </ul>	K4
4.2	Electrophoresis	<ul style="list-style-type: none"> <li>➤ Use the electrophoresis technique to separate the molecules based on MW</li> </ul>	K3
4.3	Cell Line-culture	<ul style="list-style-type: none"> <li>➤ How will you formulate a animal cell line culture for your research</li> </ul>	K5
<b>V</b>	<b>ANIMAL CELL CULTURE TECHNIQUES</b>		
5.1	Design and functioning of tissue culture laboratory	<ul style="list-style-type: none"> <li>➤ Plan and Construct a tissue culture laboratory based on your need</li> </ul>	K5
5.2	Cell viability testing	<ul style="list-style-type: none"> <li>➤ Verify the cell viability using cell viability testing method</li> </ul>	K6
5.3	Culture media preparation	<ul style="list-style-type: none"> <li>➤ Compose various culture medias according to your need</li> </ul>	K5

5.4	Types of culture: Protoplast culture Stem cell culture Cryo preservation for cells	➤ Construct a protoplast culture laboratory and the use of stem cell culture method	K5
5.5	Germplasm storage Cryobank, Pollenbank	➤ Formulate and explain the germ plasm storage technique.  ➤ Construct a cryobank or pollen bank in your area	K5  K5

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY309	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO3	PSO4
CO1	H	H	H	H	H	H	-	-	-	H	M	H	M
CO2	H	H	H	H	H	H	-	-	-	H	M	H	M
CO3	M	M	M	H	H	H	-	-	-	M	-	H	M
CO4	M	M	L	H	H	H	-	-	-	-	M	H	H
CO5	M	M	L	H	H	H	-	-	--	-	M	H	H
CO6	M	M	L	M	H	H	-	-	-	-	M	H	H

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation,</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

**CORE PRACTICAL - V: LAB IN ENVIRONMENTAL  
BIOLOGY, DEVELOPMENTAL BIOLOGY AND GENETICS**

**Semester III**

**Code: P19ZY3P5**

**Credits: 3**

**Total hrs: 75 (Total hrs per week: 5)**

**1. COURSE OUTCOMES:**

On completion of this course, the students will be able to:

<b>CO.No.</b>	<b>COURSEOUTCOMES</b>	<b>LEVEL</b>	<b>PRACTICALS</b>
CO1	Qualitatively and qualitatively estimate different ecological parameters.	K3	I
CO2	Interpret the results of qualitative and quantitative estimations	K5	I
CO3	Identify the embryonic development of chick and frog	K3	I
CO4	Apply the immunological techniques in biology	K3	II
CO5	Examine different genetic traits and chromosomal aberrations in Human being	K4	III
CO6	Prepare a pedigree chart for chromosomal traits	K3	III

**2. A. Syllabus:**

**I ENVIRONMENTAL BIOLOGY**

**35Hrs**

Different ecological parameters.

Spatial variations of dissolved oxygen concentration in water and percentage saturation

Estimation of Dissolved free carbon dioxide

Estimation of Nitrates

Estimation of Total Hardness

Estimation of Total Alkalinity

Estimation of Total Phosphates

**II DEVELOPMENTAL BIOLOGY**

**20Hrs**

Observation of sperms in Bull's semen

Observation of blastoderm in chick embryo

**Slides:** Whole mount of early hours of chick embryo development (24 Hrs, 48 Hrs, 72 and 96 hours). Yolk Plug stage, neural plate, neural fold and neural tube of frog

### III GENETICS

20Hrs

Pedigree analysis

Study of various genetic traits in Human being

Preparation of Human karyotype

Identification of syndromes

Study of sex chromatin in human buccal smear.

#### B. Topics for Self-Study:

Sl.No.	TOPICS	WEB LINKS
1	BOD, COD	<a href="#">Biochemical Oxygen Demand - an overview   ScienceDirect Topics</a> , <a href="#">What is Chemical Oxygen Demand (COD)? - Definition from Corrosionpedia</a>
2.	Histology techniques	<a href="#">Histological Techniques</a>
3.	Embryonic stem cells	<a href="#">Embryonic Stem Cells   stemcells.nih.gov</a>
4.	Gene manipulation	<a href="#">Genetic Manipulation: Definition, Pros &amp; Cons - Video &amp; Lesson Transcript   Study.com</a>
5.	NGS technology	<a href="#">Next-Generation Sequencing (NGS)   Explore the technology (illumina.com)</a>

#### C. Weblinks:

- <http://tumkuruniversity.ac.in/wp-content/uploads/2014/11/ENV-SCIENCE.pdf>
- [file:///C:/Users/dell/Downloads/BIO\\_150L\\_new\\_course.pdf](file:///C:/Users/dell/Downloads/BIO_150L_new_course.pdf)
- [https://bangaloreuniversity.ac.in/wp-content/uploads/2018/08/Syllabus-B.Sc\\_-Genetics-2018.pdf](https://bangaloreuniversity.ac.in/wp-content/uploads/2018/08/Syllabus-B.Sc_-Genetics-2018.pdf)

