



# Avinashilingam Institute for Home Science and Higher Education for Women

(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)

Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC

Coimbatore - 641 043, Tamil Nadu, India

## Department of Zoology

### M.Sc., Zoology

#### Programme Outcomes:

1. Acquire in-depth knowledge in science, gain technical and experimental skills in Zoology
2. Ability to express complex ideas in projects and research by enhancing the communicative skills
3. Enhance critical thinking by utilizing existing infrastructure to identify the problem and to discover solutions.
4. Building inquisitive skills to combat problems faced in the field of zoology by potential solutions
5. Impart team work skills to achieve shared goals in an effective manner
6. Capacity to identify resources required for a project and execute the project to completion by appropriate rules and regulations
7. Successful cope up with modern scientific trends through digital literacy to handle biological data.
8. Strengthen the ethical values to develop personal, professional and research ethics.
9. Imbibe a self-paced and self-directed learning ability to carry out independent research.
10. Identify the individual's entrepreneurial skills in life sciences.

#### Programme Specific Outcomes:

1. Understand the fundamentals and application oriented knowledge in zoology.
2. Create graduates in the fields of zoological sciences to develop innovative products for societal approaches.
3. Expand entrepreneurial opportunities in zoological sciences and train students to clear competitive exams at national level.

#### Scheme of instruction and examinations (For students admitted from 2023-2024 & onwards)

Part	Subject Code	Name of paper/component	Hours of instruction/week		Scheme of examination				
			Theory	Practical	Duration of exam	CIA	CE	Total	Credit
First Semester									
I	23MZOC01	Functional Morphology of Invertebrates	5	-	3	40	60	100	4
	23MZOC02	Functional Morphology of Vertebrates	5	-	3	40	60	100	4

	23MZOC03	Cell and Molecular Biology	5	-	3	40	60	100	4
	23MZOC04	Genetics	5	-	3	40	60	100	4
	23MZOC05	Practicals I – Invertebrates and Vertebrates	-	3	3	40	60	100	4
	23MZOC06	Practicals II – Cell and Molecular Biology and Genetics	-	5	3	40	60	100	4
<b>II</b>		<b>CSS/ Adult Education / Community Engagement and Social Responsibility</b>	2	-	-	-	-	-	-
<b>Second Semester</b>									
<b>I</b>	23MZOC07	Biochemistry	4	-	3	40	60	100	4
	23MZOC08	Animal Physiology and Endocrinology	5	-	3	40	60	100	4
	23MZOC09	Developmental Zoology	5	-	3	40	60	100	4
	23MZOC10	Bioinformatics	4	-	3	40	60	100	4
	23MZOC11	Practicals III –Biochemistry, Animal Physiology, Endocrinology, Developmental Biology and Bioinformatics	-	5	5	40	60	100	4
	23MZOC12	Mini Project	-	1	-	100	-	100	2
		Interdisciplinary Course	4	-	3	40	60	100	4
<b>II</b>	23MXCSS1/ 23MXAED1/ 23MXCSR1	<b>CSS/ Adult Education / Community Engagement and Social Responsibility</b>	2	-	-	-	-	100	2
		Professional Certification course	-	-	-	-	-	-	2
<b>Internship during summer vacation for one month</b>									
<b>Third Semester</b>									
<b>I</b>	23MZOC13	Environmental Biology and Toxicology (Open Book)	4	-	3	100	-	100	4
	23MZOC14	Microbiology	4	-	3	40	60	100	4
	23MZOC15	Immunology	4	-	3	40	60	100	4
	23MZOC16	Biotechnology	4	-	3	40	60	100	4
	23MZOC17	Evolution	4	-	3	40	60	100	4
	23MZOC18	Practicals IV –Microbiology, Immunology and Biotechnology	-	3	5	40	60	100	4
	23MZOC19	Economic Zoology (Self Study)	1	-	3	40	60	100	4
		Multidisciplinary Course	2	-	-	100	-	100	2
<b>II</b>	23MZOC20	Internship	-	-	-	100	-	100	2

I	23MZOC21	Biostatistics and Thesis Writing	4	-	3	40	60	100	4
	23MZOC22	Research Project	-	26	-	100	100	200	8

**Total credits -98**

**Other course to be undergone by the students**

MOOC course - 2 to 4 credits

Minimum 98 + 2 credits to earn the degree

**Other courses offered by the department**

**Interdisciplinary Course - 23MZOI01 – Entrepreneurial Avenues in Zoology**

**Multidisciplinary Course - 23MZOM01 – Conservation of Fauna**

**Professional Certification Course - 23MZOPC1- Conservation Biology**

## Functional Morphology of Invertebrates

Semester I  
23MZOC01

Hours of Instruction / week: 5  
No. of credits: 4

### Course Objectives:

1. To make students to understand
2. The systems of classification and morphology of invertebrates
3. The symmetry and coelom of the invertebrates and their significance

Unit 1.	<b>General principles of Animal Taxonomy</b> Definition of taxonomy, Biological classification (artificial, natural and phylogenetic)-Nomenclature-Rules of Binomial nomenclature- Hierarchy of categories-Systematics-Numerical taxonomy- New trends in taxonomy-Species concept-Typological, Nominalistic and Biological species concept-Ecospecies, Coenospecies and super species-Grade of organization - *Symmetry-Coelom-Metamerism.	20hrs
Unit 2.	<b>Locomotion and feeding</b> Locomotion by Pseudopodia, Flagella, Cilia, Undulation, Buoyancy -Hydrostatic movement in hydra and star fish. * Feeding: Patterns of feeding-Filter feeding in Polychaetes, Molluscs and Echinoderms, Deposit Feeding, Ram Feeding.	15 hrs
Unit 3.	<b>Respiration and circulation</b> Organs of respiration: Gills (Crustacea), lungs (Pila), and trachea (Insecta)- respiratory pigments - Mechanism of respiration;Circulation – Cyclosis (Paramecium), Diffusion (Sponge) *Open circulatory system (Cockroach) and closed circulatory system (Neries).	10 hrs
Unit 4.	<b>Nervous system and sense organs</b> Primitive nervous system in Coelenterata and Echinodermata; Advanced nervous system in Annelida, Arthropoda (Crustacea and Insecta) and Molluca (Cephalopoda)- Trends in neural evolution. *Sense organs: Simple and Compound eye, statocyst and osphradium, nuchal organs, tactile and olfactory receptors	15 hrs
Unit 5.	<b>Excretion and Reproduction</b> Organs of excretion - coelom, coelomoducts, nephridia, green glands and Malphigian tubules - Mechanisms of excretion and Osmoregulation. Reproduction: Asexual (Paramecium), Alternation of generation (Obelia), sexual (Fasciola and Nereis). *Larval forms of free living invertebrates and parasites- Strategies and evolution significance of larval forms.	15 hrs

\*Self study

**Total Hours: 75**

### Text Books:

1. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.

3. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002). The Invertebrates: a Synthesis, Blackwell Publishing
4. Ekambaranatha Ayyar.(2002) Manual of Zoology, Vol (I).Invertebrates, S.Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
5. Jordan E L.(2010).Text book of Invertrabrate Zoology. S Chand and Company Ltd,New Delhi.
6. Kotpal RL.(2014). Modern Text Book of Zoology, Invertebrates (9<sup>th</sup> Edition) Rastogi Publications, Meerut.

**Reference Books:**

1. Barnes RSK, Calow P, Olive PJW, Golding DW, Spicer JI.(2002). The Invertebrates: A New Synthesis. 3<sup>rd</sup> Edition. Blackwell Science, USA.
2. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
3. Eisenhour, David, Allan Larson, Susan Keen, Larry Roberts, Cleveland Hickman Jr. 2014. Animal Diversity. Boston: McGraw-Hill International.
4. Ruppert, Fox and Barness. (2015).Invertebrate Zoology: A Functional Evolutionary Approach, 7<sup>th</sup> Edition, Cengage India.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.

**Course Outcomes:**

1. Able to understand the fundamental principles of systematics.
2. Compare and understand the specific characteristics within each phyla.
3. Understand and communicate the major evolutionary significance in invertebrates.
4. Elucidate the functional significance of associated morphologies and behaviour.
5. Explicate economic importance of invertebrates.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	L	H	H	L	H	L	H	H	H
CO 2	H	H	H	H	L	H	H	H	L	M	H	H	H
CO 3	H	H	H	H	H	M	H	L	H	H	H	M	H
CO 4	H	H	H	H	M	H	H	L	L	L	H	H	H
CO 5	H	H	H	H	L	L	H	M	L	H	H	H	H

## Functional Morphology of Vertebrates

Semester I  
23MZOC02

Hours of instruction / week: 5  
No of credits: 4

### Course Objectives:

1. To know the principles of vertebrate classification
2. To understand the evolution of organ systems
3. To understand the distinctive characteristics of major vertebrate groups,

Unit 1.	<b>Outline classification of Vertebrates upto orders with examples</b> Taxonomy- Principles of Taxonomy*Super class Pisces and super class Tetrapoda - Comparative anatomy of Vertebrates	10hrs
Unit 2.	<b>Vertebrate integument and its derivatives</b> General structure and functions of skin and *its derivatives - Glands, Scales, Horns, Claws, nails, hoofs, feathers and hairs, Economic importance of vertebrates	15 hrs
Unit 3.	<b>Circulatory and Respiratory systems in Vertebrates</b> Composition and functions of blood, lymph, coagulation, cardiac cycle and its regulation in Vertebrates – Evolution of heart and aortic arches and portal systems *Respiration – Internal and external respiration, Respiratory organs and Types of respiration, accessory respiratory organs – Gill, Cutaneous, Buccal, Pulmonary and Diaphragmatic.	20 hrs
Unit 4.	<b>Nervous system</b> Comparative anatomy of the brain in relation to its functions; Nerves– cranial and peripheral nerves - *Autonomous nervous system,neuromuscular junction in vertebrates	15 hrs
Unit 5.	<b>Urinogenital system in Vertebrate</b> Types and Functions of Kidneys- Pro, Meso and Meta nephric kidneys Reproductive system, *Male and Female Gonads and Gono ducts - accessory reproductive glands, parental care of vertebrates *Self Study	15hrs

