

# **GURU NANAK COLLEGE (AUTONOMOUS)**

**VELACHERY ROAD, CHENNAI – 600042**

**(Re-accredited at 'A-Grade' by NAAC) Affiliated to University of Madras**



## **B.Sc. Advanced Zoology and Biotechnology**

**(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)**

## **SYLLABUS**

**(For the candidates admitted for the Academic year 2022-23 and thereafter)**

## **PREAMBLE**

The Advanced Zoology and Biotechnology is as a branch of biological sciences which is widely preferred because of the advantage in terms of Research orientation, wild life conservation environmental relation. The course helps to understand the aspects of animal science disciplines including growth and development, genetics, anatomy, comparative nutrition and environmental physiology. It caters to the challenging demands of the learners in the emerging field of Biotechnology by developing an inclusive learning environment. Students with a B.Sc. degree in Advanced Zoology and Biotechnology may be employed as Research Assistants, Environmental Managers, Quarantine Officers, Pest Management Officers, IFS, Collection Managers of Aquaria and Zoological Gardens, Primary and Secondary Teachers (with suitable teaching qualifications), Museum Curators (with suitable Postgraduate Degrees), Research Scientists (with suitable Postgraduate Degrees), University Academics (with suitable Postgraduate degrees). On the whole, the student is benefitted with the kind of knowledge that helps them personally as an individual of the Society and also to pursue either in Academics or use the knowledge accumulated for competitive exams and a professional career in relevant field.

## **LEARNING OUTCOME BASED CURRICULUM FRAMEWORK**

**From the Academic Year (2021- 22) and there after**

### **VISION:**

To inculcate the highest values of life science education, respect for nature and concern for ethical values among the students through good and scientific educational practices.

### **MISSION:**

1. To educate the students on the contemporary advancements in Zoology.
2. To appreciate and acquire knowledge on the taxonomic, functional and evolutionary status of various groups of animals and its role in the environment.
3. To impart global perspective and skills among students.
4. To make industry ready students for leading-edge jobs.
5. To develop research aptitude and scientific temperament thereby leading to excellence.

### **PROGRAMME OUTCOMES**

#### **B.Sc. ADVANCED ZOOLOGY AND BIOTECHNOLOGY**

The following points are the expected outcomes of the three-year B.Sc Advanced Zoology and Biotechnology programme of Guru Nanak College:

- PO1:** Demonstrate an understanding of biology at the level of molecules, cells, systems, organisms and ecosystems.
- PO2:** Demonstrate an understanding of key concepts in evolutionary biology, ecology, neurobiology, cell biology, molecular biology, biochemistry, genetics, developmental biology and physiology.
- PO3:** Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, read graphs, and understand and use information from scientific papers.
- PO4:** Demonstrate skill in communication of scientific data in standard format.
- PO5:** Demonstrate the Genetic Engineering and Recombinant DNA technology.

### **PROGRAMME SPECIFIC OUTCOMES**

#### **B.Sc. ADVANCED ZOOLOGY AND BIOTECHNOLOGY**

- PSO1:** Knowledge about the nature and basic concepts of biological science and evolutionary relationships of major group of animals.
- PSO2:** Recognize the functions of the organism at the level of gene, genome, cell, tissue, organ, and organ-system.

**B.Sc ADVANCED ZOOLOGY AND BIOTECHNOLOGY**  
**COURSE STRUCTURE 2021-24 BATCH ONWARDS**

Sem.	Part	Course Component	Subject Name	Credits	Hours	Internal	External	Total
I	I	Language	Tamil I	3	6	50	50	100
	II	English	English I	3	4	50	50	100
	III	Core I	Animal Diversity I - Invertebrata	4	6	50	50	100
	III	Core II	<b>Practical I</b> – Invertebrata and Chordata	-	2	*	*	*
	III	Allied I	Botany I	3	6	50	50	100
			<b>Allied Practical:</b> Allied Botany Practical	-	2	*	*	*
	IV	1.NME/ Basic Tamil/ Basic Hindi/Adv. Tamil	Aquaculture	2	2	-	100	100
	IV	Soft Skills I	Introduction Study Skills	3	2	-	100	100
<b>Total Credits -18 / Total Hours per week - 30</b>								
II	I	Language	Tamil II	3	6	50	50	100
	II	English	English II	3	4	50	50	100
	III	Core III	Animal Diversity II – Chordata	4	6	50	50	100
	III	Core II	<b>Practical I</b> – Invertebrata and Chordata	4	2	50	50	100
	III	Allied II	Botany II	3	6	50	50	100
			<b>Allied Practical:</b> Allied Botany Practical	4	2	50	50	100
	IV	1.NME/ Basic Tamil/ Basic Hindi/ Adv. Tamil	Occupational Zoology (Sericulture, Vermiculture and Poultry Farming)	2	2	-	100	100
	IV	Soft Skills II	Life Skills	3	2	-	100	100
<b>Total Credits -26 / Total Hours per week - 30</b>								
III	I	Language	Tamil III	3	6	50	50	100
	II	English	English III	3	4	50	50	100
	III	Core IV	Cell and Molecular Biology	4	6	50	50	100
	III	Core V	<b>Practical II</b> – Cell Biology & Genetics	-	2	*	*	*
	III	Allied III	Chemistry I	3	6	50	50	100
			<b>Allied Practical:</b> Allied Chemistry Practical	-	2	*	*	*
	IV	Soft Skills III	Job-Oriented Skills	3	2	-	100	100
	IV	2.EVS	Environmental Science	-	2	*	*	*
<b>Total Credits -16 / Total Hours per week - 30</b>								

**B.Sc ADVANCED ZOOLOGY AND BIOTECHNOLOGY  
COURSE STRUCTURE 2021-24 BATCH ONWARDS**

Sem.	Part	Course Component	Subject Name	Credits	Hours	Internal	External	Total
IV	I	Language	Tamil IV	3	6	50	50	100
	II	English	English IV	3	4	50	50	100
	III	Core VI	Genetics and Evolution	4	6	50	50	100
	III	Core V	<b>Practical II</b> – Cell Biology, Genetics and Evolution	4	2	50	50	100
	III	Allied IV	Chemistry II	3	6	50	50	100
			<b>Allied Practical:</b> Allied Chemistry Practical	4	2	50	50	100
	IV	Soft Skill IV	<b>Quantitative Aptitude/ Digital Marketing Lab/ Presentation Skills</b>	3	2	-	100	100
IV	2.EVS	Environmental Science	2	2	-	100	100	
<b>Total Credits -26 / Total Hours per week - 30</b>								
V	III	Core VII	Developmental Biology and Immunology	4	4	50	50	100
	III	Core VIII	Biotechnology and Nanotechnology	4	4	50	50	100
	III	Core IX	Animal Physiology and Biochemistry	4	4	50	50	100
	III	Core X	Biostatistics and Computer Applications with R Programming for Life Sciences	4	4	50	50	100
	III	Core XI	<b>Practical – III</b> Animal Physiology, Biochemistry, Developmental Biology and Immunology	-	4	*	*	*
	III	Core XII	<b>Practical IV</b> – Environmental Biology, Biotechnology and Microbiology	-	4	*	*	
	III	Elective I (IDE)	Wildlife Conservation	5	5	50	50	100
	IV	Value Education	Value Education	2	1	-	100	100
	V	Internship	Internship	2	-	-	-	-
<b>Total Credits -25 / Total Hours per week - 30</b>								
VI	III	Core XIII	Environmental Biology and Environmental Biotechnology	3	4	50	50	100
	III	Core XIV	Genetic Engineering and Recombinant DNA Technology	4	4	50	50	100
	III	Core XV	Applied Microbiology	4	4	50	50	100
	III	Core XI	<b>Practical – III</b> Animal Physiology, Biochemistry, Developmental Biology and Immunology	4	4	50	50	100
	III	Core XII	<b>Practical IV</b> – Environmental Biology, Biotechnology & Microbiology	4	4	50	50	100
	III	Elective - II	Clinical Laboratory Technique	5	5	50	50	100
	III	Elective III	Economic Entomology and Pest Management	5	5	50	50	100
	V	Project	Group Project	3	-	-	-	100
	V		Extension Activities	1	-	-	-	-
<b>Total Credits - 33 / Total Hours per week - 30</b>								
<b>Grand Total Credits - 144 / Total Hours - 180</b>								

# Semester-I

**CORE THEORY- I**  
**ANIMAL DIVERSITY I – INVERTEBRATA**

<b>SUBJECT CODE :</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER: I</b>	<b>CREDITS: 4</b>	<b>TOTALHOURS:90</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Invertebrata

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To acquire knowledge on basic life functions of unicellular organisms. Understand the morphology, reproduction and life cycle of *Plasmodium*. To understand the nutrition, and locomotion in protozoa and protozoan diseases in human
2. To understand cellular organization in Porifera (*Sycon*) and Coelenterate (*Obelia*) and appreciation of canal system in Sponges and polymorphic forms in Coelenterates
3. To understand the morphology, anatomy, life history of *Taenia solium* and *Ascaris*. Gain knowledge on parasitic adaptations in Platyhelminthes, biological significance of nematode parasites in humans, Excretory organs in Annelida and Metamerism in Annelida
4. To understand the organization of *Penaeus* and *Pila* with appreciation on significance of larval forms and foot in Molluscs. Know the economic importance of Mollusca
5. To understand the Echinoderms and its water vascular system. To compare functional anatomy of feeding, nervous and reproduction in invertebrates

**UNIT- I**

**(15 hours)**

Introduction to Animal kingdom and basis of classification - Principles of taxonomic characteristic and nomenclature

**Phylum Protozoa:** General Characteristics and classification upto order

**Type Study:** *Plasmodium*

**General Topics:** Nutrition in Protozoa, Locomotion in protozoa, Protozoan diseases in humans

**UNIT- II**

**(18 hours)**

**Phylum Porifera:** General Characteristics and classification upto order

**Type Study:** *Sycon*

**General Topics:** Canal System of sponges, Skeletal system in sponges, Economic importance of Porifera

**Phylum Coelenterata:** General Characteristics and classification upto order

**Type Study:** *Obelia* and *Aurelia*

**General Topics:** Economic importance of corals and coral reef, Polymorphism, Nematocyst and Evolutionary significance

**UNIT -III**

**(18 hours)**

**Phylum Platyhelminthes:** General Characteristics and classification upto order

**Type Study:** *Taenia solium* and *Fasciola hepatica*

**Phylum Nematodes:** General Characteristics and classification upto order

**Type Study:** *Ascaris*

**General Topics:** Parasitic adaptation in helminthes, Nematode parasites in humans

#### **UNIT -IV**

**(21 hours)**

**Phylum Annelida** - General Characteristics and classification upto order

**Type Study:** *Pheretima*

**General Topics:** Metamerism in annelida, Excretory organ in annelida, Economic importance of annelids

**Phylum Arthropoda:** General Characteristics and classification upto order

**Type study:** *Penaeus monodon / indicus*

**General Topics:** Crustacean Larval form and its significance, *Peripatus* and its affinities, Mouth parts in insects, Respiratory organ in arthropods, Social life in insects

**Phylum Mollusca:** General Characteristics and classification upto order

**Type Study:** *Pila*

**General topics:** Foot in Mollusca, Torsion in Mollusca and Economic importance of Mollusca

#### **UNIT -V**

**(18 hours)**

**Phylum Echinodermata:** General Characteristics and classification upto order

**Type Study:** *Asterias*

**General Topics:** Water Vascular system, Larval forms

Comparative account on functional anatomy of feeding, nervous and reproduction in invertebrates

#### **RECOMMENDED BOOK**

1. Kotpal, R.L., (2005). Invertebrates, Rastogi Publications, Meerut.
2. Jordan, E.L. and Verma, P.S. (2009). *Invertebrate Zoology* S. 14Th Edition Chand &Co. NewDelhi
3. Ekambaranatha Ayyar, M and Ananthkrishnan, T.N. (1993). *Outlines of Zoology*, Vol. I, Part I and II, Viswanathan and Co. Madras.
4. Dhama, P.S. and Dhama, J.K., (1979). *Invertebrates*, 5th ed., R. Chand Publisher.

#### **REFERENCE BOOKS:**

1. Chaudhry, S., (2003). *Fundamental Invertebrate Zoology*, S.Vikas & Co. Fatehpura, Jalandhar
2. Parker, T.J. and Haswell, W.A., (1990). *Text book of Zoology, Invertebrates*, Vol. I edited by Marshall, A.J. and Williams, W.D., CBS Publication & Dist., Delhi.
3. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). *Invertebrate Zoology: A Functional Evolutionary Approach*. VII Edition, Cengage Learning, India
4. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*. III Edition, Blackwell Science
5. Barrington, E.J.W. (2012). *Invertebrate Structure and Functions*. II Edition, EWP Publishers
6. T.C. Majpuria. (1990). *Invertebrate Zoology*, Pradeep Pub. Kitab Mahal.
7. Pechenik, J. A. (2015). *Biology of the Invertebrates*. VII Edition, McGraw-Hill Education



### Question paper pattern

Section	Question Component	Numbers	Marks	Total
<b>Section A</b>	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
<b>Section B</b>	Short Answer Answer any 5 out of 7 questions	13–19	6	30
<b>Section C</b>	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	SECTION A		SECTION B		SECTION C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
<b>I</b>	3	-	1	-	1	-
<b>II</b>	3	-	1	-	1	-
<b>III</b>	2	-	2	-	1	-
<b>IV</b>	2	-	2	-	2	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**ALLIED THEORY  
ALLIED ZOOLOGY-I**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: I</b>	<b>CREDITS: 3</b>	<b>TOTAL HOURS: 90</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Allied Zoology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand the general characters and classification of invertebrates. Gain knowledge on cellular organization, morphology, anatomy and life history of Protozoa, Porifera, Coelenterata and Platyhelminthes
2. To discuss the morphology, anatomy, larval forms and distinctive characters of Phylum Annelida, Arthropoda, Mollusca and Echinodermata.
3. To understand the distinctive characters and classification of Chordata. Gain knowledge on affinities of Prochordates. Describe the general characters and classification of class Pisces with an example.
4. To knowledge on morphology and anatomy of class Amphibia and Reptilia.
5. To compare and contrast between class Aves and Mammalia.