**3. SPECIFIC LEARNING OUTCOME (SLO):**

Unit/ Section	Contents	Specific Learning Outcomes (SLO)	Highest Blooms Taxonomic level of Transaction
<b>I</b>	<b>ENVIRONMENTAL BIOLOGY</b>		
1.1	Spatial variations of dissolved oxygen concentration in water and percentage saturation	➤ Evaluate the oxygen saturation according to space	<b>K3</b>
1.2	Estimation of Dissolved free carbon dioxide	➤ Qualitatively estimate different water quality parameters.	<b>K4</b>
	Estimation of Nitrates		
	Estimation of Total Hardness		
	Estimation of Total Alkalinity		
	Estimation of Total Phosphates		
<b>II</b>	<b>DEVELOPMENTAL BIOLOGY</b>		
2.1	Observation of sperms in Bull's semen	➤ Examine the motility and fertility of bull semen	<b>K5</b>
2.2	Observation of blastoderm in chick embryo  <b>Slides:</b> Whole mount of early hours of chick embryo development (24 Hrs, 48 Hrs, 72 and 96 hours).	➤ Observe and identify different embryonic stages of chick	<b>K4</b>
2.3	Yolk Plug stage, neural plate, neural fold and neural tube of frog	➤ Observe and identify different embryonic stages and metamorphosis of frog	<b>K3</b>
<b>III</b>	<b>GENETICS</b>		
3.1	Pedigree analysis	➤ Classify the traits	<b>K4</b>
3.2	Study of various genetic traits in Human being	➤ Categorize the allosomal and autosomal characters	<b>K4</b>
3.3	Preparation of Human karyotype	➤ Infer the chromosomal aberrations	<b>K4</b>

3.4	Identification of syndromes	➤ Discuss the cause of the human syndromes	<b>K6</b>
3.5	Study of sex chromatin in human buccal smear	➤ classify the gender using the methodology	<b>K4</b>

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P15ZY3P5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	M	M	M	L	M	M	H	H	H
CO2	H	M	M	H	M	M	M	M	H	M	-	L	H
CO3	H	H	M	M	L	M	M	L	M	-	H	M	H
CO4	H	M	H	M	H	H	L	M	H	M	H	-	H
CO5	H	H	M	H	H	M	-	L	M	-	-	-	H
CO6	H	H	M	H	H	M	M	L	M	L	H	M	H

L-Low

M-Moderate

H- High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Sample analysis, Record</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>



## ELECTIVE - IV: ANIMAL BIOTECHNOLOGY/GENOMICS AND PROTEOMICS

Semester: III

Code: P19ZY3:4/P19ZY3:A

Credit: 4

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

On completion of this course, the students will be able to:

CO.No.	COURSE OUTCOMES	LEVEL	UNIT
CO1	Discuss fundamental concepts and tools used in recombinant DNA technology	K6	I
CO2	Develop methodology to establish animal cell culture	K6	II
CO3	Create transgenic animal breeds.	K6	III
CO4	Create the importance of genetic engineering in transgenic animal production	K6	IV
CO5	Build techniques in medical biotechnology for the production of therapeutic proteins, vaccines and targeted gene therapies	K6	V
CO6	Design public policy, bio safety, and intellectual property rights issues related to animal biotechnology.	K6	V

### 2. A. Syllabus:

#### Unit – I RECOMBINANT DNA TECHNOLOGY

15Hrs

Introduction- brief history -Recombinant DNA technology: Steps in rDNA technology. Molecular tools: restriction enzymes and DNA manipulative enzymes – gene cloning vectors: plasmids, phagemids, cosmids, bacteriophages, artificial chromosomes (BACs, PACs, YACs, MACs, and HACs)- shuttle vectors, prokaryotic and eukaryotic expression vectors - specialized vectors for expression of foreign gene.

#### Unit – II GENOMIC LIBRARIES

15Hrs

Construction of cDNA - genomic DNA libraries – preparation of radioactive and nonradioactive probes- screening of libraries using oligo probes and antibodies-Nucleic acid amplification and its application in medicine– DNA sequencing- site directed mutagenesis and protein engineering.

#### Unit – III GENETIC ENGINEERING IN ANIMALS

15Hrs

Genetic engineering in animals: methods of transferring genes in to animals oocytes, eggs embryos and specific tissues (physical chemical and biological methods)- cell lines and their applications-transgenic animals (mice, cow, goat, pigs, sheep and insects)

**Unit – IV MEDICAL BIOTECHNOLOGY****15Hrs**

Medical biotechnology: Animal biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins - gene therapy- cloning. Human Genome project: objectives, strategies and progress.