**Total Hours: 75**

### Text Books:

1. Kotpal RL. (2005).Modern text book of Zoology- Vertebrates, Rastogi publications, Meerut.
2. David Randall and Kathleen French (2001). Eckert Animal Physiology. W.H.Freeman & Co Ltd; 5th Edition
3. EkambaranathaAyyar. (2005). Manual of Zoology, Vol. II, Vertebrates, S.Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai
4. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw-Hill.
5. Kotpal, R.L. 2015. Modern Text Book of Zoology – Vertebrates. Meerut: Rastogi Publications

**Reference books:**

1. Kingsley JS. (2010). Text book of vertebrate Zoology, New York, H.Holt.
2. Kim B, Susan B, Jason Y, Heddwen B (2019). Ganong's Review of Medical Physiology, McGraw-Hill Education / Medical; 26th edition
3. Kotpal RL. (2020 – 21). Modern Text Book of Zoology, Vertebrates (5<sup>th</sup> Edition) Rastogi Publications, Meerut,
4. Liem, Karel F., William E. Bemis, Warren F. Walker, Lance Grande, 2001. Functional Anatomy of the Vertebrates: An Evolutionary Perspective. Brooks Cole; 784 pages
5. Kotpal, R.L. 2017. A Text Book of Animal Diversity. Meerut: Rastogi Publications.

**Course Outcomes:**

1. Understand the unique features, taxonomy and functional morphology of different classes of vertebrates.
2. Explore the role of integument and its derivatives in major vertebrates groups.
3. Knowledge of evolution of heart and lungs of vertebrates.
4. Compare the anatomy of vertebrate nervous system in perception to phylogenetic evolution.
5. Explore the structure and function of specific organization of vertebrates.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	M	H	H	H	M	H	H	H	H	H
CO 2	H	M	H	M	H	H	H	M	H	H	H	H	H
CO 3	H	M	H	M	H	H	H	M	H	L	H	M	H
CO 4	H	L	L	L	H	H	H	M	H	L	H	H	H
CO 5	H	M	H	M	H	H	H	M	H	H	H	H	H

## Cell and Molecular Biology

Semester I  
23MZOC03

Hours of Instruction/week : 5  
No. of credits : 4

### Course Objectives:

1. To understand structural and functional components of the cell
2. To elucidate molecular mechanism of cell functioning
3. To Illustrate process of proteins synthesis and regulation of gene expression

- Unit 1. **Membrane structure and cell signalling** 15 hrs  
Structure of model 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. Cell surface receptors- signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signaling pathways.
- Unit 2. **Cell division and structural organization** 15 hrs  
Strategies of cell division- Mitosis and meiosis, central cell cycle control system- cell cycle check points- cyclin and cyclin dependent kinases –control of cell cycle.  
Structural organization and function of intracellular organelles-Nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, Protein sorting & targeting. cytoskeleton and its role.
- Unit 3. **Cancer cells and DNA replication, repair and recombination** 15 hrs  
Cancer and the cell cycle- interaction of cancer cells with normal cells, apoptosis and therapeutic interventions of uncontrolled cell growth.  
Replication- enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.
- Unit 4. **RNA synthesis and processing** 15 hrs  
Transcription factors and machinery- formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, poly adenylation, structure and function of different types of RNA, RNA transport.
- Unit 5. **Regulation of gene expression** 15 hrs  
Regulation of gene expression in prokaryotes – Operon model in prokaryotes – Lac operon hypothesis – types of control of Operons, \*Regulation of gene expression in Eukaryotes-Genomic level-Transcription level-Processing of RNA transcript-Transport of RNA out of nucleus-Translation of mRNA. Post-translational modification of proteins.

\* Self study

**Total Hours: 75**



**Text Books:**

1. Petter JR (2016). Genetics- A Molecular Approach, Third edition, Pearson Education, New Delhi.
2. Channarayappa. (2010). Cell biology, First edition, Orient Black Swan/ University Press, New Delhi.
3. Janet I, Wallace M. Karp.(2018). Cell and Molecular Biology-Concepts and Experiments, Eighth Edn. John Wiley & sons Inc., USA.

**Reference Books:**

1. David C, Nanette P, Michelle M (2019). Molecular Biology, Third Edn, Academic cell, Elsevier.
2. Veer Bala Rastogi (2007). Molecular Biology, Kedarnath Ram Nath publishers, Meerut (UP), India.
3. Ajoy Paul (2009). Text book of Cell and Molecular Biology, Second Edn, Books and Allied (P) Ltd, Kolkata, India.
4. Veer Bala Rastogi (2010). Introduction to cytology, revised edition, Kedarnath Ram Nath publishers, Meerut (UP), India.
5. Verma PS, Agarwal VK.. (2006). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Company Ltd., New Delhi.
6. Cooper GM. (2007). The cell – A molecular approach, Second Edn, ASM press, The American Society for Microbiology, USA.

**Course Outcomes:**

1. Able to describe transport across cell, cell-cell communication and mechanisms of signal transduction.
2. Outline the processes that control eukaryotic cell cycle.
3. Conceptualize and describe vesicular trafficking of secretory proteins and cell secretions.
4. Represent and illustrate the structural organization of genes and the control of gene expression.
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems.

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	L	M	H	H	H	M	H	M	H
CO 2	H	M	H	M	L	M	H	H	H	M	H	M	H
CO 3	H	M	H	H	M	M	H	H	H	H	H	L	H
CO 4	M	M	H	M	M	M	H	H	H	M	H	H	H
CO 5	M	M	H	M	L	M	H	H	H	H	H	H	H

## Genetics

Semester I  
23MZOC04

Hours of Instruction/week : 5  
No. of credits : 4

### Course Objectives:

To facilitate the students

1. To understand the basic principles of Genetics
2. To know about the applied aspects of Genetics
3. To learn and apply concepts of modern transmission and molecular genetics

Unit 1.	<b>Mendelian principles</b> : Dominance, segregation, independent assortment* Mendelian traits in man. <b>Modifications of Mendelian principles</b> : Codominance, incomplete dominance, gene interactions, pleiotropy, Complementary, Supplementary, Epistatic, Lethal and cumulative genes- genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.	20 hrs
Unit 2.	<b>Concept of gene</b> : Allele, multiple alleles, ABO blood group and Rh factor, isoallele and pseudoallele, <b>Gene mapping methods</b> : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. <b>Organelle inheritance</b> : Extra nuclear inheritance – Shell coiling in snails, inheritance of kappa particles in Paramecium, Sigma particles in Drosophila. Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance*	20 hrs
Unit 3.	<b>Sex determination and Human Genetics</b> Genetic, hormonal, metabolic and environmentally controlled sex determining mechanism Human chromosomes- Classification and Identification – Lyons hypothesis – Barr body and heterochromatin- Autosomal and sex chromosomal abnormalities in man – Amniocentesis- Chromosomal aberrations - Pedigree charts – lod score for linkage testing, Eugenics and genetic counselling - Human genome project*	15 hrs
Unit 4.	<b>Population and Applied Genetics</b> Gene pool and gene frequencies – equilibrium of gene frequencies – Hardy- Weinberg equilibrium – Rate of changes in gene frequencies through natural selection Animal Breeding – History, Aims, Methods – Inbreeding, Outbreeding and hybrid vigour*	10 hrs
Unit 5.	<b>Regulation of gene expression and Microbial Genetics</b> Concept of operon of bacteria and bacteriophages. Utility of the model organisms: <i>Escherichia coli</i> , <i>Arabidopsis thaliana</i> , <i>Caenorhabditis elegans</i> , <i>Drosophila melanogaster</i> & <i>Mus musculus</i> . <b>Methods of genetic transfers</b> - Transformation - Transduction and sexduction, - Specialized and generalized- Conjugation – F <sup>+</sup> X F <sup>-</sup> mating, HFr conjugation, F <sup>I</sup> conjugation, Transposons- Discovery, Characteristics, types of transposable elements - Ac and Dc elements, Retrotransposons, IS Elements*. *Self Study	10 hrs
		<b>Total Hours: 75</b>

### Text books

1. Strickberger MW. (2012). Genetics (Macmillan). Prentice Hall of India Pvt Ltd. New Delhi.
2. Verma PS. Agarwal VK. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Company, 2<sup>nd</sup> edition, New Delhi.

## References

1. Gardner EJ. Simmons MJ. Snustad DP. Principles of Genetics. VIII Edition. Wiley India 2008.
2. Snustad DP. Simmons MJ. Principles of Genetics. V Edition. John Wiley and Sons Inc 2009.
3. Klug WS. Cummings MR. Spencer CA. Concepts of Genetics. X Edition. Benjamin Cummings 2012.
4. Russell PJ. Genetics- A Molecular Approach. III Edition. Benjamin Cummings 2009.
5. Griffiths AJF. Wessler SR. Lewontin RC. Carroll SB. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co 2007.
6. Fletcher H. Hickey I. Genetics. IV Edition. GS, Taylor and Francis Group, New York and London 2015.

