

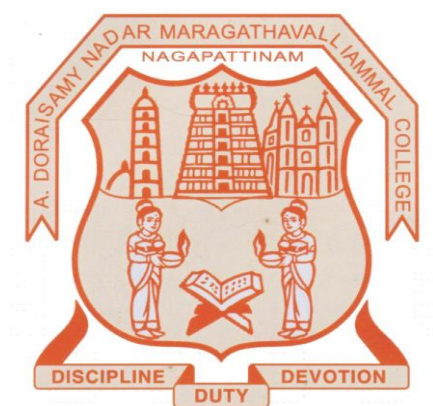
A.D.M.COLLEGE FOR WOMEN (AUTONOMOUS),

NAGAPATTINAM

(Nationally Re-accredited with “A” grade by NAAC-3rd Cycle)

PG & RESEARCH DEPARTMENT OF ZOOLOGY

(for the candidates admitted from the academic year 2019-2020 onwards)



Batch 2019- 21

M.Sc ZOOLOGY

SYLLABUS

A.D.M COLLEGE FOR WOMEN (AUTONOMOUS), NAGAPATTINAM.
M.Sc., Zoology

(for the candidates admitted from the academic year **2019 – 2001** onwards)

PROGRAMME OBJECTIVES:

1. The candidate undertaking this course will gain knowledge about the structure, function, advanced technique, hands on training and acquire skill
2. To gain significant knowledge in various branch of zoology course
3. To acquire research skill, plan & execute experimental technique independently as well as to analyze and interpret data.

STRUCTURE OF THE PROGRAMME 2019-2020

Papers	No	Credit	Marks
Core Course	14	66	1400
Elective Course	5	20	500
Project	1	4	100
Total	20	90	2000

Marks /Papers	C.I.A	S.E
Theory Papers	25	75
Practical Papers	40	60

Passing Minimum

A candidate shall be declared to have passed in each course if she secures not less than 40% marks in the end semester examination and 40% marks in the continuous internal assessment and not less than 50% in the aggregate, taking continuous internal assessment and end semester examination marks together

A.D.M COLLEGE FOR WOMEN (AUTONOMOUS), NAGAPATTINAM.
M.Sc., Zoology- Course Structure under CBCS (90 Credits)
 (applicable to the candidates admitted from the academic year **2019-2020** onwards)

Semester	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Extn.	
I	Core Course – I (CC)	Animal Phylogeny and Biodiversity	6	5	3	25	75	100
	Core Course – II (CC)	Cell and Molecular Biology	6	5	3	25	75	100
	Core Course – III (CC)	Genetics	6	5	3	25	75	100
	Core Course – IV (CC)	Microbiology& Immunology	6	5	3	25	75	100
	Core Course – V (CC)	Practical I (CC I,II,III & IV)	6	4	3	40	60	100
		Total		30	24	*	*	*
II	Core Course – VI (CC)	Developmental Biology	6	5	3	25	75	100
	Core Course – VII (CC)	Biochemistry, Biophysics & Bio techniques	6	5	3	25	75	100
	Core Course – VIII (CC)	Applied Biotechnology	6	5	3	25	75	100
	Core Course – IX (CC)	Practical II (CC VI,VII & VIII)	6	4	3	40	60	100
	Elective – I	Fishery Biology and Fish Processing Technology	6	4	3	25	75	100
		Total		30	23	*	*	*
III	Core Course – X (CC)	Animal Physiology	6	5	3	25	75	100
	Core Course – XI (CC)	Bioinformatics and Computer Applications in Biology	6	5	3	25	75	100
	Core Course – XII (CC)	Practical III (CC X & XI)	6	4	3	40	60	100
	Elective - II	Environmental Toxicology	6	4	3	25	75	100
	Elective – III	Research Methodology and Biostatistics	6	4	3	25	75	100
		Total		30	22	*	*	*
IV	Core Course – XIII (CC)	Environmental Biology& Evolution	6	5	3	25	75	100
	Core Course – XIV	Practical IV (CC XIII)	4	4	3	40	60	100
	Project Work	Dissertation	8	4	-	-	-	100
	Elective – IV	Economic Entomology	6	4	3	25	75	100
	Elective-V	Coastal Aquaculture	6	4	3	25	75	100
		Total		30	21	*	*	*
		Grand Total	120	90	*	*	*	2000

PG & Research Department of Zoology

The Department of Zoology will offer the following Major Elective Courses

1. Fishery Biology and Fish Processing Technology
2. Coastal Aquaculture
3. Bioinformatics
4. Economic Entomology
5. Research Methodology

Note:

Core Courses include Theory, Practical's & Project

No. of Courses	14
Credit per Course	4 - 5
Total Credits	70

Elective Courses

No. of Courses	5
Credit per Course	4
Total Credits	20

	Internal	External
Theory	25	75
Practical's	40	60

Project

Dissertation	80 Marks	[2 reviews – 20+20 Report Valuation	=	40 marks = 40 marks]
Viva	20 Marks			20 marks

Passing Minimum in a Subject		} Aggregate 50%
CIA	40%	
SE	40%	

Programme outcome:

1. Students who graduate with Master of Science in Zoology will:
 2. Obtain a significant knowledge on fundamental and advanced aspects of zoology
 3. Gain in-depth knowledge on different branch of zoology
 4. Gain proficiency in Laboratory techniques of basic zoology and Assimilate technical skill.
 5. Grasp the fundamental concept Animal world
- Job offer: IFS/ZSI/VCRC/ MPEDA/ICMRE/ ICFRE as Research Scientist/ Technical officers

PROGRAMME SPECIFIC OUTCOME:

1. Understand the nature and basic concepts of cell biology, Biochemistry, Taxonomy and ecology and analyze the relationships among animals , plants and microbes.(scientific knowledge).
2. Perform procedures as per laboratory standards in the area of Biochemistry, Biostatistics, Taxonomy, Economic zoology and Ecology and understand the applications of biological sciences in Aquaculture, Pisciculture, Agriculture and Medicine.(Professional skill).
3. The ability to learn about the scientific methods and how it facilitates the discovery of new knowledge in biology. This includes how to critically evaluate hypotheses and conclusions in science using verifiable data and how to clearly and effectively communicate the major concepts and hypotheses in biology in an appropriate style of presentation. (Design/development of Solutions).
4. To acquire basic knowledge and skills in the observation and study of nature , biological techniques, experimental skills and scientific investigation and certain applied branches to enable them for self employment.(Problem-Solving Skills)
5. To train academically sound future researchers and intellectual s in the area of general biology with emphasis in areas on the cutting edge of modern biology , e.g., Molecular biology, Biochemistry, Physiology, Genetics, Cytology and Environmental conservation.. (Successful Career and Entrepreneurship).

Course code & Title	MZA & ANIMAL PHYLOGENY & BIODIVERSITY		
Class	I M.Sc., Zoology	Semester	I
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To give a thorough understanding in the morphology, mode of life of Invertebrates and vertebrate animals. • To acquire an in-depth knowledge on the paleontology in animal world • To develop an holistic appreciation on the phylogeny, relationships and adaptations in animals • To understand endocrine gland and system of its regulation in vertebrates • Learn the physiology of reproductive system in vertebrates and invertebrates. 		
UNIT I	Content	No. of Hours	
	A.INVERTEBRATES Organization Symmetry in animal organization – Asymmetry, radial, biradial and bilateral symmetry Significance. Coelom – Evolution of coelom. Acoelomate, pseudocoelomate, coelomate groups (Schizocoel, Enterocoel, mesenchyme) – Significance. Metamerism – Evolution of metamerism – Pseudometamerism, cyclo metamerism, corn theory, embryological theory – Significance.	18	

	<p>Locomotion Movement in Annelids, Molluscs and Echinoderms.</p> <p>Nutrition: Filter feeding in Polychaetes, Molluscs and Prochordates.</p> <p>Respiration Gills and trachea in Arthropods – Respiration in Molluscs.</p> <p>Circulation Circulation in Arthropods and Molluscs.</p> <p>Phylogeny Phylogeny of phylum Protozoa, Bilateral, Annelida & Mollusca</p>	
<p>II</p>	<p>Excretion Different types of excretory organs in invertebrates – their structure and function.</p> <p>Nervous System Primitive types – Coelenterates and nerve net; advanced types – Nervous system in Annelids, Molluscs and Arthropods.</p> <p>Chemical Co-ordination Endocrine glands in Crustaceans and Insects – Pheromones and allele chemicals.</p>	<p>18</p>
<p>III</p>	<p>Reproduction Pattern of sexual and asexual reproduction – Invertebrate larval forms and their phylogenic significance.(Annelids, Molluscs, Arthropods and Echinoderms.)</p> <p>Invertebrate Fossils Evolutionary trends and phylogenetic importance of Trilobites, Ammonoids, Belemnoids, Nautiloids, Echinoderm fossils.</p> <p>Minor Phyla, Organisation and affinities of 1. Chaetognatha, 2. Rotifera, 3. Sipunculida, 4. Phoronida. Echiura, , Brachipoda, Onychophora</p>	<p>18</p>

<p style="text-align: center;">IV</p>	<p style="text-align: center;">B. CHORDATES</p> <p>A. Comparative study and functional Morphology of vertebrates.</p> <p>Digestive System Alimentary canal and associated glands</p> <p>Respiratory System Gill respiration in cyclostomes and fishes – Pulmonary respiration in tetrapods.</p> <p>Circulatory System Types & evolution of heart and aortic arches.</p> <p>Excretory System Types & evolution of kidneys. Origin of Chordates.</p>	<p style="text-align: center;">18</p>
<p style="text-align: center;">V</p>	<p>Nervous System Brain and spinal cord – cranial nerves, spinal nerves and visceral nerves – Autonomic nervous systems – Sympathetic – Parasympathetic.</p> <p>Reproductive System Reproductive systems – Accessory reproductive glands. Reptiles – origin and adaptive radiation Origin of birds and mammals</p> <p>Vertebrate Fossils Evolutionary significance of Ostracoderms, Placoderms, Crossopterygians, Labyrinthodonts, Dinosaurs, Archaeopteryx and Mesozoic mammals.</p>	<p style="text-align: center;">18</p>
<p>References</p>	<p>Text Books:</p> <p>Invertebrates:</p> <ol style="list-style-type: none"> 1. Barnes, R.D. (2006), Invertebrate Zoology, Cengage Publications. 2. Barrington, E.J.W. (2012), Invertebrate Structure and Functions, East west press Pvt (L)New Delhi. 3. Moore, R.C., Lolicker And Fischer, A.G. (2006), Invertebrate Paleontology, McGraw Hill Book Co., Inc., N.Y. 	

Chordates:

1. Waterman, A.J. (1971), Chordate Structure and Function, The Macmillan Company.

References:**Invertebrates:**

- 1 Gupta, Rajiv.K, (2011), Advancements in Invertebrate Taxonomy and Biodiversity.
2. Highnam, K.C. and Hill, L. (1979), The Comparative Endocrinology of Invertebrates, ELBS & Edward Arnold (Publishers) Ltd., London.
3. Hyman, G.H., The Invertebrates, Vol. I to VII, McGraw Hill Book Co., Inc., N.Y
4. Jan, A.Pechenik,(2014), Biology of the Invertebrates. McGraw – Hill Publications.
5. Kotpal, R.L.,(2015), Minor Phyla, Rastogi Publication, Meerut.
6. Vasantika Kashyap (1997), Life of Invertebrates, Vikas Publishing House Pvt. Ltd., New Delhi.

Chordates:

1. Alessandro Minelli,(2009), Perspectives in Animal Phylogeny and Evolution, Oxford University Press.
2. Colbert, H. Edwin (2011), Evolution of the Vertebrates, Wiley Eastern Limited, New Delhi.
3. Harrey Pough, John B. Heisher, William N. Mcfarland (1990), Vertebrate Life, Macmillan Publishing Co., N.Y.
4. Kent, G.C. (1976), Comparative anatomy of the Vertebrates, McGraw Hill Book Co., Inc., New York.
5. Kotpal, RL.(2015, 4th edition) Modern Text Book of Zoology Vertebrates.ISBN-10: -10:935078095X; ISBN-13:978-9350780954
6. Romer, A.S. (1974), The Vertebrate Body, W.B. Saunders, London.
7. Romer, A.S. (1979), HYMAN's Comparative Vertebrate Anatomy, III Ed., The University of Chicogo Press, London.
8. Weichert, C.K. (1965), Anatomy of the Chordates, McGraw Hill Book Co., New York.