**UNIT- I**

**(20 Hours)**

**Introduction:** Invertebrata - General characters and classification

**Protozoa** – Type study: *Plasmodium*

*vivax* **Porifera** – Type study: *Scypha*

(*Sycon*) **Coelenterata** – Type study:

*Obelia geniculata* **Platyhelminthes** - Type

study: *Taenia solium* **Nematoda** – Type

study: *Ascaris*

**UNIT- II**

**(20 Hours)**

**Annelida** – Type study: Leech

**Arthropoda** – Type study: Prawn

**Mollusca** – Type study: *Unio* (External morphology and Respiratory system)

**Echinodermata** – Type study: Starfish (External morphology and Water vascular system)

**Unit -III**

**(20 Hours)**

**Chordata** – General characters and

Classification **Prochordates** – *Amphioxus* –

Structure **Vertebrates** - Pisces- Type study:

Shark

**Unit- IV**

**(15 Hours)**

**Amphibia**- Type study: Frog (External morphology, Digestive system, Circulatory System and Reproductive system)

**Reptilia** – Type study: Calotes (External morphology, Digestive system, Circulatory System and Reproductive system)

**Unit -V****(15 Hours)****Aves** - Type study: Pigeon (External morphology and Respiratory system)**Mammalia** - Type study: Rabbit (External morphology and Circulatory system)**RECOMMENDED BOOKS****Invertebrata**

1. P.S. Dhami and J.K. Dhami – Invertebrate Zoology – S. Chand and Co. New Delhi.
2. Kotpal, R.L., (2005). Invertebrates, Rastogi Publications, Meerut.
3. Ekambaranatha Ayyar, M and Ananthkrishnan, T.N. (1993). Outlines of Zoology, Vol. I, Part I and II, Viswanathan and Co. Madras.

**Chordata**

1. Dhami, P.S., Dhami, J.K., (1982). Chordate Zoology, Dinesh Publishers, Jalandhar.
2. Kotpal, R.L., (2005). Text Book of Zoology- Vertebrates, CBS Publishers, Delhi.
3. Jordan EL and Verma. P.S., (2002). Chordate Zoology, S. Chand Publication
4. Ekambaranath Iyer. (2000). A Manual of Zoology. Vol. II S. Viswanathan and Co.

**REFERENCE BOOKS:****Invertebrata**

1. Parker, T.J. and Haswell, W.A., (1990). Text book of Zoology, Invertebrates, Vol. I edited by Marshall, A.J. and Williams, W.D., CBS Publication & Dist., Delhi.
2. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
3. Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers
4. T.C. Majpuria. (1990). Invertebrate Zoology, Pradeep Pub. Kitab Mahal.

**Chordata**

1. Bhamrah, H.S. and Juneja, K., (1990). An introduction to fishes, Anmol Publications, New Delhi
2. Parker, T.J., and Haswell, W.A., A Text Book of Zoology Vol. II- Vertebrates. Latest edition, CBS Publishers, Delhi edited by Late A.J. Marshall & Williams, W.D.
3. Dodson, E.O., (1976). A Text Book of Zoology, CBS Publishers & Distributors, Delhi.

**Question paper pattern**

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<b>Section A</b>	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
<b>Section B</b>	Short Answer Answer any 5 out of 7 questions	13–19	6	30
<b>Section C</b>	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

<b>UNITS</b>	<b>Section A</b>		<b>Section B</b>		<b>Section C</b>	
	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>
<b>I</b>	3	-	2	-	2	-
<b>II</b>	3	-	2	-	1	-
<b>III</b>	2	-	1	-	1	-
<b>IV</b>	2	-	1	-	1	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**NON-MAJOR ELECTIVE - I  
AQUACULTURE**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: I</b>	<b>CREDITS: 2</b>	<b>TOTAL HOURS: 30</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Aquaculture.

**COURSE OUTCOME:**

1. To acquire knowledge in the physico-chemical analysis of water and their impact on aquatic systems.
2. To understand the importance of aquaculture practice and different types of aquaculture practices in India with special reference to exotic and major carps and the various techniques involved in the construction of fish ponds and their management.
3. To give an insight into the importance of integrated fish farming methods.
4. To provide a basic idea about the importance of live feed in culture systems and also composition of supplementary feed.
5. To Identify and categorize the fish and shrimp diseases in the Aquaculture.

**Unit -I**

**(6 Hours)**

History of aquaculture – Purpose and importance of aquaculture – Physical and chemical characteristics features of water bodies (Freshwater brackish water and marine water) – Types of culture systems (Traditional, intensive, semi-intensive and extensive), Pond, Cage, RAS.

**Unit -II**

**(6 Hours)**

Selection criteria for cultivable species – Site selection for fish farming – Construction of fish and Prawn / Shrimp culture ponds – Types of fish ponds (breeding pond, hatchery unit, brooders pond, nursery pond, stocking pond and rearing pond) – Maintenance and management of different ponds - Feeds for cultivable species – Natural, supplementary and artificial feeds -Post-harvest technology – organic farming.

**Unit - III**

**(6 Hours)**

Types of culture – Cage Culture, Pen culture - Monoculture, Monosex culture and poly culture – Integrated fish farming (paddy cum fish culture, paddy cum prawn culture and Duck cum pig cum fish culture) – Induced breeding in Indian major carps - Biofloc fish farming.

**Unit - IV**

**(6 Hours)**

Culture of air-breathing fishes (Mullet and cat fish) - Sewage fed fish culture – Culture of pearl oyster and edible oyster.

**Unit -V**

**(6 Hours)**

Culture of marine and freshwater prawns /shrimps – Present status of shrimp farming in India - Common fish diseases (bacterial, fungal, viral and parasitic diseases) – Prevention and treatment – Fishing technology (Crafts and gears) – Preservation and processing of fish and prawn – Agencies involved in aquaculture – CAA, NFDB, ICAR, MPEDA, RGCA

**Activity - Field Visit and Submission of Report**

1. Visit to Aquaculture farm / industry

**RECOMMENDED BOOKS:**

1. R. Santhanam, N. Sukumaran and Natarajan, - A manual of fresh water aquaculture, Oxford and IBH Publishing Co Pvt. Ltd., Mumbai.
2. B.N. Yadav, - Fish and fisheries, Daya Publishing House, Delhi.
3. Shanmugam, K. (1990). Fishery Biology and Aquaculture, Hindustan Pub. Corporation, New Delhi.

**REFERENCE BOOKS:**

1. Mathew Landan, (1991). Introduction to aquaculture, John Wiley and Sons Inc..
2. V.R.P. Sinha, (1993). A compendium of aquaculture Technologies for developing countries, Oxford and IBH Publishing Company PVT. Ltd.
3. V.G. Jhingran, (1991). Fish and fisheries of India, Hindustan Publishing Corporation, Delhi.
4. T.V.R. Pillay – Aquaculture principles and practices, Fishing News Books, Blackwell Science Ltd., Oxford.
5. C.V. Kurian and Sebastien – Prawn and Prawn fisheries of India, Hindustan Publishing House, New Delhi.
6. Elvire Balugal, A. (1984). Aquaculture systems and practices – A selected Review, Daya Publishing House, New Delhi.

**Question paper pattern**

Section	Question Component	Numbers	Marks	Total
Section A	Essay Answer any 5 out of 10 questions	1 – 10	20	100
<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

UNITS	Section A	
	Theory	Problem
<b>I</b>	2	-
<b>II</b>	2	-
<b>III</b>	2	-
<b>IV</b>	2	-
<b>V</b>	2	-
<b>SECTION A (10)</b>		

**Semester-II**

**CORE THEORY– III**  
**ANIMAL DIVERSITY II - CHORDATA**

<b>SUBJECTCODE:</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER:II</b>	<b>CREDITS:4</b>	<b>TOTALHOURS:90</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Chordata.

**COURSE OUTCOME:**

1. To describe the basic and distinctive characters of each classes. To acquire knowledge on development and affinities of Protochordates and retrogressive metamorphosis of Urochordata.
2. To understand the morphology and functional anatomy of Scoliodon and understand the importance of Accessory respiratory organs, Types of fins, Migration and Parental care in fishes
3. To gain a knowledge on morphology and functional anatomy of Rana and Calotes. To discuss the parental care in amphibians, poison apparatus and biting mechanism in snakes and Mesozoic reptiles
4. To understand the morphology and functional anatomy of Columba livia and Oryctolagus. To understand the importance of Archaeopteryx, flight adaptation and migration in birds and adaptive radiation in mammals.
5. To compare the anatomy of heart, brain and jaw suspension in vertebrates.

**UNIT- I**

**(20 Hours)**

General characteristic and outline classification of Phylum Chordata - Origin of Chordata

**Protochordates:** General characters and Classification upto order

**Hemichordata:** *Balanoglossus*

**Urochordata:** *Herdmania*

**Cephalochordate:** *Amphioxus*

**General Topics:** Affinities of Urochordata and Cephalochordata - Retrogressive metamorphosis in Urochordata

**UNIT- II**

**(15 Hours)**

**Agnatha:** General characters and classification

**Type Study:** *Petromyzon*

**Pisces:** General characters and classification upto order

**Types Study:** *Scoliodon*

**General Topics:** Accessory respiratory organs in fishes, Types of fins, Migration in fishes, Parental care in fishes

**UNIT -III**

**(20 Hours)**

**Amphibian:** Origin of Tetrapoda - General characters and classification upto order

**Type Study:** *Rana*

**General Topic:** Parental care in Amphibians

**Reptilia** - General characters and classification upto order

**Type Study:** *Calotes*

**General Topics:** Poison apparatus and biting mechanism in snakes, poisonous and non –poisonous snakes, Mesozoic reptiles



**UNIT- IV****(20 Hours)****Aves** - General characters and classification upto order**Type Study:** *Columba livia***General Topics** - *Archaeopteryx*, Flight adaptation and Migration in birds, Palates in birds**Mammals:** General characters and classification upto order**Type Study:** *Oryctolagus***General Topics:** Dentition in mammals, Adaptive radiation in mammals**UNIT- V****(15 Hours)**

Comparative anatomy of the vertebrate heart and brain, Jaws suspension in vertebrates,

Distribution of vertebrates in different realms

**RECOMMENDED BOOKS**

1. Dhama, P.S., Dhama, J.K., (1982). Chordate Zoology, Dinesh Publishers, Jalandhar.
2. Kotpal, R.L., (200). Text Book of Zoology- Vertebrates, CBS Publishers, Delhi.
3. E L Jordan and P.S. Verma., (2002). Chordate Zoology, S. Chand Publication
4. Ekambaranath Iyer. (2000). A Manual of Zoology. Vol. II S. Viswanathan and Co.

**REFERENCE BOOKS:**

5. Bhamrah, H.S. and Juneja, K., (1990). An introduction to fishes, Anmol Publications, New Delhi Parker, T.J., and Haswell, W.A., A Text Book of Zoology Vol. II- Vertebrates. Latest edition, CBS Publishers, Delhi edited by Late A.J. Marshall & Williams, W.D.
6. Dodson, E.O., (1976). A Text Book of Zoology, CBS Publishers & Distributors, Delhi.
7. Young, J. Z. (2004). The Life of Vertebrates. III Edition, Oxford university press.
8. Parker T.J. and Haswell W.A. (1972). Textbook of Zoology Vertebrates. VII Ed., Volume II
9. Pough H. (2018). Vertebrate life X Edition, Pearson International.
10. Darlington P.J. (1966). The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
11. Hall B.K. and Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
12. William S. Beck, Karel, F., Liem and George Gaylord Simpson. (2000). Life: An introduction to biology. Harper Collins Publishers, New York.

**Question paper pattern**

Section	Question Component	Numbers	Marks	Total
<b>Section A</b>	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
<b>Section B</b>	Short Answer Answer any 5 out of 7 questions	13–19	6	30
<b>Section C</b>	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

<b>UNITS</b>	<b>Section A</b>		<b>Section B</b>		<b>Section C</b>	
	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>
<b>I</b>	3	-	1	-	2	-
<b>II</b>	2	-	1	-	1	-
<b>III</b>	3	-	2	-	1	-
<b>IV</b>	2	-	2	-	1	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE PRACTICAL – II**  
**PRACTICAL - I INVERTEBRATA AND CHORDATA**

<b>SUBJECTCODE:</b>	<b>PRACTICAL</b>	<b>MARKS:100</b>
<b>SEMESTER:II</b>	<b>CREDITS:4</b>	<b>TOTALHOURS:</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Invertebrata and Chordata

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To identify and classify the specimens up to order.
2. To highlight the biological significance of the given animal and relate the structure and function.
3. To understand the morphology and anatomy of Invertebrate and Chordate specimen through dissection.
4. To identify Invertebrate and Chordate specimens during field visit.
5. Mounting of mouthparts of Cockroach, Mosquito, appendages of prawn and Ctenoid Scale in mugil and Placoid scale in shark and learn the significance.