## Course Outcomes:

1. Comprehensive, detailed understanding of the chemical basis of heredity
2. Understand and describe the mechanisms that underpin biological inheritance
3. Acquire the knowledge to design, execute, and analyze the results of genetic experimentation in animal, plant model systems and human being.
4. Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.
5. Construct relevant, targeted and comprehensive personal and family histories and pedigrees and integrate genetic testing options in genetic counselling practice

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3
CO 1	H	H	L	M	L	-	H	M	H	-	H	H	H
CO 2	H	H	H	H	M	H	H	H	H	M	H	H	H
CO 3	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H

## Practicals I-Invertebrates and Vertebrates

Semester I  
23MZOC05

Hours of instruction / week: 3  
No of credits: 4

### Course Objectives:

1. To learn computer aided Simulated animal dissection
2. To study the representative organisms of each phylum of both invertebrates and vertebrates
3. To observe the birds and other animals from their natural habitats through field visits

**Invertebrate** Simulated animal dissections available on invertebrates 3 Hrs

**Five representative organisms for each phylum** 8 Hrs

- I. Amoeba, Paramecium, Plasmodium, Euglena and Balantidium
- II. Leucosolenia, Hyalonema, Euplectela, Spicules and Gemmule of Sponge
- III. Hydra, Obelia colony and medusa, Sea anemone, Madrepora and Tubipora
- IV. Fasciola, Planaria, *Taeniasolium* Bipalium and Ascaris,
- V. Neries, Chaetopterus, Megasclex, Arenicola and Polygordius
- VI. Daphnia, Cyclops, Naupilus, Centipede and Peripatus
- VII. Fresh water mussel, Mytilus, Octopus, Sepia and Pila
- VIII. Starfish, Sea urchin, Cucumaria, Thyone and Ophiothrix

T.S. of sponge – T.S. of Hydra 3 Hrs

T.S. of liver fluke – T.S. of Nereis larval forms 3 Hrs

**Vertebrates** Simulated animal dissections of shark and frog 6 Hrs

**Five representative organisms for each Phylum** 8 hrs

- I. Amphioxus, Suckerfish, Mullet, Mugil and Arius
- II. Cacapus, Rana hexadactyla, Ichthyophis, Alytes and Rhacophorus
- III. Calotes, Chameleon, Draco, Viper and Cobra
- IV. Pigeon, Woodpecker, Crane, Partridge and King fisher
- V. Bat, Loris, Pig embryo, Rabbit embryo and Sheep embryo
- VI. Mounting the slides of Planktons and Paramecium
- VII. Preparation of 5 permanent slides practical work done during the semester at the time of practical examination

**Field Visit** 14 Hrs

- Visit to zoos and national park
- Visit to Salim Ali centre for ornithology
- Visit to Sanctuaries

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

**Total Hours: 45**

### Course Outcomes:

1. Introducing the structure, function and behaviour of select invertebrate types through the observation of simulated animal dissections.
2. Reinforcing basic laboratory skills including microscopy, simulated animal dissection and careful observation
3. Providing with the ability to recognize the major groups of invertebrate
4. Record the fauna of different phylum and families through the visit to Gass Museum
5. Study the keys for the identification of bird watching through the visits to Salim Ali centre for ornithology and Silent valley

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	H	M	H	M	H	H	H	H	H
CO 2	H	H	H	H	H	L	H	M	H	H	H	H	H
CO 3	H	H	M	H	H	L	H	M	H	H	H	H	H
CO 4	H	H	H	H	H	M	M	H	M	M	H	H	H
CO 5	H	H	H	H	H	M	M	H	M	M	H	H	H

## Practicals II-Cell and Molecular Biology and Genetics

Semester I  
23MZOC06

Hours of Instruction/week : 5  
No. of credits : 4

### Course Objectives:

1. To acquire skills in squash preparation, permanent slides and staining.
2. To develop practical skills in the advanced techniques of Molecular Biology
3. To enable the use of model organisms in understanding the genetic principles.

<b>Cell Biology</b>	Slides on tissues – Epithelial, connective, bone, muscular and germ cells	5 hrs
	Preparation of Squamous epithelial cells	3 hrs
	Cell size determination using micrometer	3 hrs
	Squash preparation of onion root tip and observation of mitotic stages	3 hrs
	Meiosis in cockroach testis	3 hrs
	Study of giant chromosomes in Chironomous larva and micrometric measurements of Puffs	3 hrs
	Separation of lymphocytes using histopaque	5 hrs
	Haemolysis	3 hrs
	<b>Histology:</b> Fixation, dehydration, embedding, sectioning, staining and permanent mounting of tissues - Submission of 5 best slides for Exam evaluation	16 hrs
<b>Molecular Biology</b>	Isolation and estimation of DNA from onion	5 hrs
	Isolation of plasmid DNA from bacteria	5 hrs
	Restriction endonuclease digestion of DNA	5 hrs
	PAGE - separation and molecular weight determination of proteins.	5 hrs
<b>Genetics</b>	Culture of <i>Drosophila</i> and <i>Caenorhabditiselegans</i> –model organism	5 hrs
	Identification of phenotypic traits in <i>Drosophila</i>	3 hrs
	Study of various genetic traits in man	3 hrs

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

**Total Hours: 75**

### Course Outcomes:

1. Understand transport across cell, cell-cell communication and mechanisms of signal transduction.
2. Outline the processes that control eukaryotic cell cycle.
3. Conceptualize and describe vesicular trafficking of secretory proteins and cell secretions.
4. Represent and illustrate the structural organization of genes and the control of gene expression
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	H	M	M	H	L	H	M	M	L	H	H	H
CO 2	M	H	M	H	H	M	H	M	H	L	H	H	H
CO 3	M	H	H	M	H	L	H	M	H	L	H	H	H
CO 4	M	H	M	H	H	M	H	M	H	L	H	H	H
CO 5	M	H	H	M	H	H	H	M	M	L	H	H	H

## Biochemistry

Semester II  
23MZOC07

Hours of instruction / week: 4  
No of credits: 4

### Course Objectives:

1. To understand the chemical basis of life.
2. To study the structure, metabolism and biological significance of biomolecules
3. To enable students to understand the basic principles, working mechanism and applications of biochemical techniques

Unit 1.	<b>Principles of biophysical chemistry</b> <b>Bioenergetics</b> – Concept of free energy, endergonic and exergonic reactions, Relationship between free energy, enthalpy and entropy, laws of thermodynamics, Redox potential, High energy compounds, biological significance of ATP and cyclic AMP* <b>Biological Oxidation</b> – Enzymes involved in biological oxidation, Electron transport chain - Components and structural organisation of electron transport, Oxidative phosphorylation- Chemiosmotic hypothesis, Uncoupling of oxidative phosphorylation, mitochondrial transport systems - malate/glycerol phosphate shuttle.	8 Hrs
Unit 2.	<b>Carbohydrates and Lipids</b> <b>Carbohydrates</b> – Classification, structure and functions - Monosaccharides, Disaccharides, Polysaccharides - Homo and hetero polysaccharides. Metabolism – Glycolysis, TCA cycle, HMP shunt, gluconeogenesis, glycogenesis, glycogenolysis, gluconeogenesis <b>Lipids</b> - Classification, structure and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, lipoproteins and steroids. Metabolism - Biosynthesis of fatty acids, $\beta$ oxidation of fatty acids, ketogenesis*	12Hrs
Unit 3.	<b>Amino acids, Proteins and Enzymes</b> <b>Amino acids</b> - Structure, classification and properties Metabolism - Transamination, deamination and decarboxylation, urea cycle, inborn errors of metabolism. <b>Proteins</b> - Classification, levels of protein structure, bonds related to protein structure - Conformation of proteins by Ramachandran plot, domains, motif and folds* <b>Enzymes</b> – Characteristics, Structure, Nomenclature, Classification, Active site, Mechanism of enzyme action, Factors affecting enzyme action, Enzyme inhibition.	12Hrs
Unit 4.	<b>Biochemical techniques I</b> Electrochemical techniques – Determination of pH by hydrogen electrode and glass electrode, Buffer systems of body fluids and pH maintenance* Centrifugation – Principle, types and applications of preparative and analytical ultracentrifuges Chromatography – Principle, methodology and applications of thin layer, adsorption and gas liquid chromatography	15Hrs

**Unit 5. Biochemical techniques II**

13 Hrs

Spectroscopy – Principle, Beer and Lamberts law, types of spectra – absorbance, emission and fluorescence, Types of spectroscopy – Principle, instrumentation and applications of UV-visible spectroscopy, atomic absorption spectroscopy\*  
Electrophoresis – Principles, methodology and applications of agarose gel electrophoresis and poly acrylamide gel electrophoresis

**\*Self-Study**

**Total Hours: 60**

**Text Books:**

1. Rodwell V.W., Bender D.A., Botham K.M., Kennelly P.J., Weil P (2018). Harper's Illustrated Biochemistry, 31st edition. Tata McGraw Hill Companies Publication, New Delhi.
2. Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, Eighth edition, W.H. Freeman and Company, New York.
3. Berg, J.M., Tymoczko, J.L., Gatto, G.J. and Stryer, L. (2021) Biochemistry, Eighth edition, W.H. Freeman and Company, New York.
4. Satyanarayana, U. and Chakrapani, U. (2013). Biochemistry, Seventh Edition, Books and Allied Pvt. Ltd., Kolkatta and Elsevier, New Delhi.
5. Wilson K and Walker J. (2018) Practical Biochemistry – Principles and Techniques, Eighth Edition, Cambridge University Press, India

**Reference Books:**

1. Berg JM, Tymoczko JL, Stryer L. (2012), Biochemistry, Seventh Edition, W.H. Freeman & Company, New York.
2. Voet, D., Voet, D.J. and Pratt, C.W. (2013). Fundamentals of Biochemistry – Life at molecular level, Fourth edition, John Wiley and Sons Inc., New York.
3. Rodney Boyer (2006). Concepts in Biochemistry, Third Edition, John Wiley and Sons Inc., United States
4. Zubay, G. (2017), Biochemistry, 4<sup>th</sup> edition, McGraw-Hill Publication, New Delhi.