	9. Wiley, E.O and Lieberman S. Bruce (2011), Phylogenetics: Theory and Practice of Phylogenetic systematic, Wiley – Blackwell Publications
Course Outcome	<ul style="list-style-type: none"> • Understand and study of the Origin and phylogeny of Invertebrates and Chordates • Understand the organization, Homology and Analogy, Diversity of Invertebrate and chordates • Job offering: Nature conservation officer in Forest Department • Zoo keeper in Museum, Sanctuaries • Research Scientist in ICFRE Institutes, Van Vigyan Kendra, SACON

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZB & CELL AND MOLECULAR BIOLOGY		
Class	I M.Sc., Zoology	Semester	I
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To understand the cell structure in molecular level. • To provide the basic idea about cell cycle and regulation • To know the structure and importance of genetic material • To study the RNA synthesis in prokaryotes and eukaryotes • To understand the prokaryotes and eukaryotes gene expression and regulation 		
UNIT	Content		No. of Hours
I	CELL BIOLOGY Cell membrane: Molecular organisation- molecular models – cell permeability – cell surface differentiations and cell – cell communication – secretion and endocytic pathways. Structure and functions of cells: Cell organelles – Mitochondria, Golgi complex, Endoplasmic reticulum, Ribosomes and Lysosomes. Peroxisome. structure & function of cytoskeleton and its role in motility. Methods of cell study : Micrometry – cell culture methods – cell fractionation technique – cytochemical staining methods – cytophotometry – immunochemistry and autoradiography		18
II	Nucleus: Nucleoplasm and cytoplasmic relationship- Hammeling’s experiment, isolation techniques; ultrastructure of nuclear envelop and nucleoplasm. Chromosomes: – Biochemistry – Organization of chromatin; Chromosomal types – polytene and lamp brush chromosome. Cell division: Cell cycle and mitosis- significance of mitosis; meiosis and reproductive cycle- regulation and significance of meiosis. cell cycle-(steps - regulation and control)		18

<p>III</p>	<p>MOLECULAR BIOLOGY</p> <p>Nucleic acid: DNA and DNA types, their topology and functions</p> <p>DNA replication: Types of replication- conservative, dispersive and semiconservative methods; Process of replication - Origin, replication fork, regulation in prokaryotes and eukaryotes; Role of enzymes and other protein factors in DNA synthesis.</p> <p>DNA damage: Sources and types of DNA damage; Nuclear versus mitochondrial DNA damage; Senescence and apoptosis; DNA damage and mutations.</p>	<p>18</p>
<p>IV</p>	<p>RNA synthesis: Process of transcription- preinitiation, initiation, promoter clearance, elongation and termination; role of enzymes and other protein factors; Measuring and detecting transcription; reverse transcription; synthesis of mRNA in prokaryotes and eukaryotes; synthesis of rRNA; synthesis of tRNA; RNA processing- capping and polyadenylation. RNA editing, Splicing.</p>	<p>18</p>
<p>V</p>	<p>Genetic code: Process of translation – initiation, elongation and termination and post translational process; role of enzymes and proteins in protein synthesis – Genetic code.</p> <p>Gene regulation: Lac operon- Structure, genetic nomenclature, lactose analogs, regulation in cyclicAMP and uses in molecular biology; Trp operon- repression and attenuation.</p> <p>Protein transport: Intracellular compartments and protein sorting; vesicular traffic in secretory and endocytic pathway, transport from ER through Golgi to lysosome and endosome. Control of gene expression at transcription level regulation of phages, virus. Prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.</p>	<p>18</p>
<p>References</p>	<p>Text Books:</p> <ol style="list-style-type: none"> Dipak Ajoy Paul, (2011), Text Book of Cell and Molecular Biology, Books & Allied (P) Ltd., Kolkata 	

2. **Kumar Kan, Soma Halder**, (2009), Cell biology, Genetics , Molecular Biology, New Central Book Agency , NewDelhi.
3. **Shukla R.M.**(2005)A Text Book of cell Biology , Dominant Phblishers and Distributers, New Delhi-110002.

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1. Bruce Alberts,(2017).Molecular Biology of the Cell,Garland Science Publishing Inc,New York.
2. DeRobertis, E.D.P. , F.A., Saez, and E.M.R. De Robertis Jr. 1975. Cell biology. W.B. Saunders Company, Philadelphia.
3. Du Praw, E.J. 1968. Cell and Molecular Biology. Academic Press New York.
4. Geoffrey, M.Cooper Robert E.Hausman(2013), The Cell, Publisher Sinauer Associates Inc
5. Gerald Karp,(2013). Cell Biology, Publisher Wiley.
6. Giese, A.C. 1962. Cell Physiology. W.B. Saunders Company, Philadelphia.
7. Freifelder D 1996. Molecular Biology, 2nd edition, Narosa Publishing house
8. Lewin, B. 2000. Genes VII Oxford university press.
9. Stryer, L. 1995. Biochemistry. W.H. Freeman and company.
10. Voet, D and Voet, J. 1995. Biochemistry, 2nd edition. John Wiley and Sons Inc.

Course Outcome

- Understand the cell structure in molecular level.
- Understand basic idea of cell cycle and regulation to apply in research
- Job offers: Research Scientist in Cancer Research center, Adayar
- Research Scientist in Tata Memorial Centre for Advanved Treatment in Cancer, Parel Mumbai
- Technical officer in Centre for cellular and Molecular Biology(CCMB), TIFR at Hyderabad.

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	M	S	M	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	M	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	M	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZC & GENETICS		
Class	I M.Sc., Zoology	Semester	I
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To give an in-depth understanding on the principles and mechanisms of inheritance • To help study the fine structure and molecular aspects of genetic material • To provide an opportunity to learn the importance of inheritance in Man • To provide an understanding on the process and theories in evolutionary biology • To expose students to the basics and advances in Evolution 		
UNIT	Content		No. of Hours
I	Principles of Mendelian inheritance; Interaction of genes; Multiple alleles; Polygenic inheritance; Linkage and crossing over; Gene mapping in drosophila; Somatic crossing over in Drosophila. Sex determination in animals; Sex-linked inheritance in man and Drosophila		18
II	Eukaryotes –Fine structure of gene – Cistron, muton, recon, exon, intron, Mechanism of homologous recombination. Role of recombinase and chromosome mapping. Operon concept, regulatory mechanism in eukaryotes, attenuation and antitermination - Environmental regulation of gene expression Genes in populations – allelic and gene frequencies – implications of Hardy-Weinberg principle – Factors affecting Hardy-Weinberg equilibrium.		18

<p>III</p>	<p>Gene mutations – Chromosomal and point mutations, spontaneous and inducible mutations, reversible and suppressor mutations. Mutagens – Physical, chemical and biological. Teratogens and induced birth defects.</p> <p>Nuclear transplantation - Cell fusion : homokaryons and heterokaryons - Cytoplasts and karyoplasts Extra-chromosomal inheritance with reference to mitochondrial DNA, plastids, kappa particles, plasmids, episomes and chloroplasts.</p>	<p>18</p>
<p>IV</p>	<p>Inborn errors of metabolism: disorders of amino acid metabolism – PKU, alkaptonuria and albinism; disorders of purine metabolism – Lesh-Nhyan syndrome and ADA deficiency; disorders of carbohydrate metabolism – galactosemia and G₆PD deficiency; disorders of lipid metabolism – Tay Sach’s disease and Gaucher’s disease. Haemoglobin disorders – Sickle cell anemia and thalassemia Human Karyotype preparation and chromosomal syndromes in man – Down, Turner and Klinefelter syndromes.</p>	<p>18</p>
<p>V</p>	<p>Genetic engineering in Plant & Animal, Genetic counseling – Hereditary disorders : Aim- Purpose- Genetic Prognosis – Family history Preventive measures – High lights of genetic counseling. Pedigree analysis – Inbreeding and Outbreeding – significance, merits and demerits of inbreeding outbreeding.</p>	<p>18</p>
<p>References</p>	<p>Text Book</p> <ol style="list-style-type: none"> 1) S.Verma and V.K.Agrawal, Genetics(2000), S.Chand and company Ltd., 2) N. Arumugam, genetics and Evolution, Saras publication 3) R.P. Meyyan, genetics and Evolution, Saras publication 4) Girish Chopra, R.C. Gupta, Evolution & Genetics – R. Chand & Co 1998. 5) R.M. Shukla , Molecular genetics- Dominant Publishers & Distributors, 2001. 	

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1. **Altenburg, E.** 1970. Genetics. Oxford and IBH Publishing Company, New Delhi.
2. **Burns, G.W.** 1969. The Science of Genetics. The Mac Millan Co. New York.
3. Eldon John Garden et al.,(2006) Principles of Genetics, Published by Pearson Education India
4. **Gardener, E.J.** 1972. Principles of Genetics. John Wiley & Sons. Inc. New York.
5. **Levine, R. P.** 1968. Genetics. Holt, Rinehart and Winston Inc. New York.
6. **Lewin, B.** 1986. Genes. Wiley Eastern Ltd. New Delhi.
7. **Rothwell, N. V.** 1978. Human Genetics. Printice Hall of India.
8. **Sinnott, E.W. L.C. Dunn and T. Dobzhansky.** 1959. Principles of Genetics. Tata McGraw Hill, New Delhi.
9. William.S, Klug et al.,(2016) Genetics, Published by Pearson Education India
10. **Winchester, A.M.** 1967. Genetics, Oxford and IBH Pub. Co., New Delhi.

Course Outcome

- Student will test and deepen their mastery of genetics by applying this knowledge in a variety of problem solving situations
- Student learn the basic principles if inheritance at molecular level
- Job offer: Technician in Karyotyping in Medical Research Centre
- Research scientist in ICMR institutes
- Research Assistant in Institute of Forest Genetics and Tree Breeding, Coimbatore

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	M

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZD & MICROBIOLOGY & IMMUNOLOGY		
Class	I M.Sc., Zoology	Semester	I
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To provide an over view of the microbial world, its structure and function • To give students an intensive and in-depth learning in culture techniques • To familiarize the learner with the applied aspects of microbiology • To know the immunity and immune system of human • To study the immunodeficiency diseases and its diagnostic techniques 		
UNIT	Content		No. of Hours
I	History and Scope of microbiology - Outline classification of microorganisms – Bacteria, fungi, algae, and virus. Bacterial growth and nutrition requirements, Culture techniques - media preparation -types of culture media , isolation and Identification methods. Peservation of pure culture, Aerobic and anaerobic culture techniques.		18
II	Microbes in food - Role of microbes in food production; Dairy and non-dairy products -fermented foods and alcoholic beverages. Microbes of milk, food contamination , poisoning and spoilage – sources, symptoms and prevention of food borne infections – Bacterial and fungal toxins – methods of detection and detoxification – food sanitation in food manufacture Microbes in fermentation – production of ethanol, lactic acid, vinegar, vitamins, microbial enzymes, fuels andPharmaceuticals(antibiotics vaccines).		18

III	Causative agents, modes of transmission, symptoms, diagnosis and control of the following diseases in Man : Bacterial Disease : Pneumonia, Diphtheria, Rheumatic fever, Whooping cough, Tuberculosis, Meningitis, Botulism, Typhoid, Cholera, Gonorrhoea, Plague and leprosy. Viral diseases – Influenza, Measles, Mumps, Chicken pox, hepatitis, Poliomyelitis, Rabies, Japanese encephalitis, Yellow fever and HIV infection (AIDS).	18
IV	Immunity – Humoral and cell mediated immunity. Lymphoid organs in Man – primary lymphoid organs, secondary lymphoid organs; Cells of the immune systems ; Haemopoiesis – Antigens, Haptens, Epitopes and Paratopes; Immunoglobulins – structure and classes of immunoglobulins; Complement - Classic pathway – Alternate pathway – Biological functions of complement – complement fixation tests; Hypersensitivity.	18
V	Immunodeficiency diseases – primary and secondary immunodeficiency – AIDS – Life cycle – Transmission of HIV – Symptoms – Diagnosis, treatment for AIDS ; Immunization - Active and passive immunization – Monoclonal & Polyclonal antibodies; Immunological techniques – precipitation – VDRL test – Immunodiffusion – Immunoelectrophoresis – Agglutination – Blood typing – Widal test – Coomb’s test – passive agglutination – Immunofluorescence – ELISA – HLA typing -RIA .	18
References	<p>Text Books</p> <ol style="list-style-type: none"> 1. PELCZER, M.J., REID, R.D. and CHAN, E.C.S. (1996), Microbiology, V Ed., Tata McGraw Hill Publishing Company Ltd., New Delhi. 2. ANANTHANARAYANAN, T and JAYARAM PANIKER, C.K. (2000), Text Book of Microbiology, VI Ed., Orient Longman Ltd., Madras. 3. Ananthanarayanan, T and Jayaram paniker, C.K. and Arti Kapil (2013), Text Book of Microbiology, 9th Edi. Publi: University press(India) Pvt. Ltd., ISBN-13:978-8173718892. 	