**Unit – V BIOTECHNOLOGICAL APPLICATIONS****15Hrs**

Bioremediation - Types : Insitu – Exsitu – Strategy – Applications and Advantages – Bio sensors, bioleaching, biochips and biofuels. Applications of Probiotics – Forensic Biotechnology: DNA finger printing. Environmental applications of biotechnology–Biosafety and Bioethics.

**B. Topics for Self-Study:**

Sl.No.	TOPICS	WEB LINK
1.	CRISPR	<a href="https://www.livescience.com/58790-crispr-explained.html">https://www.livescience.com/58790-crispr-explained.html</a>
2.	Lentivirus	<a href="https://old.abmgood.com/marketing/knowledge_base/The_Lentivirus_System.php">https://old.abmgood.com/marketing/knowledge_base/The_Lentivirus_System.php</a>
3.	Personalised medicines	<a href="https://healthitanalytics.com/features/what-are-precision-medicine-and-personalized-medicine">https://healthitanalytics.com/features/what-are-precision-medicine-and-personalized-medicine</a>
4.	<i>Bioreactors in Tissue Engineering</i>	<a href="https://www.oulu.fi/spareparts/ebook_topics_in_t_e_vol2/abstracts/korossis_0102.pdf">https://www.oulu.fi/spareparts/ebook_topics_in_t_e_vol2/abstracts/korossis_0102.pdf</a>
5.	Biosimilar	<a href="https://www.dovepress.com/biosimilars-an-overview-peer-reviewed-article-BS">https://www.dovepress.com/biosimilars-an-overview-peer-reviewed-article-BS</a>

**C. Text Book:**

1. Glick, B.R. and Pasternak, J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd Ed., 2007 ASM Press, Washington. Indian Reprint, 2007.

**D. Reference Books:**

1. Primrose, S.B. and Twyman, R.M. Principles of Gene Manipulation and Genomics. 2006, Blackwell Scientific Publications.
2. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. Introduction to Genetic Analysis. 8th Ed., 2005 W. H. Freeman and Company, New York.
3. Brown, T.A. Gene Cloning and DNA Analysis: An Introduction. 5th Ed., 2006 Blackwell Publishing.
4. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. Recombinant DNA. 2nd Ed., 1992 W. H. Freeman, Scientific American Books, New York.
5. Winnacker, E.L. From Genes to Clones: Introduction to Gene Technology. 2003 Panima Publishing Corporation, New Delhi.
6. Tamarin, R.H. Principles of Genetics. 7th Ed., 2006 Tata-McGraw Hill Publishing Company Ltd., New Delhi.

7. Kreuzer, H. and Massey, A. Recombinant DNA and Biotechnology. 2nd Ed., 2001 ASM Press, Washington.

**E. Weblink:**

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=350>

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Unit/ Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomical Level of Transaction
<b>I</b>	<b>RECOMBINANT DNA TECHNOLOGY</b>		
1.1	Brief introduction to Animal Biotechnology and History	➤ Define the basics of animal biotechnology	K2
1.2	<b>Recombinant DNA technology:</b> Steps in rDNA technology	➤ Illustrate basic steps in rDNA technology	K6
1.3	Restriction enzymes and DNA manipulative enzymes	➤ Define the role of restriction enzymes in DNA manipulation	K1
1.4	Plasmids, phagemids, cosmids, bacteriophages, artificial chromosomes (BACs, PACs, YACs, MACs, and HACs) - shuttle vectors, prokaryotic and eukaryotic expression vectors	➤ Construct novel vectors for efficient gene transfer	K6
1.5	Specialized vectors for expression of foreign gene		K6
<b>II</b>	<b>GENOMIC LIBRARIES</b>		
2.1	Genomic DNA libraries	➤ Explain expression of genomic libraries in host cells	K5
2.2	Preparation of radioactive and nonradioactive probes		
2.3	Screening of libraries using oligo probes and antibodies		
2.4	Nucleic acid amplification and its application in medicine	➤ Develop new PCR amplification techniques	K6

2.5	DNA sequencing	& their role in disease identification	K4
2.6	Site directed mutagenesis and protein engineering.		K6
III	<b>GENETIC ENGINEERING IN ANIMALS</b>		
3.1	<b>Genetic engineering in animals:</b> Methods of transferring genes in to animal oocytes, eggs embryos and specific tissues (physical chemical and biological methods)	➤ Develop novel method of gene transfer techniques in to animals & cell lines	K6
3.2	Cell lines and their applications- transgenic animals (mice, cow, goat, pigs, sheep and insects)		K6
IV	<b>MEDICAL BIOTECHNOLOGY</b>		
4.1	<b>Medical biotechnology:</b> Animal biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins	➤ Improve the production of food supplements through animal biotechnology	K6
4.2	Gene therapy- cloning	➤ Develop new gene therapy strategies	K6
4.3	Human Genome Project: Objectives, strategies and progress	➤ Define the basics of human genome project & its application.	K1
V	<b>BIOTECHNOLOGICAL APPLICATIONS</b>		
5.1	Bioremediation Types: In situ – Ex situ – Strategy	➤ Develop strategies for production & application of novel bioremediation methods	K6
5.2	Bioremediation: Biosensors, bioleaching, biochips and biofuels.		K6
5.3	Applications of Probiotics		K6
5.4	Applications: Healthcare; Agriculture & Industry		K6
5.5	DNA finger printing	➤ Improve the quality of DNA finger printing	K6