**I. Dissection**

**A. Cockroach**

1. Morphological characters
2. Digestive system
3. Nervous system

**B. Prawn / Shrimp**

4. Morphological characters
5. Identification of Prawn and Shrimp species
6. Digestive system
7. Nervous system

**C. Any Bony Fish:**

8. Morphological characters
9. Digestive system

**II. Mounting**

1. Mouth parts of Cockroach
2. Mouth parts of Mosquito
3. Mouth parts of Bedbug
4. Mouth parts of House fly
5. Honeybee sting apparatus,
6. Prawn: Appendages
7. Earthworm- Body setae and Penial setae
8. Scales - Ctenoid, Placoid, Cycloid
9. Types of fins – Homocercal, Heterocercal, Diphyrcercal

### **III – Spotters**

#### **A- Classify giving reasons up to order:**

1. Paramecium
2. Scypha
3. Obelia
4. Taenia Solium
5. Ascaris
6. Neanthes
7. Penaeus
8. Asterias
9. Balanoglossus
10. Amphioxus
11. Scoliodon sorrakowah
12. Rana hexadactyla
13. Calotes versicolor
14. Columba livia
15. Oryctolagus cuniculus

#### **B- Draw labelled sketches:**

16. Obelia medusa
17. Nereis T.S.
18. Bipinnaria larva
19. Amphioxus T.S
20. Quill feather

#### **C- Comment on Biological significance:**

21. Entamoeba
22. Paramecium – Conjugation
23. Plasmodium
24. Physalia
25. Ascaris
26. Heteronereis
27. Peripatus
28. Nauplius larva
29. Rotifers
30. Copepods
31. Artemia
32. Sacculina on crab
33. Sea anemone on Hermit crab
34. Vipera russelli (Russel's viper)
35. Pteropus

#### **D – Relate structure and function:**

36. Sponge – Spicules
37. Sponge – Gemmule
38. Taenia – Scolex
39. Neanthes – Parapodium
40. Penaeus – Petasma
41. Starfish - Tube foot
42. Snake- Poison apparatus
43. Quill feather

**E. Osteology / Palate in Birds / Dentition Osteology - Frog**

44. Skull and lower jaw
45. Vertebral column
46. Pectoral girdle
47. Pelvic girdle
48. Forelimb
49. Hind limb

**Palate in Birds**

50. Pigeon – Palate
51. Crow – Palate
52. Duck – Palate

**Dentition**

53. Rabbit – Dentition
54. Dog – Dentition

**IV. Experiments / Field Visit / Study Tour**

1. Observation of Protista in pond water sample
2. Collection, Identification and Morphometric study of fishes from various habitat
3. Project report - Social behaviour of any insect, Animal behaviour
4. Report on field visit for studying the adaptation of animals (Study tour)

**ALLIED THEORY  
ALLIED ZOOLOGY-II**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: II</b>	<b>CREDITS: 3</b>	<b>TOTAL HOURS: 90</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Allied Zoology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To describe fundamental features of an animal cell. Understand the cell structure and function and the metabolic processes of cells in terms of cellular organelles, membranes and biological molecules and the concepts of molecular structure of genes and the inborn errors of metabolism. Highlight the role of Genetic counseling.
2. To understand the basic concepts of developmental biology. Explain the process of gametogenesis and fertilization. Discuss cleavage and gastrulation in chick.
3. To discuss in depth the physiology of the Digestive, Excretory, Cardiovascular and Endocrine systems.
4. To understand the basic concept of Ecology and gain knowledge on environmental degradation treatment and greenhouse effect.
5. To discuss the significance of Darwinism and Lamarckism. Explain the factors responsible for speciation.

**UNIT -I**

**(15 Hours)**

**Cell Biology:** Structure of animal cell - Mitochondria - Nucleus and nucleolus - Golgi bodies - Cell cycle and cell division – Ageing of cell

**Genetics:** Laws of Mendelism - Molecular structure of Genes - Gene concept - Gene function - X and Y – linked inheritance - Karyotype study - Pedigree analysis - Syndromes: Autosomal (Down Down's syndrome and Edward's syndromes) - Sex chromosomal (Turners syndrome and Klinefelter's syndrome) - Genetic disorders (Sickle cell anemia, Phenyl ketonuria and Cleft lip) - Genetic counselling

**UNIT -II**

**(20 Hours)**

**Developmental Biology:** Gametogenesis – Fertilization - Types and pattern of cleavage – Blastulation – Gastrulation in chick: Morphogenetic movements (Epiboly and emboly) - Organizers and Embryonic induction (Brief account) - Applied Aspects of Developmental Biology: Stem cells – *In vitro* fertilization (IVF)

**Biotechnology:** Scope and application of biotechnology - Cloning experiments in animals and man - Bioethics

**UNIT- III**

**(20 Hours)**

**Human Physiology:** History and scope of physiology - Principles of Homeostasis - Digestion and absorption of Carbohydrates, Proteins and Fats

Excretion: Structure and functions of kidney and nephron - Physiology of urine formation - Kidney failure, Dialysis and transplantation

Circulation: Structure of heart - Origin and conduction of heart beat - Cardiac cycle -

Composition and functions of blood - Blood pressure and pulse pressure - Heart diseases: Ischemia, Myocardial infarction, Rheumatic heart disease, Stroke

Endocrine glands: Hormones - Feedback mechanism - Structure, biological action and disorders of pituitary gland, thyroid gland, Islets of Langerhans, adrenal gland and sex organs

#### **UNIT -IV**

**(20 Hours)**

**Ecology:** Definition and Principles - Ecosystem: Definition and components of ecosystem (Abiotic factors and Biotic factors) - Primary and secondary production - Food chain - Food web - Trophic levels - Energy flow - Ecological pyramids - Animal relationships (Symbiosis, Commensalism, Mutualism, Antagonism, Predation, Parasitism and Competition)

#### **UNIT -V**

**(15 Hours)**

**Evolution:** Lamarckism and Neo-Lamarckism - Darwinism and Neo-Darwinism - Speciation, mimicry and coloration – Fossils - Evolution of man

#### **RECOMMENDED BOOKS**

1. Verma, P.S. and V.K. Agarwal, 2010 Reprint, Cell Biology, Genetics, Molecular Biology, Physiology, Evolution and Ecology, S. Chand & Co., New Delhi – 110 055.
2. Sambasiviah, I, Kamalakara Rao, A.P. Augustine Chellapa, S (1983). Text book of Animal Physiology, S. Chand & Co, New Delhi.
3. Verma P.S., Agarwal V.K. and Tyagi, B.S. (1995). Text book of Animal Physiology. S.Chand & Co.
4. Rastogi. S.C. (1977). Essentials of Animal Physiology. New Age International (P) Ltd., Publisher

#### **REFERENCE BOOKS:**

1. Verma, P.S. and Agarwal, V.K. (1983). Animal Ecology, S. Chand & Co, New Delhi.
2. Verma, P.S. and Agarwal, V.K. and Tyagi, B.S. (1991). Chordate Embryology S. Chand & Co, New Delhi.
3. Rastogi, V.B. and Jayaraj, M.S. (2000). Text book of Genetics, Kedarnath Ramnath Publishers, Meerut.
4. T.S.Gopalakrishnan, Itta Sambasivaiah and A.P.Kamalakararao, 1984 Principles of organic Evolution, Pearl publications, Chennai.
5. DeRobertis, EDP, De Robertis, E.M.F. Cell Biology and Molecular Biology. Eighth Edition. W.B. Saunders Co., Philadelphia, 1995.

### Question Paper Pattern

Section	Question Component	Numbers	Marks	Total
<b>Section A</b>	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
<b>Section B</b>	Short Answer Answer any 5 out of 7 questions	13–19	6	30
<b>Section C</b>	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
<b>I</b>	3	-	1	-	1	-
<b>II</b>	2	-	2	-	1	-
<b>III</b>	3	-	2	-	2	-
<b>IV</b>	2	-	1	-	1	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	



**ALLIED PRACTICAL  
ZOOLOGY - PRACTICAL**

<b>SUBJECT CODE:</b>	<b>PRACTICAL</b>	<b>MARKS: 100</b>
<b>SEMESTER: II</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS:</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Allied Zoology Practical.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To learn to identify and classify the Specimen.
2. To understand the biological significance of the biological specimen.
3. To understand the morphology and anatomy of Invertebrate and Chordate specimen through dissection.
4. Mounting of mouthparts of Cockroach, Mosquito and appendages of prawn and learn their significance.

**I. Dissection: Cockroach**

1. Digestive System
2. Nervous System

**Fish (Any bony fish)**

3. Digestive system

**II. Mounting:**

4. Mouth parts of cockroach
5. Mouth parts of Mosquito
6. Prawn: Appendages
7. Placoid Scale
8. Ctenoid scale

**III. Spotters Invertebrata**

9. *Plasmodium*
10. *Sycon*
11. *Obelia geniculata*
12. *Taenia solium* (Entire)
13. *Taenia solium* (Transverse section)
14. Leech (Entire)
15. Leech (Transverse section)
16. Fresh water mussel

**Chordata**

17. *Amphioxus*
18. Shark (Placoid scale)
19. Pigeon (Feathers)
20. Rabbit

**Cell Biology**

21. Mitosis (any one stage)
22. Meiosis (any one stage)

**Genetics**

23. Human karyotype (Normal and Abnormal)

**Developmental Biology**

24. T.S. of Mammalian Testis
25. T.S. of Mammalian ovary

**Animal Physiology**

26. Sphygmomanometer

**Ecology**

27. Animal Relationship – Sea anemone on hermit crab, Ascaris

**NON-MAJOR ELECTIVE - II  
OCCUPATIONAL ZOOLOGY  
(SERICULTURE, VERMICULTURE AND POULTRY FARMING)**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: II</b>	<b>CREDITS: 2</b>	<b>TOTAL HOURS: 30</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Occupational Zoology.

**COURSE OUTCOME**

1. To gain knowledge on morphology, life history and types of silkworm. To analyse the silkworm rearing and its economic importance.
2. To discuss the employment opportunities and women entrepreneur in sericulture sector
3. To understand the ecological classification and life cycle of earthworm. To acquire knowledge on preparation of vermicompost and vermiwash
4. To discuss the different method of vermicomposting and its economic importance
5. To gain knowledge on poultry farming and its rearing methods.

**Unit- I**

**(7 Hours)**

**Sericulture**

Definition - History and present status - Silk industry and its importance – Brief account on morphology and life history of silkworm, varieties of silkworm – Rearing technique, Mulberry cultivation – Diseases and Pest of Silkworm – Processing of cocoon – Reeling and Marketing of Silk

**Unit -II**

**(3 Hours)**

Entrepreneurship in sericulture: Prospectus of Sericulture in India - Sericulture industry in different states - Employment opportunities in mulberry and non-mulberry sericulture sector - Economics in small scale and large-scale silk worm rearing - Scope for women entrepreneurs in sericulture sector

**Unit- III**

**(7 Hours)**

**Vermiculture**

Introduction - Ecological classification of earth worms - Species of earth worms used for vermiculture - Reproduction & life cycle - Role of earth worm in solid waste management - Preparation of vermibed - Maintenance & monitoring - Preparation of vermicompost - Preparation of vermiwash

**Unit -IV**

**(3 Hours)**

Eco-science Research Foundation method - Karuna's method - Kale's method - Advantages of Vermicomposting - Prospects of vermiculture as self - employment venture.

**Unit- V**

**(10 Hours)**

**Poultry Farming**

Poultry breeds - American, Asiatic, Mediterranean, English and indigenous breeds - Poultry breeding and poultry products - Rearing of chicks, growers, layers, broilers, turkeys and quails - Diseases of poultry

Backyard Poultry Farming in India: Management - Women in backyard poultry farming

### Activity - Field Visit and Submission of Report

- Visit to Sericulture Institute / Centres in India
- Preparation of vermiculture / visit to vermiculture unit
- Visit to Poultry Farm

### Recommended Books

1. Somani, L.L. (2008). Vermicomposting and vermiwash. Agrotech Publishing Academy, Udaipur.
2. Ranganathan, L.S. 2006. Vermibiotechnology from soil health to human health – Agrobios, India.
3. Gopalakrishnan C.A and G.Murley Mohan Lal (1997). Livestock and Poultry enterprises for rural development, Vikash, New Delhi.
4. M.Seetha Lekshmy and R.Santhi (2012). Vermiculture, Saras Publication
5. Gupta B.K. (2003). Vermicomposting for sustainable agriculture, Agrobios (India), Jodhpur

### Reference Books:

1. Talashilkar and Dosani, (2005). Earthworm in Agriculture. Agrobios (India), Jodhpur.
2. Gnanamani M.R., (1998). Modern aspects of commercial poultry keeping, Giri.
3. Banarjee G.C., (1992) Poultry, Oxford and IBH, New Delhi.
4. Chauhan H.V.S. and S.Roy, (1996). Poultry diseases, diagnosis and treatment New Age International
5. Jull, Marley. A Poultry Husbandary, Tata Mc Graw Hill, New Delhi.
6. John William S. (2003). Poultry for sustainable Food Production and livelihood. Loyola Publication, Chennai
7. Mack O.North., Commercial chicken Production Manual.
8. Thomas. Singh (1982). Farm animals Management and Poultry Production. Vikas Sastry, Publishing House, New Delhi, 639 pp.
9. Harbans Singh and Eari N.Moore (1982). Livestock and Poultry Production, Prentice Hall of India, New Delhi.
10. Venkitaraman, P.R, (1983) Text book of Economic zoology (Sudharsana Publ. Kochi) AddisonWebb, Bee Keeping for profit and pleasure, Agrobios Ltd.
11. Shukla G.S, & Updhyay V.B, (2005). Economic Zoology, Rastogi Publ. Meerut. Pradip.V.Jabde, Text book of applied zoology.

### Question Paper Pattern

Section	Question Component	Numbers	Marks	Total
Section A	Essay Answer any 5 out of 10 questions	1 – 10	20	100
<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A	
	Theory	Problem
I	2	-
II	2	-
III	2	-
IV	2	-
V	2	-
<b>SECTION A (10)</b>		

# Semester-III

**CORE THEORY- IV**  
**CELL AND MOLECULAR BIOLOGY**

<b>SUBJECTCODE:</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER:III</b>	<b>CREDITS:4</b>	<b>TOTAL HOURS: 90</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of cell and molecular biology.s

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand the fundamental features of prokaryotic and eukaryotic cells and methods used to examine them. Gain knowledge on different models of plasma membrane.
2. To understand the cell structure and function and the metabolic processes of Endoplasmic reticulum, Golgi complex and Microbodies
3. To discuss the role of mitochondria and lysosomes in cell physiology. Outline the process of cell autophagy
4. To describe the structure and functions of nucleus and centrioles
5. To highlight the steps involved in cell cycle and cell division, cell aging. Acquire knowledge on intercellular and intracellular signaling

**Unit- I**

**(20 Hours)**

History of Cell biology - Cell theory – Comparison of Prokaryotic cell and Eukaryotic cell – ultra structure of animal cell

**Plasma membrane:** Different models of plasma membrane - Trilaminar model, Bimolecular leaflet model, Lattice model, Micellar model, Fluid mosaic model, Membrane transport(active, passive and facilitated) – Cell signalling – Structure and function of tight junctions - adherens junctions and gap junctions. Cytoplasm – Composition and function.