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1. **Michael, J. Pelzer, J.R, ECS. Chan,**(2001) Microbiology. McGraw Hill Publishing Company Ltd., New Delhi.
2. **Purohit, S.S,**(2006)Microbiology, Fundamentals and Applications (Agro botanical Publications)
3. **Patel, A.H.(2015),** Industrial Microbiology. Laxmi Publications New Delhi.
4. **Ross, F.C.,** Introductory Microbiology (Bell and Howell Company, London)
5. **Dubey, R.C.**(2013) Microbiology, S.chand Co., New Delhi.
6. **Anil K.Sharma . (2019) Immunology: An Introductory Textbook. 1st Edition. Jenny Stanford Publishing. ISBN: 9789814774512**
7. **David P. Stites, Abba I. Terr,** Basic & Clinical immunology 8th edition, a Lange medical book publishers
8. **Ivan Roitt,**2011. Essential immunology. 8th edition Wiley-Blackwell science Ltd.
9. **MARK Peakman and Diego vergani**(2009) Basic and clinical immunology.**Publisher Churchill Livingstone.**
- 10.**Nasora,** 2006. Immunology. 2nd edition Narosa publishing house Ltd.

Course Outcome

- Understand an overview of the microbial world, its structure and function
- Students have intensive and in-depth learning in culture techniques and familiarize the learner with the applied aspects of microbiology
- Student will be able to identify the cellular and molecular basis of immune responsiveness
- Learners understand immunology is the branch of biomedical science that deal with immune system in both health and diseases.
- Job offer: Epidemiologist, Pathology Assistant, Teacher, Veterinarian Associate, Medical and clinical Laboratory Technologists.

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	M
CO5	S	S	S	S	S	S	S	S	M	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZEY & CORE COURSE V PRACTICAL-I ANIMAL PHYLOGENY & BIODIVERSITY, GENETICS ,CELL AND MOLECULAR BIOLOGY AND MICROBIOLOGY AND IMMUNOLOGY		
Class	I M.Sc., Zoology	Semester	I
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To familiar with identification of invertebrates and chordates animal • Understand the mounting technique. • To get hands on training in culturing of animals. • Understand the alternate digital dissection by vedio clippings • To know the mendelian characters and its significance. 		
UNIT	Content		No. of Hours
I	A. INVERTEBRATES and CHORDATS 1. Taxonomy TAXONOMY OF INVERTEBRATES 1. Taxonomy. Phylum: Protozoa Euglena, Amoeba , Plasmodium Phylum:Porifera Sycon, .Spongilla Phylum:Coelentrata Physalia, Aurelia, Sea anemone Phylum:Platyhelminthes Planaria, Fasciola, Taenia		18

Phylum:Aschelminthes

Ascais

Phylum:Annelida

Nereis, Earthworm, Leech

Phylum:Arthropoda

Penaeus, Scolopendra, Scorpion, Peripatus

Phylum:Mollusca

Chiton, Dentalium, Aplysia, Mytilus, Sepia

Phylum:Echinodermata

Antedon, Cucumaria, Echinus

TAXONOMY OF CHORDATES

SUB PHYLUM: PROTOCHORDATA

Amphioxus, Balanoglossus, Ascidian, Petromyzon

Pisces: Shark , Echenein, Ophiocephalus, Anguilla,

Exocoetus, Syngnathus ,

Amphibia: Ichthyophis, Salamandra, Bufo,

Chelone, Sphenodon, Naja, Crocodylus,

Aves : Parrot , Owl, Sparrow

Mammals: Bat, Rabbit, Rattus.

II

2. Mounting

Nereis – Parapodium

Lepas – Mouthparts

Prawn - Appendages

Sea urchin – Pedicellaria, Aristotle’s lantern

Teleost – Scales

Honeybee – Sting

3. Spotters

Invertebrate larval forms.

Invertebrate fossils – Ammonoids, Belemnoids, Nautiloids and Echinoclem fossils.

Minor Phyla – Chaetognatha, Rotifera, Phoronida and Sipunculida.

18

	<p>4. Dissections</p> <p>Video clipping of dissection of shark, frog, calote and rat can be shown to the students.</p> <p>A student can make use of material available in any search web site for online dissection of shark, frog, calotes, rat using Apple quick time software</p>	
III	<p>5. Culturing of Animals</p> <p>A visit to atleast any 2 of following: Vermiculture, apiculture, sericulture, ornamental fish culture, poultry or dairy farm or Biofertilizer or Biopesticide Industry in order to evoke interest in self employment.</p>	18
IV	<p>B. CELL AND MOLECULAR BIOLOGY</p> <p>Micrometry Camera Lucida Drawings Human Buccal Smear Blood Smear – Cockroach, Man. Cytochemical detection of Carbohydrates, Proteins, Lipids, DNA and RNA.</p> <p>C .GENETICS</p> <p>Drosophila culture – Identifications of Normal, mutants & sexes</p> <p>Blood groups ABO & Rh their genetic significance.</p> <p>Pedigree analysis.</p> <p>Human karyotyping & Chromosomal abnormalities.</p> <p>Hardy Weinberg law & Calculation of gene frequencies for dominant, recessive & co-dominant traits and Multiple alleles.</p>	18
V	<p>D.. MICROBIOLOGY& IMMUNOLOGY</p> <p>Culture techniques – culture of bacteria.</p> <p>Bacterial growth curve –Counting and Antibiotic susceptibility test. Measurement of bacteria – Preparation of smears and simple staining.</p> <p>Specific staining – negative staining &Gram staining.</p>	18

Immunology

Identification of lymphoid organs in rat / mouse.

Determination of human blood group by haemagglutination test and assessment of specificity of antigen – antibody reactions.

Detection of the specific reactivity of precipitating antibody (Igg) with fractionated antigens by immunoelectrophoresis, Vidal- test.

References**Text Books:****Invertebrates:**

1. **Barnes, R.D** Invertebrate Zoology, Cengage Publications. (2006),
2. **Barrington, E.J.W.** Invertebrate Structure and Functions, East west press Pvt (L)New Delhi. (2012),
3. **Waterman, A.J.** Chordate Structure and Function, The Macmillan Company. (1971),
4. **Dipak Ajoy Paul**, Text Book of Cell and Molecular Biology, Books & Allied (P) Ltd., KolKata. (2011)
5. **S.Verma and V.K.Agrawal**, GeneticsS.Chand and company Ltd, (2000).
6. **Ananthanarayanan, T and Jayaram paniker, C.K.**and Arti Kapil Text Book of Microbiology, 9th Edi. Publi: University press(India) Pvt. Ltd., ISBN-13:978-8173718892, (2013).

References Books:**Invertebrates:**

1. Gupta, Rajiv.K, Advancements in Invertebrate Taxonomy and Biodiversity. (2011)
2. Highnam, K.C. and Hill, L. The Comparative Endocrinology of Invertebrates, ELBS & Edward Arnold (Publishers) Ltd., London. (1979).
3. Alessandro Minelli Perspectives in Animal Phylogeny and Evolution, Oxford University Press. ,(2009)

	<ol style="list-style-type: none"> 4. Colbert, H. Edwin Evolution of the Vertebrates, Wiley Eastern Limited, New Delhi. (2011) 5. Bruce Alberts Molecular Biology of the Cell, Garland Science Publishing Inc, New York. ,(2017). 6. William.S, Klug et al Genetics, Published by Pearson Education India.,(2016) 7. Patel, A.H. Industrial Microbiology. Laxmi Publications New Delhi, (2015). 8. MARK Peakman and Diego vergani Basic and clinical immunology. Publisher Churchill Livingstone, (2009).
Course Outcome	<ul style="list-style-type: none"> • Obtain thorough knowledge in the identification of vertebrate and chordate animals. • Familiar with mounting techniques. • Know to culture economically important animals • Able to do microbial culture technique • Understand the mendelian traits.

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	M	S	M	S	S	S	S
CO2	S	S	S	S	S	M	S	S	S	S
CO3	S	S	S	S	S	M	S	M	M	S
CO4	S	M	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	M	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZF & DEVELOPMENTAL BIOLOGY		
Class	I M.Sc., Zoology	Semester	II
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To introduce the concepts and process in developmental biology • To understand the genetic mechanisms and the unfolding of the same during development • To expose the learner to the new developments in embryology and its relevance to Man. • To study the cell differentiation and tissue interactions in organ development • To know the health care and advanced technology in fertilization. 		
UNIT	Content		No. of Hours
I	Gametogenesis – Spermatogenesis – Cells in seminiferous tubules, spermiogenesis, structure and types of sperm Egg: Origin of egg - growth of oocyte - synthesis and accumulation of macromolecules in the oocyte – vitellogenesis -nuclear activities during oocytes growth. Hormonal and nervous control of ovulation .Egg as a developmental system: Organization of egg, cytoplasm before and after fertilization - polarity and symmetry of egg. Egg cortex: Nature and role in amphibian development		18
II	Fertilization:Bio-chemical aspects of egg activation - molecular events during fertilization. Polyspermy. Fertilization : Events of fertilization: acrosome reaction in sperm – cortical reaction in egg - recognition of egg and sperm, physiological changes in fertilization, the process of fertilization		18

<p>III</p>	<p>Cleavage :Plan and Patterns - Chemical changes - role of nucleus and cytoplasm in cleavage - totipotency - Nuclear transplantation - nuclear clones.Mechanisms and significance of Blastulation and Gastrulation, Morphogenetic movements: selective affinity of cells - metabolism and gene activity during gastrulation.formation of germ layers in animals; embryogenesis.</p>	<p>18</p>
<p>IV</p>	<p>Organizer concept:Primary and secondary organizers - nature of induction - mechanism - gradients in the determination. Tissue interactions: Lens development.Cell differentiation : Chemical and cellular factors- differential gene activity.Ageing and alteration in developmental potentials: Gene regulation of aging.Scenesence.</p>	<p>18</p>
<p>V</p>	<p>Precaution and health care during pregnancy and gestation. Impotency: Causes of Impotency and sterility male and infertility in female – Concept of test-tube baby - Artificial Insemination in humans - In Vitro Fertilization (IVF) and Gamete-Intra-Fallopian Transfer (GIFT) – Advantages and disadvantages. Teratogenesis- Developmental mechanism of teratogenesis. Contributions of teratology to developmental biology. Teratogens and induced birth defects.</p>	<p>18</p>
<p>References</p>	<p>Text Books:</p> <ol style="list-style-type: none"> 1. Verma and Agarwal (2006) Developmental Biology 2. Veera Bala Rastogi, M.S.Jayaraj – Developmental Biology – Kedar Nath, Ram Nath. <p>References</p> <ol style="list-style-type: none"> 1. Balinsky, B.I. 1975. An Introduction to Embryology. Saunders, Philadelphia. 2. Beril, N.J. 1974. Developmental Biology. Tata McGraw -Hill Publishing Company Ltd. New Delhi. 3. Ebert, J.D., 1966. Interacting systems in Development. Holt, Rinehart and Winston, New York. 4. McEwen, R.S. 1969. Vertebrate Embryology. Oxford & IBH Publishing Co., New Delhi. 5. Nelson, O.E. 1953. Comparative Embryology of the Vertebrates. The Blackston Company, New York. 	