**Course Outcomes:**

1. Impart knowledge on the biochemical concepts of bioenergetics
2. Gain perception on the basic structure and functions of biomolecules
3. Ability to grasp insight on metabolic pathway and able to relate with well being
4. Understand fundamental concepts on enzymes and their importance in biological reactions
5. Acquire information on the principles and practical experience of a wide range of biochemical techniques.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	L	L	L	L	H	L	L	L	H	M	H
CO 2	H	M	H	M	M	H	H	H	H	H	H	M	H
CO 3	H	M	H	M	M	H	H	H	H	H	H	H	H
CO 4	H	H	H	M	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	M	H	H	H	H	H	H	H	H	H



## Animal Physiology and Endocrinology

Semester II  
23MZOC08

Hours of Instruction/week : 5  
No. of credits : 4

### Course Objectives:

1. To enable the students to understand the functions of various systems of animal body with special reference to mammals
2. Know about the role of various hormones in coordination of activities of biological systems in animals.
3. To understand and evaluate biological processes, behavioural states and animal response to different biological, social and environmental stimuli.

Unit 1.	<b>Digestive system, Circulatory and Excretory system</b> Digestive glands in a mammal –Digestion*,BMR, Blood and Lymph composition, plasma proteins, coagulation and erythropoiesis, blood volume regulation - Heart – myogenic heart, origin and conduction of cardiac impulse- ECG – Endocytosis and exocytosis in excretion -Ultra structure of Nephron – formation and concentration of urine, micturition, Electrolyte and acid base balance	15hrs
Unit 2.	<b>Respiratory, Nervous system and Sense organ</b> Respiratory pigments-Blood gas transport-Respiratory quotient – Regulation of respiration. Structure and functions of Nervous tissue-Reflex action- Conduction of nerve impulse- Autonomic nervous system, Morphology and physiology of sense organs –vision, hearing, gustation, olfaction and tactile*-	20hrs
Unit 3.	<b>Skeletal and Muscular system,Communication and Animal behaviour</b> Anatomy and physiology of axial and appendicular skeleton- Properties and mechanism of contraction of muscles -Biochemistry of muscles - Neuro muscular junction Bioluminescence-Pheromones -Biological rhythm-Circadian and Circannual rhythm-Orientation and navigation*	10hrs
Unit 4.	<b>Endocrine glands</b> Structure and functions of endocrine glands in Mammals – Pituitary – hypothalamus-Thyroid-Parathyroid–Pancreas-Adrenal and Prostaglandins* Thermo regulation – comfort zone, body temperature, physical, chemical and neural regulation, acclimatization	15hrs
Unit 5.	<b>Hormonal Control</b> Ovarian cycle, Menstrual cycle and Physiology of pregnancy, Hormonal regulation of male and female reproduction, Hormonal control of Gastric metabolism Neuroendocrine systems in Crustacea and Insecta - Hormone Analogue and its applications*- Genetic disorders due to hormonal imbalance *Self study	15hrs

**Total Hours: 75**

**Text books**

1. Rastogi SC. (2007).Essentials of Animal Physiology, New Age International, New Delhi, India.
2. Verma PS. Agarwal VK and Tyagi BS. (2010).Animal Physiology. S. Chand Publishers India

**Reference books:**

1. Christopher D. and Moyes. (2015).Principles of Animal Physiology. 3<sup>rd</sup> Edition, Pearson Publishers, U.S.
2. Arora MP. (2017).Animal Physiology. 7<sup>th</sup> Edition. Himalaya Publishing House, India.
3. Hadley. (2009).Endocrinology. George Bell Publishers, England .
4. Dharmalingam.(2010).Textbook of Endocrinology. Jaypee Medical PU, New Delhi, India.
5. Sherwood L. Klandorf H. and Yancey PH. (2008).Text Book of Animal Physiology. Cengage Learning India Pvt., Ltd.
6. HillR W. Wyse GA. and Anderson M. (2008).Animal Physiology. 2nd Ed., Sinauer Associates, Inc Publisher, Massachusetts.
7. Moyes CD. and Schulte PM. (2007). Principles of Animal Physiology. Pearson Education, Dorling Kindersley Publication. New Delhi.
8. Guyton AC. (2007).Textbook of Medical Physiology. W.B. Saunders Company, Philadelphia, London, Toronto and IgakuShoin/Saunders (Tokyo).

**Course Outcomes:**

- 1 Understand the physiological systems and their specific functions
- 2 Gain knowledge on the interactions and interdependence of physiological and biochemical processes
- 3 Be able to know the transfer of information from one group of animals to other using signals
- 4 Learn generously the life supporting properties and regulation of biological processes in the body from conception through adulthood by the endocrine glands.
- 5 Understanding of factors influencing the adaptations and responses of organisms to particular environment.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	H	H	H	H	H	H	H	H	H
CO 2	H	H	H	H	H	H	H	M	H	M	H	H	H
CO 3	H	H	H	H	H	H	H	H	H	M	H	H	H
CO 4	H	H	H	H	H	H	H	H	L	L	H	H	H
CO 5	H	M	M	M	M	M	H	H	H	M	H	H	H

**Course Objectives:**

1. To understand the basic principles of growth and development
2. To understand the general concept of ontogeny development
3. To understand the metamorphosis and assisted reproductive techniques

Unit 1	<b>Spermatogenesis and Oogenesis</b> Origin of primordial germ cells-spermatogenesis process-sertoli cells-spermatogenesis- hormonal regulations, gene expression and control-structure and biochemistry of spermatozoa.Process of Oogenesis – Development during Oogenesis*- Vitellogenesis- egg maturation – egg cortex organization of the egg	15 hrs
Unit 2	<b>Fertilization, cleavage and Gastrulation</b> Mechanism of fertilization – biochemical aspects of cleavage –molecular changes during cleavage – morphogenetic movements*- cell adhesion molecules and pattern formation. Fate Maps	15 hrs
Unit 3.	<b>Nucleus and cytoplasm in development</b> Nuclear control of development - enucleation experiments - nuclear transplantation* - cytoplasmic determinants – cytoplasmic control of nucleus during development.	15 hrs
Unit 4.	<b>Induction competence and differentiation</b> Concept of organizer –embryonic induction – types – properties, role and chemical nature of induction-concept of competence – differentiation of embryonic cells* – stem cells- concept of determination.	15 hrs
Unit 5.:	<b>Metamorphosis, Regeneration and Human development</b> Types and hormonal mechanism of metamorphosis in amphibians – regeneration process–histological changes–metaplasia–puberty –menstrual cycle –implantation – parturition –birth defects and surrogacy and ethical laws, test tube baby* * Self study	15 hrs

**Total Hours: 75**

**Text Books:**

1. Muneesh Kaint. (2013) Text Book of Chordate Embryology. Wisdom Press, First edition, New Delhi, India.
2. Morgan. TH. (2010). Embryology and Genetics. Agro House Behind Nasrani Cinema. Fourth edition, Jodhpur, India.
3. Veer Bala Rastogi. (2010). Chordate Embryology. KedarNath RamNath publication, New Delhi, India.

**Reference Books:**

1. Scott F. Gilbert, Karen Knisely.(2010.) Developmental Biology- A Student Handbook in Writing in Biology, Third Ed, Sinauer Associates Incorporated, India.
2. Lewis Wolpert (2011). Developmental Biology: A Very Short Introduction. Oxford University Press, First edition.
3. Abhilash Jain. (2010).Advanced developmental Biology. Campus Books International, first edition , New Delhi, India.

**Course Outcomes:**

1. Compare and contrast the developmental stages amongst the variety of animal phyla.
2. Understand the mechanism of fertilization, cleavage and gastrulation.
3. Describe the cellular control in the development of the embryo
4. Knowledge on the potential role of stem cells and its research applications
5. Understand the human menstrual cycle, implantation, parturition, birth defects and test tube baby

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	L	H	H	L	L	H	L	H
CO 2	H	H	H	H	M	L	H	L	L	L	H	L	H
CO 3	H	H	M	L	L	L	H	L	M	L	H	M	H
CO 4	H	H	H	H	H	H	H	H	H	L	H	H	H
CO 5	H	H	M	H	H	H	H	H	H	L	H	H	H

## Bioinformatics

Semester II  
23MZOC10

Hours of Instruction/week : 4  
No. of credits : 4

### Course Objectives:

1. To outline fundamentals of bioinformatics principles
2. To use bioinformatics tools to compare and analyse nucleic acids and protein databases
3. To explain functional genomics and the features of model organisms