5.6	Environmental applications of biotechnology	➤ Propose new policies to protect & restore the quality of environment	K6
5.7	Biosafety and Bioethics	➤ Define legal & socio, economic issues related to biotechnology and their ethical issues	K2

#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY3:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	M	-	L	-	L	-	-	-	-	M	-	L	-
CO2	-	H	-	-	-	-	-	H	-	-	-	-	M
CO3	L	-	-	H	-	M	-	-	L	-	L	-	-
CO4	-	L	-	-	L	-	H	-	M	-	-	-	M
CO5	L	-	-	-	-	H	-	-	-	L	-	-	-
CO6	-	-	M	-	-	-	-	M	-	-	M	L	-

L - Low

M - Medium

H - High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation.</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>

## CORE-X: EVOLUTION AND ANIMAL BEHAVIOUR

Semester- IV

Code: P19ZY410

Credits: 4

Total hrs: 75 (Total hrs per week: 5)

### 1. COURSE OUTCOMES

After completing this course, the students will be able to:

NO	COURSE OUTCOMES	LEVEL	UNIT
CO1	Explain the origin of life on earth and theories with evidences	K5	I
CO2	Define the various factors which affected the evolution of sex and reproductive strategies	K3	II
CO3	Illustrate the concept of speciation and evolutionary time scale	K3	III
CO4	Explain the evolutionary history of man	K5	IV
CO5	Relate the different aspects of environmental perception and communication in animals.	K3	IV
CO6	Explain the various aspects of behavior and social organization in animals	K5	V

### 2. A. Syllabus:

#### Evolution

#### Unit – I DARWINISM AND LAMARKISM

15Hrs

Origin of life – Abiogenesis – Cosmozoic and naturalistic theories – chemical evolution and origin of life – evidences and objections –Lamarckism – Mutation theory of De Vries –Darwinism : Theory of Natural selection – Facts that influence Darwins thoughts - Current challenges to Darwinism: DNA and protein phylogenies – protein evolution and neutrality theory – Molecular evolutionary clock, Micro and macroevolution. Evolution of sex and reproductive strategies.

#### Unit – II ISOLATION, SPECIATION AND PALAENTOLOGY

15Hrs

Isolation and Speciation: Isolating mechanism – Pre and post zygotic – origin of isolation –Koopman's experiment - Speciation – definition – modes – Sympatric –allopatric and quantum speciation.The evolutionary time scale: eras-periods and epoch-major events in the evolutionary time scale. Fossil history and phylogeny of man – Cultural evolution and evolutionary future of mankind – Concepts of Exobiology.

#### Animal Behaviour

#### Unit – III ETHOLOGY

15Hrs

Introduction to Ethology - Animal psychology, classification of behavioural patterns, analysis of behaviour (ethogram) - Reflexes and complex behavior - Perception of the environment: mechanical, electrical, chemical, olfactory, auditory and visual - Neural and hormonal control of behavior - Genetic and environmental components in the development of behavior - Communication: Chemical, visual, light and audio, evolution of language (primates).

**Unit – IV ANIMAL BEHAVIOUR AND BIOLOGICAL RHYTHMS 15Hrs**

Ecological aspects of behaviour: Habitat selection, food selection, optimal foraging theory, anti-predator defenses, aggression, homing, territoriality, dispersal, host-parasite relations. Biological rhythms: Circadian and circannual rhythms, orientation and navigation, migration of fishes and birds. Learning and memory: Conditioning, habituation, insight learning, association learning and reasoning.

**Unit – V REPRODUCTIVE BEHAVIOUR AND PARENTAL CARE 15Hrs**

Reproductive behavior: Mating systems, courtship, sexual selection, parental care. Social Organisation in Honey bees and Primates - aggregations, schooling in fishes, flocking in birds, herding in mammals, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, social organization in insects and primates.