**Unit- II**

**(15 Hours)**

**Cell organelles**

**Endoplasmic Reticulum:** Morphology - Chemical composition - Morphological differentiation and functions.

**Golgi complex:** Morphology - Chemical composition - Relationship with other cell components and its function with special reference to cell secretion.

**Microbodies:** Structure - Chemical composition - Functions and origin of Peroxisomes and Glyoxysomes.

**Mitochondria:** Morphology including vital examination - Light and ultramicroscopic structures - Structural variations with regard to functions - Chemical composition - Role in cell physiology - Mitochondria as semi - autonomous organoids.

**Ribosomes:** Structure and biogenesis (Prokaryotes and Eukaryotes).

**Unit -III**

**(20 Hours)**

**Nucleus and Nucleolus:** Structure and function – Structure of chromosome – Euchromatin and heterochromatin – Giant chromosome (polytene and lamp brush) - Cell cycle and cell stages – Cell division and their significance – Ageing of cell – Apoptosis – Cell signaling and regulation through GPCR and role of secondary messenger – CMP and Protein kinase.

**Centrioles:** Basal bodies – Cilia – Flagella – Microtubules - Amoeboid movement

**Lysosomes:** Morphology – Chemistry - Polymorphism in relation to cytolysis and cell autophagy.

**Unit -IV****(20 Hours)**

**Molecular Biology** – Nucleic acid – Structure of DNA and RNA (rRNA, tRNA, mRNA) – DNA replication - Repair and recombination: Unit of replication – enzymes involved in replication, Replication origin and replication fork – DNA damage and repair mechanism – DNA transcription and translation.

**Unit-V****(15 Hours )**

**Advanced studies in molecular technology:** Cancer Biology – Characteristics of cancer cell, carcinogens – Oncogenes - Tumour suppressor gene - Cancer and cell cycle - Virus induced cancer - Metastasis – Stem cell therapy.

**Tools and Techniques: Microscope:** Principles of Microscopy – Components and application of Compound Microscope - Cytological study of living Cell, Microtechniques (Fixation, stain, staining methods, vital staining) – Cytochemical techniques – Cell Fractionation – Homogenization and Centrifugation – Isolation of cellular components.

**Recommended Books**

1. Verma P.S., Agarwal V.K. (2010). Molecular Biology. S Chand Publication.
2. De Robertis, EDP, De Robertis, E.M.F. (1995). Cell Biology and Molecular Biology. Eighth Edition. W.B. Saunders Co., Philadelphia.
3. S C Rastogi. (2019). Cell Biology, New Age International (P) Ltd., Publishers
4. L. Veerakumari. (2019). Bioinstrumentation. MJM Publisher.

**Reference Books**

1. Powar, C.B., Cell Biology, Himalaya Publishing House, Bombay.
2. Alberts, B. Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. Molecular Biology of the Cell Garland Publ. Inc., New York.
3. Darnell, J., Lodish, JH. & Baltimore, D. Molecular Cell Biology, Oxford & IBH Publishing Co., New Delhi.
4. Gerald Karp, Janet Iwasa, Wallace Marshall. (2018). Karp's Cell Biology. John Wiley & Sons; 8th Edition, Global.
5. S.C. Rastogi. (2010). Cell and Molecular Biology, New Age Publishers; Third edition.
6. Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates.
7. Bruce Albert, Bray Dennis, Lewis Julian, Raff Martin, Robert Keith and Watson James. (2008) Molecular Biology of the Cell. V Edition, Garland publishing Inc., New York and London.
8. Kleinsmith, L. J. & Kish, V. M. (1995). Principles of Cell and Molecular Biology. 2e, Harper Collins. College Pubs

### Question Paper Pattern

Section	Question Component	Numbers	Marks	Total
<b>Section A</b>	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
<b>Section B</b>	Short Answer Answer any 5 out of 7 questions	13–19	6	30
<b>Section C</b>	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
<b>I</b>	2	-	1	-	1	-
<b>II</b>	3	-	2	-	2	-
<b>III</b>	3	-	2	-	1	-
<b>IV</b>	2	-	1	-	1	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	



# Semester-IV

**CORE THEORY - VI  
GENETICS AND EVOLUTION**

<b>SUBJECTCODE:</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER:IV</b>	<b>CREDITS:4</b>	<b>TOTALHOURS:90</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Genetics and Evolution

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand Mendel's law; To predict the outcome of crosses including the use of Punnett square
2. To explain the chromosomal basis of sex determination and apply that understanding to predict the sex individuals with normal and abnormal complements of sex chromosomes. And understand the structure of DNA, RNA and mechanism of DNA replication.; Highlight the types of mutation
3. To knowledge on sex-linked characteristics and their transmissions, linkage and crossing over; Describe human genetics with reference to normal and abnormal karyotypes
4. To compare Lamarckism and Darwinism; living and extinct fossils, importance of Mimicry and colorations; Discuss about the Geological time scale, convergent, divergent, parallel evolution and adaptive radiation in mammals
5. To understand the role of genetics mechanism in evolution; and explain the key concept of genetic drift, founders principle; trace the evolution of man

**Unit – I**

**(20 Hours)**

History and Scope of Genetics - Mendelism: Mendel's Experiments, Backcross or testcross, phenotype and Genotype – Monohybrid cross - Dihybrid cross, Trihybrid and Polyhybrid crosses – Interaction of genes – Epistasis - Incomplete Dominance and Co-dominance – Complementary factors (*Lathyrus odoratus*) - Supplementary factors (Maize) - Inhibitory and lethal factors - Multiple alleles (in *Drosophila*, coat colour in rabbit, blood group inheritance in man) - Erythroblastosis Foetalis

**Unit -II**

**(20 Hours)**

**Linkage:** Morgans's Experiment -Theories of linkages - Factors affecting linkage – Sex linked inheritance in *Drosophila* and man

**Crossing over:** Types – Mechanism - Cytological evidence - Significance and factors affecting crossing over – Chromosome mapping

**Sex determination:** Basis of sex determination (Genetic and environmental) - Sex determination in *Drosophila* and Man – Mechanism of dosage compensation – Sex linked characters – Sex limited genes - Cytoplasmic inheritance: Kappa particles in *Paramecium*, CO<sub>2</sub> sensitivity in *Drosophila* and milk factor in mice

**Nuclear and extra-nuclear inheritance** – Antibiotic resistance in *Chlamydomonas*, mitochondrial mutation in *Saccharomyces* and human disorder– Infective hereditary in *Paramecium* – Maternal effect – Shell coiling in snail

### **Unit -III**

**(15 Hours)**

**Genetic Material: DNA** – Double helix structure of DNA – DNA as a genetic material – experimental proof – Transformation – Transduction – Conjugation – Recombination – Sexduction - **RNA:** Structure and function

**Gene and gene concept** - Fine structure of gene – Cistron, Muton and Recon – Regulation of gene expression – Operon concept – Lac operon – Genetic code

**Mutation** – Molecular basis of mutation – Gene mutation – Chromosomal aberration – Mutagenesis

### **Unit -IV**

**(20 Hours)**

#### **Population and Applied genetics**

Hardy Weinberg law – Gene frequency and factors affecting gene frequency – Sex linked gene in human – Animal breeding - Inbreeding and out breeding, Heterosis - Hybrid vigour, Eugenics, Euphenics and Euthenics

Pedigree analysis – Human karyotyping and variations – Probability – Application in genetics - Inheritance disorder in man – metabolic disorder – Genetic counselling

### **Unit- V**

**(15 Hours)**

#### **Origin of life**

History of evolution – Significance of evolutionary biology – Theories on origin of life – support of Oparins hypothesis – Urey Miller experiment - Biogenesis and abiogenesis - Fossilization - Dating of Fossil – Living and Extinct Fossils – Phylogenetic evolution.

#### **Principles and Nature of Evolution**

Lamarckism and Neo-Lamarckism – Darwinism and Neo-Darwinism – Mutation Theory - Mimicry & Colouration – Batesian and Mullerian - Convergent, Divergent and Parallel Evolution – Co-evolution - Adaptive radiation in mammals - Isolating mechanisms – Different types – Species concept – Definition and origin of species – Allopatric and Sympatric speciation – Genetic drift – Founder's Principle – Genetic load - Geological time scale – Mass Extinction - Evolution of horse and man

#### **Recommended Books**

##### **Genetics**

1. Gupta, P K. Genetics, Rastogi Publishers, Meerut.
2. Gupta, P K. Cytology Genetics, and Molecular Biology; Rastogi Publishers, Meerut.
3. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In.

##### **Evolution**

1. Verma, P.S. and V.K. Agarwal (2002). Concept of Evolution, S. Chand & Co., Ram Nagar, New Delhi
2. Stirton, R.A., Time, life and man, C.B.S. Publishers & Distribution, Delhi.
3. Colbert, E.H., Evolution of Vertebrates, C.B.S. Publishers & Distribution, Delhi.

## Reference Books:

### Genetics

1. Goodenough U. Genetics. IIIrd Edition, Washington University, Saunders CollegePublishing.
2. Swanson, O.P., Timothy Herz and William, J. Young: Cytogenetics -The chromosome indivision, inheritance and evolution, Prentice Hall.
3. Gardner, B.S., & Smustad, D.P. Principles of Genetics, John Wiley & Sons. 6th Ed.
4. Winchester, A.M. Genetics-A survey of the Principles of Heredity, Oxford & IBH Publishing Co., New Delhi.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming
6. Pierce B. A. (2012). Genetics-A Conceptual Approach. IV Edition. W. H. Freeman and Company
7. Russell, P. J. (2009). Genetics- A Molecular Approach. IIIrd Edition. Benjamin Cummings
8. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetics Analysis. IX Edition. W. H. Freeman and Co.

### Evolution

1. Dobzhansky, T., Genetics and the origin of species. Columbia, Univ. Press, New York.
2. Mayr, E., Systematics and the origin of species, Columbia Univ. Press, New York.
3. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring Harbour Laboratory Press.
4. Barnes, C.W. (1988). Earth, Time and Life. John Wiley & Sons, New York
5. Bendall, D. S. (ed.) (1983). Evolution from Molecules to Man. Cambridge University Press, U.K.
6. Bull J.J and Wichman H.A. (2001). Applied Evolution. Annu. Rev. Ecol. Syst. 32:183-217.
7. Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
8. Chattopadhyay Sajib. (2002). Life Origin, Evolution and Adaptation. Books and Allied (P)Ltd. Kolkata, India.
9. Douglas, J. F (1997). Evolutionary Biology. Sinauer Associates.

### Question paper pattern

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer Answer any 5 out of 7 questions	13–19	6	30
Section C	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

<b>UNITS</b>	<b>Section A</b>		<b>Section B</b>		<b>Section C</b>	
	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>
<b>I</b>	2	-	1	-	1	-
<b>II</b>	3	-	2	-	2	-
<b>III</b>	2	-	1	-	1	-
<b>IV</b>	2	-	1	-	1	-
<b>V</b>	3	-	2	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE PRACTICAL – V**  
**PRACTICAL II - CELL BIOLOGY, GENETICS AND EVOLUTION**

<b>SUBJECTCODE:</b>	<b>PRACTICAL</b>	<b>MARKS:100</b>
<b>SEMESTER:IV</b>	<b>CREDITS:4</b>	<b>TOTALHOURS:</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Cell Biology, Genetics and Evolution

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand the use and handling of microscope.
2. To demonstrate blood smear preparation and enumeration of RBC and WBC.
3. To demonstrate various cell stages during mitosis and meiosis; Mounting of buccal epithelium and observation.
4. To observe and study of prepared histology slides.
5. To observe the common mutants; study on normal and abnormal karyotype and identification of human blood group.

**Cell Biology**

1. Micrometry – Components and use of microscopes – Light microscope, CameraLucida, Stage and Ocular micrometer.
2. Blood smear preparation – Differential Count of WBC
3. Counting of RBC and WBC using Hemocytometer (Demonstration)
4. Mounting of Buccal epithelium and observing living cells using vital staining
5. Mitosis in onion root tip squash
6. Meiosis in grasshopper testis squash (Demonstration)
7. Study of prepared slides of histology
  - a. Columnar epithelium
  - b. Ciliated epithelium
  - c. Glandular epithelium
  - d. Connective tissue
  - e. Cartilage T.S.
  - f. Bone T.S.
  - g. Cardiac tissue
  - h. Striated muscle
  - i. Non-striated muscle
  - j. Nervous tissue
  - k. Ovary T.S.
  - l. Testis T.S.

## **Genetics**

1. Experiments using beads or seeds to study the Mendel's laws and gene interactions
2. Pedigree Analysis
3. Observation of Common Mutants of *Drosophila* (white eye, red eye, normal wing and vestigial wing)
4. Preparation of mount of salivary gland chromosomes of *Chironomus* larva
5. Identification of human blood groups
6. Studies of human Karyotype – Normal (Male and Female), Abnormal (Down Syndrome, Turner and Klinefelter Syndrome)

## **Evolution**

1. Study of fossils from models/pictures
2. Identify the Scientist and mention their contribution
3. Report on Extinct, Endangered and Vulnerable Species

**Semester-V**



**CORE THEORY – VII**  
**DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: V</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS:60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Developmental Biology and Immunology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand the basic concepts of developmental biology.
2. To describe the mechanism and physiology of fertilization. Compare the process of cleavage, Blastulation, gastrulation, tubulation in frog and chick.
3. To understand the key concepts of development of membranes and formation of placenta, biochemical basis of embryology, regeneration and metamorphosis. Knowledge on application of Reproductive technology.
4. To discuss history of immunology and organization of immune system.
5. To highlight the structure, types and properties of antigens, immunoglobulins. Knowledge on techniques used in immunology.

**UNIT – I**

**(12 Hours)**

**Basic Concept of Development:** Origin of germ cells – Gametogenesis - Spermatogenesis and Oogenesis -Types of sperms - Types of eggs and egg membranes - Structure of Sperm and Ovum in mammals.

**Fertilization** – Acrosomal reaction, cortical reaction, physiological, biochemical changes and its significance.

**UNIT – II**

**(12 Hours)**

**Cleavage** – Types of cleavage patterns - Controlling factors and laws in cleavage - - Blastulation, Gastrulating and Tubulation in frog and chick - Fate maps in frog and chick - Presumptive areas - Organizers and inductors - Extra-embryonic membranes - Placentation in mammals.