Unit 1.	<b>Biological databases</b> <b>Introduction to Bioinformatics:</b> Definition - goals - applications; Central Bioinformatics Resources and Access Information: NCBI - EMBL-EBI; <b>Biological databases:</b> Nucleotide sequence database (GenBank, EMBL-Bank, DDBJ) - Protein database (UniProtKB, PIR, PDB, InterPro, Pfam, PRINTS, SCOP and CATH) - Specialised database (OMIM, GEO, ENA, KEGG, and PubMed); Biodiversity and ecosystem based databases. <b>Sequence format:</b> GenBank format - <b>FASTA format*</b> . Applications of bioinformatics: Clinical informatics, Cheminformatic resources and pharmacoinformatics.	12 hrs
Unit 2.	<b>Sequence analysis</b> <b>Molecular sequence alignment:</b> Importance - homology - similarity - identity - Gaps; <b>Scoring matrices:</b> PAM - <b>BLOSUM*</b> ; <b>Pairwise sequence Alignment methods:</b> DotPlot - Dynamic Programming method (Global and Local alignment) - Heuristic method (FASTA and BLAST); <b>Multiple sequence alignment and Phylogeny:</b> CLUSTALW - phylogenetic tree building.	12 hrs
Unit 3.	<b>Genomics</b> <b>Gene and Genome analysis:</b> differences between Eukaryotes, Bacteria, Archaea and viral genome - <b>Human Genome project*</b> - UCSC Genome Browser - ENCODE - Noncoding and repetitive DNA sequences - Finding genes in genome (GENCODE) - SNPs - <b>Next Generation Sequencing:</b> Overview of Techniques - Data analysis - Applications.	12 hrs
Unit 4.	<b>Proteomics</b> <b>Protein sequencing:</b> Gel electrophoresis - <b>MALDI-TOF*</b> ; <b>Protein analysis:</b> ExPASy tools - protein property prediction; <b>Protein structure prediction:</b> Ramachandran plot - homology modelling - Threading - <i>Ab Initio</i> prediction - structure validation - structure visualization tools; Application in Modern drug discovery process.	12 hrs
Unit 5.	<b>Functional genomics</b> <b>Genome expression:</b> SAGE - Microarray - RNA-seq; <b>microarray data analysis:</b> GOR2 - Descriptive statistics methods; Protein-Protein interaction - Yeast Two-Hybrid System - Protein Networks - Cytoscape; <b>Model organisms:</b> E. coli - <i>Arabidopsis thaliana</i> - Yeast - <i>Coenorhabditiselegans</i> - Drosophila - <b>Zebra fish*</b> - Mouse	12 hrs

**Total Hours: 60**

\*Self study

**Text Books:**

1. Xiong J. (2006). Essential Bioinformatics, Cambridge University Press.
2. Attwood TK, Parry DJ.(2005). Introduction to Bioinformatics, Pearson Education Singapore Pvt. Ltd.
3. Rastogi SC, Rastogi P, Mendiratta N. (2013). Bioinformatics Methods and Applications: Genomics Proteomics and Drug Discovery, 4<sup>th</sup>Edn, PHI Learning Pvt. Ltd.

**Reference Books:**

1. Richard S L, Tudor I O. (2019).Bioinformatics and Drug Discovery- Methods in Molecular Biology, 3<sup>rd</sup>Edn, Springer New York.
2. Pevsner J. (2019).Bioinformatics and functional genomics, 3<sup>rd</sup>edn, Wiley India exclusive.
3. Rui R, Xuegong Z, Michael QZ. (2013).Basic bioinformatics, Springer.
4. Chandarsekar M, Ratankumar C, Mirasif I. (2018). Basic applied bioinformatics, 1stEdn, John Wiley& sons.
5. Baxevanis AD, Ouellette BF. (2005).Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3<sup>rd</sup> Edn., Wiley Interscience, Hoboken, NJ.
6. Mount DW. (2004).Bioinformatics: Sequence and Genome Analysis, 2nd Edn, Cold Spring Harbor Laboratory Press, New York.
7. Campbell AM,HeyerLJ.(2004).Discovering Genomics, Proteomics& Bioinformatics.2<sup>nd</sup>Edn. Pearson Education, New Delhi.
8. Pennington SR, Dunn MJ. (2002).Proteomics: from Protein Sequence to function. BIOS Scientific Publishers, Oxford.
9. Sensen CW.( 2002). Essentials of Genomics and Proteomics. Wiley-VCH.
10. Kothekar V. (2004). Introduction to Bioinformatics – An ideal book for beginners in Bioinformatics, First edition, Dhruv Publications, NewDelhi.

**Course Outcomes:**

1. Locate and use the main databases at the NCBI and EBI resources and know the difference between databases, tools, repositories and be able to use each one to extract specific information
2. Extract data from specific databases using accessions numbers and gene names
3. Able to perform simple genome sequence analyses using existing tools
4. Interpret correctly the outputs from tools used to analyse biological data and make meaningful predictions from these outputs.
5. Able to describe and comprehend the fundamental concepts of molecular modelling and computational driven drug discovery

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	L	H	M	H	H	H	L	L	H	H	H	H
CO 2	H	M	M	H	L	H	M	L	M	L	H	H	H
CO 3	M	L	H	M	M	L	H	L	L	H	H	H	H
CO 4	H	H	M	M	L	M	M	L	H	M	H	H	H
CO 5	H	M	M	H	L	H	H	L	H	L	H	H	H

## Practicals III - Biochemistry, Animal Physiology, Endocrinology, Developmental Biology and Bioinformatics

Semester II  
23MZOC11

Hours of instruction / week: 5  
No of credits: 4

### Course Objectives:

1. Able to demonstrate an understanding of fundamental bio chemical principles
2. To understand the general concept of endocrine glands
3. To understand the application of Developmental Zoology.

I. Biological Chemistry	Estimation of protein in fish sample	3hrs
	Estimation of carbohydrates in fish sample	3hrs
	Estimation of fat in fish sample	3hrs
II. Animal Physiology & Endocrinology	Salivary amylase activity in relation to pH	3 hrs
	Hemoglobin estimation	2 hrs
	Preparation of haemin crystals	3 hrs
	Preparation of human blood smear	3hrs
	Enumeration of RBC and WBC using haemocytometer	3hrs
	Excretory products of animals	3hrs
	Effect of salinity on the metabolic rate of fish	3hrs
	Effect of thyroxine on the oxygen consumption fish	5 hrs
	Slides on histology of endocrine glands	3hrs
	Adrenal gland	
	Pancreas T.S	
	Pituitary gland	
	Thyroid gland	
	Thymus gland	
	Adrenal gland	2hrs
III. Developmental Biology	Study of permanent histological sections of mammalianoesophagus, stomach, duodenum, rectum, lung, adrenal, kidney, thyroid, pancreas, testis, ovary.	
	Slides on Frog Embryology	10 hrs
	T.S. of ovary	
	Cleavage - 2 cell, 4 cell, 8 cell and 32 cell stages	
	Blastula-Gastrula – olk plug stage, Neural plate, Neural fold, Neural tube	
	Tadpole – 4mm, 7mm, 10mm	
IV. Bioinformatics	Slides on chick embryology - Chick embryo - 18h, 24h, 36h, 48h, 72h and 96h	10 hrs
	1.Search engines & important sites viz., NCBI, EBI, Swiss-Prot	2 hrs
	2.Format, distinguishing features, Uses and Applications of biological databases such viz., EMBL, DDBJ, GenBank, UniProt, PIR, TrEMBL, Prosite, PRINT, Pfam, BLOCK, PDB, KEGG, OMIM, PUBMED	2 hrs
	3.Use of BLAST and its variants (especially PSI-BLAST) for the identification of very similar and divergent sequences	2 hrs
	4.Multiple sequence alignment using Clustal W and preparation of simple phylogenetic trees using Tree View	2 hrs
	5. Detection of general signals, regulatory regions and promoter prediction	2 hrs

- |  |       |
|--|-------|
| 6. Secondary structure prediction using various available tools                            | 2 hrs |
| 7. Tertiary structure and function prediction using homology modeling and ab initio method | 2 hrs |
| 8. Visualization of 3D protein structure –Rasmol-Swiss PDB viewer                          | 2 hrs |

The candidate should submit a certified bonafide record of practical work done during the semester at the time of practical examination

**Total Hours: 75**

**Reference Books:**

1. Christopher D, Moyes. (2015). Principles of Animal Physiology. 3<sup>rd</sup> Edition, Pearson Publishers, U.S.
2. MuneeshKainth. (2013). Text Book of Chordate Embryology. Wisdom Press. 1<sup>st</sup> Edition, New Delhi, India.
3. Lewis Wolpert. (2011). Developmental Biology: A Very Short Introduction. Oxford University Press; 1st edition.
4. David Hames and Nigel Hopper. (2010). Biochemistry Taylor and Francis Publication Pvt. Ltd.
5. Dharmalingam. (2010). Textbook of Endocrinology, Jaypee Medical PU, New Delhi, India.
6. Sathyanarayana U. (2005). Biochemistry Book & Allied (p) Ltd. Kolkata.

**Course Outcomes:**

- 1 Assess the estimation of protein, carbohydrate and fat using fundamental biochemical principles.
- 2 Estimation of different physiological systems and their specific functions.
- 3 Identify the factors influencing the responses of organisms.
- 4 Describe fundamental concept of molecular mechanisms of embryological stages
- 5 Basic concepts of Bioinformatics and its significance in biological data analysis.

