

## DEPARTMENT OF ZOOLOGY



### Vision

Empower the students with Academic skills, Research aptitude and Social commitment through holistic education.

### Mission

1. Foster knowledge and skills through innovative teaching and instill moral and ethical values.
2. Render opportunities for critical thinking, communication and collaboration.
3. Create research ambience to promote innovations and contemporary skills relevant to local and global needs.
4. Inspire to explore the natural resources and connect with nature.
5. Promote passion to serve the local community by creating empowered women of commitment and social consciousness through outreach and exposure programmes.
6. Facilitate life-long learning, participatory leadership and commitment to society.

### Programme Educational Objectives (PEOs)

PO No.	Upon completion of M.Sc. Degree Programme, the graduates will be able to :
PEO-1	The graduates will apply appropriate theory and scientific knowledge to participate in activities that support humanity and economic development nationally and globally, developing as leaders in their fields of expertise.
PEO-2	The graduates pursue lifelong learning and continuous improvement of the knowledge and skills with the highest professional and ethical standards.
PEO-3	The graduates will develop strong and competent knowledge with diversified professional skills in accordance with dynamic real – time challenges and career opportunities.

### PROGRAMME OUTCOMES (POs)

PO	Upon completion of M.Sc. Zoology Degree Programme, the graduates will be able to:
PO - 1	carry out internship programmes and research projects to develop scientific skills and

	innovative ideas.
PO - 2	analyze complex problems, think independently, formulate and perform quality research.
PO - 3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.
PO - 4	emerge as expressive, ethical and responsive citizens with proven expertise.
PO - 5	utilize the obtained scientific knowledge to create eco- friendly environment.

### PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO	Upon completion of M.Sc. Degree Programme, the graduates will be able to:	PO addressed
PSO - 1	explain the various aspects of life sciences including Biochemistry, Cell and Molecular Biology, Biosystematics, Genetics, Evolution, Physiology, Developmental Biology, Ecobiology, Immunology, Microbiology, Endocrinology, Bioinformatics, Biotechnology and Nanobiology.	PO - 1, 3, 5
PSO - 2	carry out experimental techniques and methods of statistical analysis appropriate for their course.	PO - 2, 4
PSO - 3	develop personal and key transferable skills and entrepreneurial skills.	PO - 2, 4
PSO - 4	independently assemble facts, summarize and draw conclusions from scientific text and develop competence in the design and execution of research.	PO - 1, 2, 4

### Eligibility for admission

A pass in B.Sc. Zoology or equivalent examination with Zoology as Major, with a minimum of 50% in major and allied papers. For SC/ST candidates, a pass in B.Sc. Zoology is sufficient.

**Duration of the course:** 2 Years.

**Medium of instruction:** English

### Passing minimum

A minimum of 50% in the external examination and an aggregate of 50% is required. There is no minimum pass mark for the Continuous Internal Assessment.

### Components of M.Sc. Zoology

Paper	No. of papers	Maximum marks per paper	Total marks
Theory Papers (Core)	15	100	1500
Theory Papers (Elective)	4	100	400
Practicals	4	100	400
Project	1	100	100
<b>Total Marks</b>			<b>2400</b>

**Course Structure**  
**Distribution of Hours and Credits**

Course	Sem. I	Sem. II	Sem. III	Sem. IV	Total	
					Hours	Credits
Core - Theory	6(4) + 6(4) + 5 (3) + 5(3)	6(4)+ 6(4) + 5 (4) + 5(4)	6 (4) + 6 (4) + 5 (4)	6 (4) + 6 (4) + 5 (4) + 5 (4)	83	58
Core - Practical	4	4 (4) + (4)	4	4 (4) + (4)	16	16
Elective	4 (3)	4 (3)	4 (3)	4 (3)	16	12
Project	-	-	5 (4)	-	5	4
<b>TOTAL</b>	<b>30 (17)</b>	<b>30 (27)</b>	<b>30 (19)</b>	<b>30 (27)</b>	<b>120</b>	<b>90</b>
<b>Non-academic Courses</b>						
* FC I: Life Skill Training I	-	(1)	-	-	-	1
* FC II: Life Skill Training II	-	-	-	(1)	-	1
* Service Learning Programme (SLP):Community Engagement Course (CEC)	-	-	(2)	-	-	2
* Summer Training Programme (Summer Vacation)	-	-	-	(1)	-	1

**\*Mandatory Courses / Programmes conducted outside the regular working hours.**

Total Number of Hours = 120

Total Number of Credits = 90+5

**M.Sc. Zoology - Courses offered**

Semester	Course Code	Title of the paper	Hours/ week	Credits
<b>I</b>	PZ2011	Core I: Biochemistry	6	4
	PZ2012	Core II: Ecobiology	6	4
	PZ2013	Core III: Structure and Function of Invertebrates	5	3
	PZ2014	Core IV: Comparative Anatomy of Chordates	5	3
	PZ2015 PZ2016	Elective I: (a) Animal Husbandry/ (b) Health Care	4	3
	PZ20P1	Practical I: Biochemistry & Ecobiology	4	4
	LST201	Life Skill Training (LST) I	-	-
<b>II</b>	PZ2021	Core V: Biostatistics, Computer Applications and Bioinformatics	6	4

	PZ2022	Core VI: Cell and Molecular Biology	6	4
	PZ2023	Core VII: Developmental Biology	5	4
	PZ2024	Core VIII: Research Methodology	5	4
	PZ2025 PZ2026	Elective II: (a) Animal Behaviour & Chronobiology/ (b) Bioinformatics	4	3
	PZ20P2	Practical II: Biostatistics, Computer Applications and Bioinformatics & Cell and Molecular Biology	4	4
	LST201	Life Skill Training (LST) I	-	<b>1</b>
	SLP201	Service Learning Programme (SLP):Community Engagement Course	-	-
<b>III</b>	PZ2031	Core IX: Physiology	6	4
	PZ2032	Core X: Genetics and Evolution	6	4
	PZ2033	Core XI: Culture and Capture Fisheries	5	4
	PZ2034 PZ2035	Elective III: (a) General Endocrinology / (b) Forensic Biology	4	3
	PZ20P3	Practical III: Physiology & Genetics and Evolution	4	4
	PZ20PR	*Project	5	4
	LST202	Life Skill Training (LST) II	-	-
<b>IV</b>	SLP201	Service Learning Programme (SLP):Community Engagement Course	-	<b>2</b>
	PZ2041	Core XII: Microbiology	6	4
	PZ2042	Core XIII: Biotechnology and Nanobiology	6	4
	PZ2043	Core IVX: Immunology	5	4
	PZ2044	Core XV: Medical Laboratory Technology	5	4
	PZ2045 PZ2046	Elective IV: (a) Parasitology/ (b) Applied Entomology	4	3
	PZ20P4	Practical IV: Microbiology & Biotechnology and Nanobiology	4	4
<b>Vacation</b>	LST202	Life Skill Training (LST) II	-	<b>1</b>
	STP201	Summer Training Programme/ Internship	-	<b>1</b>
<b>TOTAL</b>			<b>120</b>	<b>90+5</b>

\* Subject based group project (2 students per group) with an individual viva voce during the III semester.

### Self-Learning Courses (Extra Credit Courses)

Semester	Course code	Title of the paper	Hours/ week	Credits
III	PZ20S1	Life Science for Competitive Examinations	-	2
IV	PZ20S2	Environmental Impact Assessment and Audit	-	2
I/II/III/IV	-	Online Course (MOOC – Swayam / NPTEL)	-	2

## Value Added Courses

S.No.	Course code	Name of the course	Total hours
I	VACPZ1	Techniques in Biology	30

## Instruction for Course Transaction

### Theory (Core / Elective) paper hours

Components	Sem. I	Sem. II	Sem. III	Sem. IV
Lecture hours	40 / 55 / 70	40 / 55 / 70	40 / 55 / 70	40 / 55 / 70
Internal Test (2)	5	5	5	5
Quiz (2)	1	1	1	1
Class Test (2)	2	2	2	2
Class assignment/Group Discussion / Problem solving/ Field Visit Report / Article Review	2	2	2	2
Seminar	10	10	10	10
<b>Total Hours / Semester</b>	<b>60 / 75 / 90</b>	<b>60 / 75 / 90</b>	<b>60 / 75 / 90</b>	<b>60 / 75 / 90</b>

## Examination Pattern

### (a) Theory papers

Ratio of Internal and External – 40 : 60

#### Internal Components and Distribution of Marks

Component		Marks
Internal Test(2)	:	20
Seminar		4
Class Test (2)	:	4
Quiz (2)	:	4
Problem Solving / Article review/Group Discussion	:	4
Online Home Assignment	:	4
<b>Total</b>	<b>:</b>	<b>40</b>

### Question Pattern (Core/ Elective)

Internal Test	Marks	External Exam	Marks
Part A - 4 x 1 (No Choice)	4	Part A - 10 x 1 (No choice)	10
Part B - 3 x 4 (Internal Choice)	12	Part B - 5 x 3 (Internal Choice)	15
Part C - 3 x 8 (Internal Choice)	24	Part C - 5 x 7 (Internal Choice)	35
<b>Total</b>	<b>40</b>	<b>Total</b>	<b>60</b>

### (b) Practical Papers

Internal : 40 marks

External : 60 marks

**Total : 100 marks**

#### Internal: 40 marks

Performance of the experiments : 10

Regularity in attending practicals and  
submission of records : 10

Record : 5

Model exam : 15

**Total : 40 marks**

#### External: 60 marks

Major practical : 25

Minor practical : 20

Spotters (5 x 2) : 10

Record : 5

**Total : 60 marks**

### (c) Project

Ratio of Internal and External **40 : 60**

Internal (Supervisor)	Marks
I Review	10
II Review	10
Report	20
<b>External (External Examiner)</b>	
Report	40
Viva-voce (individual, open viva-voce)	20
<b>Total</b>	<b>100</b>

### (d) Foundation Course

#### Life Skill Training (LST) I & II

Ratio of Internal and External **60 : 40**

Internal Components		Marks
<b>Life Skill Training I</b>	Album (20 pages – individual work)	40
	Group Song/ Mime/ Skit (Group of 5 students)	20
	<b>Total</b>	<b>60</b>
<b>Life Skill Training II</b>	Case Study (30 page – individual work)	60
	<b>Total</b>	<b>60</b>

External Components		Marks
Life Skill Training I & II	Written exam 5 x 8 = 40 (Open Choice – any 5 out of 7 questions)	<b>40</b>

**(e) Community Engagement Course (Class hours 15 hours & Field work 15 hours)**

Ratio of Internal and External **50 : 50**

**Internal components**

Component	Marks
Assignment	10
Attendance (Fieldwork)	40

**External components**

Project Report/Case Study (individual work - 10 to 15 hours)	50

**(f) Self Learning Course**

Ratio of Internal and External **40 : 60**

**Internal Components: Internal Test (2)**

**Life Science for Competitive Examinations**

Internal Test	Marks	External Exam	Marks
Part A - 10 x 1 (Objective type question)	10	Part A - 20 x 1 (Objective type question)	20
Part B - 5 x 2 (Objective type question)	10	Part B - 10 x 2 (Objective type question)	20
Part C - 5 x 4 (Objective type question of higher order thinking)	20	Part C - 5 x 4 (Objective type question of higher order thinking)	20
<b>Total</b>	<b>40</b>	<b>Total</b>	<b>60</b>

**Environmental Impact Assessment and Audit**

Internal Test	Marks	External Exam	Marks
Part A - 4 x 1 (No Choice)	4	Part A - 10 x 1 (No choice)	10
Part B - 3 x 4 (Internal Choice)	12	Part B - 5 x 3 (Internal Choice)	15
Part C - 3 x 8 (Internal Choice)	24	Part C - 5 x 7 (Internal Choice)	35
<b>Total</b>	<b>40</b>	<b>Total</b>	<b>60</b>

**Semester I**  
**Core I - Biochemistry**  
**Course Code: PZ2011**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To impart knowledge on chemical structure, functions and metabolic process of biomolecules in living system.
2. To develop analytical and communicative skills to conduct experiments and interpret the results.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	define structure and types of chemical bonds in biomolecules such as hydrogen ions, water, protein, carbohydrate, lipid, nucleotides, enzymes and vitamins.	PSO - 1	R
CO - 2	explain the fate of biomolecules in different metabolic pathways.	PSO - 1	U
CO - 3	apply cognitive, technical and creative skills to pursue higher studies and employability in industrial, biomedical and research laboratories.	PSO - 4	Ap
CO - 4	analyse biomolecules in biological systems and relate deficiency disorders.	PSO - 3	An
CO- 5	design biochemical experiments and publish the results through effective written and oral communication after drawing accurate conclusions.	PSO - 2	E

**UNIT I** (Ref. 1, 2, 3)

**Basic concepts of biochemistry:** Scope. Atoms - molecules - chemical bonds - primary bonds and secondary bonds - pH and Hydrogen ion concentration - buffers - 'Henderson-Hasselbalch' equation - buffer systems in blood - mechanism of buffer action - acid base balance - regulation of acid base balance - acidosis and alkalosis. Water – colligative properties - water turnover and balance - electrolyte balance - dehydration and water intoxication.

**UNIT II** (Ref. 1, 2, 3)

**Carbohydrates:** Classification, structure, properties of mono, oligo and polysaccharides and biological role of carbohydrates - Carbohydrate metabolism - glycogenesis, glycogenolysis, glycolysis, Krebs cycle, Electron transport and Oxidative phosphorylation, Energetics of glucose metabolism - Pasteur effect-HMP shunt - gluconeogenesis - glyoxylate pathway - Cori cycle - Regulation and hormonal control of carbohydrate metabolism - glycogen storage diseases - blood sugar level - Glycosuria - Glucose tolerance test - Diabetes.



### UNIT III (Ref. 1, 2, 3)

**Proteins:** Classification, structure, Ramachandran plot, properties and biological role. Amino acids - classification, structure and properties - metabolism of proteins - deamination, transamination - transmethylation and decarboxylation of amino acids - glycogenic and ketogenic amino acids - formation and transport of ammonia - glucose-alanine cycle - Ornithine cycle - metabolism of phenylalanine, tyrosine and tryptophan. Porphyrins.

### UNIT IV (Ref. 4, 5, 6)

**Lipids:** Classification, structure and biological role - chylomicrons, VLDL, LDL, HDL - Lipid metabolism - theories of oxidation of fatty acids - oxidation of any one fatty acid and its bioenergetics (palmitic acid) -ketogenesis - biosynthesis of palmitic acid - metabolism of cholesterol - lipid storage diseases - role of liver in fat metabolism. Prostaglandins.Integration of carbohydrate, protein and lipid metabolism.

### UNIT V (Ref. 4, 5, 6)

**Nucleotide, Enzymes and Vitamins:** Biosynthesis and degradation of purines and pyrimidines. Enzymes: classification, nomenclature, enzyme kinetics, Michaelis - Menten constant, enzyme inhibition, mechanism of enzyme action, factors affecting enzyme activity, isozymes, coenzymes. Vitamins: Classification (fat soluble and water soluble), occurrence and biochemical role. Detoxification:mechanism of detoxification (oxidation, reduction, conjugation) - cytochrome P450 system.

#### Textbook

Ambika Shanmugam (2012). *Fundamentals of Biochemistry for Medical Students*, (7<sup>th</sup>ed.).Published by Wolters Kluwer. Madras: NavabharatOffest Works.

Satyanarayana, U. andChakrapani, U. (2013).*Biochemistry* (4<sup>th</sup>ed). India: Elsevier.

#### Reference Books

1. Chatterjea, M.N. andRanaShinde (2012). *Textbook of Medical Biochemistry* (8<sup>th</sup>ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
2. Vasudevan, D. M., SreeKumari, S. andKannanVaidyanathan (2013). *Textbook of Biochemistry for Medical Students* (7<sup>th</sup>ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
3. Nitin Jain, Jain, J.L. and Sunjay Jain (2014). *Fundamentals of Biochemistry*. New Delhi: S. Chand & Co. Ltd.
4. Jeremy M. Berg, John L. TymoczkoandLubertStryer (2006). *Biochemistry* (6<sup>th</sup>ed.). San Francisco: Freeman & Co. Publishers.
5. David L. Nelson and Michael M. Cox (2004). *Lehninger Principles of Biochemistry* (4<sup>th</sup>ed.). New York: W.H. Freeman and Company.
6. Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil(2018).*Harper's Illustrated Biochemistry* (31<sup>st</sup>ed.) New York: McGraw-HillEducation.

**Semester I**  
**Core II - Ecobiology**  
**Course Code: PZ2012**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To impart knowledge on ecosystem, population, community, environmental pollutions and natural resources.
2. To develop the skill to sensitize environmental issues and work productively within and beyond the academy for sustainable environment.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	define various laws of ecology, components of ecosystem, characteristics and dynamics of population and community, natural resources and environmental pollutants.	PSO - 1	R
CO - 2	classify different types of ecosystem, habitat, environmental factors and interpret the population processes, ecological succession, biological clock, biogeochemical cycles, biogeography, natural disasters and causes of pollution.	PSO - 1	U
CO - 3	develop cognitive, technical and creative skills which enable students for life-long learning and participate in environmental protection and conservation activities for sustainable environment and gain employability.	PSO - 3	Ap
CO - 4	analyse the nature of ecosystem, habitat, population, community, natural resources and environmental pollutions.	PSO - 2	An
CO - 5	assess the environmental issues like population explosion, urbanization, depletion of natural resources, pollution and waste managements.	PSO - 2	E
CO - 6	formulate hypotheses and test them by designing appropriate experiments, analyze, interpret the data and communicate the results through effective written and oral communication.	PSO - 4	C

**UNIT I**(Ref. 1, 5)

**Ecosystem and Habitat ecology:** Scope of Ecobiology.Environmental concepts – laws and limiting factors.The environment – physical factors (climatic factors,topographic factors, edaphic factors), biotic factorsand their interactions (symbiosis, commensalism, parasitism and competition- prey-predator interactions - Scramble and contest competition). Ecosystem: Concepts of ecosystem – structure and functions. Energy flow – single channel energy model, Y - shaped energy flow models. Productivity - Primary

production, secondary production, measurement of primary productivity. Homeostasis of the ecosystem. Habitat ecology: freshwater, marine, estuarine, terrestrial and desert.