**UNIT – III**

**(12 Hours)**

**Human Reproduction:** Puberty - Menstrual cycle – Menopause - Pregnancy and its related problems – Artificial Insemination – Cryopreservation – In vitro Fertilization (IVF) - Embryo Transfer and its advantages - Test tube baby- Amniocentesis – Super Ovulation - Ethics in Artificial Reproductive Technology (ART) and Embryo manipulation - Infertility in male and female.

**UNIT - IV**

**(12 Hours)**

**Overviews of Immune system** – Historical perspectives, Innate and Acquired immunity - Cells of the Immune System - Hematopoiesis and differentiation, B- lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural Killer Cells and Lymphocyte Activated Killer Cells, Eosinophils, Neutrophils and Mast Cells. **Organs of the Immune System:** Primary and Secondary Lymphoid Organs: Thymus, Bursa of Fabricii, Spleen, Lymph Nodes, Lymphatic System, Mucosa Associated Lymphoid Tissue (MALT) - Complement system.

**UNIT - V****(12 Hours)**

Antigens – Types, properties - Haptens – Adjuvants – Vaccines – Types – Toxoids – Antitoxins – Immunoglobulins – Structure, types, and properties – Theories of antibody production – Complement - Structure, properties, function and pathway.

Immunotechniques: Detection of molecules using Antigen-antibody reaction – In vitro methods – Agglutination reaction – Agglutination-inhibition - Immunoprecipitation – Complement fixation – Immuno-fluorescence microscopy – ELISA – RIA.

**Recommended Books****Developmental Biology**

1. Berril, N.C. (1971). *Developmental Biology*, McGraw Hill, New York.
2. Scott F. Gilbert, (2006). *Developmental Biology*, Sinauer Associates Inc., U.S.; 8th Revised edition.
3. Jain. P.C. (2007). *Elements of Developmental Biology*, 6th Edn. Rastogi Publications.
4. Agarwal, V.K. and Usha Guptha, S (1998). *Chand's simplified course in zoology, chordate embryology and histology*. S. Chand & Co Ltd.

**Immunology**

5. Rao, C.V. (2006). *Immunology*. Narosa Publishing House, New Delhi.
6. Kindt, T.J., Goldsby, R. A. and Osborne, B.A. (2007) *Kuby Immunology*. VI Edition. W.H. Freeman and Co, New York
7. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication
8. Roitt I.M. (2000). *Essential Immunology*. Blackwell Scientific Publishers

**Reference Books:****Developmental Biology**

1. Verma P.S and Agarwal V.K, (2010). *Chordate Embryology*, S Chand; Reprint of 1975 first edition.
2. Berry.A.K.(2007). *An Introduction to Embryology*, Emkay Publications, New, Delhi-51.
3. Arumugam, N. (1988). *A Text Book of Embryology*. Saras Publication, Nagercoil
4. *An Introduction to Embryology*, Saunders Company.
5. Balinsky, B.I. (1970). *An Introduction to Embryology*. Saunders Press, Phil. 3<sup>rd</sup> Edn.
6. Gibbs. (2006). *Practical Guide to Developmental Biology*. Oxford University Press
7. Werner. A. Muller. (2008). *Developmental Biology*. Springer.
8. Wolpert, L. (1998). *Principles of Development*. Oxford University Press, N. Y.

**Immunology**

1. Abbas, K. Abul and Lechtman H. Andrew (2003) *Cellular and Molecular Immunology*. V Edition, Saunders Publication.
2. Kannan, I. (2007). *Immunology*. MJP Publishers, Chennai.
3. Kenneth Murphy and Casey Weaver. *Janeway's Immunobiology*, IX Edition, Garland Science
4. Turner, C.D. and Bagnars, W.B. (1976) *General Endocrinology*, Saunders Company.
5. Chakravarthy, A. K. 1996. *Immunology*, Tata Mc Graw Hill, New Delhi.

### Question Paper Pattern

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<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
<b>I</b>	3	-	1	-	2	-
<b>II</b>	3	-	1	-	1	-
<b>III</b>	2	-	2	-	1	-
<b>IV</b>	2	-	2	-	1	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE THEORY – VIII  
BIOTECHNOLOGY AND NANOTECHNOLOGY**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: V</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS: 60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Biotechnology and Nanotechnology.

**COURSE OUTCOME:**

1. To familiarize the students with the basic concepts of biotechnology and its application in various sectors. To discuss the Global and Indian Scenario of biotechnology.
2. To understand the different enzymes involved in recombinant DNA Technology. To classify the cloning vectors based on its efficiency and the host selection process
3. To acquire knowledge on steps involved in genetic engineering and selection and screening process of recombinant cells.
4. To understand the animal cell culture and its application in various fields
5. To gain foundational knowledge in nanotechnology and its application in the field of medicine. To gain knowledge on biomimicry with different aspect.

**UNIT - I**

**(5 Hours)**

Scope and importance of biotechnology - Fields of biotechnology – History of biotechnology — Global impact of biotechnology in healthcare, aquaculture, agriculture and environment – Biotechnology in global and Indian scenario – Applications of Biotechnology

**UNIT- II**

**(20 Hours)**

Steps involved in recombinant DNA technology - Tools in Recombinant DNA technology: Enzymes – Nucleases: Exo and Endonuclease, DNase & RNase, DNA ligase, Alkaline Phosphatase, DNA polymerase, Reverse transcriptase, T4 polynucleotide kinase, terminal transferase, and homopolymer tailing.

**Classification of Cloning Vectors:** Based upon copy number, function - Cloning vector - Insertional vector, replacement vector, shuttle vector and expression vector system - Vectors - pBR322, pUC vectors, Ti plasmid vector system - Bacteriophage: Salient feature and vector system -  $\lambda$  WES vectors, Charon vector, M13 vector system, Baculoviral vector system, pBluescript vector and YAC system - Host expression system selection - *E.coli* and *Saccharomyces cerevisiae* - Host system

**UNIT- III**

**(15 Hours)**

**Techniques of Genetic Engineering:** DNA isolation - Selection of vector system - Insertion of target DNA - Various transformation techniques of vector system into host system: Transformation, transduction, microinjection, cell fusion, liposome, electroporation - Screening and selection of recombinant cells - Selectable markers- Ap<sup>F</sup> gene, Lac Z gene, HGPRT gene - Colony hybridization method and immunological test – Gene Library construction: Genomic Library and cDNA Library

**UNIT -IV**

**(8 Hours)**

**Animal Biotechnology:** History of animal cell culture – Requirements for animal cell culture – culture media and substrate – steps involved in animal tissue culture (isolation, disaggregation, establishment of cell culture) – Importance of Transgenic animals (mice, cow, sheep, hen, fish,

silk worm) – Overview of tissue engineering - Skin construct for wound healing - Bioethics in animal genetic engineering.

#### **UNIT -V**

**(12 Hours)**

**Nanotechnology:** Definition – Natural biopolymers - Construction and importance: Chitosan, collagen, silk, keratin, gelatin and their applications. Types of artificial nanoparticles and their applications - Importance of nanotechnology in the field of medicine (gold, silver and bioceramics - hydroxyapatite, eye lens), medical devices (cell on microchip, Micro array: DNA, RNA and Protein), Biomimicry - peacock and Butterfly wing effect, Bat, Gecko effect, termites-hill, lotus leaf effect - self-cleaning

#### **Recommended Books**

1. Dubey, RC., (1993). A Textbook of Biotechnology. S. Chand Publication.
2. Dubey, RC., (2014). Advanced Biotechnology. S. Chand Publication.
3. Purohit Mathur, (1999). Biotechnology Fundamental and applications. Botanica Publications
4. Shanmugam, S., (2011). Nanotechnology. MJP Publishers.
5. Rakesh Rathi, Nanotechnology, S. Chand & Co.
6. Parthasarathy, BK., (2007). Nanotechnology in Life Science Gyan Books.

#### **Reference Books:**

1. Shah H.A and Tokeer Ahmad, (2011). Principles of nanoscience and nanotechnology. NarosaPublishing House.
2. Brown.TA., (2010). Gene cloning and Introduction. Wiley Blackwell.
3. Brown J.A. (2001) – Genetics – A Molecular approach 3rd edition – Nelson Tornos.
4. Old R. W and S.B. Primrose. (1994). Principles of Gene manipulation – 5<sup>th</sup> edition – Blackwell Scientific publications.
5. John. R. W. Masters (2000). Animal cell culture – A practical approach 3rd Edition. Oxforduniv press.
6. Glick B.R. and Jack J. Pasternak, (1994). Molecular biotechnology ASM press.
7. Ramdoss, P., (2009). Animal Biotechnology Recent Concepts and Developments, MJP Publishers.
8. Subbiah Balaji, (2010). Nanotechnology. MJP Publishers.
9. Kumar, (2010). Principles of Nanotechnology, Sci. tech. Publications (India)
10. Murty,BS., Shankar. P., Baldev Raj, B B Rath and James Murday (2013). Textbook of Nanoscience and Nanotechnology

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<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
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<b>I</b>	2	-	1	-	1	-
<b>II</b>	3	-	1	-	2	-
<b>III</b>	3	-	2	-	1	-
<b>IV</b>	2	-	1	-	1	-
<b>V</b>	2	-	2	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE THEORY – IX**  
**ANIMAL PHYSIOLOGY AND BIOCHEMISTRY**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: V</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS:60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Animal Physiology and Biochemistry.

**COURSE OUTCOME**

1. To understand the history, branches, scope of physiology and principles of homeostasis. To understand the physiology of digestion and gastro-intestinal disorders
2. To discuss in depth the structure and physiology of the circulatory and respiratory system
3. To classify the animals based on excretory products. To discuss the structure and physiology of the human kidney. To acquire knowledge of the principles and mechanisms of osmoregulation and thermoregulation
4. To understand the ultrastructure of skeletal muscles, mechanism and physiology of muscle contraction. To discuss the structure, functions and biological actions of endocrine glands and to gain knowledge on reproductive physiology
5. To gain fundamental knowledge on the scope and significance of biochemistry. To acquire in-depth knowledge of enzyme classification, enzyme kinetics and its regulation. To understand the basic concepts of metabolism and to discuss the metabolic pathway of carbohydrates, lipids and protein with its regulation

**Unit- I**

**(8 Hours)**

**Introduction to Physiology:** Definition – History - Branches and scope of physiology - Principles of homeostasis

**Digestion:** Definition and types of digestion - Digestion and absorption of carbohydrates, proteins and lipids in man - Nervous and hormonal control of digestion - Gastro-intestinal disorders: GERD, Gastritis and Ulcer

**Unit -II**

**(12 Hours)**

**Circulation:** Structure of human heart - Blood: composition and functions - Blood clotting mechanism - Theories and disorders of blood clotting - Origin and conduction of heart beat - Cardiac cycle - Heart sounds - Cardiac output and Stroke volume - Regulation of heart beat - Pulse and Blood pressure: Definition and its clinical significance.

ECG – Principle and its significance - Cardiovascular diseases: Arrhythmia, Coronary Artery Diseases (CAD), Myocardial infarction, Heart failure, Cardiomyopathy, Rheumatic Heart disease, Stroke - Angiogram - Angioplasty – ESR

**Respiration:** Structure and functions of respiratory tract and Lungs - Respiratory pigments: Definition, types and its functions - Transport of respiratory gases: oxygen and carbon dioxide transport - Respiratory volumes and capacities - Respiratory quotient  
Respiratory disorders: hypoxia, hypocapnia and hypercapnia, asphyxia, carbon monoxide poisoning, bronchitis, asthma - Physiological effects of smoking - Oxygen therapy and Artificial Respiration

### **Unit -III**

**(8 Hours)**

**Excretion:** Excretory products: Definition - Classification of animals based on excretory products - Structure and functional anatomy of human kidney – Nephron - Physiology of urine formation - Hormonal regulation of excretion - Renal failure - Dialysis - Kidney transplantation

**Osmoregulation:** Osmoregulators and Osmoconformers - Mechanism of Osmoregulation in freshwater and marine fishes and crustaceans

**Thermoregulation:** Temperature regulation in poikilotherms and homeotherms - Physiology of hibernation, aestivation and diapause

### **Unit -IV**

**(20 Hours)**

**Muscle:** Definition, types and properties of muscles - Contractile proteins - Ultrastructure of skeletal muscles - Mechanisms and theories of muscle contraction - Physiological and biochemical changes during muscle contraction - Simple muscle twitch, muscle fatigue, tetanus, rigor mortis

**Neural conduction:** Structure of a neuron and its types - Nerve impulse – Definition, resting membrane potential, action potential - Neurotransmitters and its significance - Conduction of nerve impulse - Synaptic transmission, neuromuscular junctions - Reflex action and reflex arc

**Endocrine System:** Endocrinology: Endocrine glands – Structure, secretions, functions and disorders of endocrine glands of vertebrates – Pituitary, Thyroid, Parathyroid, Adrenal, Islets of Langerhans.

Hormones: Salient features, Classification and Regulation of their secretion - Modes of hormone action: signal transduction pathway for steroidal and non-steroidal hormones - Homeostasis and Feedback mechanism

**Reproductive Physiology:** Male and female reproductive organs. Physiology of male and female reproductive system.

### **Unit -V**

**(12 Hours)**

**Biochemistry:** Scope and significance of biochemistry

**Enzymes:** Definition, Classification, Nomenclature, Properties, Biological functions - Mechanism of enzyme action: Lock and key hypothesis, induced fit theory - Enzyme kinetics: Definition, Derivation of Michaelis Menten equation, Line Weaver Burk Plot - Significance of  $K_m$  and  $V_{max}$  - Enzyme inhibition and Regulation - Factors affecting enzyme activity

**Metabolism:** Definition - Catabolism Vs Anabolism - Stages of catabolism, compartmentalization of metabolic pathways - Regulation of metabolism (Brief account)

**Carbohydrate Metabolism:** Carbohydrate metabolism: Glycogenesis, Glycogenolysis, Gluconeogenesis and Glycolysis; Krebs's cycle, Electron Transport Chain, Oxidative phosphorylation - Regulation of carbohydrate metabolism

**Lipid Metabolism:**  $\alpha$ -oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms and their regulation - Biosynthesis of palmitic acid, Ketogenesis - Regulation of lipid Metabolism (Brief account)

**Protein Metabolism:** Transamination, Deamination, Transmethylation, Decarboxylation, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids – Regulation of protein metabolism (Brief account)



## **Recommended Books**

### **Physiology**

1. Guyton, A.X. (1986). Text Book of Medical Physiology, 7<sup>th</sup> Edition, Saunders Company.
2. Verma P.S., Agarwal V.K. and Tyagi, B.S. (1995). Text book of Animal Physiology. S.Chand & Co.
3. Rastogi. S.C. (1977). Essentials of Animal Physiology. New Age International (P) Ltd.,Publisher
4. Shenbulingam K and Prema Shenbulingam (1999). Essentials of Medical Physiology. JaypeeBrothers Medical Publishers (P) Ltd.