	<p>6. Patten, B..M. 1958. Foundations of Embryology. McGraw - Hill Book Company Inc., New York.</p> <p>7. Waddington, C.H. Principles of Development and Differentiation. The Mac Millan Company, New York.</p> <p>8. Twyman,R.M.-Developmental Biology – Viva Books pvt., New Delhi, Chennai,Mumbai.</p>
Course Outcome	<ul style="list-style-type: none"> • Understand the concepts and process in developmental biology • Understand the genetic mechanisms and the unfolding of the same during development • Expose the learner to the new developments in embryology and its relevance to Man • Understand egg cleavage and the mechanism of embryogenesis, organ development • Job offer: IVF laboratory, Embryologists in O&G department in Medical College and Research Centre, Research Assistant in Veterinari College and Research centre. Animal care taker.

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	M	S	S
CO2	S	M	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZG & BIOCHEMISTRY, BIOPHYSICS AND BIOTECHNIQUES		
Class	I M.Sc., Zoology	Semester	II
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> To understand the chemical nature of life and life process and provide an idea on structure and functioning of bio molecules To generate an interest in the subject and help students explore the new developments in biochemistry To learn the biophysical properties and functioning of life processes To introduce the tools and techniques available for studying biochemical and biophysical nature of life To equip the learner to use the tools and techniques for project work/ research in biology 		
UNIT	Content		No. of Hours
I	BIOCHEMISTRY Water and minerals – functions and hormonal regulation of mineral metabolism – pH – buffers, Structure, properties and classification of carbohydrates, proteins and lipidsComposition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). – their metabolism, hormonal regulation. Classification of enzymes , enzyme kinetics – Mechanism of enzyme action – regulation of enzymatic activity – Co-enzymes – Isoenzymes – functions of enzymes – Energy rich compounds and their roles, Fat- Soluble and water soluble Vitamins. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymesMetabolism of amino acids nucleotides and vitamins		18

II	<p>BIOPHYSICS</p> <p>Visible spectrum – Beer Lambert’s law and its application – Electromagnetic radiation – Uses of X-rays.</p> <p>UV rays and radio waves; Lasers and their uses in biology – Principles and applications of Colorimetry and Spectrophotometry – Laws and application of thermodynamics. Radioactivity – natural and artificial – half life – Measurement of Radioactivity: Geiger-Muller counter and Scintillation counter – Principles and applications.</p>	18
III	<p>BIOTECHNIQUES</p> <p>Microscopy – Magnification, Resolution and Numerical aperture. Compound, Phase contrast and Electron microscopes (SEM & TEM), Confocal. Camera lucida, Micrometry – Principle and their applications. Microtomy – types of microtomes – fixation, embedding, sectioning, staining and mounting procedures. Microtechnique principles, preparation of permanent slides for whole mounts and tissue sections.</p>	18
IV	<p>pH – pH meter and electrodes – buffers – acid base balance – Handerson Hasselbach equation. Homogenization – Centrifugation – types of centrifuges: Clinical, High speed and Ultra Centrifuges.</p> <p>Principle and applications of colorimetry and spectrophotometry.</p> <p>Spectroscopy :Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.</p>	18
V	<p>Chromatography – paper, thin layer, column, gas and liquid chromatograpy – Principles and application. Electrophoresis – Paper, gel (horizontal & vertical),Agarose gel and SDS – PAGE - Immunoelectrophoresis–moledif: Principles and applications</p>	18

References**BIOCHEMISTRY****Text Books:**

1. Sathiyarayanan. U, Chakrapani (2017) Biochemistry, Publisher Elsevier India.

References :

1. Deb,A.C.,(2011), Concepts of Biochemistry. Publisher – Books & Allied (P) Ltd.,Kolkata
2. Donald Voet, Judith, G. Voet, et al.,(2018) Principles of Biochemistry, Wiley Global Edition.
3. Hoar, S.W., (1983), General and Comparative Physiology, Prentice Hall, London, New York.
- 4 Raghunath Narvekar – 2008, Hand book of Biochemistry- Adhyayan publishers & Distributors.
- 5 .Sharma Dushyant Kumar – 2010, Biochemistry – Narosa publishing house.

BIOPHYSICS AND BIOTECHNIQUES**Text book**

1. Subramanian, M.A., 2005. Biophysics principles and techniques, MJP Publishers.
2. Berry, A.K. 1988. A text book biophysical chemistry, EMKAY Publication, New Delhi.

References

1. Ackerman, E. (2018). Biophysical science, Publisher - Arkose Press.
2. Annie – 2010, Biochemistry & Biotechniques – Saras Publications
3. Casey, E.J. (2018). Biophysics: Concepts and mechanics, Sagwan Press.
4. Daniel, M. 1989. Basic Biophysics for Biologists. Agro Botanical Publishers (India), Bikaner.
5. Kumarasamy.V -2012,Biophysics & Bioinstrumentation- Saras Publication

	6. Pattabhi(Vasantha) and Gautham, (2010), Biochemistry - Narosa Publishing house.
Course Outcome	<ul style="list-style-type: none"> • Understand the chemical nature of life and life process • Understand the structure of bio-molecules and its function in life • Learn the biophysical properties and functioning of life processes • Learn the advanced tools and techniques available for studying biochemical and biophysical nature of life • Job offer: Instrumentation and Lab technician, Research Assistant in Clinical Laboratory, Technician/Research Assistant in TIFR, CCMB, ICFRE, ICMRE, ICAR, AIMS Research Institute. Institute

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	M	S
CO5	S	S	S	M	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZH & APPLIED BIOTECHNOLOGY		
Class	I M.Sc., Zoology	Semester	II
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> To give an intensive and in-depth learning in the field of biotechnology To understand the modern biotechnology practices and approaches with an emphasis in technology application, medical, industrial, environmental and agricultural areas To familiarize the students with public policy, biosafety, and intellectual property rights issues To understand the commercial protection of organic compound using microbes. To learn the process of bioremediation. 		
UNIT	Content	No. of Hours	
I	Hybridoma technology: Production and Application of monoclonal antibodies – Gene Therapy — Cell bank – Animal molecular pharming. Transgenic animals – transgenic development – Transgenic mouse – embryonic stem cell pronucleus method – Transgenic fish and sheep. Bioethics in engineering.	18	
II	Agricultural Biotechnology: Genetically Modified Microbes, Phytoremediation. Bacterial Biofertilizers –Rhizobium, Azospirillum inoculants – Nitrogen fixing, Phosphate Mobilizing- VAM fungi. Green manuring – Cyanobacteria Azolla, Anabaena. Benefits of biofertilizers - Biopesticide management.	18	
III	Industrial and Microbial Biotechnology – Fermentation Fermentors, Selection of microbes, Fermentation medium – Penicillin, Vitamin B ¹² , Amino acids and Proteases – Production of compounds by microbial fermentation – Ethanol and acetone Antibiotics – microbes used – commercial production of anti Cell Protein (SCP) production and their advantages- Spirulina.	18	

<p>IV</p>	<p>Medical Biotechnology – Applications of r-DNA technology i - Recombinant DNA proteins and their uses: i) Interferon, ii) Factor VIII, iv) Urokinase and v) Tissue plasminoge Recombinant vaccines: Hepatitis-B, Rabies and FMD Vaccine production of penicillin – DNA finger printing and its use in F</p>	<p>18</p>
<p>V</p>	<p>Environmental Biotechnology – Bioremediation – <i>In-situ</i>, <i>situ</i>.Bioremediation of Xenobiotics- dyes, havy metals, co through VAM fungi, Effluent treatment using genetically i microbes. Intellectual Property Rights–copy right, trademarks. industrial design rights and trade secrets.</p>	<p>18</p>
<p>References</p>	<p>Text books:</p> <ol style="list-style-type: none"> 1. Abbasi (SA) Ramasami E(1999), Biotechnology methods of pollution control. 2. Bahadur (Bir),ED , Essential of biology & biotechnology 3. Dubey, R.C (2014) A text book of biotechnology. S. Chand and Company, New Delhi. 4. Ignacimuthu .s (1995) , Basics Biotechnolgy - Tata Mcgraw Hill. 5. Jogand s.v (1993), Advances in Biotechnology -Himalaya. 6. Kumar H.D (1991) A text book of biotechnology – Affiliated East west 7. Lohar(Prakash.s)(2004) Biotechnology. 8. Purohit S.S Mathur S.K - Biotechnology: Fundamental and application –Agrobios goel 9. Rana S.V.S (1990) Recent trends in Biotechnology & Biosciences society of Bioscience. 10. Sathyanarayana, U (2005) Biotechnology. Books and Allied P.Ltd. Kolkata. 11. Sohal (Harvinder s) ; Srivastava (Asok.k) (1994), Ashish Pulishing House. 12. Trehan (keshav) (1990), Biotechnology –Wiley Eastern Ltd. <p>Reference:</p> <ol style="list-style-type: none"> 1.Bains, W. (1998). Biotechnolgy from A to Z. Oxford University Press, Oxford. 2.Dubey, R.C. (2014). Text book of Biotechnology, S.Chand & Company Ltd. Ram Nagar, New Delhi 	

	<p>3. Lydell Norris,(2016),Text Book of Biotechnology. Publisher – Syrawood Publishing Home.</p> <p>4.Ranga, M.M. (1999). Animal Biotechnology. Agrobios (India) Jodhpur.</p> <p>5. Sathyanarayana.U,Chakrapani.U,(2008), Biotechnology. Publisher – Books & Allied (P) Ltd.,</p> <p>6. Trevan, M.D, Boffery, S. Goulding, K.H. &Stanbury, P. (1984). Biotechnology: The BiologicalPrinciples. Tata McGraw Hill Publishing company Limited, New Delhi.</p> <p>7. Wiley,(2017), A Text Book of Biotechnology. Editor H.K.Das.</p>
<p>Course Outcome</p>	<ul style="list-style-type: none"> • Understand advance technique and its application in the field of biotechnology • Understand the modern biotechnology practices and approaches with an emphasis in • technology application, medical, industrial, environmental and agricultural areas • Familiarize the students with public policy, biosafety, and intellectual property rights issues • Job offer: BCG vaccine Laboratory Chennai. Pasteur Institute Ooty, Clinical laboratory, Medical Research Centre, IVF laboratory, Research Assistant/ JRF/SRF/ in the Research Institute of ICAR, ICMRE, VCRC, TIFR, CCMB, Fisheries University and Research centre

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE1 & ELECTIVE COURSE I FISHERY BIOLOGY & FISH PROCESSING TECHNOLOGY		
Class	I M.Sc., Zoology	Semester	II
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To Learn the fish techniques of different fishes. • To learn the management strategy. • To know the fish processing technique. • To learn the induce breeding technique and fish pathology. • To study the fish population, growth and stock assessment 		
UNIT	Content		No. of Hours
I	World and Indian Fisheries – Prospects and Problems – Plans, Policies and Current Status of Indian Fisheries. Marine fisheries ; Sardines, Mackerels, Sciaenids, Ribbonfish, Silver bellies, Pomfrets, Carangids, Sharks, Shrimps, Prawns, Crabs, Lobsters, Mussels and Clams Inland fisheries ; Freshwater – riverine, reservoir, pond and cold water fisheries- Spawning and breeding habits of fishes. Estuarine and brackish water fisheries and their economics		18
II	Culture fisheries : Integrated fish farming technology – rice – cum – brackish water fisheries, rice-cum-common carp culture, fish –cum-duck culture, Sewage – fed fisheries – monosex culture – polyculture. Ornamental fish culture and its economics		18
III	Fish Gears and Crafts used in South Indian Fisheries. Fish endocrinology – Induced breeding – techniques – examples. Fish Pathology : Parasites – Protozoan, fungal, bacterial, worms and arthropods		18
IV	Assessment of fish stocks : Marking and recapture method, area sampling method, biostatistical method, egg count method, hydroacoustic method, remote sensing. Age and Growth : Scale method, otolith method, other skeletal parts as age indicators, length – frequency method, length – weight relationship and condition factor. Population studies : estimation of population size, marking, tagging, population dynamics, population models.		18