## **UNIT II** (Ref.1, 2, 3, 10)

**Population and Community:** Population - structure and regulation, growth form, population fluctuations, population processes, life history strategies - diagrammatic and conventional life tables. Concept of Metapopulation. Community - basic terms, community structure, composition and stratification. Ecological niche, Ecotone and Edge effect, Ecotype. Ecological succession - types, general process, concept of climax.

## **UNIT III** (Ref. 1, 6, 7, 11, 12)

**Biogeochemical cycles:** water cycle, carbon cycle, nitrogen cycle, sulphur cycle and phosphorous cycle. **Natural resource ecology:** classification of resource, mineral resource, land resource, forest resource, water resource, energy resource- conventional and non-conventional. **Remote sensing:** physical basis – information extraction – role in ecological research. **Natural Disaster Management:** Floods, earthquakes, cyclones, landslides, Tsunami, Mitigation and Disaster Management.

## **UNIT IV** (Ref. 1, 9, 11, 12)

**Biogeography:** patterns of distribution (continuous, discontinuous, endemic), descriptive zoogeography, zoogeographical regions of the world. Dynamic biogeography (dispersal dynamics, dispersal pathways, migration, ecesis). **Biodiversity:** Importance, Human impact on biodiversity, Endangered wildlife species - special projects in India - IUCN red list - hot spots. Levels of diversity - species, genetic, ecosystem. GIS and satellite imaging in biodiversity assessment. Biodiversity indices: Shannon-Weiner index, Simpson index, Similarity and dissimilarity index, Association index. Conservation of species: *In situ* and *Ex situ*- Wildlife sanctuaries, national parks and biosphere reserves - Indian Board of Wild Life (IBWL) - National Board for Wild Life (NBWL) - Wild Life Conservation Laws and Trade Laws (CITES) in India.

## **UNIT V** (Ref. 1, 4, 7, 11)

**Pollution ecology:** Green House gas emission and Global warming. Impact of chemicals on biodiversity - Pesticides and fertilizers in agriculture. Bio-indicator and biomarkers of environment. Carbon footprint, Carbon sink. Waste management: solid, liquid and gaseous wastes. e-wastes. Toxicology: Biomagnification and bioaccumulation, toxicants, classification, toxicity (LC<sub>50</sub> and LD<sub>50</sub>), OECD Test Guidelines for the Chemicals (420, 423), mode of action of toxicants. **Urbanization:** Possible advantages of urbanization – problems, solutions – satellite villages- biovillages. Environmental ethics. Central and State Pollution Control Boards. Environmental auditing, Environmental impact assessment, Legislations for environmental Protection.

## **Textbook**

Eugene P. Odum, Murray Barrick, Gary W. Barret (2005). *Fundamentals of Ecology* (5<sup>th</sup> ed.). UK: Brooks/Cole Publishers.

Trivedi, P.C. and Sharma, K.C. (2003). *Biodiversity Conservation*. Jaipur: Avishekar Publishers.

## **Reference Books**

1. Sharma, P.D. (2017). *Ecology and Environment* (13<sup>th</sup> ed.). Meerut: Rastogi Publications.
2. Begon and Mortimer (1992). *Population Ecology*. Delhi: UBS Publishers.

3. Dash, M.L. (1996). *Fundamentals of Ecology*. New Delhi: Tata McGraw Hill Publishing Company Ltd.
4. Subramanian, M.A. (2004). *Toxicology: Principles and methods*. Chennai: MJP Publishers.
5. Tyler Miller, G. (2004). *Environmental Sciences* (10<sup>th</sup>ed.). Thomson Brooks, Chennai: Chennai Microprint Pvt. Ltd.
6. Prabu, PC., Udayasoorian and G. Balasuramanian (2009). *An Introduction to Ecology and Environmental Science*. Delhi: Avinash Paperbacks.
7. Biswarup Mukherjee (2011). *Environmental Biology and Toxicology*. Faridabad: Silver Line Publications.
8. Benny Joseph (2005). *Environmental Studies* (2<sup>nd</sup>ed.). Delhi: Tata McGraw Hill Companies.
9. Bhatia, A.L. (2010). *Textbook of Environmental Biology*. New Delhi: I.K. International Publishing House Pvt. Ltd.
10. Anupam Pandey (2012). *Population Ecology*. New Delhi: I.K. Discovery Publishing House Pvt. Ltd.
11. Ignacimuthu S.J. (2012). *Environmental Studies*. Chennai: MJP Publishers.
12. Supriyo Chakraborty (2004). *Biodiversity*. Jaipur: Pointer Publishers.

**Semester I**  
**Core III - Structure and Function of Invertebrates**  
**Course Code: PZ2013**

No. of hours/ week	No. of credits	Total number of hours	Marks
5	3	75	100

**Objectives**

1. To provide knowledge on the functional aspects of systems of invertebrates on a comparative basis.
2. To empower students with skills to comprehend the taxonomical and physiological functions of vital systems in invertebrates.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recognise the organisation of coelom, mode of locomotion, nutrition, respiration, excretion and significance of larval forms of invertebrates.	PSO - 1	R
CO - 2	comprehend the systematic position and physiological functions of vital systems in invertebrates.	PSO - 4	U
CO - 3	apply the cognitive skills to pursue higher studies and employability relevant fields.	PSO - 3	Ap
CO - 4	explore the structure and functions of vertebrates.	PSO - 2	An

**UNIT I** (Ref.2, 5, 7)

**Principle of Animal taxonomy:** Species concept. International code of zoological nomenclature -Taxonomic procedures.New trends in taxonomy - Animal collection, handling and preservation.Organization of coelom - Acoelomates -Pseudocoelomates-Coelomates.Protostomia and Deuterostomia.

**UNIT II** (Ref.1, 2, 3)

**Locomotion and Nutrition:** Pseudopodia – Flagella and ciliary movement in protozoa - hydrostatic movement in Coelenterata, Annelida and Echinodermata. Nutrition and digestion -patterns of feeding and digestion in lower metazoan – Filter feeding in polychaeta, Mollusca and Echinodermata.

**UNIT III** (Ref.1, 2, 3, 4)

**Respiration and Excretion:** Organs of respiration - gills, lungs and trachea -respiratory pigments - Mechanism of respiration. Excretion – organs of excretion - coelom, coelomoducts, nephridia and Malpighian tubules – mechanisms of excretion and osmoregulation.

#### **UNIT IV (Ref.1, 2, 3, 4)**

**Nervous system:** Primitive nervous system - Coelenterata and Echinodermata, Advance nervous system - Annelida, Arthropoda (crustacean and insects) and Mollusca (Cephalopoda). Endocrine organs in Invertebrates.

#### **UNIT V (Ref.1, 2, 3)**

**Invertebrata larvae and Minor Phyla:** Larval forms of free living invertebrates - Larval forms of parasites- Strategies and evolutionary significance of larval forms.Minor Phyla (structural features and affinity) - significance -organization and general characters.

#### **Textbook**

Jordan, E.L. and Verma, P.S. (2010).*Invertebrate Zoology*.New Delhi: S. Chand & Co. Ltd.

#### **Reference Books**

1. Kotpal, R.L. (2004). *Modern Textbook of Zoology- Invertebrates* (9<sup>th</sup>ed.). Meerut: Rastogi Publications.
2. Ayyar, E.K. and Ananthakrishnan, T.N. (1995). *Manual of Zoology, Vol. I (Invertebrata), Part I & II*. Madras: S. Viswanathan Printers and Publishers Pvt. Ltd.
3. Dhami, P.S. and Dhami, J.K. (1979). *Invertebrate Zoology*.Ram Nagar, New Delhi: S. Chand & Co. Ltd.
4. Jan, A. Pechenik (2002). *Biology of Invertebrates* (4<sup>th</sup> ed.). New Delhi: Tata McGraw-Hill Publishing Company Ltd.
5. George Gaylord Simpson (2018). *Principles of Animal Taxonomy*. India: Scientific Publishers.
6. Lal, S.S. (2004). *A Text Book of Practical Invertebrate Zoology*.Meerut: Rastogi Publications.
7. Kapoor, V.C. (2019). *Theory and Practice of Animal Taxonomy and Biodiversity* (8<sup>th</sup>ed.). New Delhi: Oxford and IBH Publishers.
- 8.Barrington, E.J.W. (1969). *Invertebrate Structure and Function*. Great Britain. Thomas Nelson and Sons Ltd.

**Semester I**  
**Core IV - Comparative Anatomy of Chordates**  
**Course Code: PZ2014**

No. of hours/ week	No. of credits	Total number of hours	Marks
5	3	75	100

**Objectives**

1. To provide the knowledge of origin, structure and function of different organ system of vertebrates.
2. To develop the skills to analyse the anatomy of vertebrates and its significance.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	identify the morphology and anatomy of major groups of vertebrates.	PSO - 1	R
CO - 2	interrelate the development of integuments, circulatory system, respiratory system, skeletal system, sense organs and nervous system.	PSO - 1	U
CO - 3	apply the cognitive skills to pursue higher studies and gain employability in academic and research institutions.	PSO - 3	Ap
CO - 4	analyse the anatomy of different groups of vertebrates.	PSO - 4	An

**UNIT I** (Ref. 1, 2, 8)

**Protochordates:** Origin of Chordata. Chordate characters - classification of protochordata- general characteristics, development and affinities of Hemichordata, Urochordata, Cephalochordata.

**UNIT II** (Ref. 1, 2)

**Vertebrate Integument:** Origin and classification of vertebrates. Vertebrate integument and its derivatives- development, general structure and functions of skin and its derivatives - glands, scales, horns, claws, nail, hoofs, feathers and hairs.

**UNIT III** (Ref. 1, 2, 6)

**Circulation and Respiration:** General plan of circulation in various groups - blood - evolution of heart - evolution of aortic arches and portal systems. Respiratory system - characters of respiratory tissue- internal and external respiration - comparative account of respiratory organs.

**UNIT IV** (Ref. 1, 2, 6)

**Skeletal and Urinogenital system:** Skeletal system - form, function, body size and skeletal elements of the body - comparative account of jaw suspensorium, vertebral column - limbs and girdles. Evolution of urinogenital system in vertebrate series.

## **UNIT V (Ref. 1, 2, 6)**

**Sensory and Nervous system:** Sense organs - simple receptors - organs of olfaction, taste and hearing- lateral line system - electroreception. Nervous system - comparative anatomy of the brain in relation to its functions - comparative anatomy of spinal cord - nerves - cranial, peripheral and autonomous nervous system.

### **Textbook**

Jordan, E.L. and Verma, P.S. (2011). *Chordate Zoology*. New Delhi: S. Chand and Company Ltd.

### **Reference Books**

1. Ekambaranatha Ayyar, M. and Ananthakrishnan, T.N. (1995). *A Manual of Zoology, Volume II (Part I & II)*. Chennai: S. Viswanathan Pvt. Ltd.
2. Kotpal, R. L. (2014). *Modern text book of Zoology – Vertebrates* (3<sup>rd</sup>ed.). Meerut: Rastogi Publications.
3. Kingsley, J.S. (2016). *Outlines of Comparative Anatomy of Vertebrates*. Allahabad: Central Book Depot.
4. Milton Hilderbrand (1998). *Analysis of vertebrate structure*. (5<sup>th</sup>ed.). New York: John Wiley and Sons Inc.
5. Dhami P.S. and Dhami J.K. (1972). *Chordate Zoology*. New Delhi: S. Chand and Company Ltd.
6. Kardong, K. (2002). *Vertebrates: Comparative Anatomy, Function and Evolution*. Chennai: Tata McGraw Hill Publishing Company Ltd.
7. Young, J. Z. (2004). *The Life of Vertebrates* (3<sup>rd</sup> ed.). London: Oxford University Press.
8. Verma P.S. (2010). *A manual of Practical Zoology Chordates*. New Delhi: S. Chand & Co. Ltd.



**Semester I**  
**Elective I (a) - Animal Husbandry**  
**Course Code: PZ2015**

No. of hours/ week	No. of credits	Total number of hours	Marks
4	3	60	100

**Objectives**

1. To gain knowledge on livestock management and construction of farms.
2. To develop skills on livestock farming and extend it to the society.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	acquire knowledge on Livestock resources, construction and management of Livestock farms.	PSO - 1	U
CO - 2	identify the breeds and stages of livestock.	PSO - 1	R
CO - 3	analyse the ethical laws formulated by the Animal Welfare Board.	PSO - 4	An
CO - 4	develop entrepreneurial skills and gain employability in animal farms and research laboratories.	PSO - 3	Ap

**UNIT I** (Ref: 1, 2, 5, 7)

**Livestock farming (Ruminants I):** Prospects of livestock industry in India. Introduction and scope of cattle farming. Housing systems- selection of site, layout and design. Selection of cattle - important exotic and indigenous breeds and their characteristics. Fodder production and preservation of green fodder. Management and feeding practices of calves, heifers, pregnant, lactating and dry animals, bulls and working animals. Cattle Diseases. Parasites – ecto and endo parasites.

**UNIT II** (Ref: 1, 2, 3, 4, 5, 6, 7)

**Livestock farming (Ruminants II):** Breeds of sheep and goat. Important economic traits for meat, milk and fibre. Management and feeding practices during different stages of growth and production (milk, meat and wool). Breeding schedule and management of ram and buck. Weaning and fattening of lambs and kids. Methods of milking and precautions. Factors affecting quality and quantity of milk production and milk products.

### **UNIT III** (Ref: 1, 2, 5, 7)

**Livestock (Non ruminants):** Scope of swine farming. Important exotic and indigenous breeds and their characteristics. Housing and feeding of swine. Management of different categories of swine: pregnant sows, pig-lets, growing stock, lactating sows. Horses, donkeys and mules: feeding, Foaling and care of newborn. Care of race horses and preparing horses for show.

### **UNIT IV** (Ref: 1, 2, 5)

**Laboratory and Pet animal management:** Handling, weighing, sexing and weaning of laboratory animals (rat and rabbit). Marking for identification, Feeding schedule. Prophylactic measures and Hygienic care. Handling of dogs and pet birds - Feeding practices and care of young ones. Grooming and bathing of dogs. Marketing.

### **Unit V** (Ref: 1, 8, 9, 10, 11, 12)

**Animal welfare:** Animal welfare and ethics - role and current status of Animal Welfare Board of India and other welfare organizations. Common offences against animals - Prevention of Cruelty to Animals (PCA) Act, 1960. Functions of Animal ethics committee (CPCSEA). Livestock Importation Act - Evidence, liability and insurance.

### **Textbook**

Mathialagan, P. (2007). *Textbook of Animal Husbandry and Livestock Extension*. (3<sup>rd</sup>ed.). Lucknow: International Book Distributing Co.

### **Reference Books / Web link**

1. Tarit Kumar Banrjee (2016). *Applied Zoology*. London: New Central Agency (P) Ltd.
2. Supriti Sarkar, Gautam Kundu, Korak Kanti Chaki. (2016). *Introduction to Economic Zoology* London: New Central Agency (P) Ltd.
3. Nagendra S. Pawar. (2008). *Applied Zoology*. New Delhi: Adhyayan Publishers.
4. Sukumar De. (2005). *Outlines of Dairy Technology*. New Delhi: Oxford University Press.
5. Williamson. G and Payne. J. A. (1978). *An introduction to Animal Husbandry in the Tropics*. London: Longman Group Limited.
6. Whyte. R. O. (1968). *Land, Livestock and Human Nutrition in India*. Delhi: UBS Publishers.
7. Cole. H. H. (1966). *Introduction to Livestock Production*. London: Freeman and Company.
8. <https://www.oxfordscholarship.com>.
9. <http://www.awbi.in/about.html>
10. <https://indiacode.nic.in>
11. <https://www.nacenkampur.gov.in>
12. <https://nacenkampur.gov.in>

**Semester I**  
**Elective I (b) - Health Care**  
**Course Code: PZ2016**

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

**Objectives**

1. To make the students realize the importance of the health of the body, develop a healthy personality so as to live a healthy and successful life.
2. To acquire independent employable skills in voluntary organizations or in health sectors.

**Course Outcomes**

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	spell quality life and factors that determine health.	PSO - 4	R
CO - 2	outline the concept of health and well-being, personal health care, maternal and child health, environmental and mental health, alternative medicine and first aid.	PSO - 3	U
CO - 3	make use of the different aspects of health and well-being in day to day life.	PSO - 3	Ap
CO - 4	examine personal health problems and its remedies.	PSO - 1	An

**UNIT I(Ref.4)**

**Concept of health and well-being:**Definition - Physical, mental, social and positive health - Quality of life. Determinants of health: Heredity - Environment - Lifestyle - Socio-economic conditions - Health services. Nutrition and Health: Nutrients that provide energy - Carbohydrates - Lipids - Proteins. Nutrients that regulate: Vitamins - Minerals - Water. Healthy diet - Food guide Pyramid - Snacking - Vegetarian diet - Fast food.

**UNIT II(Ref.2)**

**Personal Health Care:**Protecting skin - common skin problems - Dry Skin, Acne, Dermatitis, Psoriasis, skin infections – skin cancer - caring for the skin. Hair - General care, cleaning tips, preventing hair loss, Anti dandruff strategies. Teeth - Common dental problems - General care of teeth - Dental checkup. Eye - Common eye problems - Eye diseases - General care of eyes - Vision checkup. Ear - general care - do's and don'ts.

**UNIT III(Ref. 2)**

**Maternal and Child Health:**Motherhood - pregnancy confirmation test - Prenatal care - Intra natal care - problems during pregnancy - Miscarriage and stillbirth - premature birth - labor and delivery - Family planning. Child health: Care of the newborn - Feeding - Nutritional guidelines - Care of the under-five (Toddler and Preschool).

**UNIT IV(Ref.2)**

**Environmental and Mental Health:** Mental health: Characteristics - Types: Schizophrenia - Manic depressive psychoses - Paranoia - Neurosis - Personality and character disorders. Environmental health: health in the home environment - pollution at home - diseases. Safety at home: Fall - Fires - Poisoning - Electrical hazards - Safety in road (Auto mobile - Pedestrian) - Disaster management (Severe weather condition - Flood- Lightning - Cyclone - Earthquake – Landslides- Tsunami).