### **Biochemistry**

1. Jain, J.L et.al. (2005). Fundamentals of Biochemistry. S. Chand & Co, New Delhi.
2. Ambika Shanmugam. Fundamentals of Biochemistry for Medical Students. Wolters Kluwer(India) Pvt. Ltd., New Delhi
3. Satyanarayana U., Chakrapani U (1999). Biochemistry. Books and Allied (P) Ltd.
4. Lehninger A.L., Nelson D.L., Cox M.M. (2005). Principles of biochemistry (W. H. Freeman,USA).

## **Reference Books:**

### **Physiology**

1. Gerard J. Tortora., Bryan Derrickson (2000). Principles of Anatomy and Physiology. JohnWiley & Sons, Inc.
2. Best, J.P. (1985). Best and Taylor's Physiological Basis of Medical Practice (11<sup>th</sup> Edition)William and Wilkins.
3. Ganong, W.F. (2003). Review of Medical Physiology, McGraw Hill, New Delhi.
4. Schmidt-Nielson K. (2002). Animal Physiology. Prentice Hall India Ltd.
5. Hoar, W.S. (1983). General and comparative physiology, Adaptation and Environment (3rdEdition) Cambridge University Press.
6. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander 's Human Physiology, XI Edition.,McGraw Hill
7. Pat Willmer., Graham Stone and Ian Johnston (2000). Environmental Physiology of Animals.Blackwell Publishing Company.
8. Golds Worthy, G.J. Robinson, J. and Mordue, W. (1981). Endocrinology, John Wiley andSons, New York.

### **Biochemistry**

1. Stryer L, J. M. Berg, J.L. Tymoczko (2001). Biochemistry (W.H. Freeman and Company,New York).
2. Rawn J.D. (1989). Biochemistry (Neil Patterson).
3. Voet D., Voet, J.G. (2004). Biochemistry (John Wiley & Sons).
4. Voet, D., Voet, J.G. and Pratt, C.W. (2008). Fundamentals of Biochemistry: Life at themolecular level (John Wiley & Sons).

### Question Paper Pattern

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<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE THEORY-X**  
**BIostatISTICS AND COMPUTER APPLICATIONS WITH R PROGRAMMING**  
**FOR LIFE SCIENCES**

<b>SUBJECTCODE:</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER: V</b>	<b>CREDITS: 4</b>	<b>TOTALHOURS:60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of biostatistics and computer applications with r programming for life sciences

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To apply basic statistical concepts commonly used in Life Sciences; Explain how statistical techniques studied are incorporated in the analysis of research data. Calculate descriptive statistics and able to draw graphs; Compute a sample mean, sample variance, and a sample standard deviation.
2. To understand normal distribution and hypothesis testing. Knowledge on Regression analysis and Theories of probability
3. To recognize the importance of data collection and its role in determining scope of inference.
4. To explore and understand how to use the R documentation.
5. To read structured data into R from various sources.

**UNIT-I**

**(12 Hours)**

Introduction to Biostatistics - Types of data, Collection, Classification and Tabulation of the Primary data, Secondary Data, Discrete data and Continuous data, Diagrammatic and Graphical representation of grouped data - Frequency Distribution (univariate and bivariate) - Cumulative frequency distribution and their graphical representation, Histogram frequency polygon - Concept of central tendency -Measures of dispersion

**UNIT-II**

**(12 Hours)**

Normal distribution - Simple Correlation - Hypothesis testing- Student's t-test - Chi-square analysis - Regression Analysis - Theories of probability

**UNIT-III**

**(12 Hours)**

Introduction – R Features – How to run R – Variables – Basic data types – Operators – Datastructure – Vectors – Data frames – Lists – Matrices – Arrays, Factors

**UNIT-IV**

**(12 Hours)**

R Programming Structure – Control statements – Loops – R Functions – Input / Output accessing the keyboard and monitor, reading and writer files - R graphics – R Plot, LineR, ScatterplotR, Pie Charts, R Bars

**UNIT-V**

**(12 Hours)**

R Math & Statistical Functions – Built in math functions, Statistical function, Central tendency (Mean, Mode, Median), Hypothesis testing, t-test, Chi-square test – Correlation - Normal Distribution.

### Recommended Books

1. "R in Action, Rob Kabacoff, Manning"
2. Statistics with R Programming Sandip Rakshit, McGraw Hill Education
3. R For Dummies- and Rie de Vries, Publisher - John Wiley & Sons
4. Statistical Analysis in Simple Steps Using R , Kiran Pandya, - SAGE Publications Limited
5. Jared P. Lander, R for Everyone, Pearson Education Publisher
6. Paul Teetor, R Cookbook, Oreilly.
7. An Introduction to Statistical Learning: with Applications in R by Gareth James - SpringerPublisher.

### Reference Books:

1. P.N. Arora & P.K. Malhotra (1996). Biostatistics (Himalaya Publishing House, Mumbai).
2. Sokal & Rohlf (1973). Introduction to biostatistics (Toppan Co. Japan).
3. W.J. Evens, G.R. Grant (2005). Statistical methods in Bioinformatics: An introduction (Springer).
4. P.K. Sinha (2004). Computer fundamentals (BPB).
5. Suresh K. Basandra (2008). Computers today (Galgotia Publications Pvt. Ltd., New Delhi).

### Question Paper Pattern

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer Answer any 5 out of 7 questions	13–19	6	30
Section C	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
I	3	-	-	1	1	1
II	2	-	-	1	-	1
III	2	-	2	-	1	-
IV	3	-	2	-	1	-
V	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**ELECTIVE I: INTERDISCIPLINARY ELECTIVE (IDE)  
WILDLIFE CONSERVATION**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER:V</b>	<b>CREDITS: 5</b>	<b>TOTAL HOURS:75</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Wildlife Conservation

**COURSE OUTCOME**

On completion of the course the students will be able

1. To understand the importance and need for wildlife conservation. Explain the causes of wildlife depletion.
2. To acquire knowledge on population estimation and wildlife photography
3. To outline the wildlife health care and confliction and control measures
4. To highlight wildlife management and legislation.
5. To knowledge on wildlife protection.

**UNIT – I**

**(15 Hours)**

Introduction to wildlife and its conservation. Economic importance and Need for conservation - Definition of wildlife – Causes of wildlife depletion – Endangered species – Threatened and Rare species - India as a mega wildlife diversity country- Gulf of Mannar – Marine ecosystem sanctuary – Mangrove ecosystem - National Biodiversity Authority

**UNIT – II**

**(15 Hours)**

Population Estimation : Basic concepts and application – Direct Count (Block Count, Transect Methods, Point Counts, Visual Encounter Survey, Waterhole Survey) – Indirect Count (Call Count, Track and Signs, Pellet Count, Pug Mark) – Tagging - Wildlife Photography: Types of camera, camera traps - Field equipments – Altimeter, Pedometer, Field Compass, Binoculars, Radio Collaring, GPS, GIS - Remote sensing in wildlife management

**UNIT – III**

**(15 Hours)**

Wildlife health care and human wildlife confliction - Infectious wildlife diseases – Viral (Rabies) – Bacterial (Anthrax) – Basic reasons for conflicts - Damage caused by wild animals and control measures

**UNIT – IV**

**(15 Hours)**

Wildlife Management and Legislation – Wildlife Protection Act 1972, IUCN, CITES, NBA, Project tiger, Project elephant – Wildlife trade and regulation - Biodiversity Act 2000 - Ecotourism and Eco restoration - Anti-poaching operations – Village Forest Council (VFC)

**UNIT –V**

**(15 Hours)**

Wildlife Protection – Definition – *in-situ* and *ex-situ* conservation – Zoos and Zoological Parks – National Parks and Sanctuaries (Aringar Anna Zoological Park, Guindy National Park, Srivilliputtur Wildlife Sanctuary, Vedanthangal Bird Sanctuary, Mudumalai and Periyar Tiger Reserves, Nilgiris Biosphere Reserve) – National Bureau of Plant genetic resources, Fish genetic resources and animal genetic resources

**Exercises (Optional)**

- Visit to National Zoological Parks and Sanctuaries
- Study on wetlands or about high-altitude fauna

**Recommended Books**

1. Saharia, V.B. (1987). Wildlife in India. Nataraj Publications, Dehradun.
2. A Book on Wildlife Protection Act 1972, Lawmann
3. A Book on the Red Data Books by IUCN.

**Reference Books:**

1. The Eye of the Elephant: An Epic Adventure in the African Wilderness by Delia Ownes
2. The Book of Indian Birds by Salim Ali.
3. Analysis and Management of Animal Population by Byron.K. Williams.

**Question paper pattern**

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<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
<b>I</b>	3	-	1	-	1	-
<b>II</b>	3	-	2	-	1	-
<b>III</b>	2	-	1	-	2	-
<b>IV</b>	2	-	2	-	1	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**Semester-VI**

**CORE THEORY-XIII**  
**ENVIRONMENTAL BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY**

<b>SUBJECTCODE:</b>	<b>THEORY</b>	<b>MARKS:100</b>
<b>SEMESTER:VI</b>	<b>CREDITS: 3</b>	<b>TOTALHOURS:60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Environmental Biology and Environmental Biotechnology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To demonstrate an understanding of the principles of ecology and ecosystem
2. To understand the importance of biogeochemical cycles and obtain knowledge on ecological succession
3. To knowledge on freshwater and marine habitat, National and International Environmental organizations, Red Data Book and Wildlife management.
4. To knowledge on freshwater and marine habitat, National and International Environmental organizations, Red Data Book and Wildlife management.
5. To understand the technologies, tools and techniques in the field of environmental biotechnology.

**UNIT- I**

**(12 Hours)**

Ecology – Definition - Subdivision and scope of ecology - Ecological factors - Temperature and light as ecological factors - Ecosystem – Definition – Types of Ecosystem - Components of ecosystem - Grazing and detritus type of food chain - Food web and trophic levels - Ecological pyramids -Pyramids of number - Biomass and Energy

**UNIT- II**

**(12 Hours)**

Energy flow - Flow of energy through a food chain in relation to laws of thermodynamics - Biogeochemical cycles – Nitrogen and phosphorous cycle - Laws of limiting factor- Liebig's law of minimum, Shelford's law of tolerance and concept of limiting factors. Ecological niche – Concept of ecological niche - Ecological succession – Definition - Types of succession

**UNIT- III**

**(10 Hours )**

Freshwater habitats – Lentic and lotic; Marine habitat – Zonation - Intertidal sandy shore, intertidal muddy shore, rocky shore – Deep sea adaptation  
Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones  
Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations.  
National and International Environmental Organizations - Red Data Book - Wildlife management – Conservation of biodiversity.

**UNIT -IV**

**(13 Hours)**

Bioremediation of Environmental Pollutants in soil and water – oils, heavy metals and detergents – Microbial biodegradation of Xenobiotic compounds – Bioremediation - concepts and application – Biotreatment of dye industrial waste – source and origin of dyes. Treatment technologies of dyes – Bioplastics: Biopols (PHB), Biolac (Polylactic acid)



**UNIT -V****(13 Hours)**

Non-conventional source – Biomasses as a source of bioenergy – types of biomass – plant, animal and microbial biomass – Various industrial effluent treatment methods – sugar, distillery, dairy, tannery and pharmaceutical industries – Biogas from solid waste – composting and vermicomposting

**Recommended Books**

1. Mayr, E., Principles of Systematic Zoology, McGraw-Hall, New York.
2. Krebs, J.C., Ecology, Harper & Row, Publ., New York.
3. Odum, E.P., Fundamentals of Ecology, Saunders College Publishers, Philadelphia.
4. George L.C., Elements of Ecology, Johnes Wiley, New York.
5. Kendeigh, S.C., Ecology with special reference to animals, Prentice-Hall of and New Delhi.
6. Smith, Ecology, Harper & Row Publishers, New York.
7. Kormondy, Concepts of Ecology, Prentice Hall of India, New Delhi.
8. Jogdand, G. N. (1995). EBT: Himalaya Publishers.

**Reference Books:**

1. S. K. Agarwal. (1998). EBT, APH Publishers
2. Alan Scragg, (1999). Environmental Biotechnology, Longman “Environmental Biotechnology: Concepts and Application” by Jordening H J and Winter J n Publication.
3. Evans G M and Furlong J C. Environmental Biotechnology: Theory and Application”.
4. Bhattacharya B C and Banerjee R. Environmental Biotechnology
5. Indu Shekhar Thakur. Environmental Biotechnology: Basic Concepts and Applications”
6. Perry L McCarty and Bruce E Rittmann. Environmental Biotechnology
7. P K Mohapatra. Textbook of Environmental Biotechnology
8. S K Agarwal. Environmental Biotechnology

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<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
<b>I</b>	3	-	2	-	1	-
<b>II</b>	3	-	1	-	1	-
<b>III</b>	2	-	1	-	1	-
<b>IV</b>	2	-	2	-	2	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE THEORY – XIV**  
**GENETIC ENGINEERING AND RECOMBINANT DNATECHNOLOGY**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: VI</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS: 60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Genetic engineering and Recombinant DNA Technology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand the basic concepts of gene cloning. Discuss the importance of enzymes and plasmids used in genetic engineering.
2. To acquire knowledge on cloning vectors for E.coli and identification of recombinants and structure and reproduction of bacteriophages.
3. To describe cloning vectors for yeast and fungi and identification of recombinants from gene library and methods of clone identification.
4. To obtain knowledge on various techniques used in genetic engineering and recombinant DNA technology and application of rDNA technology in Medicine and Agriculture.
5. To compute animal cell culture method. Discuss the application of genetic engineering in medicine, recombinant proteins and vaccine production.