O/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	M	H	H	H	M	M	L	H	H	H
CO 2	H	H	M	M	H	H	H	M	M	L	H	H	H
CO 3	H	H	M	H	H	H	H	M	L	L	H	H	H
CO 4	H	H	M	M	H	M	H	M	L	L	H	H	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H



**Environmental Biology and Toxicology**  
(Open book)

Semester III  
23MZOC13

Hours of Instruction / week: 4  
No of credits: 4

**Course objectives:**

1. To understand the various factors of environment
2. To know about the strategies for disaster management
3. To learn about the implications of environment on human health and social issues
4. To have knowledge about environmental toxicants and their hazards

Unit 1	<b>Introduction to Environmental Studies and Biodiversity</b> Definition – Types of environment – Natural resources- forest, water, mineral, food and energy. <b>Biodiversity:</b> Classification – Values of biodiversity – Biodiversity at global level, Hot spots, Biogeographical classification of India, India mega biodiversity Nation- endangered and endemic species of India-Threats of biodiversity& Conservation.	12hrs
Unit 2	<b>Population Ecology and Human Health</b> - Density, natality, mortality, life tables, fecundity tables, survivorship curves. Unique and group attributes of population: mortality, age ratio, sex ratio, dispersal. Factors regulating population dispersal and growth: Exponential and logistic growth. Population explosion. Public health- Value education, HIV/AIDS- Human rights.	12hrs
Unit 3	<b>Social Issues and Disaster management</b> Sustainable development- Urban problem related to energy – Water management and conservation, Resettlement and rehabilitation of people, Environmental ethics, Climate change, Wasteland reclamation, Consumerism, Environmental Protection Acts. <b>Disaster management</b> – Definition, cause and mitigation measures for Flood, Earth quake, Tsunami, Cyclone and Land slide.	12hrs
Unit 4	<b>Environmental Toxicants and Health hazards</b> Survey of environmental toxicants – pesticides, automobile emissions, heavy metals, fertilizers, food additives, radioactive substances, accumulation of toxic residues in organisms — routes of entry, absorption, distribution, excretion and biotransformation of toxicants, mode of action, dose response relationship, teratogens, carcinogens, mutagens, safety evaluation of toxicants, role of LC <sub>50</sub>	12hrs
Unit 5	<b>Case studies:</b> <i>In situ</i> and <i>Ex situ</i> conservation of Indian animals: Population management - Project Tiger and Elephant - Captive breeding programme- Public participation in conservation – Poaching of wild animals – Man animal conflict Cauvery Water dispute - Heavy metals in water and soil, Bioaccumulation of toxicants, Mining and quarrying in India - Survey of food additives – Pesticides in food commodities- Fuel conservation.	12hrs

**Total Hours: 60**

**Text Books:**

1. Verma PS and Agarwal VK. (2018). Cell biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand and Company Ltd New Delhi.
2. Kapoor M. (2009). Disaster Management. Motilal Banarsidass Publishers Private Ltd New

Delhi.

3. Raman Sivakumar. (2010). Environmental Science & Engineering. Tata McGraw Hill Education Private Ltd

**Reference books:**

1. Primack RB. (2010). Essentials of Conservation Biology. Sinauer Associates: USA
2. Mittermeier RA, Meyers PR, Gil and. Mittermeier CG. (2000). Hotspots: Earth's biologically richest and most endangered Terrestrial Ecoregions. Cemex/Conservation International USA

**Course outcomes:**

1. Learn about the complexity of natural resources and understand the conservation strategies of biodiversity
2. Reflect critically on their roles, responsibilities and identities as citizens, consumers and environmental actors in a complex interconnected world.
3. Develop a critical understanding of the social environment and Indian constitutional provisions concerning environmental protection.
4. Demonstrate the core concept of toxicology and identify the contemporary issues in toxicology
5. Appreciate the ethical, cross-cultural and historical context of environmental issues and application of ecological and physical sciences in environmental problem solving.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	H	L	H	H	H	M	H
CO 2	H	H	H	H	H	H	H	H	H	H	H	M	H
CO 3	M	H	H	H	H	H	H	L	H	M	H	M	H
CO 4	H	H	H	H	H	H	H	H	H	H	H	M	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H

## Microbiology

Semester III  
23MZOC14

Hours of instruction / week: 4  
No of credits: 4

### Course objectives:

1. To recognize the similarities and differences between microbial groups
2. To enable the students to know the biology and pathogenesis of infectious diseases
3. To understand the role of microbes in various fields

Unit 1	<b>Microbial Taxonomy</b> History – Contributors to Microbiology, Scope of Microbiology*, Classification of microbial kingdom, Structure and outline classification of bacteria, fungi and virus	12 hrs
Unit 2	<b>Methods in Microbiology</b> Sterilization techniques - Physical and Chemical, Culture media – Types and Preparation, Methods of growing microbes, Cultivation of aerobes – Batch and continuous culture, Anaerobes- Gas Pack method, Methods of isolation and maintenance of pure culture, Identification of bacteria, Nutritional requirements for microbes, Growth curve of microbe, Factors affecting microbial growth, Measurements of microbial growth*	12 hrs
Unit 3	<b>Industrial Microbiology</b> Bioprocessing, Fermentors- Types, Functions, Design and Operation, Microbial selection, Types of Fermentation-Submerged, Solid and Surface type, <b>Stages in fermentation</b> - Upstream and Downstream Processing, Strain Improvement, Fermented products- Single Cell Protein, Wine, Citric acid*	12 hrs
Unit 4	<b>Environmental Microbiology</b> Bioremediation - Criteria for bioremediation, Bioremediation techniques, Methods for removal of pollutants (heavy metals), Biosorption – Mechanism of biosorption, Types of biosorbents, Factors affecting biosorption, Desorption and recovery, Advantages and disadvantages, Large scale industrial effluent treatment, Bioindicators*	12 hrs
Unit 5	<b>Medical Microbiology</b> Microbial Infection – Routes of infection, types of infection, types of infectious diseases, microbe – host interaction, Approaches in diagnosis Bacteria – <i>Staphylococcus aureus</i> , <i>Salmonella typhi</i> , <i>Mycobacterium tuberculosis</i> , <i>Treponema palladium</i> Fungus - Mycoses – Superficial –Dermatophytoses, Subcutaneous – Mycetoma, Systemic– Histoplasmosis, Opportunistic –Candidiasis Virus – Herpes virus, Hepatitis virus, Rabies virus, Human Immuno Virus* * Self study	12 hrs
<b>Total Hours: 60</b>		

**Text Books:**

1. Chess B. and Talaro KP(2021).Talaro's Foundations in Microbiology, 11<sup>th</sup> Edition, Mc-Graw – Hill Publishing Company Ltd., New Delhi .
2. Willey J, Sherwood L, WoolvertonCJ, (2016). Prescott's Microbiology, 10<sup>th</sup> Edition, Mc-Graw – Hill Publishing Company Ltd., New Delhi.
3. Ananthanarayan R, Paniker CKJ (2013). Ananthanarayan and Paniker's Textbook of Microbiology, 9<sup>th</sup> Edition, University Press, Hyderabad

**Reference Books:**

1. Micheal J, Pelzar JR, Chan ECS, Krieg NR (2009). Microbiology, 10<sup>th</sup> Edition, Tata Mc-Graw – Hill Publishing Company Ltd., New Delhi.
2. Dubey R and Maheshwari DK (2022). A text book of Microbiology, S. Chand and Company Ltd., New Delhi.
3. Rajan R (2007).Medical Microbiology, First Edition, MJP Publishers, Chennai,.
4. Casida, J.R. (2009). Industrial Microbiology, Fifth Edition, New Age International Publishers, New York.

**Course Outcomes:**

1. Gain knowledge on microbial diversity and its significance
2. Apply culture techniques in clinical and research problems
3. Describe the importance of microbes in industrial sector
4. Acquaint the interaction between microbes and environment for sustainable development
5. Identify the integral role of microbes in pathogenesis and its control measures

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	H	H	M	M	M	M	M	H	M	H	H	H
CO 2	H	H	H	H	M	H	M	H	H	H	H	H	H
CO 3	M	H	H	M	H	H	M	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	M	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	M	H	H	H	H	H	H

## Immunology

Semester III  
23MZOC15

Hours of Instruction / week: 4  
No of credits: 4

### Course objectives:

1. To outline the key components of the innate and adaptive immune responses
2. Define the cellular/ molecular pathways of humoral /cell-mediated immune response
3. Be able to acquaint with immune system of our body

Unit 1.	<b>Introduction to Immunology</b> <b>Types of immunity</b> -Innate and Acquired immunity, Ultra structure and functions of primary and secondary lymphoid organs, Cell types - origin and differentiation of B and T cells-specific functions.	12 hrs
Unit 2.	<b>Antigens and Immunogens</b> <b>Antigens</b> - essential features, epitopes, classes of antigens, <b>Immunoglobulins</b> - 3D structure-classes- antigenic determinants- class switching-generation of antibody diversity, <b>antigen-antibody interaction</b> - affinity, avidity, cross reactivity, precipitation and agglutination reaction, radio immuno assay, ELISA, immuno fluorescence. Application of Immunological techniques in disease diagnosis.Tracer techniques: Principle and Applications, Unit of radioactivity, half-life and measurement of radioactivity.	12 hrs
Unit 3.	<b>Immune response</b> <b>Immune response</b> - antigen recognition- processing and presentation-interaction of T and B cells – <b>cell mediated and humoral immunity</b> - cytokines and immune response –immunological memory, <b>hypersensitivity reaction</b> - type 1, type 2, type 3 and type 4 reactions, immuno deficiency diseases,Immunological tolerance	12 hrs
Unit 4.	<b>MHC and Complements</b> <b>Major Histocompatibility Complex</b> : structure of MHC molecules –types - MHC and antigen presentation, <b>Complements</b> - classical and alternative pathways and immunological significance	12 hrs
Unit 5.	<b>Transplantation and tumour immunology</b> <b>Transplantation immunology</b> : HLA typing-immunology of graft rejection-immuno suppressive therapy, <b>Tumour immunology</b> - tumour antigen, immunity against cancer, cancer immuno therapy, <b>Auto immunity</b> - organ specific and systemic auto immune diseases, <b>Immuno prophylaxis</b> - active immunization-recent approaches to vaccine production- passive immunization.	12 hrs

**Total Hours : 60**

### Text Books:

1. Kuby J. (2007).Immunology, 7th edition, W. H. Freeman and Co, New York.
2. Benjamini E, Coico R, Geoffrey S. (2000).Immunology- A short course, 4<sup>th</sup> Edition, John Willey Inc., New York.
3. Roitt I, Brostoff J, Male D. (2002). Immunology, 7<sup>th</sup> edition, Mosby Publishers, London.