**B. Topics for Self-Study:**

Sl.No.	TOPICS	WEB LINKS
1.	Phylogenetic trees	<a href="https://courses.lumenlearning.com/suny-wmopen-biology1/chapter/phylogenetic-trees/">https://courses.lumenlearning.com/suny-wmopen-biology1/chapter/phylogenetic-trees/</a>
2.	Molecular divergence	<a href="https://www.ncbi.nlm.nih.gov/books/?term=Molecular+divergence">https://www.ncbi.nlm.nih.gov/books/?term=Molecular+divergence</a>
3.	Molecular clocks	<a href="http://www.as.wvu.edu/~kgarbutt/QuantGen/Gen535Papers2/Molecular_Clocks.htm">http://www.as.wvu.edu/~kgarbutt/QuantGen/Gen535Papers2/Molecular_Clocks.htm</a>
4.	Chronopharmacology	<a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3885389/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3885389/</a> <a href="https://link.springer.com/chapter/10.1007/978-981-32-9779-1_16">https://link.springer.com/chapter/10.1007/978-981-32-9779-1_16</a>
5.	Animal Domestication	<a href="https://www.nationalgeographic.com/animals/reference/domesticated-animals/">https://www.nationalgeographic.com/animals/reference/domesticated-animals/</a> <a href="https://www.intechopen.com/books/animal-domestication/animal-domestication-a-brief-overview">https://www.intechopen.com/books/animal-domestication/animal-domestication-a-brief-overview</a>

**C. Text Books:**

1. Brian, K. H. and Benedikt Hall, G. Strickberger's Evolution. 4th Ed., 2008 Jones and Bartlett Publishers, Inc,

2. Goodenough, J., Betty, M. and Wallace, R.A. Perspectives on Animal Behaviour.1993 John Wiley,

**D. Reference Books:**

1. Futuyma, D.J.Evolutionary Biology. 3rd Ed.,1998 Sinauer Associates, Sunderland, Massachusetts,
2. Alcock, J. Animal Behaviour: An Evolutionary Approach. 7th Ed.,2001 Sinaur Associates, Inc.
3. Krebs, J.R and Davis, N.B. Behavioural Ecology. 3rd Ed., 1993 Blackwell,
4. Ridley, M. Evolution. 2nd Ed.,2004 Indian Edition. Blackwell Scientific Publishers, Oxford, UK,
5. Rastogi, V.B. Organic Evolution. 12th Ed., KedarNath Ram Nath, Meerut.

**E. Weblinks:**

1. <https://b-ok.asia/book/2325474/f08119>
2. <https://b-ok.asia/book/3504212/b99824>
3. <https://b-ok.asia/book/1250880/8dcac2>

**3. SPECIFIC LEARNING OUTCOMES (SLO):**

Unit /Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomy Levels of Transaction
<b>I</b>	<b>DARWINISM AND LAMARKISM</b>		
1.1	Origin of life – Abiogenesis – Cosmozoic and naturalistic theories – chemical evolution and origin of life – evidences and objections	➤ Explain how life might have originated on this planet	K2
1.2	Lamarckism – Mutation theory of De Vries –Darwinism : Theory of Natural selection – Facts that influence Darwins thoughts - Current challenges to Darwinism: DNA and protein phylogenies – protein evolution and neutrality theory	<ul style="list-style-type: none"> <li>➤ Compare Lamarckism and mutation theory for evolution</li> <li>➤ Explain Darwin's theories on natural selection and challenges</li> </ul>	K2
1.3	Molecular evolutionary clock, Micro and macroevolution. Evolution of sex and reproductive strategies.	➤ Compare micro and macro evolution	K2
<b>II</b>	<b>ISOLATION, SPECIATION AND PALAENTOLOGY</b>		



2.1	Isolation and Speciation: Isolating mechanism – Pre and post zygotic – origin of isolation –Koopman’s experiment - Speciation – definition – modes – Sympatric –allopatric and quantum speciation.	<ul style="list-style-type: none"> <li>➤ Explain the concept of speciation and gene regulation.</li> <li>➤ List out the examples and adaptation of both allopatric and sympatric speciation</li> </ul>	K4
2.2	The evolutionary time scale: eras-periods and epoch-major events in the evolutionary time scale.	<ul style="list-style-type: none"> <li>➤ Relate broad patterns in the fossil record to major geological events in time scale</li> </ul>	K1
2.3	Fossil history and phylogeny of man – Cultural evolution and evolutionary future of mankind. Concepts of Exobiology.	<ul style="list-style-type: none"> <li>➤</li> <li>➤ Explain hominid evolution by discussing landmark phylogenetic transition and also cultural evolution in relation to society.</li> </ul>	K5
III	<b>ETHOLOGY</b>		
3.1	Introduction to Ethology - Animal psychology, classification of behavioural patterns, analysis of behaviour (ethogram) - Reflexes and complex behavior -	<ul style="list-style-type: none"> <li>➤ Classify behavioral patterns and reflexes</li> </ul>	K4
3.2	Perception of the environment: mechanical, electrical, chemical, olfactory, auditory and visual - Neural and hormonal control of behavior - Genetic and environmental components in the development of behavior -	<ul style="list-style-type: none"> <li>➤ Analyse the significance of animal perception and develop methods to regulate animal behavior</li> </ul>	K6
3.3	Communication: Chemical, visual, light and audio, evolution of language (primates).	<ul style="list-style-type: none"> <li>➤ Illustrate the forms of communication in animals and its role in language development.</li> </ul>	K3
IV	<b>ANIMAL BEHAVIOUR AND BIOLOGICAL RHYTHMS</b>		