**UNIT V**(Ref. 1, 3, 5)

**Alternative medicine and First aid:** Naturopathy - Homeopathy- Ayurveda - Unani - Siddha. First aid: First aid procedures for dehydration - heart attack - fractures and dislocation, burns - bleeding - poisoning - electric shocks - drowning.

**Reference Books**

1. Park, K. (1995). *Park's Textbook of preventive and social medicine*. Jabalpur: M/S BanarsidasBhanot Publishers.
2. Getchell, Pippin and Varnes (2006). *Perspectives on Health*. USA: D C Heath & Co.
3. LakshmanaSarma and Swami Nathan. S. (1960). *Speaking of nature cure – Regain, retain and improve health the drugless way*. New Delhi: Sterling Publications Pvt. Ltd.
4. Tom Sanders and Peter (2004). *Emery Molecular basis of human nutrition*. London: Taylor and Francis Publishers.
5. Eva Roman (2008). *First aid*. New Delhi: Indiana Publishing House.

**Semester I**  
**Practical I - Biochemistry and Ecobiology**  
**Course Code: PZ20P1**

No. of hours/week	No of credits	Total number of hours	Marks
4	4	60	100

**Objectives**

1. To design and perform biochemical experiments.
2. To understand the interaction between abiotic and biotic environment.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the knowledge necessary for professional or academic work in the field of biochemistry and ecology.	PSO - 1	U
CO - 2	analyse the biomolecules and physico-chemical parameters in samples.	PSO - 2	An
CO - 3	develop drawing and writing skills and design experiments.	PSO - 4	Ap
CO - 4	estimate the components of an ecosystem.	PSO - 2	E

**Biochemistry**

1. Colorimetry- verification of Beer-Lambert's law.
2. Preparation of Acid & Alkali solutions and acid-base titration applying Henderson-HasselBalch' equation.
3. Preparation buffers of known pH and solutions of known molarity, normality, percentage, ppt, ppm.
4. Chromatographic separation of amino acids.
5. Quantitative estimation of glucose (Blood/ Tissue).
6. Quantitative estimation of protein (standard graph).
7. Quantitative estimation of total lipid (Blood/ Tissue).
8. Quantitative estimation of ascorbic acid.
9. Quantitative estimation of blood urea.
10. Determination of salivary amylase activity in relation to substrate applying Michaelis - Menten equation.

**Instruments/ Charts/Models**

Colorimeter, pH Meter, Centrifuge, Chromatogram, Electrophoretic unit

**Ecobiology**

1. Measurement of primary productivity (O<sub>2</sub> measurement method).
2. Sampling of animal population using quadrat method.

3. Observation of life table in an insect.
4. Collection and identification of freshwater planktons.
5. Measurement of turbidity using Secchi disc.
6. Estimation of  $LC_{50}$  of a pesticide.
7. Estimation of  $H_2S$  in water sample.
8. Estimation of salinity in water sample.
9. Estimation of  $CO_2$  in water sample.
10. Study report of a pond ecosystem.

**Specimen/ Chart/ Models**

Commensalism (Shark and *Echeneis*), Mutualism (Sea anemone and Hermit crab), Food chain, Food web, Conventional energy source (coal) and non-conventional energy source (wind mill).

**Semester I**  
**Life Skill Training - I**  
**Course Code: LST201**

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

**Objectives:**

- To understand the fundamental rules of success
- To practice integrity in day to day life

**Course Outcomes (COs)**

CO No.	<i>Upon completion of this course, the students will be able to:</i>	PSO Addressed	Cognitive Level
CO-1	Understand the human values to lead a successful life	PSO-	U
CO-2	Apply the ethics in real life situation	PSO-	A
CO-3	Analyse and improve one's attitude	PSO-	Y

**Unit I**

Success - Success formulae.

Goals - The law of Karma, The law of clarity, and The law of flexibility.

Positive Mental Attitude - The law of optimism and self-confidence.

**Unit II**

Purposeful-Burning desire - The law of desire and The law of energy.

Planning and Preparation - The law of planning.

**Unit III**

Resources - The law of maximization - Time and its management: health, courage, strengths and weaknesses, attitude, will and skill, enthusiasm, initiative, creativity/resourcefulness/ingenuity, experience, appearance, orderliness and neatness, courtesy, politeness and manners, charisma, live life, have luck and skills.

**Unit IV**

Self-discipline - The law of time preference and The law of direction.

Action - The law of applied effort and The law of compensation.

Persistence.

**Unit V**

Prayers - The partnership with God - work with commitment towards the goal - work and prayer.

Values - to attain stability in life - Benjamin Franklin's thirteen virtues.

**Text Book**

Rao, C.N. (2014). 10 Fundamental Rules of Success. India: V & S Publisher.

**ReferenceBooks:**

1. Bellamy, D.R. (1999). 12 Secrets for Manifesting your Vision, Inspiration and Purpose. India: Master Mind Books.
2. Iyer, S.S. (2009). Managing for Value. New Delhi: New Age International Publishers.
3. Sharma, S.P. (1999). Success Through Positive Thinking. Delhi: Pustak Mahal
4. Raj, A.S. (2015). Personality Development. Delhi: Firewall Media.



**Semester II**  
**Core V - Biostatistics, Computer Applications and Bioinformatics**  
**Course Code: PZ2021**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To enable the students to collect and use the data to derive inferences in various biological experiments.
2. To develop analytical skills of statistics and draw valid conclusions in research.

**Course Outcomes**

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	recall different biological data, methods of collection, processing and retrieval tools in sequence analysis.	PSO - 1	R
CO - 2	explain measures of dispersion, significance of data and soft wares applied in biostatistics and biological databases.	PSO - 2	U
CO - 3	analyze the data and interpret the results manually or by using software.	PSO - 2	An
CO - 4	apply statistical and bioinformatics tools in research and gain employability in Research and Development organizations.	PSO - 3	Ap
CO - 5	evaluate biological data and critically analyse the research findings.	PSO - 4	E
CO - 6	formulate hypothesis, solve problems and present data to the scientific community.	PSO - 4	C

**UNIT I** (Ref. 1, 2, 7, 9)

**Data collection and presentation:** Population and sample in biological studies - variables - sampling methods. Types of biological data. Measurement scales - ratio scale, interval scale, ordinal scale, nominal scale - parameters and statistics. Accuracy and precision. Data collection and presentation: Tabulation - graphs - diagrams. Frequency distribution - histogram - frequency curves and Ogives. Measures of central tendency: types of mean, median, mode.

**UNIT II** (Ref. 1, 2, 7, 8, 9)

**Measures of dispersion:** Range - quartile and percentile - mean deviation - standard deviation - coefficient of variation - skewness and kurtosis - standard error. Distribution: Binomial, Poisson and Normal. Parametric and non-parametric tests. Hypothesis testing - single and two population mean - types of error (Type I and Type II) - Chi-square analysis - test for goodness of fit and homogeneity.

**UNIT III** (Ref. 1, 2, 7, 8, 9)

**Analysis of Data:** Student's *t*-distribution - Analysis of variance (ANOVA): one way classification and two way classification (Factorial design). Probability: Addition theorem, multiplication theorem and conditional theorem. Permutation and combination.

Correlation - types, methods of study and testing the significance. Regression: equations – regression lines - simple linear regression and testing its significance. Mathematical modeling in biology: types and applications.

#### UNIT IV

**Computer applications:** Microsoft office - M.S. Power point. MS Excel. Statistical function: Descriptive statistics -*t*-test, ANOVA, correlation, regression, Chi-square test, table and charts. Viruses and worms. Statistical Packages: SPSS, Minitab, Sigmaplot, Originpro (Brief account).

#### UNIT V (Ref. 10)

**Bioinformatics:** Scope - Biological data bases - Data base retrieval tools (Locus link, ENTREZ, Pubmed and SRS) - Nucleotide sequence data base (NCBI, EMBL) - Protein data base (Protein data bank-PDB). Data base similarity research tools (BLAST, MSA). Biological sequence analysis: sequence alignment, pair-wise alignment and multiple sequence alignment. Protein structure visualizing tools (RasMol, Swiss PDB Viewer). Applications of bioinformatics tools.

#### Textbooks

Gurumani, N. (2005). *An Introduction to Biostatistics*. Chennai: MJP Publishers.

Attwood, T.K and Parry Smith, D.J. (2005). *Introduction to bioinformatics*. Delhi: Pearson Education Pvt. Ltd.

#### Reference books

1. Pillai, R.S.N. and V. Bagavathi (2016). *Statistics Theory and Practice* (8<sup>th</sup> ed.). New Delhi: S. Chand Publishing Company Ltd.
2. Khan, I. and Khanum, A. (2014). *Fundamentals of Biostatistics* (3<sup>rd</sup> ed.). Hyderabad: Ukaaz Publications.
3. Zar, J.H. (1984). *Biostatistical Analysis* (2<sup>nd</sup> ed.). London: Prentice-Hall International Inc.
4. Bailey, N.T.J. (1997). *Statistical methods in Biology* (3<sup>rd</sup> ed.). New York: Cambridge University Press.
5. Sokal, R. and James, F. (1973). *Introduction to Biostatistics*. Tokyo, Japan: W.H. Freeman and Company Ltd.
6. Daniel, W.W. (1987). *Biostatistics: A foundations for Analysis in the Health Sciences*. New York: John Wiley & Sons.
7. Gupta, S.P. (1998). *Statistical Methods*. New Delhi: S. Chand and Company Ltd.
8. Banerjee, P.K. (2005). *Introduction to Biostatistics*. New Delhi: S. Chand and Company Ltd.
9. Pranab Kumar Banerjee (2009). *Introduction to Biostatistics*, New Delhi: S. Chand and Company Ltd.
10. Ignacimuthu, S. (2013) *Basic Bioinformatics* (2<sup>nd</sup> ed.) New Delhi: Narosa Publishing House.

**Semester II**  
**Core VI - Cell and Molecular Biology**  
**Course Code: PZ2022**

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	4	90	100

**Objectives**

1. To provide knowledge on the structure and functions of bio-membranes, cell organelles and signaling pathways.
2. To avail employment in educational institutions and research laboratories.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recognize the structural and functional organization of plasma membrane, cell organelles, cell receptors, protein synthesis and abnormal cell growth.	PSO - 1	R
CO - 2	illustrate cellular organization and changes occurring in cells.	PSO - 1	U
CO - 3	analyse the prokaryotic and eukaryotic cells, flow of genetic information from DNA to protein, cell signaling and regulation of cell cycle.	PSO - 2	An
CO - 4	evaluate the changes in the cells, cell cycle and proteins involved in the regulation and apoptosis.	PSO - 4	E
CO - 5	apply the principles and techniques of molecular biology for research and employment.	PSO - 3	Ap

**UNIT I** (Ref. 1, 4)

**Cell Structure and Functions of cell organelles:** prokaryotic and eukaryotic cells - structure. Plasma membrane: Structure and function. Active transport and pumps-transport by transporter proteins - membrane potential. Tight junction, Gap junction. Cytoskeleton - Microfilaments, intermediate filaments and microtubules. Extracellular matrix - Collagen and non-collagen components.

**UNIT II** (Ref. 4, 5)

**Cell organelles and Nucleic acids:** Structure and functions of Nucleus: Nuclear pores, Nucleolus. Mitochondria, Ribosomes, Endoplasmic reticulum (ER): Rough and Smooth ER - Golgi complex - lysosomes. DNA and RNA: Types, structure and functions.

### **UNIT III** (Ref. 1, 2, 3).

**Signaling pathways:** Cell adhesion molecules - Extra cellular signaling – signaling molecules and their receptors - Pathways of intracellular signal transduction: G protein coupled receptors - Cyclic AMP pathways - Receptor Tyrosine Kinases (RTKs): Ras, Raf and MAP kinase pathway - second messengers - signaling from plasma membrane to nucleus.

### **UNIT IV** (Ref. 1, 6)

**Protein synthesis and transport:** Transcription and Translation in Prokaryotes and Eukaryotes. Gene regulation - positive and negative, Protein trafficking - sorting - transport from endoplasmic reticulum to Golgi, transport to lysosome - exocytosis - endocytosis. Membrane protein and secretory proteins.

### **UNIT V** (Ref. 1, 3)

**Normal and abnormal cell growth:** Cell cycle - Mitosis - Meiosis. Regulation of cell cycle: Cyclin and Cyclin dependent kinases. Apoptosis - mechanism and significance. Molecular aspects of cancer, proto-oncogenes - oncogenes, tumour suppressor genes.

### **Textbook**

Lodish, H. and Berk, A. (2016). *Molecular Cell Biology* (8<sup>th</sup> ed.). New York: W.H. Freeman and Company Limited Publication.

### **Reference Books**

1. Gupta, P.K. (2014). *Cell and Molecular Biology* (4<sup>th</sup> ed.). New Delhi: Rastogi Publication.
2. Geoffrey M. Cooper and Robert E. Hausman (2013). *The cell: A Molecular Approach* (6<sup>th</sup>ed.). Massachusetts, USA: Sinauer Associates Publication.
3. Pranav Kumar and Usha Mina (2018). *Life Sciences – Fundamentals and Practice I*. (4<sup>th</sup> ed.). New Delhi: Pathfinder Publication.
4. Powar C.B. (2010). *Cell Biology*. Hyderabad: Himalaya Publisher.
5. Alberts B., Johnson. A., Lewis, J., Raff, M., Roberts, K. and Watter, P. (2008). *Molecular Biology of the Cell* (5<sup>th</sup> ed.). New York: Garland Science Publication.
6. De Robertis, E.D.P. (2011). *Cell and Molecular Biology* (8<sup>th</sup> ed.). New York: Lippincott Williams & Wilkins Publication.

**Semester II**  
**Core VII - Developmental Biology**  
**Course Code: PZ2023**

No. of hours/ week	No. of credits	Total number of hours	Marks
5	4	75	100

**Objectives**

1. To enable the students to gain knowledge on the process by which a zygote, multiplies, differentiates and develops into an adult.
2. To gain employment in fertility centers, hospitals and health centers.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	discuss basic concepts and developmental processes of different organ systems and techniques in reproductive biology.	PSO - 1	R
CO - 2	distinguish the embryonic structures, origin and development of organ systems.	PSO - 1	U
CO - 3	analyse the regulating mechanisms of developmental processes and identify deformities.	PSO - 2	An
CO - 4	apply knowledge to pursue higher studies and gain employability in biological research laboratories.	PSO - 3	Ap

**UNIT I** (Ref. 1, 2, 5)

**Reproductive system:** Historical perspectives and theories of embryology. Sexual and asexual reproduction - Parthenogenesis and types. Male reproductive system of a mammal, spermatogenesis, structure and function of sperm, semen and seminal fluid. Female reproductive system of a mammal, oogenesis, ovulation, vitellogenesis, types of eggs.

**UNIT II** (Ref. 1, 2, 3)

**Fertilization and molecular aspects:** Mechanism of fertilization, theories of fertilization. Cleavage: Laws - planes - patterns - chemical changes during cleavage. Cleavage and blastulation in chick and mammal. Cell lineage, fate map of chick and mammal.

**UNIT III** (Ref. 1, 2, 4)

**Morphogenetic movements and Organogenesis in chick and mammals:** Gastrulation - germinal layers and their derivatives, neurogenesis, notogenesis, development of mesoderm and coelom. Organogenesis: eye, skin and its derivatives, heart, kidney, limbs, alimentary canal and its derivatives.

#### **UNIT IV(Ref. 1, 3, 6)**

**Development of reproductive organs in man:** development and differentiation of testis, development of male genital ducts and accessory glands. Development and differentiation of ovary, development of female genital ducts and accessory glands. Teratogenesis and teratogens. Infertility - causes and treatment, development of extra embryonic membranes. Placentation in mammals.

#### **UNIT V (Ref. 1, 3, 5)**

**Embryonic induction, Metamorphosis and Regeneration:** Embryonic induction in vertebrates - types - exogenous and endogenous. Theories of organizer or inductor, competence. Differentiation - characteristics and types, selective action of genes in differentiation. Metamorphosis in insects and amphibians. Neoteny. Regeneration - regenerative ability in animals and mechanism.

#### **Text Book**

Balinsky, B. I. (2012). *An Introduction to Embryology* (5<sup>th</sup> ed.). Philadelphia: Cengage Learning Publishers.

#### **Reference books**

1. Jain, P.C. (2017). *Elements of Developmental Biology (Chordate Embryology)*. New Delhi: Vishal publishing Co.
2. Wolpert, L. (2010). *Principles of Development* (4<sup>th</sup> ed.). United Kingdom: Oxford University Press.
3. Ronald W. Dudek and James D. Fix (2005). *Embryology* (3<sup>rd</sup> ed.). Philadelphia, USA: Lippincott Williams and Wilkins Publication.
4. Chattopadhyay, S. (2017). *An Introduction to Developmental Biology* (2<sup>nd</sup> ed.). Kolkata: ArnabhaSen, Books and allied (P) Ltd.
5. Twyman, R. M. (2004). *Developmental Biology*. New Delhi: BIOS Scientific Publishers.
6. Verma, P. S. and Agarwal, V. K. (2014). *Chordate Embryology: Developmental Biology*. New Delhi: S. Chand and Company Ltd.
7. Gayatri Prakash (2007). *Reproductive Biology*. United Kingdom: Alpha Science International Ltd.
8. Sastry, K.V. and Shukla, V. (2003). *Developmental Biology* (1<sup>st</sup> ed.). New Delhi: Rastogi publications.

**Semester II**  
**Core VIII - Research Methodology**  
**Course Code: PZ2024**

No. of hours/ week	No. of credits	Total number of hours	Marks
5	4	75	100

**Objectives**

1. To enable the students to understand the working principles of bio-instruments and methodologies used in biological investigations.
2. To enhance report writing skills and create self-employment opportunities.