**Reference Books:**

1. Tizard IR.( 1995). Immunology- an introduction, 4th Edn., Saunders College Publishing, Philadelphia.
2. Chakravarty AK. (2006). Immunology and Immunotechnology. Oxford University Press. New Delhi,.
3. Banarjee A, Nirmala B.(2008). Fundamentals of Microbiology and Immunology, 2<sup>nd</sup> Edition, New central Book Agency, Kolkata.
4. Murphy K, Travers P, Walport M. (2007). Immunology, 7<sup>th</sup> edition, Garland Science, UK.
5. David M, Jonathan B, David BR, Roitt IM.(2013). Immunology, 8<sup>th</sup> Edition, Elsevier- Saunders publications, UK.
6. Subash CP(2012). Text Book of Microbiology and Immunology, 2<sup>nd</sup> Edn, Elsevier India.

**Course Outcomes:**

1. Describe the cell types and organs that are involved in immune response
2. Apply immunological techniques to solve certain clinical and research problems
3. Able to differentiate between various types of hypersensitivity reactions
4. Identify the main mechanisms of immune tolerance and autoimmunity
5. Explain adverse functions of these cellular and molecular components during abnormal circumstances

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	L	L	H	H	H	H	H	H	H
CO 2	M	M	H	H	H	M	H	M	H	M	H	H	H
CO 3	M	M	M	H	H	L	M	H	H	L	H	H	H
CO 4	H	H	H	M	M	L	H	M	M	L	H	H	H
CO 5	M	H	M	H	M	M	H	M	H	M	H	H	H

## Biotechnology

Semester III  
23MZOC16

Hours of instruction/week: 4  
No of credits: 4

### Course objectives:

1. To enable the student to learn the recent advances in Biotechnology
2. To learn the application of r-DNA technology
3. To develop practical knowledge and acquire analytical skills.

<b>Unit 1</b>	<b>Introduction –Scope and importance of biotechnology</b> <b>Enzymes in genetic engineering-</b> Basic principles and Enzymology, Genetic engineering. Basic steps of gene cloning, DNA manipulative enzymes. Exonucleases, Endonucleases, Restriction Endonuclease and it's types*, S1 Nuclease, DNA ligase, Alkaline phosphatase, Reverse transcriptase, DNA Polymerase, Methyl transferase, Polynucleotide kinase, Terminal transferase	12 hrs
<b>Unit 2</b>	<b>Vectors in gene cloning</b> – Cloning vehicles, Plasmids, Bacteriophages, Cosmids, Phagemids, Yeast artificial chromosomes, Bacterial artificial chromosomes, expression vectors, shuttle vectors, Transposons. Gene cloning strategies, Preparation of rDNA and its introduction into host cells - Transformation, conjugation, electroporation, microinjection, transduction, direct gene transfer, agroinfection, liposome fusion, biolistics*.	12 hrs
<b>Unit 3</b>	<b>Identification of recombinants:</b> Restriction enzyme analysis, Southern blotting, Northern blotting, In-situ hybridisation, DNA Sequencing, PCR, Primer-design, and RT- (Reverse transcription) PCR. DNA Probes, RFLP, RAPD*.Encoding genetic information, Decoding the codons : the role of transfer RNAs.Construction and analysis of gene libraries, site directed mutagenesis.	12 hrs
<b>Unit 4</b>	<b>Animal Biotechnology-</b> Facilities for animal cell culture - Sterilization- Media Preparation- Physico- chemical properties of culture media – Types of media – Balanced salt solutions – complete culture media - Serum free medium-Characterization of cultured cells – Primary cell culture – Techniques for primary cell culture – Cell lines and its types – Subculture and its types- stem cells and its types*. Applications, advantages and disadvantages of animal tissue culture.	12 hrs
<b>Unit 5</b>	<b>Applications of biotechnology in human welfare –</b>  Tissue plasminogen activator, Erythropoietin, interferon's – recombinant vaccines- Monoclonal antibodies –Gene therapy-Transgenic animals -Ethical issues related to transgenic animals.Genetically Modified Microorganisms (GEMOs) – Gene Therapy Biotechnology and Bio-safety operation guidelines and regulations. Intellectual property right and protection* –Forms of protection, General Agreement of Tariffs and Trade (GATT) and Trade Related IPR's (TRIPs), Patenting of biological Materials - significance.	12 hrs

**Text Books:**

1. Nita Verma.(2013). Biotechnology, 1<sup>st</sup> edition, PACIFIC publication, New Delhi
2. Prakash S Lohar. (2012). Text book of Biotechnology, 1<sup>st</sup> edition, MJP publishers, Chennai
3. Sobti RC, Suparna S. Pachauri. (2009). Essentials of Biotechnology, 1<sup>st</sup> edition. Ane Books Pvt. Ltd, Chennai, New Delhi, Mumbai
4. Dubey RC. (2006). A textbook of Biotechnology, S.Chand and Company Ltd., New Delhi.
5. Satyanarayan,U. Chakrapani.U (2010). Biotechnology, 2<sup>nd</sup> edition ArunabhaSen publisher, Kolkata.

**Reference Books:**

1. Glick BR, Pasternak JJ, Patten CL. (2010).Molecular Biotechnology: Principles and Applications of Recombinant DNA, Fourth edition, ASM Press, Canada
2. Ponmurugan P, GangatharaPrabhuB. (2012). "Biotechniques". 1st edition. MJP publishers, Chennai, New Delhi

**Course Outcomes:**

1. Understand the tools and techniques in rDNA technology and its applications
2. To understand the theoretical and experimental implications of vectors in research and gene cloning
3. Provide the ability to decipher, evaluate and understand data generated from biotechnology-based assays
4. Comprehend fundamental concepts and principles of establishing animal cell culture
5. Understand the importance of patent laws and intellectual property rights

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	M	M	L	M	H	L	M	L	H	H	H
CO 2	H	M	H	H	H	M	H	M	H	M	H	H	H
CO 3	H	M	H	H	H	H	H	L	H	M	H	H	H
CO 4	H	H	H	M	M	M	M	L	H	M	H	H	H
CO 5	H	H	M	M	L	H	M	M	H	M	H	H	H



## Evolution

Semester III

Hours of instruction / week: 4

23MZOC17

No of credits : 4

### Course objectives

1. To facilitate the students
2. To understand the basic principles of Evolution
3. To know about the origin of life and theories of Evolution

#### Unit 1. **Origin of life and evolutionary concept**

Concept and evidence of evolution-morphology, comparative, embryology and paleontology anatomy. Theories of Evolution- Lamarkism, Darwinism, Devries mutation theory and Modern theory. Origin of life-Oparin theory, Prebiotic synthesis and Biological evolution-origin of coacervates, Protocells.

12hrs

#### Unit 2. **Mechanism of Evolution**

Variation- Types of variation-Isolation- Premating and Post mating mechanism -Hardy Weinberg's law of equilibrium and significance-Natural selection-Types-Polymorphism-Types and significance -Molecular evolution - Evolution of Protein. Molecular evolution and phylogenetics: molecular clocks; rates of evolution; Species concepts and speciation; phylogenetic reconstruction; Neutral theory; molecular systematics.

12hrs

#### Unit 3. **Consequences of Evolution**

Adaptation – Types of adaptation, Divergent and Convergent of Evolution, Structural adaptations- Classification of adaptations, Mimicry- protection, aggressive and conscious mimicry, Protective coloration- \*Biological significance of colours.

12hrs

#### Unit 4. **Paleontology and Behavioral evolution**

Paleontology-Classification of rocks-Fossils- Types, Formation, dating and significance. Geological time scale- Eras- Periods – Epoch. Behavioral evolution- \*Group selection, Altruism, Kin selection and Sexual selection

12hrs

#### Unit 5. **Human evolution and Philosophical issues**

History of primates, significant stages in evolution of man , Comparison between humans and other primates – Fossil and Genetic evidence of origin of modern man.\*Cultural evolution and Evolutionary future of mankind.

12hrs

\*Self study

**Total Hours: 60**

### Text Books:

1. Brian K, Hall, Benedikt Hall grímsson. Stirricker's (2014). Evolution, 5<sup>th</sup> Edition, Jones and Bartlett India Pvt. Ltd. Publishers.
2. Veer Bala Rastogi. (2014). Organic Evolution, 12<sup>th</sup> Revised Edition, Kedarnath Ram Nath Publishers, Meerut.
3. Rao CV. (2005). Human evolution and its uniqueness, Atlantic Publishers and distributors, New Delhi.
4. Verma PS, Agarwal VK. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Second Edition, S. Chand Company Ltd, New Delhi.