V	Fish Processing and Preservation technology Salting, Icing, Sundrying, Smoking, Canning, Tinning, and Freezing techniques, Cold Storage, Brine water, brief account on transport and marketing. Lay out of Processing Plant - Factory Hygiene and Sanitation, Fish products and by products .	18
References	<p>Text Books:</p> <ol style="list-style-type: none"> 1. Khanna, S.S. and Singh, H.R. (3rd Edition, 2015). A Text book of Fish Biology and Fisheries. Narendra Publishing House. ISBN:9789384337117. 2. Handbook of Fisheries and Aquaculture (2017). Publisher:ICAR. ISBN-10-9788171641062; ISBN-13:978-8171641062. 3. Arumugam,N (2014). Aquaculture and Fisheries. Saras Publication.ISBN-10:9382459995; ISBN-13:978-9382459996 4. BISWAS, S.P., (1993) Manual of Methods in Fish Biology, International Book Co., Absecon Highlands, New Jersey. 5. JHINGRAN, V.G., (1991) Fish and Fisheries of India. Hindustan Publishing Copr., New Delhi. 6. PILLAI, T.V.R. (1993) Aquaculture : Principles and Practices. Fishing News Agency, London. 7. AGARWAL, S.C. 2006. History of Indian Fisheries. Daya publication. 8. SRIVASTAVA, C.B.L. A Text Book of Fishery science and Indian Fisheries. Kitab Mahal Publishers. <p>Reference Books :</p> <ol style="list-style-type: none"> 1. Bhardwaj,K.D. (2011)Modern Technique in Fish Handling and Processing. Cyber Tech Publications. ISBN-108178846896 ; ISBN-13 :978-8178846897. 2. Krishnaveni,G. and Veerabhdra Rao,N. and Veeranjanyulu, K.(2016) Récent Technologies in Fish and Fisheries. Rigi publication. ISBN-10 :9384314587 ; ISBN-13 :978-9384314583. 3. Bernard A. Megrey. (2nd Edition,2009) Computers in Fisheries Research. Publisher : Springer. ISBN-10 :1402086350 ; ISBN-13 :978-1402086359. 4. Sen,D.P.(2005) Advances in Fish Processing Technology. Allied Publisher Pvt. Ltd. ISBN-10 :8177646559 ; ISBN-13 :978-8177646559. 5. Faridi,A.Z.,(2014) Text Book of Fish Processing Technology.Neha Publishers pvt. Ltd., ISBN-10 :9350301792 ; ISBN-10 :978-3550301791. 6. Daniela Borda, Anca I Nicolau, Peter Rasper. (2017) Trends in Fish Processing Technologies.CRC Press Taylor & Francis Group. ISBN : 9781498729178. 7. Bose, A.N., Yang, C.T., And Mishra, A. (1991) Coastal Aquaculture Engineering. Oxford and IBH Publishing Co., PVt. Ltd., New Delhi. 8. Chakrabarti N.M., (1994) Diseases of Cultivable Freshwater Fishes and Their Control. International Books and Periodicals Supply service, New Delhi. 9. Day, F., (1986) The Fishes of India, Vols., I & II. Today and Tomorrow's Book Agency, New Delhi. 	

	<p>10. Govindan, T.K. (1992) Fish processing Technology, Oxford and IBH Publishing Co., Pvt. Ltd., New Delhi.</p> <p>11. MPEDA Hand book of Aquafarming (1992) Freshwater Fishes, Marine Products Export Development Agency, Kochi.</p> <p>12. New, M.B., Tacon., A.G.J., and CSAVAS., I. (1993) Farm – made – Aqua feeds. Food and Agriculture Organization of United nations, Rome.</p> <p>13. Santhanam, R., (1990) Fisheries Science, Daya Publishing House, New Delhi.</p> <p>14. Seghal, K.K. (1992) Recent Researches in Cold Water Fisheries, Today and Tomorrow's Publishers and Printers, New Delhi.</p> <p>15. Sinha, V.R.P. (1993) A Compendium of Aquaculture Technologies for Developing Countries. Center for Science and Technology and Oxford and IBH Publishing Co., Pvt., Ltd., New Delhi.</p> <p>16. Subbha Rao (1986) Economics of Fisheries, Daya Publishing House, New Delhi.</p> <p>17. Trivedi, K.K. (1986) Fisheries Development: 2000 A.D. Association of Indian Fishery Industries and Oxford and IBH Publishing Co., Pvt. Ltd., New Delhi.</p> <p>18. Uma Sharma., & Grover, S.P., (1982), An Introduction to Indian Fisheries, Bishen Singh Mahendra Pal Singh, Dehra Dun. Prediction</p> <p>19. Rajagopalasamy, C.B.T & Velayutham, P. 1999. Quality control of Fish and Fishery products.</p>
<p>Course Outcome</p>	<ul style="list-style-type: none"> • Understand the fish techniques of different fishes. • Understand and familiarized with construction of pond and its management strategy. • Hands on training in fish processing technique. • Familiarize with Induced breeding • Job offer: Self employment, Entrepreneur, Executive in fish products, Aquarist, Research Assistant in Fisheries university and Research centre, MPEDA, RGCA, CIBA, CMFRI •

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	M	S	S	M	S	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	M	S	M	M	S
CO4	S	S	M	M	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZIY & CORE COURSE IX PRACTICAL -II DEVELOPMENTAL BIOLOGY, BIOCHEMISTRY, BIOPHYSICS, BIOTECHNIQUES AND BIOTECHNOLOGY		
Class	I M.Sc., Zoology	Semester	II
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To understand the study of reproductive cells and its motility. • To know the estimation techniques of biological samples. • Understand the principles and mechanisms of bioinstruments. • Know the purpose of microtechnique. • Understand the isolation and separation of nucleic acid by advanced biotechnique 		
UNIT	Content		No. of Hours
I	A. Developmental Biology <ol style="list-style-type: none"> 1. Preparation of sperm suspension in frog/bull and observation of the spermatozoa. 2. Observation of live spermatozoa and study of rate of motility of sperm in frog /bull semen. 3. Vaginal smear preparation in rat / mouse to study the stages of oestrous cycle. 		18
II	B. Biochemistry <ol style="list-style-type: none"> 1. Estimation of total protein in biological sample. 2. Estimation of total carbohydrate in biological sample. 3. Estimation of Amino acids in muscle & liver tissue of chick 4. Buffer preparation – determination of pH using pH meter. 		18
III	C. Biophysics <ol style="list-style-type: none"> 1. Colorimeter--Determination of Optical Density of samples using Standards. 2. Centrifuge-Preparation of samples using low and high speed centrifuges. <ol style="list-style-type: none"> a. Chromatography- 3. Separation of free sugars in different samples (Paper). 4. Separation of neutral lipids (TLC). 5. Electrophoresis-Separation of human serum proteins (Demonstration only). 		18
IV	D. Biotechniques : Micrometry, fixation, embedding, serial sections, cytological staining, mounting of tissues, organs and embryos.		18

V	<p>E.Biotechnology</p> <ol style="list-style-type: none"> 1. Isolation of genomic DNA 2. Plasmid isolation 3. Agarose gel electrophoresis of DNA 4. DNA fragmentation using restriction enzymes (Demonstration) 5. Blotting technique (southern and western) Demonstration only 	18
References	<p>Text Books:</p> <ol style="list-style-type: none"> 1. Verma and Agarwal Developmental Biology, (2006) 2. Veera Bala Rastogi, M.S.Jayaraj – Developmental Biology – Kedar Nath, Ram Nath. 3. Subramanian, M.A., 2005. Biophysics principles and techniques, MJP Publishers. 4. Ackerman, E. Biophysical science, Publisher - Arkose Press, (2018). 5. Sathiyarayana. U, Chakrapani Biochemistry, Publisher Elsevier India, (2017) 6. Dubey, R.C (2014) A text book of biotechnology. S. Chand and Company, New Delhi <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Verma and Agarwal Developmental Biology, (2006) 2. Veera Bala Rastogi, M.S.Jayaraj – Developmental Biology – Kedar Nath, Ram Nath. 3. Deb,A.C. Concepts of Biochemistry. Publisher – Books & Allied (P) Ltd.,Kolkata,(2011). 4. Wiley A Text Book of Biotechnology. Editor H.K.Das,(2017). 	
Course Outcome	<ul style="list-style-type: none"> • Hands on training in observation of live cells. • Ability to quantify the biological samples. • Able to understand the basic mechanisms and operating of bioinstruments. • Understand the microtechnique for slide preparation.. • Know the application of advanced biotechniques. 	

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	M	S	M	S
CO2	S	S	S	M	S	M	S	S	S	S
CO3	S	S	S	S	S	S	S	S	M	S
CO4	S	S	M	S	S	M	M	S	M	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZJ & ANIMAL PHYSIOLOGY		
Class	II M.Sc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims:		
UNIT	Content		No. of Hours
I	Homeostatic mechanism - Osmo and Ionic regulations in Fishes; Temperature and pH regulations in animals; Acclimatization to high altitudes; Hydrostatic pressure; Buoyancy, Nutrition – Nutritional requirements, types, essential, aminoacids, and fatty acids – vitamins and their role. Respiration – Respiratory pigments and their functions. Exchange of gases – transport of O ₂ and CO ₂ – regulatory mechanisms; Haemoglobin – Chemistry – structure – Respiratory quotient-neural and chemical regulation of respiration.		18
II	Circulation – Heart,-Functions of Heart, heart beat, cardiac rhythm and regulation; Blood coagulation; Types of transport mechanisms, blood pressure, ECG; Excretion – Excretion in relation to different habitats – Detoxification pathways of Ammonia, Urea, and Uric acid formation, Vertebrate Nephron – Mechanisms of urine formation and Acid base balance. Nervous system - Neurons,- Nerve impulse action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture		18
III	Chemistry of muscular contraction,Photoreceptor – Vertebrate eye, photo chemistry, visual information and adaptations of eye. Phonoreceptor – Vertebrate ear, physiology of hearing; Electric organs, Bioluminescence – chemistry and control; Chronobiology –Biological rhythm and biological clock.		18
IV	Endocrine glands in vertebrates and feedback system in endocrine regulation of vertebrates. Pituitary gland (Adenohypophysis , Pars Intermedia and Neurohypophysis) - Characteristics, structural organization , biosynthesis, regulation and functions of hormones .Hypothalamic regulation for release of pituitary hormones. Pineal gland - hormones and their role in photoperiodic response in vertebrates. Thyroid gland -- characteristics, structural organization,synthesis and functions of hormones. Parathyroid gland- structure, synthesis and functions of hormones		18