4.	4.1	Ecological aspects of behaviour: Habitat selection, food selection, optimal foraging theory, anti-predator defenses, aggression, homing, territoriality, dispersal, host parasite relations	➤ Define habitat selection, foraging pattern and defense mechanisms	K2
	4.2	Circadian and circannual rhythms, orientation and navigation, migration of fishes and birds.	➤ Explain the regulation of circadian rhythms	K4
	4.3	Learning and memory: Conditioning, habituation, insight learning, association learning and reasoning.	➤ Explain the role of biology in learning and memory and its form.	K5
V	<b>REPRODUCTIVE BEHAVIOUR AND PARENTAL CARE</b>			
5		Reproductive behavior: Mating systems, courtship, sexual selection, parental care.	➤ Analyse the importance of reproductive behavior and parental care in species perpetuation.	K4
		Social Organisation in Honey bees and Primates - aggregations, schooling in fishes, flocking in birds, herding in mammals, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, social organization in insects and primates.	➤ Analyze the social organization in survival of animals	K4

**MAPPING SCHEME FOR THE PO, PSOS AND COS:**

P19ZY410	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	M	H	L	M	H	H	M	H	H	H	L
CO2	H	H	M	M	L	L	H	M	L	H	H	H	L
CO3	H	H	L	L	L	L	H	M	L	H	H	H	L
CO4	H	H	L	L	L	M	H	H	L	H	H	H	L
CO5	H	H	L	L	L	L	H	M	M	H	H	H	L
CO6	H	H	L	M	L	L	H	L	M	H	H	H	L

L-Low

M-Moderate

H- High

## 5. COURSE ASSESSMENT METHODS:

Direct
1. Continuous Assessment Test I, II 2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation. 3. End Semester Examination
Indirect
1. Course-end survey

### ELECTIVE - V: APPLIED ENTOMOLOGY/BIOINFORMATICS

Semester: IV

Code: P19ZY4:5/P19ZY4:A

Credit: 4

Total hrs: 75 (Total hrs per week: 5)

#### 1. COURSE OUTCOME

On completion of this course, the students will be able to:

CO.No.	COURSE OUTCOMES	LEVEL	UNIT
CO1	Classify the different orders of insect organisms	K4	I
CO2	Categorize the biological life cycle of agricultural and industrial important pests.	K4	II
CO3	Examine the structure and mode of action of important insecticides belonging to different groups	K4	III
CO4	Apply Integrated Pest Management	K4	IV
CO5	Recommend methods of insect control and the damages and benefits regarding practical applications.	K5	V
CO6	Improve employability skills of students to become an entomologist in government and private sectors.	K6	V

#### 2. A. Syllabus:

##### Unit- I INSECT CLASSIFICATION

15Hrs

Introduction to Entomology - General characters of Class Insecta –Outline Classification of insects upto orders Classification of following insect orders Orthoptera, Hemiptera, Diptera, Hymenoptera, Lepidoptera, Coleoptera, Insect Pest and their Classification

## Unit-II PEST OF AGRICULTURAL AND INDUSTRIAL IMPORTANCE 15Hrs

Life history, nature of damage and control measures of major pests of Pest of rice: Rice stem borer (*Scirpophaga incertulas*) - Pest of Sugarcane: The shoot borer (*Chilo infuscatellus*) - Pest of coconut: The rhinoceros beetle (*Oryctes rhinoceros*) - Pest of cotton: The spotted bollworm (*Earias insulana*)- Pests of Stored Products. **Insects of Industrial importance** - Biology and rearing of Honey bees, Silk worm, Lac insect–Useful Products and their Economic Values.

## Unit-III -PEST OF MEDICAL AND VETERINARY IMPORTANCE 15Hrs

Insect vectors of human diseases; Mosquitoes, Housefly, Bedbug, Sand fly, TseTse fly - Identification, nature of attack, and control measures. Veterinary pests: Identification, nature of attack, and control measures of insect pest of domestic animals – Fowl, cattle, sheep and goat. Insects of forensic importance – crime detection using entomological science.

## Unit-IV PEST CONTROL MEASURES 15Hrs

**Pest control measures:** Cultural–mechanical–physical and Biological methods - **Chemical control-** Insecticides - classification of insecticides based on mode of entry – mode of action and chemical nature – Insecticidal formulations– insecticidal toxicity (LD 50 / LC 50).