**Course Outcomes**

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	outline the principles and working mechanism of laboratory equipments and research techniques.	PSO - 1	R
CO - 2	explain laboratory or field procedures, methods, and instrumentation for biological studies.	PSO - 1	U
CO - 3	analyze scientific methods to develop hypotheses, design and execute experiments by selecting the appropriate research techniques.	PSO - 2	An
CO - 4	conceptualize research processes, data presentation, report writing and publication in journals.	PSO - 3	Ap
CO - 5	evaluate scientific ideas and design experiments to address medical, social and environmental problems.	PSO - 4	E

**UNIT I** (Ref. 1, 2)

**Microscope:** Principle - types - interference, fluorescence, confocal, electron microscopes - scanning tunneling microscope, atomic force microscope, near field scanning optical microscope, magnetic force microscope. Photomicrography.

**UNIT II** (Ref. 1, 2, 5)

**Centrifugation:** Principle - factors affecting sedimentation rate - Types and applications of centrifuges. Cryotechniques- cryopreservation. **Cytotechnology:** Whole mounts. Microtome: Rotary and Freezing microtome. Microtomy: Fixation - dehydration - clearing - embedding - sectioning - staining - mounting.

**UNIT III** (Ref. 3, 4, 5)

**Chromatography:** Principle, types - gas and liquid chromatography - High Performance Liquid Chromatography - Ion exchange - Affinity chromatography. **Electrophoresis:**

Principles, types - gel - Polyacrylamide gel, agarose gel, Blotting techniques, Iso electric focusing - Immunoelectrophoresis. Protein sequencing methods.

#### **UNIT IV** (Ref. 3, 4, 5)

**Spectroscopy:** principle, types - UV-Visible Spectroscopy, Atomic Absorption Spectroscopy, flame photometer, chemiluminometer, Nuclear Magnetic Resonance spectroscopy, FTIR spectrometry - Electron Spin Resonance, Magnetic Resonance Imaging - applications. Radio activity counters.

#### **UNIT V** (Ref. 6, 7)

**Experimental design and Report writing:** Essential steps in research - Literature collection - Review of literature - Bibliography - Literature citation - Research report - Tables - Figures - Formatting and typing - Online literature collection - open access journals - Predatory journals - Impact factor - Citation index- H-index- Plagiarism - Copy Right - Patent.

#### **Textbooks**

Veerakumari, L. (2006). *Bioinstrumentation*. Chennai: MJP Publishers.

Gurumani, N. (2006). *Research Methodology for Biological Sciences*. Chennai: MJP Publishers.

#### **Reference Books**

1. Marimuthu, R. (2008). *Microscopy and Microtechnique*. Chennai: MJP Publishers.
2. Prakash, M. and C.K. Arora (1998). *Microscopical Methods*. New Delhi: Anmol Publications Pvt. Ltd.
3. Keith Wilson and John Walker (2018). *Principles and Techniques of Practical Biochemistry* (8<sup>th</sup> ed.). United Kingdom: Cambridge University Press.
4. Pranav Kumar (2018). *Fundamentals and Techniques of Biophysics and Molecular Biology*. New Delhi: Pathfinder publication.
5. RamnikSood (2006). *Medical Laboratory Technology*. New Delhi: Jaypee Brothers Medical Publishers Pvt. Ltd.
6. R. Paneerselvam. (2016). *Research Methodology*. New Delhi: PHI Learning Pvt. Ltd.
7. Gurumani. N. (2010). *Scientific thesis writing and paper presentation*. Chennai: MJP Publishers.



**Semester II**  
**Elective II (a) - Animal Behaviour and Chronobiology**  
**Course Code: PZ2025**

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

**Objectives**

1. To acquaint students with deep understanding of Animal behaviour and Chronobiology.
2. To develop skills of animal watching and procure jobs in sanctuaries.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe animal behaviour, reflexes, biological rhythms and Chronobiology.	PSO - 1	R
CO - 2	summarize the history of ethology, social behaviour in animals, organization of circadian system in multicellular animals.	PSO - 1	U
CO - 3	illustrate the developing compassion towards animals, group selection, altruism, predict biological clock system, circadian pacemaker system in vertebrates.	PSO - 1	Ap
CO - 4	analyse the patterns of animal behaviour and complexity of biological clock system in vertebrates.	PSO - 3	An
CO - 5	assess the relevance of biological clocks for human welfare and taking decisions.	PSO - 4	E

**UNIT I**(Ref. 1, 3, 4, 5, 6)

**Introduction to Animal Behaviour:** Principles of Animal Behaviour, Historical perspectives of ethology, Approaches to animal behaviour. Ethogram - Methods and recording of a behaviour. Innate behavior, Neurological basis of animal behaviour, hormonal control of behaviour.

**UNIT II**(Ref. 1, 4, 5, 7)

**Patterns of Behaviour:** Reflexes - types, reflex path, characteristics of reflexes. Orientation: Primary and secondary orientation, kinesis - orthokinesis, klinokinesis; taxis - tropotaxis, klinotaxis, menotaxis, mnemotaxis. Learning: Associative learning, classical and operant conditioning, Habituation and Imprinting. Memory - types of memory.

### **UNIT III(Ref. 1, 4, 5)**

**Social and Sexual Behaviour:** Social Behaviour: Concept of Society; various modes of animal communication. Altruism; Insect's society with Honey bee as example; Foraging in honey bee and bee communication. Nesting behavior in birds. Sexual Behaviour: Mate choice, intra-sexual selection (male rivalry), inter-sexual selection (female choice), sexual conflict in parental care.

### **UNIT IV(Ref. 1, 6, 8, 9, 10)**

**Introduction to Chronobiology:** Historical developments in chronobiology; Biological oscillation: the concept of average, amplitude, phase and period. Biological clocks: central and peripheral biological clock, adaptive significance of biological clocks, Chronopharmacology, Chronomedicine, Chronotherapy.

### **UNIT V(Ref. 1, 2)**

**Biological Rhythm:** types of biological rhythms: short- and long- term rhythms, Circadian rhythms - molecular biology of the circadian pacemaker system, Tidal rhythms and Lunar rhythms. Circannual rhythms, Photoperiod and regulation of seasonal reproduction of vertebrates, Role of melatonin.

### **Textbook**

Agarwal, V.K. (2009). *Animal Behaviour (Ethology)*. New Delhi: S. Chand and Company Ltd.

### **Reference Books / web link**

- 1.Sanjib Chattopadhyay (2012). *LIFE: Evolution, Adaptation and Ethology*. Kolkata: Books and Allied (P) Ltd.
2. Chandrashekar, M.K. (1985). *Biological Rhythms*. Madras Science Foundation.
3. Mohan P. Arora. (2016). *Animal Behavior*. Chennai: Himalaya Publishing House.
4. Auprey Manning and Mariam Stamp Dowkins (2012). *An Introduction to Animal behavior*. UK: Cambridge University Press.
5. Slatter P. J. B. (1985). *An Introduction to Ethology*. UK: Cambridge University Press.
6. Saha T. K. (2009). *An Introduction to Animal behaviour*. Delhi: Emkay Publications.
7. Machve K. K. (2016). *Evolution of Animal Behaviour*. Thiruvananthapuram: Manglam Publications.
8. [http://www.apiindia.org/pdf/progress\\_in\\_medicine\\_2017/mu\\_75.pdf](http://www.apiindia.org/pdf/progress_in_medicine_2017/mu_75.pdf)
9. <https://www.pharmatutor.org/articles/chronopharmacology-overview>
10. <https://www.sciencedirect.com/topics/medicine-and-dentistry/chronotherapy>

**Semester II**  
**Elective II (b) - Bioinformatics**  
**Course Code: PZ2026**

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

**Objectives**

1. To understand the application of computer technology, to study and process biological data.
2. To develop skills to use bioinformatics tools.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the basics of bioinformatics.	PSO - 1	U
CO - 2	choose bioinformatics tools and data bases.	PSO - 1	R
CO - 3	interpret sequence alignment and alignment programs.	PSO - 2	U
CO - 4	identify the tools for drug discovery, docking and molecular phylogeny.	PSO - 3	An
CO - 5	use bioinformatics tools for molecular data analysis and submission.	PSO - 4	Ap

**UNIT I** (Ref. 1)

**Introduction to Bioinformatics and databases:** Introduction and definition, applications, Databases: Types of databases. Biological databases: nucleotide sequence databases - GenBank, DDBJ, EMBL, NCBI; Protein sequence databases - PDB, Uniprot, TrEMBL; NDB. Chemical databases; PubChem, ChemBank, CSD; Bibliographic databases- MEDLINE, PUBMED.

**UNIT II** (Ref. 1)

**Sequence Analysis:** Sequence alignment and alignment programs; Comparison of two sequences - Dot Matrix analysis; Scoring schemes - PAM Matrices and BLOSUM Matrices; Dynamic programming- Needleman-Wunch algorithm, Smith-Waterman algorithm, BLAST and FASTA; Multiple Sequence Alignment, ClustalW; Storing alignments.

**UNIT III** (Ref. 6, 7)

**Drug Designing:** Drug discovery process - drug target identification, target validation, Lead compound identification, Lead optimization, Docking (importance, mechanics of

docking, docking sites), Quantitative structure-activity relationship. Preclinical and clinical development.

#### **UNIT IV (Ref. 1)**

**Phylogenetic analysis:** Molecular phylogenetic analysis; methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees - maximum parsimony, distance and maximum likelihood; phylogenetic software resources.

#### **UNIT V (Ref. 1)**

**Genomics and Proteomics:** Central dogma of molecular biology. Genomics - structural, comparative and functional. Proteomics - expression, structural and functional. Types of sequences used in Bioinformatics – DNA sequences, RNA sequences, Protein sequences.

#### **Textbook**

Rastogi, S. C. Mendiratta, N. and Rastogi, P. (2011). *Bioinformatics*. PHI Learning Private Limited, New Delhi.

#### **Reference Books**

1. Attwood, T.K. and Parry-Smith, D.J. (2006). *Introduction to Bioinformatics*. Dorling Kindersley Publication: Delhi.
2. Gladis Helen Hepsyba, S. and Hemalatha, C.R. (2009). *Basic Bioinformatics*. Chennai: MJP Publishers.
3. John De Britto, A. (2011). *Bioinformatics*. Sivakasi; Anto Art Craft Printers.
4. Sundaralingam, R. and Kumaresan, V. (2008). *Bioinformatics*. Nagercoil: Saras Publication.
5. Jin Xiong (2006). *Essential Bioinformatics*. UK: Cambridge University Press.
6. Hooman H. Rashidi and Lukas K. Buehler (2000). *Bioinformatics Basics: Application in Biological Science and Medicine*. New York: CRC Press.
7. Mohan Bansal, A.S. (2003). *Medical Informatics – A primer*. New Delhi: Tata McGraw- Hill Publishing Company Ltd.

**Semester II**  
**Practical II - Biostatistics, Computer applications and Bioinformatics**  
**&Cell and Molecular Biology**  
**Course code: PZ20P2**

No. of hours/week	No of credits	Total number of hours	Marks
4	4	60	100

**Objectives**

1. To design an experimental problem and evaluate critically with inferential biostatistics and necessary computer skills.
2. To develop the skills involved in cell biology, histology and biomolecules separation techniques.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	analyze and interpret the collected data using statistical methods manually and soft wares.	PSO - 1	An
CO - 2	evaluate the biological samples applying research techniques.	PSO - 2	E
CO - 3	develop drawing and writing skills through record and design experiments.	PSO - 2	Ap
CO - 4	design biological experiments.	PSO - 2	C

**Biostatistics, Computer applications and Bioinformatics**

1. Collection of biological data (Primary and Secondary).
2. Classification and representation (Graphical and Diagrammatic) of collected data.
3. Measures of dispersion- standard deviation and standard error.
4. Estimation of population by Mark and Recapture method using beads.
5. Correlation co-efficient – length and width of molluscan shells.
6. Study of probability using coin tossing with 2 and 3 coins and chi square test.
7. Regression Analysis.
8. Test of significance (student's *t*-test).
9. Preparation of graph using M.S. Excel.
10. Retrieval of DNA and protein sequence from NCBI.
11. Visualizing protein structure using RasMol.

**Charts/ Models**

NCBI, SWISS-PROT and PubMed

## **Cell and Molecular Biology**

1. Isolation and observation of sub cellular organelles.
2. Observation of mitosis - onion root tip.
3. Observation of meiosis - grasshopper testis.
4. Observation of polytene chromosome - salivary gland of Chironomus larva.
5. Barr-body identification.
6. Observation of striated muscle fibre - coxal muscle of cockroach.
7. Observation of adipocytes - fat body of cockroach.
8. Haemolymph smear (Cockroach).
9. Whole mount preparation of a specimen.
10. Sectioning and staining of a tissue.

## **Spotters/ Slides**

Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

**Semester II**  
**Life Skill Training - I**  
**Course Code: LST201**

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

**Objectives:**

- To understand the fundamental rules of success
- To practice integrity in day to day life

**Course Outcomes (COs)**

CO No.	<i>Upon completion of this course, the students will be able to:</i>	PSO Addressed	Cognitive Level
CO-1	understand the importance of soft skills	PSO-	U
CO-2	apply the tools and techniques for effective communication	PSO-	A
CO-3	analyse and improve mental health	PSO-	Y

**Unit I**

Soft and Hard Skills - significance of soft skills.

Communication Skills - Types of communication - elements of communication - constituents of communication - characteristics of effective communication.

**Unit II**

Body Language - Body language interpretation -tips for better body language.

Interpersonal Skills - Tools for effective conversation and building interpersonal skills.

**Unit III**

Listening Skills - Listening types - tips for listening - listening and leadership.

Soft Skills and Johari Window -Johari windows - advantages of Johari window.

**Unit IV**

Change Management -Change Vs Zones - tips for managing change.

Stress Management - Types, causes of stress, symptoms of stress and tackling stress.

**Unit V**

Motivation - Types of motivation - Hierarchy of needs - tips for motivation.

Time Management - Pareto's principle - tools and techniques for time management.

(Compilation will be provided to the students)

**Reference Books:**

1. Melgosa, J. (2013). Positive Mind. (3<sup>rd</sup> ed.). Spain: Safeliz.
2. Shukla, A. (2010). The 4-Lane Expressway to Stress Management. New Delhi: Unicorn Books.
3. Pease, A. (1990). Body Language. India: Sudha Publications Pvt. Ltd.

## Semester II & III Service Learning Programme (SLP): Community Engagement Course

**Course Code: SLP201**

S. No.	Module Title	Credits

### Objectives

- To develop an appreciation of rural culture, life-style and wisdom among students
- To learn about the status of various agricultural and rural development programme
- To understand causes for rural distress and poverty and explore solutions for the same
- To apply classroom knowledge of courses to field realities and there by improve quality of learning

### Learning Outcomes

After completing this course, student will be able to

- Gain an understanding of rural life, culture and social realities
- Develop a sense of empathy and bond so mutuality with local community
- Appreciate significant contributions of local communities to Indian society and economy
- Learn to value the local knowledge and wisdom of the community
- Identify opportunities for contributing to community's socio-economic improvements

**Credit:** 2credits, 30hours, atleast 50% in field, compulsory for all students.

### Contents:

Course Structure:

2 Credits Course (1Credit for Classroom and Tutorials and 1 Credit for Field Engagement)

S. No.	Module Title	Module Content	Assignment	Teaching/ Learning Methodology	No.of Classes
1	<b>Appreciation of Rural Society</b>	Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of “soul of India lies in villages’(Gandhi),	Prepare a map (physical, visual or digital) of the village you visited and write an essay about inter-family relations in that village.	- Class room discussions	2
				- Field visit**	4
				- Assignment Map	2



		rural infrastructure			
2	<b>Understanding rural economy &amp; livelihood</b>	Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets	Rural household economy, its challenges and possible pathways to address them	- Field visit** - Group discussions in class - Assignment	3 4 1
3	<b>Rural Institutions</b>	Traditional rural organisations, Self-help Groups, Panchayatiraj institutions (Gram Sabha, Gram Panchayat, Standing Committees), local civil society, local administration	How effectively are Panchayatiraj institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual)	Classroom - Field visit** - Group presentation of assignment	2 4 2
4	<b>Rural Development Programmes</b>	History of rural development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM Awas Yojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.	Describe the benefits received and challenges faced in the delivery of one of these programmes in the rural community; give suggestions about improving implementation of the programme for the rural poor.	- Classroom - Each student selects one program for field visit** Written assignment	2 4 2

**\*\*Recommended field-based practical activities:**

- Interaction with SHG women members, and study of their functions and challenges; planning for their skill building and livelihood activities
- Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at the worksite
- Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures
- Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan (GPDP)

- Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource mobilization
- Visit Rural Schools/ mid-day meal centres, study Academic and infrastructural resources and gaps
- Participate in Gram Sabha meetings, and study community participation
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
- Attend Parent Teacher Association meetings and interview school dropouts
- Visit local Anganwadi Centre and observe the services being provided
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries,
- Organize awareness programmes, health camps, Disability camps and cleanliness camps
- Conducts oil health test, drinking water analysis, energy use and fuel efficiency surveys
- Raise understanding of people's impacts of climate change, building up community's disaster preparedness
- Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
- Formation of committees for common property resource management, village pond maintenance and fishing

### **Teaching & Learning Methods**

A large variety of methods of teaching must be deployed:

UGC will prepare an ICT based MOOC for self-paced learning by students for the 1 credit to be conducted in the classroom.

Reading & classroom discussions, Participatory Research Methods & Tools, Community dialogues, Oral history, social and institutional mapping, interactions with elected panchayat leaders and government functionaries, Observation of Gram Sabha, Field visits to various village institutions.

### **Recommended Readings**

#### **Books:**

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015 [un.org/sdgs/](http://un.org/sdgs/)
4. M.P. Boraian, Best Practices in Rural Development, Shanlax Publishers, 2016.