V	<p>Pancreas -Structure ,hormones and their functions. Adrenal gland- Structural organizations, biosynthesis and functions of cortical and medullary hormones .</p> <p>Gonadial gland-Structure of mammalian testis and ovary - male and female sex accessory organs - hormones of testis and ovary - estrous and menstrual cycle - hormones of pregnancy - parturition - hormonal control of lactation</p>	18
References	<p>Text Books:</p> <ol style="list-style-type: none"> 1.Arumurugam, N., Animal Physiology, Saras Publication-kanyakumari. 2.Verma, P.S., Tyagi, B.S, and Agarwal, Animal physiology, Saras Publication, S.Chand and Co., New Delhi. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Prosser C.L, Brown, F.A. 1965. Comparative Animal physiology W.B.SandersCompany London. 2. Nagabhushnam. R, Kodarkar. M.S., and Sarojini,R. 1983. Text book of Animal Physiology, Oxford& IBH publishing co. New Delhi. 3. Bykov . K.M., 1960. Text book of physiology . Foreign languages publishing house , Moscow. 4. Hurkat, P., Mathur. C., A book of Animal physiology. S.Chand & co (PVT) Ltd., Ram Nagar New Delhi 5. Hoar, S.W., 1978. General and Comparactive Physiology, Prentice Hall, London, New York. 6. Malcolm.S.Gordon – Animal Physiology – principles and Adaptations- Macmillan Publishing co. a. Inc _ Newyork.. 7. Haris, G.W. and B.T. Donovan. 1968. The Pituitary Gland. S. Chand and Co., 8. Bentley, P.J. 1985. Comparative vertebrate endocrinology, Second Edition, Cambridge University Press. Cambridge. 9. Mac Hadley. 1992. Endocrinology, 3rd Edition. Prentice – Hall Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey. USA. 10. Ingleton, P.M. and J.T. Bangara. 1986. Fundamentals of comparative vertebrate endocrinology, Kluwer Academic Publishers 11. Turner, C.D. and J.T. Bangara. 1986. General endocrinology. Saunders International Student edition. Toppan Company Limited. Tokyo. 12. Prakash S Lohar Endocrinology, Hormones and Human Health. 13. Ashoke Kumar Boral – Mammalian endocrinology – New central Book Agency(P) ltd – London. 14. Rao.C.V. A Text book of Immunology Narosa Publishing house – Chennai. 15. Peter Wood – Understanding Immunology – Pearson Education ltd – Chennai. 	
Course Outcome	<ul style="list-style-type: none"> • Have enhanced knowledge of mammalian physiology • Understand the function of physiological systems such as respiratory, circulatory and metabolic system. • Understand the physiological response to that environment. • Able to analyze and report on experiments in physiology. • Understand the endocrine organs structure and functions 	

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	M	M	S	S	S	M	M
CO5	S	S	S	M	M	S	S	S	M	M

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZK & RESEARCH METHODOLOGY AND BIOSTATISTICS		
Class	II M.Sc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • This study is being undertaken within a framework of a set of approaches and uses procedures, methods and techniques that have been tested for their validity and reliability. • Biostatistics provides a clear specification of the hypothesis to be tested. • Know the basic concept of biostatistics • Understand the applications of statistic in biological data • Obtain in depth knowledge in data collection 		
UNIT	Content		No. of Hours
I	Concepts of Research and Research Formulation Basic concepts of research – Meaning, Objectives, Motivation and Approaches. Types of Research – Descriptive / Analytical, Applied/ Fundamentals, Quantitative/Quantitative, Conceptual/Empirical. Research Methods versus Methodology, Research and scientific method. Research process. Observation and facts, Prediction and Explanation, Induction, Deduction. Defining and Formulating the research problem. Selecting the problem and necessity of defining the problem.		18
II	Literature review and Thesis Writing Source , Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review, Computer aided searches, Search engines – Google, Yahoo. Hypothesis – Null and Alternate Hypothesis and testing of hypothesis.Components of a thesis- writing the introduction, material and methods, presenting the results, writing the discussion, citing the references, tables and figures, bibliography.		18
III	Research and Documentation – Abstracts and research papers – Preparation and submission of research paper for peer reviewed journals- citation index – h-index - impact factors – creation and usage of Google scholar account – Project Proposal writing, Research articles, Oral Communications.		18
IV	<u>B. BIOSTATISTICS</u> Definition – development of Biostatistics, data in Biostatistics – samples and population, variables, accuracy and precision, derived variables, frequency distribution, handling of data.		18

	Descriptive Statistics: arithmetic mean, other means, median, mode, range, standard deviation, practical methods for computing mean and standard deviation, coefficient of variations, probability distribution – binomial and Poisson distribution, estimation and hypothesis testing	
V	<p>Student's t, confidence limit, analysis of variance, single classification, two way analysis of variance, assumptions, regression, correlation, analysis of frequencies.</p> <p>Multivariate analysis – Definition and derivation of Principal components, statistical properties of Principal components, Principal components using correlation matrix, Principal components with equal and/or zero variance.</p>	18
References	<p>Text Books:</p> <ol style="list-style-type: none"> 1.GURUMANI,N.2007.Research Methodology for Biological Sciences.MJP Pub.Chennai. 2.P.RAMADASS & A.WILLSON ARUNI,2009. Research and writing. MJP Pub.Chennai. <p>Reference Books:</p> <ol style="list-style-type: none"> 3.ANDERSON,J.,DURSTON,B.,POOLE,M.1991.Thesis and Assignment writing. New Age International Pvt .Ltd., New Delhi. 4.Conference of Biological Editors.1972. Style Manual for Biological Journals,American Institute of BIOLOGICAL Science, Washington,D.C. 5.KOTHARI,C.R.2006. Research Methodology & Research Techniques .New Age Int.Pub. 6.JAWAHAR,P.2000. The preservation of Zoological specimen.Government Museum,Chennai. 7.GILES,R.H.JR.(Ed) 1984.Wildlife Management Techniques 3rd edition.The Wildlife Society,Washington.D.C.Nataraj Publishers,Dehradun.India. 8.PAUL OLIVER.2005.Writing Your Thesis. Vistaar Publications.New Delhi. 9.SUNDAR RAO,P.S.S & J.RICHARD.2006.Introduction to Biostatistics and Research Methods(4th) .Prentice Hall,New Delhi. 10.BAILEY, N.T.J. (1997), Statistical Methods in Biology, III Ed., Cam. University Press, N.Y. 11.SOKAL, R. and JAMES, F. (1973), Introduction to Biostatistics, W.H. Freeman and Company Ltd., Tokyo, Japan. 	
Course Outcome	<ul style="list-style-type: none"> • Understand the basic concept of research. • Learn the importance and sources of literature and hypothesis testing concept.. • Efficient in document preparation, research article writing and project proposal writing.. • Learn data collection and descriptive statistics. • Ability to use the applications of biostatistics to conduct research in the area of biology. 	

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZLY & CORE COURSE XII PRACTICAL – III (CORE COURSE X & XI) ANIMAL PHYSIOLOGY AND RESEARCH METHODOLOGY AND BIostatISTICS		
Class	II MSc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • Animal physiology associated practical allow student to explore particular systems in detail and to develop relevant lab skills through the study of examples. • Research methodology uses procedures, methods and techniques that have been tested for their validity and reliability. • Biostatistics encompasses the design of biological experiments and analysis of data. • Familiar with histology slide preparation • Understand the different data collections 		
UNIT	Content		No. of Hours
I	ANIMAL PHYSIOLOGY 1. Quantitative estimation of amylase activity. 2. Effect of substrate concentration on salivary amylase activity 3. Effect of enzyme concentration on the activity of salivary amylase. 4. Effect of pH concentration on the activity of salivary amylase.		18
II	5. Quantitative estimate of Protein by Biurette/ Lowry method 6. Study of oxygen consumption in fish. 7. Effect of Thyroxin on the respiratory metabolism of fish.		18
III	1. Demonstration of endocrine organs in vertebrates (any one) 2. Demonstration of reproductive system in vertebrate (Rat/Mouse) 3. Histological study of Pituitary, Adrenal, Testis, Ovary, corpus luteum, Intestine, Pancreas and Thyroid gland. A record of laboratory work and twenty slides containing serial sections (20 slides) shall be submitted at the time of practical examination.		18
IV	RESEARCH METHODOLOGY Primary data collection and submission Secondary data collection and submission Document preparation and submission (topic selection is own interest)		18

V	BIOSTATISTICS	18
	Problems related to Chi-square test Student's t – test Correlation Regression	
References	Text Books: 1.ARUMURUGAM, N., Animal Physiology, Saras Publication-kanyakumari. 2.VERMA, P.S., TYAGI, B.S, AND AGARWAL, Animal physiology, Saras Publication, S.Chand and Co., New Delhi. 3.GURUMANI,N.2007.Research Methodology for Biological Sciences.MJP Pub.Chennai. 4.SOKAL, R. AND JAMES, F. (1973), Introduction to Biostatistics, W.H. Freeman and Company Ltd., Tokyo, Japan. Reference Books: 1.HURKAT, P., MATHUR. C., A book of Animal physiology. S.Chand & co (PVT) Ltd. Ram Nagar, New Delhi 2. KOTHARI,C.R.2006. Research Methodology & Research Techniques .New Age Int.Pub. 3. SUNDAR RAO,P.S.S & J.RICHARD.2006.Introduction to Biostatistics and Research Methods(4 th) .Prentice Hall,New Delhi. 4.BAILEY, N.T.J. (1997), Statistical Methods in Biology, III Ed., Cam. University Press, N.Y.	
Course Outcome	<ul style="list-style-type: none"> • Understand the concept and principle of quantitative analysis of physiological enzymes. • Learn the estimation method of protein and metabolic activity of fish. • Hands on training in preparation of histological slide. • Develop skill in problem solving related to biological sample data. • Efficient with big data analysis software package-SPSS 	

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	M	S	M	S	M	S	S
CO2	S	S	S	S	S	M	S	M	S	S
CO3	S	S	S	S	M	S	S	S	S	S
CO4	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE2 ELECTIVE COURSE II BIOINFORMATICS AND COMPUTER APPLICATIONS IN BIOLOGY		
Class	II M.Sc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To understand the importance of bioinformatics in biology • To familiar with application of bioinformatics tool • To know the concept of biostatistics • To understand the applications of biostatistics in biology • To obtain in depth knowledge in computer and its application 		
UNIT	Content		No. of Hours
I	BIOINFORMATICS Objectives of Bioinformatics, kinds of data used, Data integration, Data analysis, Carriers in Bioinformatics, Scope of bioinformatics – Useful bioinformatics sites – Bioinformatics in Pharmaceutical industry – Bioinformatics orientation in IT industry. Biological databases –Tools for Searching biological databases – Sequence and Structural databases – Nucleotide Sequence Databases - NCBI, GENE BANK, EMBL DDBJ. Protein Sequence databases – Swissprot, PIR – Structural database (PDB, CATH, and SCOP).		18
II	Sequence alignment – Methods of pair wise alignment –Algorithms– Needleman &wunch algorithm – Smith waterman algorithm – Amino acid substitution matrices – PAM – BLOSUM- Multiple sequence alignment (MSA) – Clustal W. Phylogenetic analysis: Concept of trees, Methods of Phylogenetic analysis - Distance matrix methods, Characters based methods- Steps on Constructing alignments and phylogenies		18
III	Conceptual models of protein structure – Predicting Protein structure and function from sequence – Determination of structure – feature detection – secondary structure prediction – predicting 3 D structure - the relationship of protein three – dimensional structure to protein function.		18
IV	COMPUTER APPLICATION IN BIOLOGY Introduction to computer: History of computer – components of a computer – block diagram – input devices – output devices-classification of computer – computer virus. Computer Programming concepts: Algorithms, Flowchart. Computer operating system: DOS and WINDOWS		18
V	MS office application: <ol style="list-style-type: none"> 1. Word Processor : MS - Word 2. Data Processor : MS - Excel 3. Presentation : MS Power point Computer application: Office automation: E-mail and Internet. Applications of statistical packages: SPSS.		18

References	Text Books: <ol style="list-style-type: none"> 1. S.P.GUPTA – Statistical Methoda, Suldan chand & son, Educational Publishers- News Delhi. 2. Pillai, R.S.N. and Bagavathi. 2009. Statistics. S. Chand, New Delhi. 3. Gurumani, N. 2002. An introduction to Biostatistics. MJP Publishers, Chennai. 4. Gopi, 2011.Evolution Biostatistics & computer application. Saras publication. 5. Arumugam, N. 2010. Biostatistics ComputerApplication, Bioinformatics instrumentation. Saras publication. References: <ol style="list-style-type: none"> 1. Sokal, R.R. and F.J. Rohif. 1981. Biometry. W.K. Freeman. San Francisco. 2. Taxali. R.K. 1997. PC Software made simple. Tata McGraw Hill Publishing Company Ltd., New Delhi. 3. Bailey, N.T.J.(1997) , Statistical Methods in Biology, III Ed., Cam.University Press, N.Y. 4. Palanichamy.D. and Manoharn, M.Statistical Methods for biologist (Palani Paramount Publications). Gupta R.K.,S.P.Test Book of statistic. 5. Zar,J.H., 1996 .Biostatistical Analysis, 6. SOKAL,R. and JAMES, F.(1973), Introduction to Biostatistics, W.H. Freeman and Company Ltd., Tokyo, Japan. P.N.Elhance. Fundamentals of Stsstics, Kitab Mahal, Allahabad
Course Outcome	<ul style="list-style-type: none"> • Understand the Biological databases and its scope. • Learn sequence alignment to construct phylogenetic tree using of bioinformatic tools.. • Skill to predict protein structure using RASMol package. • Understand the concept of computer programming which make it necessary to integrate informatics when solving biological problems. • Understand it has become an important focus for industry, particularly in the post-genomic era.