## Unit-V IPM - BIOLOGICAL CONTROL 15Hrs

**Insect pest-Management: Biological control;** Ecological basis and agents of biological control–Parasites, Parasitoids, Predators. Autocidal control. Methods of sterilisation – Male Sterilization technique, Chemo sterilants. Pheromonal control, Insect repellents, Insect anti feedants, Insect attractants – definition, applications, advantages and disadvantages. Microbial control of crop pests by employing bacteria, virus and fungi - Integrated pest management (IPM).

### B. Topics for Self-Study:

Sl.No.	CONTENTS	WEB LINK
1.	Tritrophic Interactions	<a href="https://en.wikipedia.org/wiki/Tritrophic_interactions_in_plant_defense">https://en.wikipedia.org/wiki/Tritrophic_interactions_in_plant_defense</a>
2.	Sterile insect release method	<a href="https://ipmworld.umn.edu/bartlett">https://ipmworld.umn.edu/bartlett</a>
3.	Biology and Control of Pulse Crop Pests	<a href="https://www.ag.ndsu.edu/publications/crops/pulse-crop-insect-diagnostic-series-field-pea-lentil-and-chickpea">https://www.ag.ndsu.edu/publications/crops/pulse-crop-insect-diagnostic-series-field-pea-lentil-and-chickpea</a>
4.	<i>Corcyra cephalonica</i>	<a href="https://www.plantwise.org/KnowledgeBank/datasheet/15444">https://www.plantwise.org/KnowledgeBank/datasheet/15444</a>

5.	Forensic Entomology	<a href="https://ifflab.org/forensic-entomology-using-insects-for-forensic-investigations/">https://ifflab.org/forensic-entomology-using-insects-for-forensic-investigations/</a>
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### C. Text Books:

1. David, B.V. and Ananthkrishnan, T.N., General and Applied Entomology. 2<sup>nd</sup> Ed., 2004, Tata McGraw Hill, New Delhi.
2. Ignacimuthu, S. S and Jayaraj S, Biological Control of Insect Pests 2003 Phoenix Publ, New Delhi.

### D. Reference Books:

1. David, B.V. Elements of Economic Zoology. 2003, Popular Book Depot, Chennai.
2. Nalinasundari, M.S. and Santhi, R. Entomology. 2006, MJP Publishers, Chennai.
3. Awasthi, V.B. Introduction to General and Applied Entomology. 2002, Scientific Publishers, Jodhpur.
4. Norris, R.F., Caswell-chen, E.P. and Kogan, M. Concepts in Integrated Pest management 2002, Prentice Hall, New Delhi.
5. Racheigl and Racheigl, Biological and Biotechnological Control of Insect Pests. 1998, CRC Press.
6. Srivastava, K. P., A, Textbook of Applied Entomology Vol. I. 2<sup>nd</sup> ed. 1988 Kalyani Publishers, New Delhi.

### E. Weblink:

1. <https://nptel.ac.in/courses/126/104/126104003/>

### 3. SPECIFIC LEARNING OUTCOMES (SLO):

Unit/Section	Contents	Specific Learning Outcomes	Highest Bloom's Taxonomical Level of Transaction
<b>I</b>	<b>INSECT CLASSIFICATION</b>		
1.1	Insect Classification: - Introduction to Entomology – General characters of Class Insecta – Outline Classification of insects up to orders Classification of following insect orders Orthoptera, Hemiptera, Diptera, Hymenoptera, Lepidoptera, Coleoptera, Insect	➤ Classify insects according to their orders	K4

	Pest and their Classification.		
<b>II</b>	<b>PEST OF AGRICULTURAL AND INDUSTRIAL IMPORTANCE</b>		
2.1	Pest of Agricultural and industrial importance: - Life history, nature of damage and control measures of major pests of Pest of rice: Rice stem borer ( <i>Scirpophaga incertulas</i> ) – Pest of Sugarcane: The shoot borer ( <i>Chiloinfuscatellus</i> ) – Pest of coconut: The rhinoceros beetle ( <i>Oryctes rhinoceros</i> ) – Pest of cotton: The spotted bollworm ( <i>Earias insulana</i> ) – Pests of Stored Products.	➤ Apply various control measures to eliminate the damage causing pests.	K3
2.2	Insects of Industrial importance – Biology and rearing of Honey bees, Silk worm, Lac insect – Useful Products and their Economic Values.	➤ Categorize the importance of insects in industrial purpose	K4
<b>III</b>	<b>PEST OF MEDICAL AND VETERINARY IMPORTANCE</b>		
3.1	Pest of medical and veterinary importance: - Insect vectors of human diseases; Mosquitoes, Housefly, Bedbug, Sand fly, TseTse fly – Identification, nature of attack, and control measures.	➤ Analyze the nature of human diseases caused by insect vectors.	K4
3.2	Veterinary pests: Identification, nature of attack, and control measures of insect pest of domestic animals – Fowl, cattle, sheep and goat.	➤ Classify the nature of diseases caused by insect vectors in domestic animals and	K4