#### **Journals:**

1. Journals of Rural development, (published by NIRD & PR Hyderabad)
2. Indian Journal of Social Work, (by TISS, Bombay)
3. Indian Journal of Extension Education (by Indian Society of Extension Education)

4. Journal of Extension Education (by Extension Education Society)
5. Kurukshetra (Ministry of Rural Development, GoI)
6. Yojana (Ministry of Information and Broadcasting, GoI)

**Semester III**  
**Core IX - Physiology**  
**Course Code: PZ2031**

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

**Objectives**

1. To impart knowledge on the structure and functions of various organs, organ systems and associated disorders.
2. To develop skills relevant for pursuing higher education and apply the knowledge in their life.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the structure and functions of organ systems.	PSO - 1	R
CO - 2	describe the anatomy of different physiological systems at the tissue and cellular levels.	PSO - 1	U
CO - 3	carry out physiological studies in the laboratory, interpret data and graphs and write a report.	PSO - 2	Ap
CO - 4	analyze the physiological changes in relation to environmental conditions.	PSO - 3	An
CO - 2	evaluate the physiological functioning of different organs.	PSO - 4	E

**UNIT I (Ref. 1, 2, 6)**

**(18 hrs.)**

**Nutrition:** types of nutrition and feeding mechanisms in animals. Digestion - functional anatomy of the digestive system of man, Movements of gastrointestinal tract, Secretory functions of the alimentary tract and glands, digestion and absorption. Metabolism of protein, carbohydrate and lipid. Gastrointestinal disorders - Gallstones, liver cirrhosis, gastritis, peptic ulcer and appendicitis.

**UNIT II (Ref. 1, 6, 7, 8)**

**(18 hrs.)**

**Respiration and Homeostasis:** Functional anatomy of the respiratory system of man, transport of respiratory gases, regulation of respiration, respiratory problems - bronchial asthma, pneumonia and pulmonary tuberculosis. Homeostasis - Osmoregulation - types and mechanism, Thermoregulation - classification and mechanism, Deep sea physiology, High altitude and space physiology, Bioluminescence - physiology and functions.

**UNIT III (Ref. 1, 2, 3)****(18 hrs.)**

**Circulation:** Haemopoiesis, Blood clotting. Myogenic and neurogenic heart. Functional anatomy of the human heart, cardiac cycle, pacemaker, heart rate, regulation of cardio-vascular system. Blood pressure, sphygmomanometer, electrocardiogram (ECG), heart diseases - atherosclerosis, coronary thrombosis and angina pectoris. Lymphatic system - organization, composition and functions.

**UNIT IV (Ref. 1, 9, 11)****(18 hrs.)**

**Neuro-muscular system:** Structure of the brain and neuron, neurotransmitters, synapse, nerve impulse conduction, reflex activity, electroencephalogram (EEG). Neural disorders - meningitis and epilepsy. Types of muscle, structure and properties of skeletal muscle, mechanism of muscle contraction, neuromuscular junction. Sense organs - structure and functions of skin and eye.

**UNIT V (Ref. 1, 6, 9)****(18 hrs.)**

**Excretion and Reproduction:** Patterns of excretion, structure and function of kidney of man, nephron, formation of urine – counter current mechanism, micturition, renal disorders – nephritis, renal calculi, dialysis. Structure of testis and ovary (human), oestrus and menstrual cycle, ovulation, pregnancy, parturition and lactation, hormonal regulation of reproduction.

**Reference Books**

1. Sembulingam, K. & Prema Sembulingam (2013). *Essentials of Medical Physiology* 6<sup>th</sup> ed.). Bangalore: Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Guyton & Hall (2010). *Textbook of Medical Physiology* (12<sup>th</sup> ed.). Philadelphia: John E. Hall, Saunders Elsevier.
3. Elaine N. Marieb (2003). *Human Anatomy and Physiology* (6<sup>th</sup> ed.). San Francisco: Daryl Fox publisher.
4. Sawant, K.C. (2011). *Human Physiology*. New Delhi: Wisdom Press/ Dominant Publishers and Distributors Pvt Ltd.
5. SaradaSubrahmanyam & Madhavankutty, K. (2001). *Textbook of Human Physiology* (6<sup>th</sup> ed.). New Delhi: S. Chand and Company Ltd.
6. William. S. Hoar (1984). *General and Comparative Animal Physiology* (2<sup>th</sup> ed.). Prentice Hall of India.
7. Prosser, C. L. (1991). *Comparative Animal Physiology* (4<sup>th</sup> ed.). United States: John Wiley and Sons Ltd.
8. Nielsen Knut Schmid (2007). *Animal Physiology, Adaptation and Environment* (5<sup>th</sup> ed.). New Delhi: Cambridge University Press.
9. Nagabushanam, R., Kadarkar, M.S. & Sarojini, R. (2002). *Textbook of Animal Physiology*. New Delhi: Oxford and IBH Publishing Company.
10. Sobti, R.C. (2008). *Animal Physiology*. New Delhi: Narosa Publishing House

Pvt. Ltd.

11. Rastogi, S.C. (2007). *Essentials of Animal Physiology* (6<sup>th</sup> ed.). New Delhi: JBA Publishers.

**Semester III**  
**Core X - Genetics and Evolution**  
**Course Code: PZ2032**

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

**Objectives**

1. To enrich the knowledge on the principles of heredity at molecular level and to discern the evolutionary significance.
2. To develop skills for assessing heritability, identifying genetic disorders and constructing phylogenetic trees.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the principles of inheritance, mutation, genetic disorders, genetic equilibrium and patterns of evolution.	PSO - 1	R
CO - 2	describe Linkage and crossing over, Gene concept, Hardy Weinberg law and gene frequency, principles and methods of molecular evolutionary studies.	PSO - 1	U
CO - 3	interpret the heritability and its measurements, molecular and biochemical basis of genetic diseases, gene frequencies of population, Universal Tree of Life, cultural evolution of man.	PSO - 2	Ap
CO - 4	analyse the expressivity of genes, chromosome mapping, inheritance of particular character through Pedigree chart, Factors affecting Hardy Weinberg equilibrium and phylogenetic relationship.	PSO - 3	An
CO - 5	evaluate allelic and non-allelic interactions, effects of mutation, selection, migration, adaptation on Mendelian population.	PSO - 4	E

**UNIT I** (Ref. 1, 2, 5)

**(18 hrs.)**

**Mendelian Genetics:** Mendelian principles. Gene interactions - complementary, supplementary and epistatic, Multiple allelism. Linkage and crossing over – types – mechanism – theories. Chromosome mapping - linkage maps, tetrad analysis, mapping with molecular markers and somatic cell hybrids. LOD score linkage test. Polygenic inheritance. Heritability and its measurements. QTL mapping.

**UNIT II** (Ref. 3, 5)

**(18 hrs.)**

**Molecular and Human Genetics:** Gene concept. Mutation – types and effects of gene mutation - mutagens - Chromosomal mutation. DNA damage and repair. Human chromosomes, Karyotyping, Chromosomal banding and painting. Pedigree analysis. Disorders of amino acid metabolism - Phenylketonuria, Alkaptonuria, albinism, Disorders of nucleic acid metabolism - Gout, ADA deficiency, Disorders of carbohydrate metabolism - Von Gierke's disease, G<sub>6</sub>PD deficiency, Disorders of lipid metabolism - Tay Sach's disease, Gaucher's disease, Hemoglobin disorders - sickle cell anemia, thalassemia.

**UNIT III (Ref. 1, 9)**

**(18 hrs.)**

**Population Genetics and Evolution:** Mendelian populations - Hardy Weinberg law and genetic equilibrium. Calculation of gene frequencies for autosomal - dominant and recessive alleles, codominant alleles and multiple alleles. Factors affecting Hardy Weinberg equilibrium – selection, heterozygous advantage, mutation, migration, random genetic drift – Founder's effect. Genetic load and death - neutralist hypothesis - genetic polymorphism.

**UNIT IV (Ref.2, 9)**

**(18 hrs.)**

**Molecular evolution:** Principles of molecular evolution studies – types and rates of nucleotide substitution in DNA sequences. Molecular clock. Molecular phylogeny - phylogenetic tree - Distance Matrix and Parsimony based approach - kinds of molecular phylogenies – Universal Tree of Life. Phylogenetic and biological concept of species. Adaptive radiation. Isolating mechanisms. Modes of speciation - allopatry and sympatry.

**UNIT V (Ref. 9, 11)**

**(18 hrs.)**

**Origin of higher categories:** Major trends in the origin of higher categories. Microevolution, macroevolution, mega evolution and coevolution. Evolution rates, phyletic gradualism and punctuated equilibrium. Origin and Evolution of Primates: Evolution of Anthropoid Primates - The first hominids - Australopithecines and origin of modern man - Bipedalism – communication - speech - language - altruism and morality. Evolution of culture.

**Reference Books**

1. Verma, P.S. & Agarwal, V.K. (2010). *Genetics* (9<sup>th</sup> ed.). New Delhi: S. Chand Publishing.
2. Verma, P.S. & Agarwal, V.K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*. New Delhi: S. Chand Publishing.
3. Peter Snustad, D. & Michael J. Simmons (2009). *Principles of Genetics* (5<sup>th</sup> ed.). USA: John Wiley & Sons, Inc.
4. Eldon John Gardner, Michael J. Simmons & D. Peter Snustad (2005). *Principles of Genetics* (8<sup>th</sup> ed.). New Delhi: Wiley (India) Pvt. Ltd.
5. Monroe W. Strickberger (2015). *Genetics* (3<sup>rd</sup> ed.). India: Pearson Education.
6. Robert F. Weaver and Philip W. Hedrick (1989). *Genetics*. New York: W. M. C. Brown Publishers.
7. Emmanuel. C., Rev. Fr. Ignacimuthu, S. & Vincent, S. (2006). *Applied Genetics*. Chennai: MJP Publishers.
8. Hickey, G. I., Fletcher, H. L. & Winter, P. (2010). *Genetics*. New York: Taylor and Francis Group Publications.

9. Sanjib Chattopadhyay (2008). *Evolution, Adaptation and Ethology*. Kolkata: Books and Allied Pvt. Ltd.
10. Maynard Smith, J. (1999). *Evolutionary Genetics*. England: Oxford University Press.
11. Monroe W. Strickberger (2000). *Evolution* (3<sup>rd</sup> ed.). Sudbery, Massachusetts: Jones and Bartlett Publishers.
12. Ledyard Stebbins (1971). *Processes of organic evolution*.
13. Mark Ridley (1996). *Evolution*. England: Blackwell Science Ltd.
14. Arora, M. P. (2000). *Organic Evolution*. Mumbai: Himalaya Publish House.
15. Tomar, B.S. & Singh, S.P. (2000). *Evolutionary Biology*. Meerut: Rastogi Publications.
16. Ahuja, N. (2008). *Evolution and Population Genetics*. New Delhi: Pearl Books.
17. Savage, J.M. (1969). *Evolution*. New Delhi: Amerind Publishing Co. Pvt. Ltd.

**Semester III**  
**Core XI - Culture and Capture Fisheries**  
**Course Code: PZ2033**

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

**Objectives**

1. To impart knowledge on the construction, maintenance and management of cultivable organisms in aqua farms.
2. To practice aqua farming and extend it to the society.

**Course outcomes**

CO	Upon completion of this course the students will be able to :	PSOs addressed	CL
CO - 1	recall the culture of finfish, shellfish and their management.	PSO - 1	R
CO - 2	describe different types of aquatic organisms, construction of ponds, nutrition and breeding in aquaculture.	PSO - 1	U
CO - 3	relate culture practices, breeding techniques, fish pathology, fishery genetics.	PSO - 2	Ap
CO - 4	analyse physico-chemical and nutritional factors for optimizing aquaculture, fish marketing and preservation.	PSO - 3	An
CO - 5	assess profitability of an established aqua farm.	PSO - 4	E

**UNIT I (Ref. 1, 2) (18 hrs.)**

**Aquaculture:** Purpose and importance of aquaculture - basic qualification of candidate species - cultivable freshwater and marine fishes - global and Indian scenario of aquaculture. Construction and maintenance of fish farm: selection of site - lay-out and types of ponds - aquatic plants and their control - control of fish predators - liming - fertilization of ponds. Kinds of aquaculture - Integrated fish farming - Sewage fed fish culture - Pen and cage culture.

**UNIT II (Ref. 1, 2, 3) (18 hrs.)**

**Nutrition and Breeding:** Nutritional requirements, Culture of fish feed organisms - phytoplankton (diatom), zooplankton (rotifers, cladocerans), *Artemia*, *Tubifex*. Artificial feed and feed formulation. Seed collection - Breeding techniques - Induced breeding by hypophysation, Ovaprim, Factors influencing induced breeding. Sex identification - collection - rearing and selection of brooders, Transportation of fish seed.

**UNIT III (Ref. 1, 3, 5, 9, 10) (18 hrs.)**



**Culture and Pathology:** Finfish culture - Indian major carps, Tilapia and murrel. Shellfish culture: freshwater and marine prawns, lobsters, crabs, edible and pearl oysters. Ornamental fish culture and its prospectus. Fish pathology - Bacterial, Viral and Fungal diseases, Ectoparasites, Endoparasites, nutritional deficiency diseases in fishes.

#### UNIT IV (Ref. 6, 7)

(18 hrs.)

**Fishery Genetics:** Chromosomes in fishes, chromosome set manipulation, Gynogenesis and Androgenesis: sex control- Genome centromere mapping- Inbreed depression – Production of inbred lines. Intrinsic and extrinsic factors in sex control and sex reversal. Induced polyploidy. Sex determination in fishes, Sex patterns – Gonochorism – hermaphroditism – Diandry and Digyny – Dichromatism. Transgenic fishes.

#### UNIT V (Ref. 1, 3)

(18 hrs.)

**Capture Fisheries:** Inland fisheries (riverine, lakesterine and cold-water fisheries) - Estuarine fisheries - Marine fisheries. Fishing methods- crafts and gears. Remote sensing and GIS in fisheries. Fish spoilage and methods of fish preservation. Economic importance of fishes: Food value and fish by-products. Fish Marketing and co-operative societies in aquaculture. Common fishes of Kanyakumari.

#### Reference Books

1. Pandey, K. & Shukla, J.P. (2005). *Fish and Fisheries*. Meerut: Rastogi Publications.
2. Pillay, T.V.R. (1990). *Aquaculture: Principles and Practices*. England: Fishing News Books Ltd.
3. Jhingran, V.G. (1997). *Fish and Fisheries of India*. New Delhi: Hindustan Publishing Company.
4. Santhanam, R. (1990). *Fisheries Science*. New Delhi: Daya Publishing House.
5. Khanna, S. S. & Singh, H. R. (2014). *A Text Book of Fish Biology and Fisheries*. Delhi: Narendra Publishing House.
6. Ghosh, R. (2007). *Fish Genetics and Endocrinology*. New Delhi: Swastik Publishers.
7. Reddy, P.V., Ayyappan, G.K., Thampy, S., & Gopal Krishna, D.M. (2005). *Text book of Fish genetics and Biotechnology*. New Delhi: Indian Council of Agricultural Research.
8. Jai Singh, P. (2008). *Fishes of Kanyakumari – A Hand Book on the Study of Fishes* (2<sup>nd</sup> ed.). Nagercoil: Tower Graphics Printer.
9. Schaperclaus, W. (2001). *Fish Diseases, Vol.I and II*. New Delhi: Oxonian Private Ltd.
10. Santhanam, R., (2008). *A manual of Freshwater Aquaculture*. New Delhi: Oxford and IBH Publishing Company, South Asia Books.
11. Khanna, S. S. (2005). *An Introduction to fishes*. Allahabad: Silver line Publications.

12. Santhanam, R. (2008). *A manual of Freshwater Aquaculture*. New Delhi: Oxford and IBH Publishing Company, South Asia Books.
13. Khanna, S.S. (2005). *An Introduction to fishes*. Allahabad: Silver line Publications.

**Semester III**  
**Elective III (a) - General Endocrinology**  
**Course Code: PZ2034**

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

**Objectives**

1. To impart knowledge on the function and the pathology of the endocrine system.
2. To develop skills for analysing clinical problems of the endocrine system and pursue research.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	define the concepts of endocrine system, hormones, biosynthesis and pathology.	PSO - 1	R
CO - 2	associate the role of the endocrine system in relation to homeostasis, growth, development, behaviour and environmental factors.	PSO - 2	U
CO - 3	apply the knowledge of endocrine pathology to hormone-related disorders.	PSO - 4	Ap
CO - 4	envisage women related physiological processes related to endocrine glands and hormones.	PSO - 3	An
CO - 5	correlate endocrine regulation of growth, reproduction and metamorphosis in various invertebrates and vertebrates.	PSO - 4	E

**UNIT I (Ref. 1, 2, 4, 5, 6)**

**(12 hrs.)**

**Endocrine glands and hormones:** Historical perspective and scope of endocrinology. Chemical messengers - neurocrine, paracrine, autocrine, endocrine, pheromones and chalone. Hormones - classification of hormones, gastro-intestinal hormones and maternal – foetal placental hormones. Pathophysiology of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, gonads.

**UNIT II (Ref. 1, 2, 4)****(12 hrs.)**

**Neurosecretion and Neuroendocrine mechanisms:** Neuroendocrine integration - endocrine control of neural function. Neuroendocrine mechanisms and functions in insects, crustaceans and non-arthropod invertebrates. Analogous neurosecretory systems of invertebrates and vertebrates.

**UNIT III (Ref. 1, 4, 5, 6)****(12 hrs.)**

**Hormone synthesis and mechanism of Hormone action:** Biosynthesis of amines - catecholamines, thyroxine, protein - growth hormone and insulin and steroid hormones - sex hormones. Pathophysiological correlates of hormone action. Endocrine disorders due to receptor number and function.

**UNIT IV (Ref. 1, 3, 4)****(12 hrs.)**

**Endocrine Integration:** Diffuse effect of hormones - Hormonal regulation of growth, development and metabolism, reproductive cycle and pregnancy, parturition and lactation, migration (birds and fishes), behaviour and hibernation, neoplastic growth, colour change in vertebrates.

**UNIT V (Ref. 1, 4, 6)****(12 hrs.)**

**Endocrine methodologies:** Assay of hormones, surgical methods, radioisotope studies, pharmacological methods and replacement therapy. Animal models for research. Hormonal therapy.