**UNIT- I**

**(12 Hours)**

**Biotechnology** – Definition and scope - Achievements of biotechnology - Biotechnology in India - Introduction to gene cloning - DNA manipulative enzymes - nucleases, ligases, polymerases, modifying enzymes, restriction enzymes and its nomenclature, topoisomerases – plasmids - Basic features of plasmids - Plasmid classification - Blunt and sticky ends - Linkers adapters

**UNIT- II**

**(12 Hours)**

**Vectors:** Bacterial vector – pBR322 and pUC vectors - Phage vectors – Lambda, M13, cosmid and phagemid - Artificial chromosomes - YAC, BAC, PAC, HAC - Expression vectors and shuttle vectors - Plant vectors - Ti and Ri - Animal virus derived vectors - SV40, vaccinia, Retro viral vectors - Host strain for transformation.

**UNIT -III**

**(12 Hours)**

**Genetically Modified Organisms**

Production of cloned and transgenic animals - Nuclear transplantation - Retroviral method - DNA microinjection - Applications of transgenic animals - Production of pharmaceuticals - Production of donor organs - Knock out mice - Production of transgenic plants - Agrobacterium mediated transformation - Applications of transgenic plants - Insect and herbicide resistant plants.

**UNIT -IV**

**(12 Hours)**

Agarose and polyacrylamide gel electrophoresis - Southern, northern and western blotting - Colony hybridization - *In situ* hybridization - Genomic cloning - Transformation of *E. coli*, yeast and plant cells - PCR: Types, applications and limitations - Applications of rDNA technology to medicine and agriculture

**UNIT -V****(12 Hours)****Animal Cell Culture and rDNA Application in Health**

Basic techniques in animal cell culture - Primary culture and cell lines - Culture media - Natural and synthetic - Cryopreservation of cultures - Recombinant vaccines - Gene therapy (*in-vivo* and *ex-vivo*), Production of recombinant proteins - Monoclonal antibodies - Insulin and growth hormones – Medicine - Hepatitis vaccine production

**Recommended Books**

1. Dubey, R.C. (1995). A Text Book of Biotechnology, S. Chand & Co. Ltd., Ram Nagar, NewDelhi – 110 055.
2. White Bruce A. (1997). PCR cloning protocols: from molecular cloning to genetic engineering (Humana Press).
3. Terence A. Brown (2006). Gene cloning and DNA analysis: An introduction (Wiley-Blackwell).
4. Bernard R. Glick, Cheryl L. Patten, (2017) Molecular Biotechnology, Principles & applications of recombinant DNA, 5th edition, ASM Press.

**Reference Books:**

1. Kumaresan V. (2005). Biotechnology, Saras Publications. Nagercoil.
2. J. Sambrook, D.W. Russell (2001). Molecular cloning: A laboratory manual (Cold springHarbour Laboratory Press).
3. R.M. Old, S.B. Primrose (2001). Principles of gene manipulation (Wiley- Blackwell).
4. B. D. Hames, S. J. Higgins (1995). Gene probes: A. practical approach (Oxford UniversityPress).
5. Tuan Rocky S. (1997). Recombinant gene expression protocols (Edition Illustrated, PublisherSpringer).
6. Sandy B. Primrose, Richard Twyman (2006). Principles of gene manipulation and genomics(Wiley Blackwell).
7. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation andGenomics, 7th Edition, Blackwell Publishing Co., USA.

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<b>TOTAL MARKS</b>				100

**Break up of questions for theory**

<b>UNITS</b>	<b>Section A</b>		<b>Section B</b>		<b>Section C</b>	
	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>	<b>Theory</b>	<b>Problem</b>
<b>I</b>	3	-	1	-	1	-
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<b>III</b>	2	-	2	-	1	-
<b>IV</b>	2	-	2	-	2	-
<b>V</b>	2	-	1	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE THEORY – XV  
APPLIED MICROBIOLOGY**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: VI</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS: 60</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Applied Microbiology

**COURSE OUTCOME:**

1. To discuss the history of microbiology with case studies. To gain knowledge on principles and types of microscopy. To apply the knowledge to understand the classification of microbes and to understand the morphology and fine structure of bacteria
2. To classify the bacteria and to acquire skills in microbial culture techniques
3. To acquire knowledge on microbial growth, staining and sterilization technique
4. To discuss the significance of food microbiology, dairy microbiology, soil microbiology, water microbiology and medical microbiology
5. To appreciate how microbiology is applied in the production of industrial products and to understand the types of fermenters. To understand the basic principles of environmental microbiology and be able to apply the knowledge to understanding and solving environmental issues

**UNIT- I**

**(8 Hours)**

History - Scope of Microbiology in India – Case studies: Leishmaniosis, Leptospirosis, Salmonellosis, Typhoid, Bengal famine (Cholera), Romanian Plague, Spanish flu, Corona virus, Fungus: Cutaneous, sub-cutaneous and Systemic; Parasites: Malaria, Elephantiasis, Giardia.

Microscopy: Principle of microscopy – Light Microscopy - Bright field, Dark field, Phase contrast, Fluorescent, Electron Microscopy – Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM) - Whittaker's classification of microbes - Morphology and fine structure of bacteria: Size, shape, cilia, pili, flagella, capsule, cell wall and its composition - Cytoplasmic membrane, protoplast, spheroplast, cytoplasm, vacuoles, genetic material (genomic DNA and plasmid), cell inclusions, bacterial spores

**UNIT -II**

**(8 Hours)**

Evolution of microbes - Classification and salient features of bacteria, actinomycetes, virus, fungi and algae.

Nutritional requirements - Culture techniques: Media and its types - Microbial growth: Monoculture Growth curve and its significance - Generation time - Measurement of growth - Effect of environmental factors on growth.

**UNIT -III**

**(10 Hours)**

Bacterial inoculation methods - Spread Plate (quadrant, continuous and lawn culture) and pour plate - Anaerobic culture methods - Methods of preservation and maintenance of cultures  
Staining: Principles of staining - Types: Simple staining, differential staining (gram, acid-fast), negative staining, special staining (flagellar, capsular and endospore staining, metachromatic granular staining) - Bacterial identification methods: Morphology, biochemical and molecular technique (16s r RNA)

Sterilization and disinfection – Principles – Physical and chemical methods

**UNIT -IV****(20 Hours)****Applied Microbiology**

**Food Microbiology:** Fermented foods (pickles, bread, idly) - Food spoilage - Food poisoning - Food preservation

**Dairy Microbiology:** Milk and fermented milk products (curd and cheese) – Pasteurization – Probiotics - Milk - borne diseases (Tuberculosis, Brucellosis, Mad cow disease)

**Soil Microbiology:** Common soil microbes – Plant growth promoting microbes (bacteria and endophytic fungus) – Nitrogen fixation - Siderophores – Phosphatase, IAA, biofertilizer

**Water Microbiology:** Microbiology of drinking water - Water-borne diseases

**Medical Microbiology:** Koch's postulate - Host-microbe interaction - Diseases of Gastro-enteric system: Cholera, typhoid and viral hepatitis - Respiratory system: Influenza, Pneumonia - Nervous system: Meningitis, Tetanus and Polio - Genital system: Gonorrhoea, Syphilis and Candidiasis - Zoonotic: Rabies and Plague - Nosocomial infection - Methicillin Resistance *Staphylococcus aureus* (MRSA) - *Pseudomonas aeruginosa* (blue wound) - Antibiotics: Classification and mechanism of action

**UNIT -V****(14 Hours)**

**Industrial Microbiology:** Fermentation - Basic concepts and types of fermentation (submerged and solid state) - Basic design of fermentor and types - Application of microbes in industrial products: Ethanol, wine, vinegar preparation - Microbial enzymes: Amylase, protease, cellulase and lipase - Organic acid: Lactic acid and citric acid - Nutraceuticals: Vitamins, amino acids and phytohormones

Biopesticides - Biosurfactants – Biosensors - Antibiotics (Penicillin) – Brief Account

**Environmental Microbiology:** Role of Microbes in Sewage and Waste water treatment, bioremediation, biomineralization, biomining and bioleaching (Brief account)

**Recommended Books**

1. Jacquelyn G. Black, Laura J. Black, (2005). Microbiology: Principles and Exploration. Wiley
2. Subhash Chandra Parija, (2009). Textbook of Microbiology and Immunology. Elsevier-ReedElsevier India Pvt. Ltd.
3. Dubey, R. C. and Maheshwari, D.K. (2005). A Text Book of Microbiology. S. Chand & Co.Ltd., New Delhi.
4. Tortora, Funke and Case. (2006). Microbiology- An Introduction. Pearson Education
5. Pelczar Jr. M.J., Chan E.C.S., and Kreig N.R. (2001) Microbiology – McGraw Hill Inc. New York.

**Reference Books:**

1. Joanne, M. Willey, Linda M. Sherwood and Christopher, J. Woolverton, (2008). Microbiology – McGraw – Hill. International Edition
2. Sundara Rajan, S (2002). College Microbiology – Vol. I to IV, Vardhana Publications, Bangalore – 560 095
3. Alexander N. Glazer and Hiroshi Nikaido, (1994). Microbial Biotechnology: Fundamentals of Applied Microbiology. W.H. Freeman and Co., New York.
4. Stuart Hogg. (2005). Essential Microbiology. John Wiley & Sons Ltd.
5. Stainer R.Y., Ingraham J.L., Wheelis M.L. and Painter P.R., (1999) General Microbiology – Macmillan Education Ltd. London.
6. Rittmann, B.E. and P.L. McCarty, (2001). Environmental Biotechnology: Principles and Applications. McGraw- Hill, New York.
7. Ahmed, N., F.M. Qureshi and O.Y. Khan, (2001). Industrial Environmental

Biotechnology, Horizon Press.

8. Edward Alcamo, (1995). Microbiology. Wiley Publishing Inc.
9. Thomas J Montville, Karl R. Mathews, (2005). Food Microbiology: An Introduction. ASM Press, Washington, DC

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<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
I	2	-	1	-	1	-
II	2	-	2	-	1	-
III	3	-	1	-	1	-
IV	3	-	1	-	2	-
V	2	-	2	-	1	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**ELECTIVE - II**  
**CLINICAL LABORATORY TECHNIQUES**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: VI</b>	<b>CREDITS: 5</b>	<b>TOTAL HOURS: 75</b>

**Course Framework:**

Introduction to fundamental concepts of Clinical Laboratory Techniques

**Course Outcome**

1. To recognize the responsibilities of laboratory and health care personnel and interact with them with respect for their jobs and patient care. To gain knowledge to treat medical waste disposal and personal safety measures
2. To understand the principle and working procedure of the clinical laboratory equipment
3. To be competent in collecting, processing, and analyzing the blood specimens
4. To evaluate the organ function test and to analyse the physical, Chemical and microscopic examination of urine and stool samples
5. To analyse the physical, chemical and microscopic examination of body fluids. To perform and identify the disorders of lipid metabolism. To perform the Thyroid Profile, Rheumatoid arthritis profile, Pregnancy test and Hormone Tests for Ovarian and Testicular Disorder

**UNIT -I**

**(10 Hours)**

Introduction – Scope of the subject - Basic laboratory principles - Code of conduct of medical laboratory personnel - Use of the laboratory - Organization of clinical laboratory and role of medical laboratory technician - Medical laboratory professional and professionalism in laboratory workers - Clinical Laboratory records- Modern Laboratory set up - Quality control: Accuracy, Precision, and Reference values - Clinical borne infection and personnel hygiene Common causes of accidents in lab – laboratory safety – Biomedical waste. Classification of wastes coding – Treatment of medical waste disposal- Personal safety measures – Fire safety

**UNIT -II**

**(10 Hours)**

Common Laboratory Equipment's: Incubator, Hot Air Oven, Water Bath - Anaerobic Jar, Centrifuge, Autoclave, Colorimeter, pH meter, Haemoglobinometer, Hemocytometer, Microtome, PCR. Glassware – Description of glassware, its use, handling and care Imaging Techniques: X-ray – Ultrasound – MRI - CT and PET scan

**UNIT -III**

**(15 Hours)**

Basic steps for drawing a blood specimen - requirement of blood collection - Blood collection - Phlebotomy - Sampling errors - Collection and preservation of biological fluids - Anticoagulants - Preservation of samples - Chemical preservatives - Process of analyzing the specimens - The laboratory report.

Total Cell Count – RBC, WBC, platelets and absolute eosinophil count - Estimation of hemoglobin PCV and Erythrocyte Indices - M.C.V. - M.C.H - M.C.H.C (Methods and process of estimation) - Erythrocyte Sedimentation Rate (E.S.R.) - Westergren Method - Factors influencing sedimentation - Laboratory factors which influence ESR - Importance of ESR reticulocyte count - Differential Count - Bleeding time - clotting time - prothrombin time



**UNIT -IV****(20 Hours)**

Evaluation of organ function test Function of liver in health and disease – Jaundice –Hepatitis - Liver function test - Assessment and clinical manifestation of renal, hepatic, pancreatic, gastric & intestinal function - Enzyme of pancreatic origin and biliary tract - Test of myocardial infarction

Examination of Urine – Collection of urine - Components of routine urine analysis - Physical and Chemical Examination - Sugar in Urine - Tests for Sugar (Benedict's test) – Test for Protein - Ketone Bodies (Rothera's Test, Gerhardt's test) - Bile in Urine (Test for Bilirubin) - Test for Bile salts - Hay's Test - Blood in Urine: Test for Hematuria (Benzidine Test and Guaiacum Test)

Microscopic Examination of Urine: Kidney function test - Crystals found in urine (uric acid & urates, Calcium oxalates, Cystine, Drug crystals, Ammonium magnesium phosphates, Calcium carbonate) - Casts in urine - Cells in urine - RBC, pus cells, epithelial cells, spermatozoa, bacteria and tumour cells Examination of stool - physical, chemical and microscopic examination

**UNIT -V****(20 Hours)**

Body Fluids: Characteristics of Cerebrospinal Fluid - Synovial fluid - Pleural fluid - Pericardial fluids - Peritoneal Fluids - Semen analysis - Physical, chemical and microscopic examination - Sperm count, motility and its interpretation

Disorders of lipid metabolism - Normal levels of cholesterol, triglycerides, phospholipids, free fatty acids and lipoprotein in blood - Abnormal levels of lipids causing diseases - Lipidosis, Atherosclerosis, hyper and hypo lipo-proteinemias, sphingolipidoses, Niemann- Pick disease, Gaucher's and Tay-Sach's disease – Causes and pathology.