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	M	S	M	S	S	M	S
CO2	S	S	S	S	S	S	S	S	M	S
CO3	S	S	S	S	M	S	M	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating
 M-Moderately Correlating
 W-Weakly Correlating
 N-No Correlation

Course code & Title	MZ2 & ELECTIVE COURSE II ENDOCRINOLOGY		
Class	II M.Sc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • Understand the hormones and its classification • Learn hormone synthesis, secretion, regulation, transport and metabolic fate • Understand the biological effects of catecholamines • Learn the reproductive hormones and reproduction • Understand the fundamental concept of hormone signal transduction 		
UNIT	Content	No. of Hours	
I	Hypothalamic and pituitary hormones: Hormones – classification, biosynthesis, circulation in blood, modification and degradation. Hormone receptors – structure and regulation. Mechanism of hormone action. Hypothalamic and pituitary hormones. Hypothalamic releasing factors. Anterior pituitary hormones: biological actions, regulation and disorders of growth hormones, ACTH, gonadotropine and prolactin. Leptin. Posterior pituitary hormones – biological actions and regulation of vasopressin. Diabetes insipidus and SIADH secretion. Oxytocin, Hypopituitarism	18	
II	Thyroid and parathyroid hormones: Thyroid hormones – synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid functions tests. Hyper and hypothyroidism. Hormonal regulation of calcium and phosphate metabolism. Secretion and biological actions of PTH, calcitonin and calcitriol. Hypercalcemia and hypocalcemia Rickets and osteomalacia	18	
III	Adrenal hormones: Adrenal cortical hormones. Synthesis, regulation, transport, metabolism and biological effects. Adrenal function tests. Cushing's syndrome, aldosteronism, congenial adrenal hyperplasia, adrenal cortical insufficiency. Adrenal medullary hormones – synthesis, secretion, metabolism, regulation and biological effects of catecholamines. Pheochromocytoma.	18	
IV	Gonadal, G.I. and pancreatic hormones: Gonadal hormones: Biosynthesis, regulation, transport, metabolism and biological actions of androgens. Hypogonadism and gynecomastia. Biosynthesis, regulation, transport, metabolism and biological effects of oestrogen and progesterone. The menstrual cycle. Pregnancy – diagnostic tests and biochemical changes. Foetal monitoring. Amenorrhoea. Pancreatic hormones – synthesis, regulation, biological effects and mechanism of action of glucagons, somatostatin and insulin. Insulin receptor. Brief account of gastrointestinal	18	

V	Signal transduction: Fundamental concepts and definitions of signals, ligands and receptors, endocrine, paracrine and autocrine signaling. Receptors and signaling pathways – cell surface receptors, ion channels, G-protein coupled receptors, receptor kinases (tyr, ser/thr). Signal transduction through cytoplasmic and nuclear receptors. The Ras-raf MAP kinase cascade, second messengers – cyclic nucleotides, lipids and calcium ions. Crosstalk in signaling pathways.	18
References	<p>Text Books:</p> <p>1. Williams Textbook of Endocrinology – Wilson and Foster 13th ed. 2015. 2. Mechanisms of hormone action – Autind and Short, 1980.</p> <p>Reference Books</p> <p>3. Harper’s Biochemistry – Murray et al. 26th ed. McGraw Hill, 2003. 4. Principles of Biochemistry – Mammalian Biochemistry, Smith et al. McGraw Hill, 1983. 5. Williams et al, Textbook of Endocrinology, 2015</p>	
Course Outcome	<ul style="list-style-type: none"> • Understand the classification and biosynthesis of hormones. • Learn about hormonal regulation and biological actions. • Understand adrenal hormones and syndromes.. • Understand gonadal hormones and its importance. • Understand concept of signal transduction and signaling pathways. 	

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	M	S	M	S	M	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	M	S
CO5	S	S	S	S	S	S	S	M	S	M

S- Strongly correlating
M-Moderately Correlating
W-Weakly Correlating
N-No Correlation

Course code & Title	MZE3 & ELECTIVE COURSE III ENVIRONMENTAL TOXICOLOGY		
Class	II M.Sc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To understand the concept of Environmental biology • To obtain in depth knowledge in solid waste management • To study the toxicants, effects, causes and management • Learn the classification of toxics substances <ul style="list-style-type: none"> • To understand the bio transformation and bio indicators 		
UNIT	Content		No. of Hours
I	Concepts of ecology: Limiting factors- Liebig’s law of minimum- Shelford’s law of tolerance Population ecology: Attributes, estimates, density, diversity indices; Factors influencing population fluctuations Community ecology: community structure, dominance, stratification, succession and niche concept.		18
II	Habitat Ecology- lake, marine, rocky, muddy and sandy shore, estuary, terrestrial-grassland,forest,desert. Biodiversity –basic concepts, types, values, threats , methods of conservation- sustainable development and biodiversity indices. Wildlife conservation-Wildlife sanctuaries and National Parks-Biosphere Reserves. Pollution – sources, effects, and control of air, water, organic pollutants, BOD, COD, pesticides, heavy metals, thermal, radiation, oil, land and noise pollution – industrial pollution – with reference to Distilleries, paper mills and Tanneries		18
III	Solid Waste Management: Types of solid wastes – degradable and non-degradable wastes; Collection, segregation, transportation and disposal of solid wastes (integrated waste management, Landfill, incineration, recycling, biological reprocessing, energy recovery, avoidance and reduction).		18

	Biomedical waste management-Components of biomedical wastes, waste management and protection from biomedical wastes.Status of solid waste management in India.	
IV	<p>Elements of Toxicology: Definitions – Scope – Classification.</p> <p>Toxic substances(Environmental Toxicants):Pesticides(Insecticide-Organochlorine, Organophosphate, carbamates) – Herbicides, Fungicides – Automobile emission – Heavy metals – Radioactive substances.</p> <p>Effects of Toxic substance: Elementary account on reversible and irreversible toxic effects. Evaluation of toxicity : acute, chronic toxicity.</p> <p>Determination of toxicity: LC50, LD50 and EC50.</p> <p>Route of Entry of Toxicants: Food, Water, Air, Skin and La animals –</p> <p>Absorption and Distribution of toxicants; (storage depots, storage deports).</p>	18
V	<p>Excretion of toxicants: important routes (Renal, biliary, pulr</p> <p>Less important routes (fecal, salivary, placental,milk and</p> <p>Kinetics of excretion.</p> <p>Bio – Transformation – Phase I reaction and phase II reaction.</p> <p>Safety Evaluation of Toxicants: Risk management and monitoring – Environmental hazard and risk assessment – Criteria for safety evaluation – Upper and lower confidence limits – Cumulative toxicity – Evaluation of combined toxicity – Role of Lc50 or LD50 values in safety evaluation of toxicants – Behavior of Toxicants in the environment – Bio indicators</p>	18
References	<p>Text Books:</p> <p>1.BISWARUP MUKERJEE – Fundamentals of Environmental Biology –Silverline Publications – Allahabad.</p> <p>2.AGARWAL – Environmental Biology – AgroBotanical Publishers (India)-New Delhi.</p>	

Reference Books :

1. ODUM, E.P. (1996) Fundamentals of Ecology (III Edn), Nataraj Publishers, Dehradun.
2. SHARMA, B.K. and KAUR, H. (1997) Environmental Chemistry, Goel Publishing House, Meerut.
3. TACCONI, L. (2000) Biodiversity and Ecological Economics : Participation, Values and Resource Management. Earthscan Publications Ltd., London.
4. CASTRI, F.D. and YOUNES, T. (1996). Biodiversity : Science and Development. CAB Int., Wallingford, U.K.
5. CHAPMAN, J.L., and REISS, M.J. (1997). Ecology – Principles and Applications, CAMBRIDGE University Press, U.K.
6. CLARKE, G.L. (1963). Elements of Ecology, John Wiley and Sons, Inc., New York.
7. GHOSH, G.K. (1992). Environmental Pollution, Ashish Publishing house, New Delhi.
8. SHARMA, B.K. and KAUR, H. (1997). An Introduction to Environmental pollution, Goel Publishing House Meerut.
9. SINHA, R.K. (1996) Biodiversity (Global Concerns), Commonwealth Publishers, New Delhi.
10. MUNN, R.E. (1975) Environment Impact Assessment, Principles and Procedures, John Wiley and Sons, Toronto.
11. AHMAD, Y.J and SAMMY, G.K. (1985). Guidelines to Environmental Impact Assessment in Developing Countries. Hodder and Stoughton, London.
12. KANNAN. K. (1991) Fundamentals of Environmental pollution. S.Chand & Co., Ltd., New Delhi

Course Outcome	<ul style="list-style-type: none"> • Understand the concept of population and community ecology. • Learn pollution sources, effect, control methods. • Learn Solid waste management and its status in India. • Understand toxic substances, effect, evaluation, toxicity determination and route of entry. • Understand excretion of toxicants and biotransformation.
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Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	M	M	S	S	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	M	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE3 & ELECTIVE COURSE III WILD LIFE BIOLOGY		
Class	II M.Sc., Zoology	Semester	III
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To study about wildlife biologists and zoologists. • To understand research & development, carry out in wildlife management. • To know the conservation plans that combat these threats, and protect our natural resources. • Understand the importance of wildlife censuses • Know the wild life protection Act And its importance 		
UNIT	Content		No. of Hours
I	Definition of wildlife: Causes of wildlife depletion- need for wildlife conservation – IUCN Categories – endangered species of birds and mammals in India.		18
II	Wildlife sanctuaries, National park and Biosphere reserves – Definition and importance.Sanctuaries: vedanthangal Bird sanctuary – Mudumalai wildlife sanctuary – point calimere wildlife sanctuary.National parks: Corbett national park, guindy national park, Biosphere reserves – Gulf of Mannar		18
III	Importance of Wildlife Censuses – Censuses Techniques: Direct methods – Line Transect Method –Block count method. Indirect Method: Pugmark techniques and pellet methods.		18
IV	Zoos and their importance – types of enclosures – food and feeding of zoo animals – veterinary care of zoo animals – zoo education. Case study of Aringar Anna Zoological Park.		18
V	Wildlife (Protection) Act 1972: Introduction – Schedule – Declaration of Wildlife Sanctuary and National parks. Human wildlife conflicts with reference to Elephant		18
References	Text Books: <ol style="list-style-type: none"> 1. Saharia.V.B 1982 Wildlife in India, Nataraj Publishers, Dehradum. 		