**Reference Books**

1. Mac E. Hadley and Jonathan Levine (2009). *Endocrinology*. India: Pearson Education(Singapore) Pvt. Ltd.
2. Aubrey Gorbman and Howard A. Bern (1974). *A textbook of Comparative Endocrinology*. Bombay: John Wiley and Sons, Inc. Wiley Eastern Pvt. Ltd.
3. Barrington, E.J.W (1975). *An Introduction to General and Comparative Endocrinology*, 5<sup>th</sup> Ed. London: Oxford University Press.
4. Donnell Turner, C. and Joseph T. Bagnara, W.B. (1976). *General Endocrinology* (6<sup>th</sup>ed.). Philadelphia: Saunders Company.
5. James Griffin and Sergio R. Ojeda (1988). *Textbook of Endocrine Physiology*. London: Oxford University Press.
6. Prakash S. Lohar (2005). *Endocrinology: Hormones and Human Health*. Chennai: MJP Publishers.

**Semester III**  
**Elective III (b) – Forensic Biology**  
**Course Code: PZ2035**

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

**Objectives**

1. To emphasize the importance of scientific methods in crime detection.
2. To develop skills for disseminating information on the advancements in the field of forensic science.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the fundamentals of forensic biology, psychology and criminal profiling.	PSO - 1	R
CO - 2	outline the use of scientific evidence in a legal context using basic facts, fundamental principles and functions of forensic science.	PSO - 2	U
CO - 3	apply the knowledge gained on forensic, dermatoglyphic, serological and odontological techniques to render forensic service during real-time crime scenes.	PSO - 3	Ap
CO - 4	analyse fingerprints, personal identification evidence, bite marks and pug marks.	PSO - 3	An
CO - 5	Evaluate information to find strategies to resolve problems in forensic biology.	PSO - 4	E

**UNIT I** (Ref. 1, 2, 3)

**(12 hrs.)**

**Introduction to Forensic Biology:** Concepts and scope, functions and historical aspects of forensic science. Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. Forensic dermatoglyphics - biological basis of fingerprints,

formation of ridges, fundamental principles of fingerprinting, types of fingerprints, fingerprint patterns, automated fingerprint identification system.

**UNIT II** (Ref: 4, 5, 9, 10)

**(12 hrs.)**

**Forensic examinations:** Forensic examination of hair - importance, nature, location, structure, growth phases of hair, collection, evaluation and tests for their identification. Forensic Serology - identification of body fluids, collection and preservation of blood evidence, distinction between human and non-human blood, semen - forensic significance of semen, composition and morphology of spermatozoa, collection, evaluation and tests for identification of semen. Composition and forensic significance of saliva, sweat, milk and urine.

**UNIT III** (Ref. 6, 7, 8)

**(12 hrs.)**

**Forensic Odontology:** Structural variation, types of teeth - human and non-human teeth, determination of age from teeth, eruption sequence, dental anomalies, their significance in personal identification. Bite marks - forensic significance, collection and preservation of bite marks, photography and evaluation of bite marks, lip prints in forensic investigations.

**UNIT IV** (Ref. 1, 2, 6)

**(12 hrs.)**

**Forensic Entomology and Forensic Microbiology:** Forensic Entomology - insects of forensic importance, collection of entomological evidence during death investigations. The role of aquatic insects in forensic investigations, insect succession on carrion and its relationship to determine time since death, factors influencing insect succession on carrion, its application to forensic entomology. Forensic Microbiology - types and identification of microbial organisms of forensic significance.

**UNIT V** (Ref. 2, 6, 10)

**(12 hrs.)**

**Wildlife Forensics:** Importance of Wildlife Protection Act-1972- Schedules in the protection of endangered species of flora and fauna. Identification of wildlife materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods. Identification of pug marks of various animals, DNA techniques in wildlife investigations.

**Reference Books**

1. S. Chowdhuri (1971). *Forensic Biology*. New Delhi: BPRD.
2. R. Saferstein (1993). *Forensic Science Handbook* (Vol. 3). New Jersey: Prentice Hall.
3. R.S. Ramotowski (2013). *Lee and Gaensleen's, Advances in Fingerprint Technology* (3<sup>rd</sup> ed.). Boca Raton: CRC Press.
4. L. Stryer, (1988). *Biochemistry* (3<sup>rd</sup>ed.). New York: W.H. Freeman and Company.
5. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, (1993). *Harper's Biochemistry*. Norwalk: APPLETON and Lange.

6. M. Bernstein (1997). *Forensic odontology in, Introduction to Forensic Sciences* (2<sup>nd</sup> ed.), W.G. Eckert (Editor). Boca Raton: CRC Press,
7. J. Dix (1999). *Handbook for Death Scene Investigations*. Boca Raton: CRC Press.
8. V.J. Geberth, (2006). *Practical Homicide Investigation*. Boca Raton CRC Press,
9. W.G. Eckert and S.H. James (1989). *Interpretation of Bloodstain Evidence at Crime Scenes*. Boca Raton: CRC Press.
10. G.T. Duncan and M.I. Tracey (1997). *Serology and DNA typing in, Introduction to Forensic Sciences* (2<sup>nd</sup> ed.), W.G. Eckert (Editor.). Boca Raton: CRC Press.

**Semester III**  
**Project**  
**Course Code: PZ20PR**

Hours/ Week	Credits	Total Hours	Marks
5	4	75	100

**Objectives**

1. To enable students to design experiment, analyse data and interpret results.
2. To develop skills to identify subject related problems in the neighbourhood and report to the scientific community.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explore new areas of research in Zoology and allied field of life science.	PSO - 1	Ap
CO - 2	analyze a research problem and construct tools for data collection.	PSO - 2	An
CO - 3	write research reports and present results in the scientific community.	PSO - 3	Ap
CO - 4	develop skills to serve in Life science related industries and agencies.	PSO - 3	E
CO - 5	develop skills to publish articles in reputed journals.	PSO - 4	C

**Guidelines**

- All the students must undertake dissertation work at the final year (III semester).
- The students, with the consent of the Supervisor, HoD and the Principal can pursue their project in another institution, especially with MoU/ Collaboration for the successful completion of the project work.

Evaluation	Marks	Month/ Date	Evaluator
Proposed title, review of literature and objectives.	-	3 <sup>rd</sup> Week of III Semester	-
I Review	10	July	Supervisor
II Review	10	August	Supervisor
Final- Internal/ External	20/40	September/ October	Internal / Ext. examiner
*Viva-voce (individual & open)	20	October /November	Ext. examiner
Total marks	100		

\* Mode of presentation by Power Point

## **Dissertation framework**

I. The dissertation format should be in:

- Font - Times New Roman
- Heading - Font size 14 (Bold) - Uppercase
- Sub headings - Font size 12 (Bold) – Lowercase; should be numbered.

(Eg: Introduction 1; Subheading 1.1; 1.2 ....)

- Text, the content of the dissertation – Font size -12 (Normal).
- Citation - Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

- i) A paper, a monograph or a book with single author may be designated by the name of the first author followed by the year of publication, placed inside brackets at the appropriate places in the text.
  - ii) A paper, a monograph or a book with two author may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.
  - iii) A paper, a monograph or a book with more than two authors may be designated by the name of the first author followed by et al, and the year of publication, placed inside brackets at the appropriate places in the text.
- Line space - 1.5
  - Margin - 2” on the left and 1” on the right, Gutter -0.5.
  - Page Numbering – Bottom middle alignment; excluding initial pages and reference
  - Total number of pages - Minimum 30 - Maximum 50 (excluding initial pages and reference).
  - The Tables and Figures should be included subsequently after referring them in the text of the Thesis.
  - The thesis from Chapters should be printed on both sides.

II. Dissertation must be completed within the stipulated time.

III. Submission of Dissertation:

- one soft copy (PDF format in CD)
- three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

**The report - dissertation will have three main parts:**

**I. Initial Pages - in the following sequence**

- i. Title Page
- ii. Certificate from the Supervisor
- iii. Declaration by the candidate endorsed by the Supervisor and HOD.
- iv. Acknowledgement (within one page - signed by the candidate).
- v. Table of Contents
- vi. List of abbreviations
- vii. Abstract

## **II. Main body of the dissertation**

- i) Introduction with Literature review and Objectives
- ii) Methodology
- iii) Results
- iv) Discussion
- v) Summary
- vi) References(DOI number of the journals can be included)

The guidelines for References

1. Journal Article: with Single Author  
Waldron, S 2008, 'Generalized Welch bound equality sequences are tight frames', IEEE Transactions on Information Theory, vol. 49, no. 9, pp. 2307-2309.
2. Journal Article: with Two Authors  
Conley, TG & Galeson, DW 1998, 'Nativity and wealth in mid-nineteenth century cities', Journal of Economic History, vol. 58, no. 2, pp. 468-493.
3. Journal Article: with more than two Authors  
Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009, 'Bounds on the sum capacity Of synchronous binary CDMA channels', Journal of Chemical Education, vol. 55, no. 8, 3577-3593.
4. Books  
Holt, DH 1997, Management Principles and Practices, Prentice-Hall, Sydney.
5. E-book  
Aghion, P & Durlauf, S (eds.) 2005, Handbook of Economic Growth, Elsevier, Amsterdam. Available from: Elsevier books. [4 November 2004].
6. Conference Proceeding Paper with editors  
Riley, D 1992, 'Industrial relations in Australian education', in Contemporary Australasian industrial relations: proceedings of the sixth AIRAANZ conference, ed. D. Blackmur, AIRAANZ, Sydney, pp. 124-140.
7. Conference Proceeding Paper without editors  
Fan, W, Gordon, MD & Pathak, R 2000, 'Personalization of search engine services for effective retrieval and knowledge management', Proceedings of the twenty-first international conference on information systems, pp. 20-34.
8. Website  
Australian Securities Exchange 2009, Market Information. Available from: <[http://www.asx.com.au/professionals/market\\_information/index.htm](http://www.asx.com.au/professionals/market_information/index.htm)>. [5 July 2009].
9. Patent  
Cookson, AH 1985, Particle trap for compressed gas insulated transmission systems, US Patent 4554399.
10. Thesis: Unpublished



Hos, JP 2005, Mechano chemically synthesized nanomaterials for intermediate temperature solid oxide fuel cell membranes. Ph.D. thesis, University of Western Australia.

11. Newspaper: Print

Ionesco, J 2001, 'Federal election: new Chip in politics', The Advertiser 23 October

Reference List Order

Arrange entries in alphabetical order by the surname of the first author followed by the initials of the author's given name(s).

**III. Appendices (if any – the primary data, article published during the tenure of this programme)**

**Semester III**  
**Practical III - Physiology & Genetics and Evolution**  
**Course code: PZ20P3**  
**(Conducted during III Semester)**

Hours/ Week	Credits	Total Hours	Marks
4	4	60	100

**Objectives**

1. To equip the students to analyse the physiological processes and inheritance.
2. To develop the skill to trace the phylogenetic relationship of living organisms.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the functioning of organ and organ systems and Mendelian inheritance, population genetics, adaptive radiation and evidence of evolution.	PSO - 1	R
CO - 2	interpret the importance of factors in physiological activities and genes in inheritance, changes in gene and gene frequencies in a population.	PSO - 3	U
CO - 3	identify the sex and mutant forms in <i>Drosophila</i> , clinical features of disorders, gene frequencies in natural population.	PSO - 2	Ap
CO - 4	design experiments based on Hardy-Weinberg Law, enzyme activity and effect of physical factors on physiological activities.	PSO - 4	An

**Physiology**

1. Effect of temperature on heartbeat of Freshwater Mussel and calculation of Q<sub>10</sub>.

2. Effect of temperature on salivary amylase activity and calculation of  $Q_{10}$ .
3. Effect of pH on salivary amylase activity.
4. Salt loss and salt gain in a freshwater fish.
5. Examination of excretory products of fish, bird and mammals.
6. Survey of digestive enzymes in Cockroach.
7. Counting of blood cells using a hemocytometer.
8. Haemolysis of blood – Demonstration.
9. Observation of haemin crystals in blood.
10. Estimation of haemoglobin.

**Charts/ Slides/ Models/ Bookplates/ Instruments**

EEG, ECG, Conditional reflex, Skeletal muscle, Kymograph, Sphygmomanometer, Intestine, Nervous tissue, Liver, Lungs, Heart, Kidney.

## **Genetics and Evolution**

1. Demonstration of monohybrid and dihybrid cross using beads.
2. Identification of sex and mutant forms of *Drosophila*.
3. Observation of Simple Mendelian Traits in man.
4. Calculation of gene frequencies using Hardy-Weinberg equilibrium - ABO blood group.
5. Demonstration of natural selection using beads.
6. Demonstration of genetic drift using beads.
7. Analysis of dermatoglyphic data (fingerprint patterns) of the class population.
8. Study of homologous organs (fore limbs and hind limbs of vertebrates).
9. Study of analogous organs (wings of animals).
10. Adaptive radiation - beaks in Birds.

**Specimens / Charts / Models / Photographs**

Karyotype of syndromes (Down's syndrome, Klinefelter's syndrome and Turner's syndrome), Chromosomal banding Pedigree chart, Fossils (Ammonite, Trilobite, Nautiloid fossil), Geographical isolation (Indian and African Elephants), Seasonal Isolation (Sea Urchin), Phylogram, Universal Tree of Life, Coevolution.

**Semester III**  
**Life Skill Training - II**  
**Course Code: LST202**

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

**Objectives:**

1. To aid students in making right choices and decisions
2. To create awareness on practical methods that lead to personal and societal development

**Course Outcome (CO)**

CO No.	<i>Upon completion of this course, the students will be able to:</i>	PSO Addressed	Cognitive Level
CO-1	Identify the root cause of social evils and it's consequences	PSO-	An
CO-2	Understand the importance of personal and emotional well being	PSO-	Un
CO-3	Empathise with the needy and disabled	PSO-	Ap

**Unit I**

Corruption - causes and types. Seeds and remedies of corruption.

Casteism - causes and consequences.

Communalism - characteristics - causes and remedial measures.

Regionalism - characteristics - causes and remedial measures.

**Unit II**

Abortion - reason and methods. Birth control

Alcoholism - alcoholism and causes of drinking. Harmful effects of liquor.

Drug addiction - causes - effects and control of drug addiction.

**Unit III**

Depression - signs - causes and treatments.

Suicide - signs and treatments. Child labour.

#### **Unit IV**

Divorce - causes and effects. Steps to avoid divorce.

Dowry system in India - Legislations to inhibit dowry system. Cases and problems.

#### **Unit V**

Care and concern for the aged and disabled - need to take care of elders. Caring of someone with physical disability.

HIV and aids - basic facts - causes - prevention and treatment.

#### **Text Book:**

(Compilation will be provided to the students)

#### **Reference Books:**

CN. Shankar Rao, India Social Problems - A Sociological Perspective. S. Chand and Company Limited. New Delhi. 2015.

CN. Shankar Rao, Sociology of Indian Society. S. Chand and company limited. New Delhi. 2004

Gawain, Shakti and Laurel King. Living in the Light. - A Guide to Personal Transformation. Natraj Publishing. Canada. 1998.

**Semester III**  
**PG Self-Learning Course**  
**Life Science for Competitive Examinations**  
**Course Code: PZ20S1**

No of credits	Marks
2	100

**Learning Objectives**

1. To enable the students to gain knowledge on various fields of life sciences.
2. To face competitive examinations like UGC-CSIR, NET and other similar examinations.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the terms in Molecular Cell Biology, Developmental Biology, Taxonomy, Physiology, Inheritance, Ecology and Evolution.	PSO - 1	R
CO - 2	summarise related concepts of biology.	PSO - 4	U
CO - 3	apply the acquired knowledge in entry level services.	PSO - 2	Ap
CO - 4	analyse and interpret the concepts for research and higher education.	PSO - 3	An

**UNIT I**

**Molecular Cell Biology:** Membrane structure and function: Structure of cell membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum,

peroxisomes, plastids, vacuoles, chloroplast, structure and function of cytoskeleton and its role in motility. Organization of genes and chromosomes: Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. Cell division and cell cycle: Mitosis and meiosis, steps in cell cycle, regulation and control of cell cycle. DNA replication, repair and recombination: Unit of replication, enzymes involved replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination. RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport. Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins. Control of gene expression at transcription and translation level: regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing.

## UNIT II

**Developmental Biology and Taxonomy:** Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination. Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons. Post embryonic development - larval formation, metamorphosis; regeneration, environmental regulation of normal development; sex determination. Programmed cell death, aging and senescence. Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications. Outline classification of animals and microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa.

## Unit III

**System Physiology – Animal:** Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance,

cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Digestive system: Digestion, absorption, energy balance, BMR. Thermoregulation: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. Stress and adaptation. Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation.

#### UNIT IV

**Inheritance Biology:** Mendelian principles: Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Human genetics: Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.

#### UNIT V

**Ecology and Evolution:** The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. 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. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax. Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical

zones of India. Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). Emergence of evolutionary thoughts: Lamarck; Darwin - concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis. Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

### Reference Books

1. Vijay N. Waghmare (2004). *Life sciences for NET/SLET exams of UGC-CSIR*. Maharashtra: Mudra Publication.
2. Dr. A P Singh and Kumar Pushkar (2010). *CSIR-UGC NET/JRF/SLET Life Sciences (Paper I & II)*. New Delhi: Upkar Publishers.
3. Arun Chaudhary, B. L., Chaudhary and Kailash Choudhary (2007). *CSIR/NET Life Sciences*. New Delhi: New Age Publishers.
4. Kumar Pranav Mina Usha (2011). *CSIR-JRF-NET: Life Sciences Fundamentals and Practice (Part - I)*. New Delhi: Pathfinder Academy.
5. Ashish Nagesh, Quaiser J. Hossain, Prashant Kumar (2012). *UGC-CSIR NET (JRF & LS) Life Science*. Chennai: Arihant Publishers.
6. Rupendra Singh (2014). *CSIR NET/JRF Life Sciences* (4<sup>th</sup>ed.). Lucknow: Catalyst Center of Excellence Pvt. Ltd.
7. Pramod Singh (2014). *Trueman's UGC CSIR-NET Life Sciences*. New Delhi: Danika Publishing Company.
8. RPH (2014). *CSIR-UGC NET Life Science (Popular Master Guide): Life Sciences*, RPH Editorial Board.