		apply various control measures to eliminate veterinary pests.	
3.3	Insects of forensic importance – crime detection using entomological science.	➤ Identify insects in criminal investigation	K4
IV	<b>PEST CONTROL MEASURES</b>		
4.1	Pest control measures: - Cultural–mechanical – physical and Biological methods – Chemical control – Insecticides	➤ Apply various pest control measures	K4
4.2	classification of insecticides based on mode of entry – mode of action and chemical nature – Insecticidal formulations – insecticidal toxicity (LD50/LC 50).	➤ Classify insecticides based on mode of entry, action and chemical nature	K4
V	<b>IPM - BIOLOGICAL CONTROL</b>		
5.1	Insect pest – Management: Biological control; Ecological basis and agents of biological control–Parasites, Parasitoids, Predators. Autocidal control.	➤ Evaluate insect pest management using biological approach	K5
5.2	Methods of sterilisation – Male Sterilization technique, Chemo sterilant. Pheromonal control, Insect repellents, Insect antifeedants, Insect attractants – definition, applications, advantages and disadvantages.	➤ Utilize available sterilisation methods to control insect pests	K3
5.3	Microbial control of crop pests by employing bacteria, virus and fungi – Integrated pest	➤ Improve integrated pest management	K6

	management (IPM).	system for microbial pest control.	
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#### 4. MAPPING SCHEME FOR THE PO, PSOS AND COS:

P19ZY4:1	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	-	-	L	-	-	M	-	-	M	-	L	-
CO2	M	-	L	-	-	L	-	-	M	-	M	-	-
CO3	-	M	-	-	L	-	-	M	-	-	-	-	H
CO4	-	-	-	M	M	H	-	-	-	-	M	-	-
CO5	-	-	M	-	-	-	-	-	M	-	-	L	-
CO6	M	-	-	M	-	-	H	-	-	L	-	-	M

L - Low

M - Medium

H - High

#### 5. COURSE ASSESSMENT METHODS:

Direct
<ol style="list-style-type: none"> <li>1. Continuous Assessment Test I, II</li> <li>2. Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation,</li> <li>3. End Semester Examination</li> </ol>
Indirect
<ol style="list-style-type: none"> <li>1. Course-end survey</li> </ol>



**PG - PROGRAMME ARTICULATION MATRIX**

S.No	COURSE NAME	COURSE CODE	Correlation with Programme Outcomes and Programme									
			PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PS 1
1	Functional Morphology of Invertebrates and Chordates	P19ZY101	H	H	H	L	L	-	H	H	-	H
2	Cell Biology	P19ZY102	H	-	M	H	H	H	H	L	-	-
3	Molecular Biology and Bioinformatics	P19ZY103	H	-	M	H	H	H	H	-	-	-
4	Core Practical I	P19ZY1P1	H	-	H	H	H	H	H	H	-	-
5	Core Practical II	P19ZY1P2	H	-	H	H	H	H	H	H	-	-
6	Microbiology	P19ZY1:1	H	-	H	H	H	H	H	L	-	-
7	Animal Physiology	P19ZY204	H	-	H	H	H	H	H	H	-	H
8	Biochemistry	P19ZY205	H	-	M	H	H	H	H	-	-	-
9	Immunology	P19ZY2:1	H	-	H	H	H	H	H	M	-	-
10	Biostatistics	P19ZY2:3	H	-	H	H	H	H	H	-	-	-
11	Core Practical III	P19ZY2P3	H	-	H	H	H	H	H	-	-	M
12	Core Practical IV	P19ZY2P4	H	-	-	H	H	H	H	-	-	-
13	Environmental Biology	P19ZY306	H	H	H	H	H	H	H	H	H	-
14	Developmental Biology	P19ZY307	H	-	-	H	H	H	H	M	-	M
15	Genetics	P19ZY308	H	-	-	H	H	H	H	-	-	M
16	Research Methodology and Biotechniques	P19ZY309	H	-	-	H	H	H	H	-	-	L
17	Core Practical V	P19ZY3P5	H	H	H	H	H	H	H	-	H	-
18	Animal Biotechnology	P19ZY3:1	H	-	-	H	H	H	H	H	-	L
19	Evolution and Animal Behaviour	P15ZY410	H	H	H	H	H	H	H	H	-	L
20	Applied Entomology	P15ZY4:1	H	-	M	H	H	H	H	M	H	L

## **PROJECT**

**Semester-IV**

**Credits : 5**

**Code: P19ZY4PJ**

**Total Hrs. : 300**