Thyroid Profile - Rheumatoid arthritis profile - Pregnancy test - Hormone Tests for Ovarian and Testicular Disorder

**Recommended Books**

1. Satyanarayan, U. Biochemistry, Books and Allied (P) Ltd. Kolkata-India
2. Ramanic Sood, Laboratory Technology (Methods and interpretation) 4th Ed. J.P. Bros, NewDelhi
3. Mukharji, Medical Laboratory Techniques, Vol - I, II & III, 5th Edn. Tata Mc Graw Hill,Delhi.
4. Satish Gupta, Short text book of Medical Laboratory for technician J.P. Bros, New Delhi

**Reference Books:**

1. Teitz, Clinical Chemistry. W.B. Saunders Company Harcourt (India) Private Limited, NewDelhi.
2. Kaplan, Clinical Chemistry, Mosby Company, St. Louis Washington, D.C. Toronto.
3. Fischbach, (2005). Manual of lab and diagnostic tests, Lippincott Williams Wilkins, NY
4. Gradwohls, (2000). Clinical laboratory methods and diagnosis. (ed) Ales C. Sonnen wirth andleonard jarret, M.D.B.I., New Delhi.
5. Ochei, J., and Kolhatkar, (2002). Medical laboratory science theory and practice, Tata McGraw- Hill, New Delhi.
6. Kanai L. Mukherjee, (2007). Medical laboratory technology Vol.1.Tata McGraw Hill.

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### Break up of questions for theory

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	Theory	Problem	Theory	Problem	Theory	Problem
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<b>IV</b>	3	-	2	-	1	-
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<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**ELECTIVE - III**  
**ECONOMIC ENTOMOLOGY AND PEST MANAGEMENT**

<b>SUBJECT CODE:</b>	<b>THEORY</b>	<b>MARKS: 100</b>
<b>SEMESTER: VI</b>	<b>CREDITS: 5</b>	<b>TOTAL HOURS: 75</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Economic Entomology and Pest Management

**COURSE OUTCOME**

1. To classify the insects upto orders and acquire knowledge on collecting, mounting and preservation of insects
2. To understand the morphology, reproduction and development of insects. To discuss the beneficial and harmful insects.
3. To understand the origin and history of pests and classify the pest and the types of crop losses
4. To understand the bionomics, Ecology and Management of crop pest and stored grain pest. To discuss the Medically important and household pests
5. To understand the integrated pest management and the role of biotechnology in pest management.

**UNIT -I**

**(12 Hours)**

**Entomology** – Introduction - **Salient features of Insects** - Classification of insects up to orders (Economical important groups) - Methods of collecting, mounting and preservation of insects

**UNIT -II**

**(15 Hours)**

**Morphology of Insects** - Segmentation in insect - Structure of head, antennae, thorax, legs and wings - Various types of mouth parts

**Reproduction and development:** Embryonic and post-embryonic development - Types of metamorphosis - Role of Neuroendocrine system in development.

**Beneficial and harmful insects** - Economic importance of honeybees, silkworm and lac insect – Parasitic and predatory insects

**UNIT -III**

**(13 Hours)**

**Pests:** Origin and history – Definition - Classification of pests - Pest status - Pest population dynamics - Types of crop losses

**UNIT -IV**

**(15 Hours)**

**Bionomics/ecology and management**

**Crop pests:** Rice (*Leptocorisa acuta*) - Wheat (*Sesamia inferens*) - Pulse (*Helicoverpa armigera*) - Sugarcane (*Scirpophaga nivella*, *Pyrilla perpusilla*) - Cotton (*Earias vitella*, *Pectinophora gossypiella*) - Vegetable (*Raphidopalpa faveicollis*) - Fruit (*Papilio demoleus*)

**Stored grain pests:** *Sitophilus oryzae* - *Corcyra cephalonica* - *Trogoderma granarium* - *Callosobruchus chinensis*.

**Medically important and household pests:** Fleas, mosquitoes, housefly, sandfly, cockroach, and termites

**UNIT -V****(20 Hours)**

**Integrated pest management (IPM):** – Definition – Principle - Components of IPM and advantages – Strategies for integrated pest management: Mechanical, Physical, Cultural

**Biological Control** – Principle - Bio-control agents (Parasitoids, predators and pathogens (NPV, Bacteria, Fungi and nematodes) - Merits and demerits (Brief account)

**Chemical Control** - Classification of insecticide - Conventional insecticides - Insecticide adjuvants and formulations - Control with reference to Chlorinated hydrocarbons – Organophosphates, Carbamates, Botanical, Synthetic pyrethroids – Fumigants -Insect Growth Regulator (IGR) compounds & Pheromones (Brief account)

**Genetic Control** - Sterile insect techniques (SIT)- Sterile insect release method (SIRM)- Radio-sterilization and chemo-sterilization, Hybrid sterility and other strategies of Genetic control (Brief account)

Pesticides and environmental pollution – Precautions in handling pesticides Role of biotechnology in pest management (Brief account)

**Recommended Books**

1. Nayar, K.K., T.N. Ananthkrishnan and B.V. David. (1992). General and Applied Entomology. Tata McGraw Hill Publishing Co., Ltd., New Delhi
2. David, B.V., (1992). Pest Management and Pesticides Indian Scenario, Namratha Publications, Madras.
3. Atwal, A.S. (1993) Agricultural Pests of India and South East Asia. Kalyan Publishers, NewDelhi.
4. Ramakrishna Iyer, T.V., Economic Entomology, Government Publications. Madras.

**Reference Books:**

1. David, B.V. and T. Kumarasamy, (1984). Elements of Economic Entomology, Popular BookDepot, Madras
2. Metcalf, C.L. and W.P. Flint, (1973). Destructive and Useful Insects. 4th Ed., Tata McGrawHill Publishing Co. Ltd., New Delhi
3. Roya D.N. and A.W.A. Brown (Eds), (1981). Entomology Medical and Veterinary (3rd Ed.)The Bangalore Printing and Publishing Company, Bangalore
4. Imms, A. D. A General Text Book of Entomology. Chapman & Hall, UK
5. Chapman, R. F. (1998) The Insects: Structure and Function. Cambridge University Press, UK
6. Snodgrass, R. E. Principles of Insect Morphology. Cornell Univ. Press, USA
7. Borror, D. J., Triplehorn, C. A., and Johnson, N. F. Introduction to the Study of Insects. M Saunders College Publication, USA
8. Tembhare, D.B. (2012). Modern Entomology, Himalaya Publishing House Pvt, Ltd, Mumbai
9. Dennis, S. Hill (2005) Agricultural Insect Pests of the Tropics and their Management, Cambridge University press
10. Pedigo, L.P. (1996) Entomology and Pest Management. Prentice Hall, New Delhi.
11. S. Pradhan. Insect Pest of Crops. National Book Trust, New Delhi.

### Question Paper Pattern

Section	Question Component	Numbers	Marks	Total
<b>Section A</b>	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
<b>Section B</b>	Short Answer Answer any 5 out of 7 questions	13–19	6	30
<b>Section C</b>	Essay Answer any 4 out of 6 questions	20– 25	10	40
<b>TOTAL MARKS</b>				100

### Break up of questions for theory

UNITS	Section A		Section B		Section C	
	Theory	Problem	Theory	Problem	Theory	Problem
<b>I</b>	2	-	1	-	1	-
<b>II</b>	2	-	2	-	1	-
<b>III</b>	2	-	1	-	1	-
<b>IV</b>	3	-	2	-	1	-
<b>V</b>	3	-	1	-	2	-
<b>SECTION A (12)</b>			<b>SECTION B (7)</b>		<b>SECTION C (6)</b>	

**CORE PRACTICAL - XI**  
**PRACTICAL III – ANIMAL PHYSIOLOGY, BIOCHEMISTRY,**  
**DEVELOPMENTAL BIOLOGY AND IMMUNOLOGY**

<b>SUBJECT CODE:</b>	<b>PRACTICAL</b>	<b>MARKS: 100</b>
<b>SEMESTER: VI</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS:</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Animal Physiology, Biochemistry, Developmental Biology and Immunology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understanding the principle, working procedure and applications of BP apparatus, Respirometer and Kymograph.
2. To knowledge on digestive enzymes in cockroach, detection of nitrogenous waste products and estimation of oxygen consumption.
3. To understand the principle, procedure and significance of qualitative analysis of sugar; Understand the principle of estimation of glycogen and protein.
4. To describe the structure and significance of histological slides, specimens and materials related to developmental biology.
5. To explain the principle, working mechanism and applications of techniques used in immunology.

**ANIMAL PHYSIOLOGY**

1. Survey of digestive enzymes in Cockroach
2. Study of human salivary activity in relation to temperature
3. Estimation of oxygen consumption in fishes with reference to body weight
4. Study of ciliary activity in Freshwater Mussel in relation to temperature
5. Detection of nitrogenous waste products in fish tank water, bird excreta and Mammalian kidney
6. Preparation of Hemin crystals
7. Determination of bleeding time and clotting time
8. Measurement of blood pressure using sphygmomanometer
9. Measurement of oxygen consumption of cockroach using Respirometer. (Demonstration)
10. Use of Kymograph
11. Histological Slides - Mammalian pituitary, thyroid, pancreas, adrenal gland

**BIOCHEMISTRY**

12. Qualitative analysis of protein and lipids
13. Qualitative analysis of sugar (Glucose, Fructose, Lactose and Starch)
14. Estimation of total protein by Lowry's method.
15. Estimation of carbohydrates by Anthrone reagent
16. Qualitative analysis of human urine for sugar
17. Preparation of starch from potato
18. Preparation of casein from milk
19. Preparation of gluten from wheat flour
20. Chromatographic techniques – Paper and TLC
21. Determination of pH in milk

### **DEVELOPMENTAL BIOLOGY**

1. Study of the following prepared slides, museum specimens and materials.
2. Section of testis and ovary showing the maturation stages of gametes.
3. Slides of mammalian Sperm and Ovum.
4. Study of Egg types – Frog's egg, Hen's egg.
5. Slides of cleavage stages, blastula, gastrula and neurula of frog.
6. Slides of different stages of chick embryo. 18 Hours (primitive streak stage), 24 hours, 48 hours, 72 hours and 96 hours.
7. Placenta of Sheep, Pig and Man.

### **IMMUNOLOGY**

1. Immuno-electrophoresis
2. Antigen - antibody reactions – Agglutination, Precipitation ring test. (Demonstration)
3. ABO, Rh typing
4. Hemagglutination, Yeast agglutination and Hemagglutination -inhibition assay

**CORE PRACTICAL - XII**  
**PRACTICAL IV– ENVIRONMENTAL BOLOGY, BIOTECHNOLOGY AND**  
**MICROBIOLOGY**

<b>SUBJECT CODE:</b>	<b>PRRACTICAL</b>	<b>MARKS: 100</b>
<b>SEMESTER: VI</b>	<b>CREDITS: 4</b>	<b>TOTAL HOURS:</b>

**COURSE FRAMEWORK:**

Introduction to fundamental concepts of Environmental Biology, Biotechnology and Microbiology.

**COURSE OUTCOME:**

On completion of the course the students will be able

1. To understand the principle, methodology and significance of estimation of oxygen, salinity, carbon dioxide, carbonates, bicarbonates and calcium in the given water samples
2. To demonstration of PCR, blotting techniques, staining techniques and media preparations
3. To knowledge on identification of planktons; and adaptation of aquatic and terrestrial animals based on the study of museum specimens; and microbial slides
4. To understand the basic principle on instrumentation
5. To knowledge on natural ecosystem during field visit

**ENVIRONMENTAL BIOLOGY**

1. Estimation of O<sub>2</sub>, salinity, pH, free CO<sub>2</sub>, Carbonates and bicarbonates, Calcium in water samples
2. Use of Rain gauge, Maximum & minimum thermometer, Hygrometer, Anemometer and Barometer
3. Analysis of phytoplankton and zooplankton in fresh water and marine water
4. Adaptations of aquatic and terrestrial animals based on a study of museum specimens - rocky, sandy, muddy shore animals, flying and burrowing animals
5. Study of natural ecosystem and field report of the visit

**BIOTECHNOLOGY**

1. Isolation of DNA and RNA
2. Analysis of DNA by agarose gel electrophoresis
3. Demonstration of PCR technique
4. Separation of proteins by Native and SDS-PAGE
5. Demonstration of Blotting techniques
  - a. Southern blot
  - b. Northern blot
  - c. Western blot
6. Instrumentation – Components and application of instruments – Homogenizer, Centrifuge, Electrophoresis, Colorimeter, Spectrophotometer, pH meter.
7. Project report on animal cell culture / Visit to any Biotechnology Institute



## **MICROBIOLOGY**

1. Staining - Simple staining, Gram staining
2. Media Preparation for microbial culture
3. Preparation of Solid media – Nutrient agar, Mac Conkey's agar
4. Preparation of Liquid media – Nutrient broth, Peptone water
5. Biochemical characterization and Identification of Microbes – *E.coli* – (Demonstration)
6. Antibiotic sensitivity test – Demonstration
7. Examination of algae in freshwater bodies
8. Milk quality test-methylene blue reductase test, Urea test
9. Screening for Lipase and amylase producing bacteria
10. Identification of fungus by using Lactophenol cotton blue staining
11. Instruments –Autoclave, Hot air oven, Laminar air flow, Incubator, Fermentor
12. Microscopy – Light Microscope, Phase Contrast Microscopy
13. Spotters – *E. coli*, *Staphylococcus aureus*, *Penicillium*, *Rhizopus*, *Aspergillus niger*, *Aspergillus flavus*, *Streptomyces*, *Lactococcus lactis*, Parasite - cyst and eggs