**Semester IV**  
**Core XII - Microbiology**  
**Course Code: PZ2041**

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

**Objectives**

1. To facilitate the students to understand the microbes and their significance.
2. To develop skills in microbial techniques relevant to industries, environment and disease management.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the structure, distribution and life cycle of microorganisms and their role in human welfare.	PSO - 1	R
CO - 2	explain culture techniques, growth, fermentation and microbial products.	PSO - 2	U
CO - 3	Apply the microbiological laboratory skills in clinical research, food industries and environmental management.	PSO - 3	Ap
CO - 4	analyze beneficial and harmful microbes	PSO - 3	An
CO - 5	evaluate the microbial importance and applications in various fields.	PSO - 4	E

**UNIT I (Ref. 1, 5)**

**(18 hrs.)**

**Virus, Fungi and Protists:** History and scope of microbiology. Classification of microorganisms - Whittaker's five kingdoms and three domain classification. Virus - General properties, viral taxonomy. Bacteriophages – life cycle – Lytic and Lysogenic. Sub viral agents – viroid, virusoids, prions and satellite viruses. Cultivation of viruses and purification assays. Virus-host interactions. Fungi: classification – morphology - filamentous, non-filamentous and dimorphic fungus. Apicomplexa– *Toxoplasma*.

**UNIT II (Ref. 1, 2) (18 hrs.)**

**Bacteria and culture techniques:** Bacteria - classification – Bergey's system, morphology, structure and functions of cell walls (Gram positive & Gram negative), flagella, fimbriae and pili. Fine structure of *Escherichia coli*. Bacterial nutrition - nutrient requirements, nutritional classes, uptake of nutrients. Bacterial growth and measurements. Types of culture media - pure culture and isolation techniques - streak plate and pour-plate technique.

**UNIT III (Ref. 1, 9) (18 hrs.)**

**Industrial Microbiology:** Fermentation - production of microbial products - alcohol (ethanol), antibiotics (penicillin), vitamin B<sub>2</sub> and Vitamin B<sub>12</sub>. Biofertilizers - steps for preparing bacterial biofertilizers, Mass cultivation of *Cyanobacteria*, *Azolla* and *Trichoderma*. Production of mycorrhizal fungi – Vesicular Arbuscular Mycorrhiza (VAM) and yeast. Industrial uses of yeast and moulds. Probiotics- *Lactobacillus* and *Saccharomyces*. Bacterial insecticides – *Bacillus* species.

**UNIT IV (Ref. 1, 7) (18 hrs.)**

**Environmental Microbiology:** Microbiological analysis of water - Coliform test, Most Probable Number (MPN) test, and Membrane Filter (MF) test. Sewage treatment – small scale and large-scale treatment. Biogas production – solubilization, acetogenesis and methanogenesis. Microbial leaching – copper and uranium leaching. Biodegradation of petroleum and xenobiotics, bioremediation and biosorption. Microbes as biofilms, biosensors, nanomaterials.

**UNIT V (Ref. 1, 2) (18 hrs.)**

**Medical Microbiology:** Gnotobiotic animals, distribution of normal microbiota of the human body. Nosocomial infections. Fungal diseases - Candidiasis and Aspergillosis. Bacterial diseases - Streptococcal pneumonia, Typhoid, Tetanus. Viral diseases – SARS, MERS, Covid-19, Ebola, Hepatitis-B, Rabies. Sexually transmitted diseases – Gonorrhea, Syphilis. Microbial drugs - Drug administration, determination of antimicrobial activity, mechanism of antimicrobial agents effectiveness of antimicrobial drugs. Methods of controlling microbes. Current problems of antibiotic resistance in man.

**Reference Books**

1. Dubey R.C. & Maheswari, D.K. (2010). *A textbook of Microbiology* (3<sup>rd</sup> ed.). New Delhi: S. Chand and Co.
2. Joanne, M., Wiley Linda M., Sherwood Christopher J. & Woolverton. (2013). Prescott's Microbiology. America: McGraw-Hill International.
3. Arti Kapil. (2013). Anandanarayan & Paniker's textbook of Microbiology. Hyderabad: Universal Press.
4. John L. Ingraham & Catherine A. (2004). *Introduction to Microbiology*. UK: Ingraham Thomson Brooks / Cole.

5. Alcamo E. (2001). Fundamentals of Microbiology. 6th Ed. New Delhi: Jones and Bartlett Publishers.
6. Pelzar, Chan and Krieg (2006). *Microbiology*. New Delhi: Tata McGraw Hill Publishing Company. Ltd.
7. Vijaya Ramesh, K. (2004). *Environmental Microbiology*. Chennai: MJP Publishers.
8. Powar, C.B. and Dagainawala, H.F. (2008). *General Microbiology*, Vol. 2. Chennai: Himalaya Publishing House.
9. Singh, R.P. (2007). *General Microbiology*. New Delhi: Kalyani Publishers.
10. Johri R.M., Snehlatha, Sandhya Sharma (2010). *A Textbook of Algae*. New Delhi: Wisdom Press.

### Semester IV

### Major Core XIII - Biotechnology and Nanobiology

#### Course Code: PZ2042

Hours/ Week	Credits	Total Hours	Marks
6	4	90	100

#### Objectives

1. To enable the students to understand the essence of biotechnology and become aware of the advances in Nanobiology.
2. To develop skills to apply biotechnological principles in research related to genetic manipulations, industrial and environmental biotechnology.

#### Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the various techniques used in modern biotechnology.	PSO - 1	U
CO - 2	outline the basic concepts of Biotechnology and Nanobiology, its application and threat to the society.	PSO - 2	R
CO - 3	apply the biotechnological principles in research and judicial use of bio- and nanotechnology to solve societal problems.	PSO - 2	Ap
CO - 4	analyze the impact of biotechnological products and genetically modified organisms in bioremediation.	PSO - 3	An
CO - 5	evaluate the function, gene modulation and their effects on improvement of crops and animals after the applications of cloned genes.	PSO - 4	E
CO - 6	design simple experiments on biotechnology and communicate the results through publication.	PSO - 3	C

#### UNIT I (Ref. 2, 3, 4)

(18 hrs.)

**Gene cloning:** Basic steps of gene cloning, restriction and modifying enzymes, linkers and adaptors, cloning and expression vectors, construction of chimeric DNA, nucleic acid probes, DNA libraries, polymerase chain reaction, blotting techniques,

molecular markers, DNA sequencing, synthesis of oligonucleotides, DNA fingerprinting. Human Genome Project.

**UNIT II (Ref. 3, 5)**

**(18 hrs.)**

**Animal Biotechnology:** Culture media, primary culture and cell lines, pluripotent stem cell lines, tissue engineering. *In vitro* fertilization and embryo transfer in animals; gene transfer methods. Primary explanation techniques – organ and embryo culture – transgenic animals - cattle, sheep, fish and pigs - transgenic animals as models of human disease. Ethical issues in transgenesis.

**UNIT III (Ref. 1, 3, 6)**

**(18 hrs.)**

**Medical and Enzyme Biotechnology:** Medical Biotechnology - hybridoma technology and monoclonal antibodies – applications of biotechnology in medicine, vaccines, diagnostics and forensics. Gene therapy – pharmacogenomics. Enzyme biotechnology - isolation and purification of enzymes, uses of enzymes in industries, immobilization of enzymes and their uses, Biosensors. Terminator and traitor technology. Intellectual Property Rights.

**UNIT IV (Ref. 2, 3, 4)**

**(18 hrs.)**

**Industrial and Environmental Biotechnology:** Industrial Biotechnology - design of fermenter, sterilization, media design, production of metabolites - downstream processing and *in situ* recovery of products, microbial biotransformation, microbial biomass production (SCP). Environmental Biotechnology - bioremediation and phytoremediation - genetically engineered microorganisms (GEMs) - treating oil spills, detection of pesticide in soil and their degradation, sequestering heavy metals. Biomining and Biofuels.

**Unit V (Ref. 7, 8, 9, 10, 11, 12)**

**(18 hrs.)**

**Nano Biotechnology:** Nanomaterials - types and properties, DNA and protein nanoarrays, biosystems (microbes) as nanofactories. Application of nanotechnology - medical diagnostics, imaging, drug delivery, contact lenses, dental implants, Scaffolds for tissue engineering, cosmetics, agro-practices and nano food products, environmental remediation - prevention of contamination, maintenance and quality enhancement. Risks and threats of nanoparticles in the environment.

**Reference Books**

1. Gupta P.K. (2009). *Elements of Biotechnology*. Meerut: Rastogi Publications.
2. Singh B.D. (2003). *Biotechnology - Expanding Horizons*. Chennai: Kalyani Publishers.
3. Satyanarayana V. (2004). *Biotechnology*. Kolkata: Books and Allied (P) Ltd.
4. Dubey R.C. (2006). *A Textbook of Biotechnology* (4<sup>th</sup> ed.). New Delhi: S. Chand and Co. Ltd.
5. Rema L.P. (2006). *Applied Biotechnology*. Chennai: MJP publishers.
6. Prakash S. Lohar, (2012). *Biotechnology*. Chennai: MJP publishers.
7. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey & Goldie Oza (2012). *BioNanotechnology: Concepts and Applications*. New Delhi: Ane Books Pvt. Ltd.
8. Vinod Labhasetwar & Diandra. L. Leslie-Pelecky (2007). *Biomedical applications of Nanotechnology*. New Jersey: Wiley Publications.

9. Jo Anne Shatkins (2008). *Nanotechnology: Health and Environmental Risks*. New York: CRC Press.
10. Y.S. Raghavan (2010). *Nanostructures and Nanomaterials: Synthesis properties and applications*. New Delhi: Arise Publishers and distributors.
11. Parthasarathy, B.K. (2007). *Nanotechnology in Life Science*. New Delhi: Isha Books.
12. Rakesh K. Yadav (2009). *Investing in Nanotechnology*. New Delhi: Mangalam Publications.

**Semester IV**  
**Core IVX - Immunology**  
**Course Code: PZ2043**

Hours/ Week	Credits	Total Hours	Marks
5	4	75	100

**Objectives**

1. To facilitate the students to appreciate the defense functions of the immune system.
2. To develop the skill to determine the immunomodulatory strategies used to enhance or suppress the immune response.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall the importance of immunity, immune response, MHC, BCR and TCR, antigen –antibody interaction.	PSO - 1	R
CO - 2	relate the evolution of immune molecules in different groups of animals, immunodeficiency diseases and immunotechniques.	PSO - 1	U
CO - 3	make use of immunization schedules, differentiate the types of hypersensitive allergic reactions and symptoms.	PSO - 2	Ap
CO - 4	analyse the immune response in relation to toxicants, vaccines, tumour, and infectious diseases.	PSO - 3	An
CO - 5	evaluate the role of immune cells and humoral factors in immune response	PSO - 3	E
CO - 6	predict immuno-nano materials for immunodiagnostic, therapeutic techniques and research.	PSO - 4	C

**UNIT I (Ref. 1, 9)**

**(15 hrs.)**

**Immune system in invertebrates and vertebrates:** Immunity - Innate and acquired, Types. Lymphoid organs and immune cells. Antigens and Immunoglobulins – characteristics, haptens, types. Immune Response - Humoral and Cell-mediated. Immunological memory (Anamnesis). Immunization - immunization schedule and vaccines.

**UNIT II (Ref. 6, 7, 9)**

**(15 hrs.)**

**B and T cell:** B cells - Development, maturation, activation and differentiation - B cell receptor (BCR) - B cell co-receptor complex - signal transduction from B cell antigen receptor, major pathways of BCR signaling. T cells - maturation, activation and differentiation, T cell receptor (TCR), T cell co-receptor complex - formation of T and B cell conjugates, Costimulation in T cell response and signal transduction. Clonal anergy. Antigen processing and presentation – role of antigen presenting cells – cytosolic pathway and endocytic pathway.

### UNIT III (Ref. 6, 7, 9)

(15 hrs.)

**Major and minor histocompatibility complex:** MHC class I and II molecules, cellular distribution and regulation of MHC expression, MHC in immune responsiveness, MHC and susceptibility to infectious diseases. Minor histocompatibility (H) antigens. Immune effector mechanisms: Cytokines and their functions, Complement system – classical and alternative pathways, biological functions.

### UNIT IV (Ref. 5, 8)

(15 hrs.)

**Immune system in health and diseases:** Tumour immunology - tumour antigens, immune response to tumour, immune surveillance, immune-diagnosis of tumour antigens, immune-therapy of tumors. Hypersensitivity- factors causing hypersensitivity, Type I, II, III, and IV reactions. Immunodeficiency - primary and secondary. Autoimmune diseases - characteristics, causes, classification, localized - Diabetes mellitus and systemic - rheumatoid arthritis. Immune response to infectious diseases and treatment - Protozoan disease - Malaria, Bacterial disease - Tuberculosis, Viral disease - AIDS.

### UNIT V (Ref. 3, 4)

(15 hrs.)

**Antigen-antibody interaction:** Complement fixation test - precipitation reaction in fluids and precipitin curve. Radial immunodiffusion and double immunodiffusion. Agglutination reaction - hemagglutination, bacterial agglutination, coated particle agglutination, agglutination inhibition. Radio immuno assay - ELISA - Immunofluorescence - Flow cytometry. Transplantation: classification of grafts, mechanism of graft rejection, graft versus host reaction, immunosuppressive therapy during transplantation.

### Reference Books

1. Goldsby, R.A., Kindt, T.J. & Osborne, B.A. (2007). *Kuby's Immunology* (6<sup>th</sup>ed.). New York: W.H. Freeman and Company.
2. Deves, P., Martin, S., Burton, D. & Roitt I.M. (2017). *Roitt's Essential Immunology* (13<sup>th</sup>ed.). Oxford: Wiley-Blackwell Scientific Publication.
3. Ashim, K., Chakravarthy (2007). *Immunology and Immunotechnology* (2<sup>th</sup> ed.). Delhi: Saurabh Printers Pvt. Ltd.
4. Dasgupta, A. (1992). *Modern Immunology* (2<sup>th</sup> ed.). New Delhi: Jaypee Brothers Medical Publications Pvt. Ltd.
5. Gupta, S.K. (1991). *Immunology perspectives in Reproduction and Infection*. New Delhi: Oxford and IBH publication Co. Pvt. Ltd.
6. Hannigan, B.M., Moore, C.B.T. & Quinn, D.G. (2010). *Immunology* (2<sup>th</sup> ed.). India: Viva Book Pvt. Ltd.
7. Rao, C.V. (2006). *Immunology* (2<sup>th</sup> ed.). Chennai: Narosa Publishing House.

8. Murphy, K., Travers, P. and Walport, M. Garland (2008). *Janeway's Immunobiology* (7<sup>th</sup> ed.). New York: Science Publishers.
9. Dulsy Fathima and Arumugam, N. (2020). Immunology. Nagercoil: Saras Publications.

**Semester IV**  
**Core XV - Medical Laboratory Technology**  
**Course Code: PZ2044**

Hours/ Week	Credits	Total Hours	Marks
5	4	75	100

**Objectives**

1. To impart knowledge on laboratory principles, clinical analysis and safety measures in handling samples.
2. To develop skills on laboratory investigations adopted in medical diagnostic laboratories.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	outline the laboratory principles applied in diagnosis of disease and methods of biomedical waste disposal.	PSO - 1	R
CO - 2	explain the type of specimens, collection and use of appropriate diagnostic techniques.	PSO - 2	U
CO - 3	prepare reagents, handle instruments and perform clinical analysis.	PSO - 3	Ap
CO - 4	interpret and validate the results.	PSO - 4	An

**UNIT I (Ref.1, 5)**

**(15 hrs.)**

**Laboratory instruments and safety measures:** Scope of Medical laboratory technology. Laboratory principles - Organization of clinical laboratory - Role of medical laboratory technician. Laboratory instruments: Common glass wares in clinical laboratory - Centrifuges - Water bath – Refrigerator – Autoclave - Hot air oven – Mixer – Laminar air flow – Microscope – Analyser –Spectrometer – Cell counter - Blood bank. Safety measures - Cleaning and sterilization methods - antiseptics and disinfectants - hospital and clinic borne infection and personnel hygiene.

**UNIT II (Ref. 1, 2, 3, 5, 6)**

**(15 hrs.)**

**Clinical sample collection, processing and storage:** Specimen collection and processing of blood, urine and cerebrospinal fluid, separation of serum and plasma, Handling of specimens for testing, preservation and transport of specimen, factors affecting the clinical results, effect of storage on sample. Anticoagulants: EDTA, Dipotassium salts of EDTA, oxalate, sodium citrate and sodium fluoride. Techniques of sample processing: Throat Swab, Sputum, blood, urine, stool, pus, CSF, other body fluids, other swabs like from wounds, skin clipping, spore strips.

**UNIT III** (Ref.1, 2, 3, 5, 6, 7, 8)

**(15 hrs.)**

**Body fluid analysis:** Physical, chemical and microscopical examination of cerebrospinal fluid, pleural fluid, synovial fluid. Haematological techniques - Haemoglobin estimation, Erythrocyte Sedimentation Rate, Differential count, Total Red Blood cell count, Total White blood cell count, Platelet count. Blood banking technology - Blood typing, collection and storage and plasma separation. Diagnosis of Covid-19.

**UNIT IV** (Ref. 1, 3, 5)

**(15 hrs.)**

**Histopathology:** Introduction of histopathology, labelling and transportation of tissue specimens, tissue processing- fixation, sectioning, staining and mounting, manual and automated method. Cryostat, frozen sections of fresh, fixed and unfixed tissue, freeze drying, rapid frozen sections and staining for emergency diagnosis.

**UNIT V** (Ref. 1, 2, 3, 7, 8)

**(15 hrs.)**

**Clinical sample analysis and biomedical waste management:** Physical, chemical and microscopical examination of sputum, urine and stool. Routine examination of urine and their clinical significance. Pregnancy test. Semen: Sample collection and microscopic examination for count and morphology. Bio-medical waste – waste generation, segregation, disposal. Management of Bio-medical Waste, Technologies for Treatment for BMW, Legal Aspects and Environment Concern. COVID

**Reference Books**

1. Mukerjee, K. L. & S. Ghosh, (2010). *Medical Laboratory Technology*, Volume I, II, III. New Delhi: McGraw Hill.
2. Sood. R. (2006). *Textbook of Medical Laboratory Technology*. New Delhi: Jaypee.
3. Rajan, S. (2012). *Manual for Medical Laboratory and Technology* (1<sup>st</sup> ed.). Chennai: Anjanaa Book House.
4. John Bernard Henry (2001). *Clinical diagnosis and management by laboratory Methods* (20<sup>th</sup> ed.). Philadelphia: Saunders & Co.
5. Mary Vijaya, T., Mini, M.L., Sunitha Kumari, K. & Asha, K.R.T. (2003). *Practical Clinical Biochemistry Manual*. Kaliakkavilai: Rishi Publications.
6. Himadri Panda (2019). *Biomedical Waste Management, Recycling and Applications* (1<sup>st</sup> ed.). India: Discovery Publishing house Pvt. Ltd.