**Reference Books:**

1. Franklin Shull A. (2008). Evolution, Second Edition, J.V. Publishing House, Jodhpur.
2. Mark Ridley. (2004). Evolution, Third edition, Blackwell Science Ltd, USA.
3. Gould SJ. (2002). The structure of evolutionary theory. Harvard University Press, Cambridge,

**Course Outcomes:**

1. Understand the contemporary observations of biological evolution
2. Knowledge and skills in Phylogenetic analysis and related to *molecular evolution*
3. Analyze the role of pattern, adaptive features of consequences of evolution.
4. Acquire evolutionary information of the fossil record
5. Investigate the evolutionary basis of behavior in primates and man.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	M	H	H	M	H	H	H	M	H
CO 2	H	H	L	M	M	H	H	H	H	M	H	M	H
CO 3	H	H	L	H	L	H	H	H	H	M	H	M	H
CO 4	H	H	L	M	M	H	H	M	H	H	H	M	H
CO 5	H	H	M	M	L	H	H	M	H	M	H	M	H

## Practicals IV- Microbiology, Immunology and Biotechnology

Semester III  
23MZOC18

Hours of instruction / week: 3

No of credits: 4

### Course objectives:

1. To understand the biochemical aspects of microorganisms
2. To enable the students to know the molecular based techniques
3. To describe the biotechnological techniques in research problems

### Microbiology

1	Methods of growing microbes –Agar, Broth, Slant, Stab culture	2 Hrs
2	Techniques for pure culture of microbes – Spread, pour and streak plate methods	3 Hrs
3	Isolation and enumeration of microbes from soil, water and air.	3Hrs
4	Identification of bacteria by Gram and Negative staining	3Hrs
5	Biochemical tests – Indole, Methyl red, Voges Proskauer, Citrate Utilization, Catalase and Starch Hydrolysis Tests	3Hrs
6	Identification of fungi by lacto phenol cotton blue staining	2Hrs
7	Determination of Microbial growth – Turbidity method	3Hrs
8	Production of Wine	2Hrs
9	Bioremediation of industrial effluent/ sewage water using biosorbents	2Hrs
10	Antibiotic sensitivity test	3Hrs

### Immunology

11	Haemagglutination	2Hrs
12	Single radial Immunodiffusion technique	3Hrs
13	Enzyme Linked Immunosorbent Assay	2Hrs

### Biotechnology

14	Isolation and estimation of DNA from goat liver	3Hrs
15	Agarose Gel Electrophoresis of DNA	3Hrs
16	Polymerase Chain Reaction for amplification of DNA (Demonstration)	3Hrs
17	Restriction digestion of DNA	3Hrs

**Total Hours: 45**

### Course Outcomes:

1. Able to isolate and identify microbes
2. Analyze the pathogenicity of disease causing microorganisms
3. Execute immunological techniques to solve clinical problems
4. Assess the bio sorbents that clean environment
5. Apply biotechnological methods in research sectors

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	H	H	H	M	M	L	L	H	H	H
CO 2	H	M	H	H	H	H	M	M	M	L	H	H	H
CO 3	M	M	H	H	H	H	M	M	H	M	H	H	H
CO 4	H	M	H	H	H	H	H	M	H	H	H	H	H
CO 5	H	M	H	H	H	H	M	M	H	L	H	H	H

## Economic Zoology (Self-study)

Semester III  
23MZOC19

Hours of instruction/week: 1  
No of credits: 4

### Course objectives:

1. To disseminate information on economic aspects of Zoology
2. To inculcate knowledge on useful animals to man kind
3. To understand the modern techniques of animal culture

<b>Unit 1</b>	<b>Apiculture</b> Life history of honey bee, kinds of honey bees- natural hives- Artificial hive – Newton's hive and other appliances-Diseases and Enemies: Diseases and enemies- control and preventive measures.Bee Economy: Products of apiculture industry and its uses (honey, bees wax, propolis, pollen)	3 hrs
<b>Unit 2</b>	<b>Sericulture</b> Life cycle and rearing of silkworm moth ( <i>Bombyxmori</i> ), Silkworm rearing technology: Early age and Late age rearing- Types of mountages Spinning- harvesting and storage of cocoons.Diseases- Protozoan, bacterial, fungal & viral- setting up of a sericulture unit.	3 hrs
<b>Unit 3</b>	<b>Pisciculture</b> Cultivable species of fishes in India –construction of a pond – polyculture- Sewage fed fish culture – induced breeding.Fish diseases: Bacterial- viral – parasitic.	3 hrs
<b>Unit 4</b>	<b>Vermiculture</b> Cultivable species of earthworm – vermi composting methods – conditions required for vermicomposting – vermicast – vermiwash. Vermicompost Technology: Small Scale Earthworm farming for home gardens- Conventional commercial composting- Earthworm Farming (Vermiculture)- vermicomposting harvest and processing.	3 hrs
<b>Unit 5</b>	<b>Poultry Science</b> Breeds of fowls – the deep litter system – practical aspects of chick rearing – management of growers and layers – feed formulations –Diseases- management vaccines.	3 hrs

**Total Hours: 15**

### Text Books:

1. Upadhyay VB. Economic Zoology. Rastogi Publications, Meerut 2006
2. Yadav, Manju. Economic Zoology. Discovery Publishing House, New Delhi 2003

3. RavindranathanKR. Economic Zoology. Dominant Publishers & Distributors 2003

**Reference Books:**

1. Nigam HC. Modern Trends in Biology & Economic Zoology. Vishal Publ. Co., Jalandhar, Punjab 2006
2. JawaidAhsan, Sinha, SP.A Handbook of Economic Zoology. S. Chand Group Publ., New Delhi 2008.

**Course outcomes:**

1. Apply the knowledge of managing beehives for honey production and marketing
2. Acquire knowledge about the rearing of silkworms and causative agents of silkworm diseases.
3. Understand various methods of aquaculture practices.
4. Role of Vermiculture in protecting the environment and managing the waste
5. Describe poultry breeds and basic concepts related to vaccines.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	M	M	H	H	H	H	H
CO 2	H	H	H	H	H	H	M	M	H	H	H	H	H
CO 3	H	H	H	H	H	M	M	L	H	H	H	H	H
CO 4	H	H	H	H	H	H	M	L	H	H	H	H	H
CO 5	H	H	H	H	H	M	M	M	H	H	H	H	H

## Biostatistics and Thesis Writing

Semester IV  
23MZOC21

Hours of instruction / week:4  
No of credits: 4

### Course objectives:

1. To learn the methods of data collection and the application of statistical methods in solving biological problems
2. To know the principles of research design and thesis writing

#### Unit 1: **Introduction to Statistics**

Statistics –Scope, limitations and applications- primary and secondary data-sources of statistical data- classification and tabulation of data-\*Diagrammatic and Graphical representation of statistical data – line diagram, bar diagrams, pidediagram, pictogram, cartogram, pie chart, line graph, histogram, frequency polygon, frequency distribution, frequency curve and Ogive curve

12 hrs

#### Unit 2: **Descriptive statistics**

Measures of central tendency – \*objectives, mean, median and mode, uses, merits and demerits  
Measures of dispersion – \*objectives, range, quartile deviation, mean deviation, standard deviation, absolute and relative measures of dispersion, uses, merits and demerits  
Correlation and regression analysis - definition, uses, types of correlation, methods of studying correlation – scatter diagram, graphic method, Karl Pearson's coefficient of correlation, rank correlation, concurrent deviation, \*least squares method, regression lines, regression equations, regression coefficients

12 hrs

#### Unit 3: **Sampling and Theoretical Distribution**

Sampling – meaning, advantages, concept of parameter and statistics, sample size, \*sampling error--\*Introduction of probability and its applications-Types of samples – probability samples – simple random sample, stratified random sample, systematic sample, cluster sample, multistage. Non-probability samples– purposive sampling, quota sampling, accidental sampling- Theoretical distributions – Binomial, Poisson and Normal distributions- properties, uses and applications

12 hrs

#### Unit 4: **Testing of Hypothesis**

Testing hypothesis-null hypothesis, alternative hypothesis, student's t- test- Analysis of variance - one way and two way classification- Non-parametric-chi-square test, Kruskal Wallis Test, Sign Test, Wilcoxon signed-rank test and distribution free tests.

12 hrs

**Unit 5: Research Design and Report Writing**

12hrs

Research – knowledge and sciences, types and application, research definition – research design – identifying the problem, reviewing the literature, designing the study – \*chapter outline

Documentation - report writing, presentation, test layout, use of tables and figures, their placement, numbering, foot notes to tables and figures, spacing and alignment, referencing – reference systems, essential information – special capitalization and alphabetical and chronological order, editing and evaluating the final report, \*components of a research thesis. Plagiarism, Plagiarism tool, Research Ethics.

**\*Self study**

**Total Hours: 60****Textbooks:**

1. Veer BalaRastogi.(2015).Biostatistics-Third revised edition,Medtech publications.
2. Agarwal , S,C.(2007). A handbook of fish farming. Narendra pub. House, Delhi.
3. Annadurai,B .(2007). A text book of Biostatistics, New age International Pvt. Ltd Publishers, Chennai.
4. Gurumani ,N.(2006). Research Methodology, MJP publishers, Chennai.
5. Gupta, S,P.(2004). Statistical methods, Sultan Chand and Sons Publishers, New Delhi.

**References Books:**

1. Suresh,K ,Sharma.(2016).Research Methodology & Biostatistics.
2. CharabatyNM, Chakrabaty PP, and S.C.Mondal SC.(2010). Biology, breeding and farming of important food fishes. Narendra pub. House, Delhi.
3. Ronald, N. Forthofer, EunSul Lee.(2010). Introduction to Biostatistics, Elsevier Publications India Pvt. Ltd, New Delhi.
4. Klaynekl Daniel.(2009). Biostatistics, Wiley India Pvt. Ltd., New Delhi.

**Course Outcomes:**

1. Understand the basic concept and applications of biostatistics.
2. Ability to calculate the descriptive statistics and its significance
3. Knowledge on implementation of hypothesis in validating a model.
4. Identify the appropriate hypothesis testing procedure related to variables and samples
5. Interpret current knowledge and skills to new methods in research design and report writing.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	H	H	M	H	L	H	H	H
CO 2	H	H	H	H	H	H	H	L	M	L	H	H	H
CO 3	H	H	H	H	H	H	H	L	M	L	H	H	H
CO 4	H	H	H	H	H	H	H	L	L	L	H	H	H
CO 5	H	H	H	H	H	H	H	M	L	L	H	H	H