7. Najih A. Naser & Saleh A. Naser (1998). *Clinical Chemistry Laboratory Manual*. USA: Moshby Inc.
8. Sabtiri Sanyal (2000). *Clinical Pathology*. Delhi: Reed Elsevier India Pvt. Ltd.

**Semester IV**  
**Elective IV (a) - Parasitology**  
**Course Code: PZ2045**

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

**Objectives**

1. To enable the students to be aware of the cosmopolitan distribution of parasites, vectors and their control measures.
2. To develop skills for employment in clinical laboratories and health departments.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	define the basic biology and life cycle of parasites including epidemiology, diagnosis and treatment.	PSO - 1	R
CO - 2	explain morphological characters of parasites, developmental stages and their infestation.	PSO - 1	U
CO - 3	identify appropriate techniques and develop basic skills for detection of parasites.	PSO - 3	Ap
CO - 4	analyse the medical and public health aspects of human parasitic infections.	PSO - 2	An
CO - 5	compare the diagnostic methods of parasitic infestation in veterinary hospitals, clinics and research laboratories.	PSO - 4	E

**UNIT I (Ref. 1, 2)**

**(12 hrs.)**

**Introduction:** Taxonomy and classification of parasites - origin and evolution of parasitism - host parasite relationship, classification of parasites and hosts - transmission of parasites - Parasitic zoonoses- pathogenesis - clinical manifestations of parasitic diseases.

**UNIT II (Ref. 3, 4)**

**(12 hrs.)**

**Protozoan parasites:** Introduction and classification. Intestinal Amoeba - Pathogenic free living amoeba - Intestinal flagellates - Trypanosomiasis, Leishmaniasis, Balantoidiasis, Malaria, Isosporiasis, Toxoplasmosis, Cryptosporidiosis, Pneumocystis. Protozoans of minor medical importance.

**UNIT III (Ref. 3, 4)****(12 hrs.)**

**Helminth parasites:** Trichuriasis, Trichinellosis, Strongyloidiasis, Ascariasis, Enterobiasis, Filariasis, hookworm diseases, Dracunculiasis, Onchocerciasis, Loiasis - Larva migrants. Nematodes of lesser medical importance - Diphylobothriasis, Taeniasis, Echinococcosis, Sparganosis, Schistosomiasis, Fascioliasis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Trematodes of minor medical importance.

**UNIT IV (Ref. 5, 6)****(12 hrs.)**

**Parasitic Insects:** Prevalence, transmission and control of parasitic infections. Parasitic infection in a compromised host. Applied Parasitology - Eosinophilia in parasitic infections, Nosocomial parasitic infections. Evasion and parasitic mode of life - morphological, biochemical and ethological adaptations. Quality assurance and laboratory safety.

**UNIT V (Ref. 7)****(12 hrs.)**

**Diagnostic methods in parasitology:** General rules for microscopical examination. Microscopical examination of blood, stool, urine, sputum and biopsy material for parasites. Cultural examination - preparation of media - techniques for cultivation of *E. histolytica*, Leishmania, Plasmodium. Immunodiagnostic methods - IFA, AGD, IHA, IFAT, CFT, DAT, BF, DFAT. Molecular characterization of stage specific antigen nucleotide probes for diagnosis of protozoan diseases.

**Reference Books**

1. Cheng, C.T. (1964). *The Biology of Animal Parasites*. Tokyo: Toppan Company Ltd.
2. Chatterjee, K.D. (1981). *Parasitology*. Calcutta: Chatterjee Medical Publishers.
3. Rajesh Karyakarte & Ajit Damle (2008). *Medical Parasitology* (2<sup>nd</sup> ed.). Kolkata: Books and Allied (P) Ltd.
4. Ichhpujani R.L. & Rajesh Bhatia (2002). *Medical Parasitology*. New Delhi: Jaypee printers.
5. Patvaik, B.D. (2001). *Parasitic Insects*. Delhi: Dominant Publishers and Distributors.
6. Jones, A.W. (1976). *Introduction to Parasitology*. Boston, USA: Addison-Wesley Publishing Company.
7. Subah, C.P. (2001). *Textbook of Medical Parasitology*. Chennai: All India publishers and Distributors.

**Semester IV**  
**Elective IV (b) - Applied Entomology**  
**Course code: PZ2046**

Hours/ Week	Credits	Total Hours	Marks
4	3	60	100

**Objectives**

1. To impart knowledge on insect diversity and economically important insects.
2. To develop skill to collect, identify and differentiate pests from productive insects and their management.

**Course Outcomes**

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	identify locally available insects, the pests of agriculture, domestic animals and public health, types of infestations and their control measures.	PSO - 1	R
CO - 2	distinguish the salient features of insects, beneficial insects, pests and their control measures.	PSO - 1	U
CO - 3	demonstrate research and effective communication skills, to recommend the application of safer pest control measures.	PSO - 4	Ap
CO - 4	analyze the types, damages and loss caused by pests and their effective control measures.	PSO - 2	An
CO - 5	design an experiment to evaluate the effectiveness of methods of pest control.	PSO - 3	E

**UNIT I** (Ref.1, 3, 5, 8, 9)

**(12 hrs.)**

**Insecta:** Salient features of Class Insecta and orders - Orthoptera, Isoptera, Hemiptera, Diptera, Coleoptera, Lepidoptera, Dermaptera, Odonata, Neuroptera and Hymenoptera. Categories of pests (major and minor) – based on occurrence, types and level of infestation. Types of damage caused by insect pests to crops. Causes of pest outbreak.

**UNIT II** (Ref. 3, 4, 5, 6, 7)

**(12 hrs.)**

**Agricultural Entomology:** Life history and control measures of agriculture crop pest – Cereal - Paddy (*Scirpophagaincertulas*), Oil seeds - Coconut (*Oryctes rhinoceros*), Maize (*Chilopartellus*), Vegetables – Brinjal (*Leucinodes orbonalis*), Okra (*Eariasvitella*), Pulses (*Helicoverpaarmigera*), Fruits – Banana (*Odoiporuslongicollis*), Mango (*Sternochetusmangiferae*), Tomato (*Macrosiphumeuphorbiae*). Sugarcane (*Scirpophagaexcerptalis*), Rubber (*Seissetia*

*nigra* Nietn), Curry leaves (*Papilio demoleus*), Stored products (*Callosobruchuschinensis* and *Sitophilus oryzae*).

### UNIT III (Ref. 2, 3, 4, 6)

(12 hrs.)

**Pests of Domestic Animals:** Stable fly and cattle fly; Fowl - shaft louse and chicken flea; sheep and goat - head maggot and sheep ked. Insects associated with medical importance and management - head louse *Pediculus humanus capitis*, mosquitoes - *Anopheles*, *Culex*, *Aedes*, flea - *Xenopsyllacheopsis*, eye fly, sand fly, ticks, mites and bed bug. Insects associated with household insects - cockroaches, termites and silverfish.

### UNIT IV (Ref. 2, 3, 4, 5)

(12 hrs.)

**Productive and beneficial insects:** Types, Life cycle and economic importance - honey bees and Silkworms. Lac insects – lac cultivation, shellac. Biological control agents- Lacewings, ladybird beetles, *Trichogramma*. Pollinators, Weed killers, Scavengers, Insect as food and feed. Insects as biological indicators and experimental models. Cochineals - *Dactylopius coccus*. Medicinally important insects.

### UNIT V (Ref. 6, 7, 8, 9)

(12 hrs.)

**Pest management:** Assessment of pest status. Economic Injury Level, Pest Control - Chemical control - pesticides. Biological control - predator, parasites, biocides and microbial control. Recent trends in pest control - Pheromones, Attractants, Repellents, Antifeedants, Chemosterilants and chitin inhibitors. Host - plant resistance to insects, *Bt* cotton - concepts and application. Concepts of Biointensive Integrated Pest Management (BIPM) and biopesticides.

### Reference Books

1. Ambrose, D.P (2017). *The Insects: Structure, Function and Biodiversity* (2<sup>nd</sup> ed.). Ludhiana: Kalyani Publishers.
2. Ambrose, D.P. (2017). *The Insects: Beneficial Harmful Aspects* (2<sup>nd</sup> ed.). Ludhiana: Kalyani Publishers.
3. David, B & Ananthakrishnan, T.N. (2016). *General and Applied Entomology* (2<sup>nd</sup> ed.). New Delhi: Tata McGraw hill publishing company Ltd., India.
4. Vasantharaj David, B. & Ramamurthy, VV. (2012). *Elements of Economic Entomology* (7<sup>th</sup> ed.). Chennai: Namratha publications.
5. Awasthi, V.B. (2012). *Introduction to General and Applied Entomology* (3<sup>rd</sup> ed.). India: Scientific publishers,
6. Abishek Shukla, D. (2009). *A Handbook of Economic Entomology*. New Delhi: Vedams eBooks.
7. Ministry of Agriculture, Government of India (1995). *Manual on Integrated Pest Management in Rice & Cotton*.
8. Chapman RF. (1998). *The Insects: Structure and Function*. Cambridge: Cambridge Univ. Press.
9. Romoser, W.S & Stoffolano, J.G. (1998). *The Science of Entomology*. New York:

**Semester IV**  
**Practical IV – Microbiology & Biotechnology and Nanobiology**  
**Course Code: PZ20P4**

Hours/ Week	Credits	Total Hours	Marks
4	4	60	100

**Objectives**

1. To demonstrate competency in routine microbiological and biotechnological techniques.
2. To develop skills in cell culture and analytical techniques for procuring employability in research laboratories.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recall microbiological and biotechnological experiment protocols.	PSO - 1	R
CO - 2	identify tools and techniques relevant to microbiology and bio-nanotechnology.	PSO - 2	U
CO - 3	perform microbiological and biotechnological experiments pertinent for the welfare of the environment and society.	PSO - 4	Ap
CO - 4	analyse the impact of microbiological, biotechnological products and genetically modified organisms in bioremediation.	PSO - 3	An

**Microbiology**

1. Preparation of culture media.
2. Isolation of bacteria from soil and water (Streak plate method).
3. Serial dilution technique.
4. Measurement of growth of bacteria (turbidimetric method).
5. Bacterial count by plate count method.
6. Observation of bacterial motility by Hanging Drop method.
7. Gram staining of bacteria.
8. Negative staining of bacteria.
9. Methylene blue reduction test to assess the quality of milk.
10. Antibiotic susceptibility test by disc-diffusion method.

**Specimen/ Models/ Charts**

*Salmonella*, *Clostridium*, Rabies virus, hepatitis – B, *Entamoeba*, *Azolla*, ocular and stage micrometer, inoculation loop, autoclave, laminar airflow chamber.

**Biotechnology and Nanobiology**

1. Extraction and estimation of genomic DNA from goat liver.
2. Separation of DNA using Agarose gel electrophoresis.
3. Polymerase chain reaction (Demonstration).
4. Culture of animal cells (Demonstration).
5. Immobilization of yeast cells using sodium alginate method.
6. Alcohol fermentation from fruit juice (wine).
7. Estimation of ethanol content in wine.
8. Production of amylase by bacteria.
9. Preparation of nanosolution (silver).
10. Biofabrication of nanomaterials by using plant materials.

**Flow charts/ Instruments/ Figures**

Plasmid DNA isolation, Insulin production by rDNA Technology, Hybridoma production, Synthesis of DNA nanoarray, Southern blotting, Biosensor (glucometer), Air-lift bioreactor, Superbug, Buckyballs, Dendrimers.

**Semester IV**  
**Life Skill Training - II**  
**Course Code: LST202**

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

**Objectives:**

1. To improve the integral growth of human being towards sustainable development.
2. To create awareness about human rights, values and their significance and their role.

**Course Outcome (CO)**

CO No.	<i>Upon completion of this course, the students will be able to:</i>	PSO Addressed	Cognitive Level
CO-1	Understand the pros and cons of organ donation and transplant.	PSO-	
CO-2	To recognise their rights and address the issues pertaining to human rights violation.	PSO-	
CO-3	To acquire the skills required for a successful personal and professional life.	PSO-	

**Unit I**

Generation gap - causes. Bridging the generation gap.

Donate life - pros and cons of organ donation - organ donation and transplant.

**Unit II**

Impact of mass media on society - functions and social impacts of media.

Responsible freedom - freedom and responsibility.

**Unit III**

Violation of human rights - the right to live free. Freedom to move - freedom of thought and freedom of expression. Right to democracy - types of violations and safeguarding of human rights.

**Unit IV**

Impact of materialism on youth.

Terrorism - causes - solutions to rid the world of terrorism and remedy.

**Unit V**

Marriage preparation - Fidelity and permanence. Values to practice for a successful marriage. Tips for a successful marriage.

Professional ethics and human values - work ethics - ethics and character. Civic virtues and respect for others. Types of value and its nature. Professional value and duty ethics - how to face challenges in the work place.

**Text Book:**

(Compilation will be provided to the students)

**Reference Books:**

Baghel, Dr. Sanjay Singh. *Social Media and Indian Youth*. Apple Books. New Delhi.2015.

Bhagwan , Dada. *Generation Gap* . mahavideh Foundation. Ahmedabad. 2000.

M. Govindarajan, S. Natarajan and V.S. Senthil Kumar. *Professional Ethics and Human Values*. PHI Learning Private Limited. New Delhi .2013.

Don Miguel Riuz and Heather Ash Amara. *The Seven Secrets to Healthy , Happy Relationships*. Hierophant Publishing . 2018.



**Semester IV**  
**PG Self-Learning Course**  
**Environmental Impact Assessment and Audit**  
**Course Code: PZ20S2**

No of credits	Marks
2	100

**Learning Objectives**

1. To demonstrate the students the importance of EIA and environmental audits.
2. To develop the skill to assess and audit the impact of environmental pollution.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	define activities involved in Environmental Auditing, Environmental protection and project proposals.	PSO - 1	R
CO - 2	describe the impact of proposed developments on natural and man-made environment.	PSO - 4	U
CO - 3	develop cognitive, technical and creative skills which enable students for life-long learning and participate in environmental protection and conservation activities for sustainable environment and gain employability.	PSO - 2	Ap
CO - 4	formulate hypotheses and test them by designing appropriate experiments, analyze, interpret the data and communicate the results through effective written and oral communication.	PSO - 3	An

**UNIT I**

**Introduction to Environmental Impact Assessment(EIA) and Audit:** Environment and Industries, Input information, Plant operation, Environmental Management planning, Waste Streams impact on water bodies.

**UNIT II**

**Environmental Impact Assessment planning:** Activities, Methodology for Environmental Impact Assessment, Role of Environmental Engineering firm, Role of Regulatory agencies and control boards, Role of the Public.

### UNIT III

**Environmental Audit:** Introduction, Environmental information Purpose and advantage of studies, General approach of environmental Auditing Environmental Audit, Audit programs in India, Auditing program in major polluting Industries, Reports of the Environmental audit studies.

### UNIT IV

**Pollution prevention and control laws and acts:** Constitution of India and environment, Environment laws, Administrative and legislative arrangement for Environmental protection, Indian Standards, Pollution control acts in India, critical appraisal, fiscal incentives for environmental protection.

### UNIT V

**Environmental Projects:** Guidelines of preparation of project report and its evaluation, methods of clearance from the concerned authorities at various levels.

### Reference Books

1. Prabu, PC., Udayasoorian and G. Balasuramanian (2009). *An Introduction to Ecology and Environmental Science*. Delhi: Avinash Paperbacks.
2. Biswarup Mukherjee (2011). *Environmental Biology and Toxicology*. Faridabad: Silver Line Publications.
3. Santosh Kumar Garg, Rajeshwari Garg and Ranjini Garg (2007). Delhi: Khanna Publishers.
4. Hunt D. Johnson C (1995). *Environmental Management Systems*. London: McGraw Hill.
5. International Chamber of Commerce (1991). *ICC Guide to Effective Environmental Auditing*. Paris: ICC Publication No 483.

## Value Added Course

### Techniques in Biology

Course Code: VACPZ1

Total Number of Hours	Theory Hours	Training Hours
30	10	20

#### Learning Objective

1. To enable the students to understand the working principles of instruments used in biological investigations.
2. To enhance the skills to use the tools and techniques in biology.

#### Course Outcomes

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	outline the principles and working mechanism of specific tools and techniques.	PSO - 1	R
CO - 2	explain laboratory procedures, methods, and instrumentation for biological studies.	PSO - 1	U
CO - 3	analyze assumed hypotheses and execute experiments by selecting the appropriate research techniques.	PSO - 2	An
CO - 4	apply relevant techniques to address medical, social and environmental problems.	PSO - 4	Ap

#### Unit I

**pH Meter and Centrifuge:** Principle, Instrumentation and application of pH Meter and centrifuge.

#### Unit II

**Spectrophotometer and Semi-autoanalyser:** Principle, Instrumentation, applications of spectrophotometer and semi-autoanalyser.

#### Unit III

**Chromatography:** Principle, Instrumentation of Chromatography - Thin Layer, Column and High Performance Liquid Chromatography.

#### Unit IV

**Electrophoresis:** Principle, Methods and Application of Polyacrylamide gel Electrophoresis and Agarose gel Electrophoresis.

#### Unit V

**Microscopy:** Working Principle of microscopes - compound, phase contrast, fluorescence. Photomicrography.

#### Reference Books

1. Veerakumari, L. (2006). *Bioinstrumentation*. Chennai: MJP Publishers.
2. Gurumani. N. (2006). *Research Methodology for Biological Sciences*. Chennai: MJP Publishers.