	<p>2. Goutam Kumar Saha and Subhendu Mazumdar- Wildlife Biology: An Indian Perspective</p> <p>3. Ashok Shantilal Kothari and Boman Framji Chhapgar; Wildlife of the Himalayas and the Terai Region (Bombay Natural History Society)”</p> <p>4. Raymond F Dasmann- Wildlife Biology</p> <p>Reference Books:</p> <p>1. Dasman.R.F 1964 Wildlife Biology, Jhon and Wildy and sons New York. Pp231</p> <p>2. Giles R.H.J (Ed) 1984 Wildlife Management Techniques 3rd Edition. The Wildlife Society, Washington, D.C. Natraj Publishers, Dehradum, India.</p> <p>3. Sesharri.B 1986 India’s Wildlife reserves, Sterling Pup’rs pvt Ltd., New Delhi.</p> <p>4. A. R. E. Sinclair, Graeme James Caughley, and John M. Fryxell</p> <p>5. John M. Fryxell, A. R. E. Sinclair and Graeme James Caughley</p> <p>6. Anthony R.E.. Sinclair, John M. Fryxell, Graeme Caughley. – 2nd ed. p. cm. Rev. ed</p>
<p>Course Outcome</p>	<ul style="list-style-type: none"> • Understand the need of wildlife conservation and categories of IUCN. • Know wildlife sanctuaries and National parks. • Learn wildlife census techniques and methods.. • Understand the importance of Zoo’s and case study. • Know wildlife protection Act’s

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	M	S	M	S	S	M	S	M	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	M	S	M	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZM & ENVIRONMENTAL BIOLOGY AND EVOLUTION		
Class	II M.Sc., Zoology	Semester	VI
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To learn the limiting factors of the environment • Understand the basic concept of biodiversity and its indices • Learn the advanced technique of remote sensing and satellite image anal • Understand the modern concept of origin of life • Learn the advanced evolutionary process at the molecular level 		
UNIT	Content		No. of Hours
I	Concepts of ecology: Limiting factors- Liebig's law of minimum- Shelford's law of tolerance Population ecology: Attributes, estimates, density, diversity indices; Factors influencing population fluctuations Community ecology: community structure, dominance, stratification, succession and niche concept Solid Waste Management: Types of solid wastes – degradable and non-degradable wastes; Collection, segregation, transportation and disposal of solid wastes (integrated waste management, Landfill, incineration, recycling, biological reprocessing, energy recovery, avoidance and reduction). Biomedical waste management-Components of biomedical wastes, waste management and protection from biomedical wastes.Status of solid waste management in India.		18
II	Habitat Ecology- lake, marine, rocky, muddy and sandy shore, estuary, terrestrial-grassland,forest,desert Biodiversity –basic concepts, types, values, threats , methods of conservation- sustainable development and biodiversity indices. Wildlife conservation-Wildlife sanctuaries and National Parks-Biosphere Reserves Pollution – sources, effects, and control of air, water, organic pollutants, BOD, COD, pesticides, heavy metals, thermal, radiation, oil, land and noise pollution – industrial pollution – with reference to Distilleries, paper mills, Tanneries,		18

	<p>indicator organisms – bioaccumulation – biomagnification and biomonitoring of pollutants.</p> <p>Environmental impact assessment (EIA) – definition, steps in EIA, method of EIA, problems involved in EIA, reporting (EIS).</p>	
III	<p>Remote sensing – aerial photography – satellite images – thermal, infra – red, radar images, ecological applications – resources exploration, understanding environmental factors, predicting natural hazards. GIS and its application, Space ecology – Exobiology – hazards of space travel. Environmental Protection Act 1986, 1990, 1997 and Environmental Protection Act –Air quality 2010</p>	18
IV	<p>Origin and Evolution of Life-theories of origin of life-modern concept of origin of life -origin of basic biological molecules, abiotic synthesis of organic monomers and polymers- origin of Prokaryotes- origin of eukaryotic cells</p> <p>Present status of the concept of natural selection – genetical theory of natural selection – evidences for the role of natural selection Neo – Lamarckism – present concept of recapitulation – genetic and non-genetic variations – origin and evolutionary significance.</p> <p>Polymorphism and selection – definitions, transient polymorphism, balanced polymorphism, genetic polymorphism, enzyme polymorphism and selection advantages. Fossils- fossilization and its significance.</p> <p>Geological time scale - eras, periods and epochs</p>	18
V	<p>Polyploidy and evolution – genetic assimilation – genetic speciation – species concept – evolutionary trends – canalization of selection – orthoselection.</p> <p>Molecular evolution – gene evolution, evolution of gene families, molecular drive, assessment of molecular variation, punctuated equilibria and neutrality theory.</p> <p>Evolution of population – from races to species, adaptation pattern, behavioural adaptations and strategies, sexual competition and selection, isolating mechanisms, mode of speciation and evolutionary rate.</p>	18

	<p>Adaptation - Nature and types of adaptation – Adaptive trends - Quantifying adaptation - Batesian and Mullerian mimicry and evolution. Evolution of human brain ,communication,speech and language. Evolution of culture</p>	
<p>References</p>	<p>Text Books:</p> <ol style="list-style-type: none"> 1. Biswarup Mukerjee – Fundamentals of Environmental Biology – Silverline Publications – Allahabad. 2. Agarwal – Environmental Biology – AgroBotanical Publishers (India)-New Delhi. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. ODUM, E.P. (1996) Fundamentals of Ecology (III Edn), Nataraj Publishers, Dehradun. 2. SHARMA, B.K. and KAUR, H. (1997). Environmental Chemistry, Goel Publishing House, Meerut. 3. TACCONI, L. (2000) . Biodiversity and Ecological Economics : Participation, Values and Resource Management. Earthscan Publications Ltd., London. 4. CASTRI, F.D. and YOUNES, T. (1996). Biodiversity : Science and Development. CAB Int., Wallingford, U.K. 5. CHAPMAN, J.L., and REISS, M.J. (1997). Ecology – Principles and Applications, CAMBRIDGE University Press, U.K. 6. CLARKE, G.L. (1963). Elements of Ecology, John Wiley and Sons, Inc., New York. 7. GHOSH, G.K. (1992). Environmental Pollution, Ashish Publishing house, New Delhi. 8. SHARMA, B.K. and KAUR, H. (1997). An Introduction to Environmental pollution, Goel Publishing House Meerut. 9. SINHA, R.K. (1996) Biodiversity (Global Concerns), Commonwealth Publishers, New Delhi. 10. MUNN, R.E. (1975) . Environment Impact Assessment, Principles and Procedures, John Wiley and Sons, Toronto. 	

	<p>11. AHMAD, Y.J and SAMMY, G.K. (1985). Guidelines to Environmental Impact Assessment in Developing Countries. Hodder and Stoughton, London.</p> <p>12 .KANNAN. K. (1991) . Fundamentals of Environmental pollution. S.Chand & Co., Ltd., New Delhi</p> <p>13 .KRISHANAN, N.T. (1994). Environmental Biology. JJ Publication, Madurai.</p> <p>14 .VERMA, S.R. , SHARMA, R.S. and RANI, G. (1988). Ecology and Animal behaviour. Jaiprakash Nath & Co., Meeru</p>
Course Outcome	<ul style="list-style-type: none"> • Understand Scope of Ecology with sub divisions. • Know the components of ecosystem and animal relationship. • Understand Biogeochemical cycles • Understand the importance and conservation of Biodiversity • Learn origin of life and theories of evolution

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE4 & ELECTIVE COURSE IV ECONOMIC ENTOMOLOGY		
Class	II M.Sc., Zoology	Semester	VI
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To study the insect pests and their control measures. • To study the economic importance of insects as pollinators, predators and insect pests (vector borne diseases) and their control. • To study the basic concepts of pesticides and integrated pest control. • Familiar with culturing of economically important beneficial insect • To know the life cycle of harmful insect test 		
UNIT	Content		No. of Hours
I	Scope, An outline classification of insects ; Life cycle of a Hemipteran, Coleopteran and Lepidopteran pest (Two examples with mouth parts of insects-useful and harmful insects)And their interrelations with environments, Insects as pollinators, Parasitoids, Scavengers and weed killers		18
II	Beneficial insects: Sericulture – Types of silkworm. Life cycle and rearing of mulberry silkworm, Bombyx mori- Life cycle and rearing of non mulberry silkworm (Tasa - Antheraeamylitta); Cocoon processing for silk fabric – cocoon boiling, reeling, re reeling, winding, doubling, twisting and weaving. Apiculture – Types of honeybees. Life cycle, culture, movable frame hive, bee products and its economic importance Lac culture : lac insect,-lacciferlacca – Life cycle, Lac processing, Lac products and Economic importance.		18
III	Harmful insects – Pest of stored grains, Rice, Coconut, Cotton, Sugarcane, Pulse crops, Cereal crops, Oilseed crops and pest of Fruits and Vegetables.		18

	Household pests of medical importance – Mosquito, Housefly, Cockroach, Ticks, Mites, Louse, Bed bug, Plasmodium, Filarial worm, Loa loa, Dust Mite.	
IV	Principles and methods of pest management – Principles of Insect control – Prophylactic measures – Conventional, Mechanical, Physical methods – Genetic control and Quarantine. Biological control : Parasites, Predators and Microbial agents. Chemical methods : Pesticides – general classification – classification based on mode of action, mode of entry and bio pesticides	18
V	Recent trends in pest control – Pheromones, Attractants, Repellants and Chemosterilants. Integrated pest management and its importance & applications. Assesment to pest population, Estimation of pest damage – Pest outbreak – Pest surveillance	18
References	<p>Text Books:</p> <ol style="list-style-type: none"> 1.VASANTHARAJ DAVID. B and V.V. RAMAMURTHY (2011). Elements of Economic Entomology, Namrutha publications, Chennai 600 116. 2.TEMPHARE. D.B (2009) Modern Entomology, Himalaya publishing Mumbai. 3.AMBROSE, DUNSTON P., (2004) The insects: Structure, function and Biodiversity, Kalyani. <p>Reference Books:</p> <ol style="list-style-type: none"> 4.CHAPMAN, R.F (2002) The insect structure and functions. English Languages Book Society, Hooder Strongon. 5.MIKE, W., SEVICE (1999) Medical Entomology for student, Cambridge press. 6.NAYER, K.K., ANANTHAKRISHNAN T.N and DAVID B.V General and Applied Entomology. M.Grow Hill Publications, Newdelhi. 7.RATHNASWAMY G.K (1986). A handbook of medical Entomology and Elementry Parasitology S. Viswanathasn printers & Publishers Pvt.Ltd. 	

	<p>8.SRINIVASTAVA, K.P (1993) A Text book of applied Entomology. Vol I & II Kalyani Publishers, New Delhi.</p> <p>9.P.G FENEMORE, ALLAPRAKASH, (1992). Applied Entomology : Wiley Eastern Ltd., Delhi.</p> <p>10.ULLAL., S. R and M.N NARASIMHANNA (1987). Hand book of Practical sericulture, Central silk board (Ministry of textiles – Government of India), United Mansion, 39, Mahatma Gandhi road, Bangalore.</p> <p>11.P.G. FENEMORE Manual. Silkworm Rearing. FAO Agricultural Service Bulletin, Rome</p> <p>12.WIGGLES WORTH J.B., 1994. Insect physiology, Chapman and hall, London.</p> <p>13.TEMPHARE D.B., 1984. A text book of insects Morphology, Physiology and Endocrinology.S. Chand and Co., New Delhi.</p>
Course Outcome	<ul style="list-style-type: none"> • Study the classification of insects. • Understand the beneficial insect in detail. • Learn how pest become harmful insect. • Learn integrated pest management methods. • Understand the pest control measures and methods

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	M	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	M	S	M	S	S	M	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	M	S	M	S	M	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE4 & ELECTIVE COURSE IV NUTRITION AND CLINICAL BIOCHEMISTRY		
Class	II M.Sc., Zoology	Semester	VI
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To learn the nutritional requirement • Understand the basal metabolic and energy balance • Hands on training in clinical biochemistry • Learn the advanced biochemical analysis • Understand the criteria for selecting a method for biochemical analysis 		
UNIT	Content	No. of Hours	
I	Nutritional requirements :Basic concepts, scope and methodology; Principal food components; Vitamins: structure and function; Food nutrients: recommended allowances and their modifications under stress conditions; Deficiency and excess of principal nutritional components; Formula diets and c.	18	
II	Nutrition in health and diseases: Protein energy malnutrition; Energy balance and requirements: basal metabolic rate (BMR); Factors affecting BMR and its measurement; Resting metabolic rate; Specific dynamic action of food; Dietary fat and heart disease and cancer; Atherosclerosis: risk factors and protective measures; Nutritional management of diabetes and obesity; Weight management; Anthropometric measurements; Nutrition and infection; Basics of nutrigenomics	18	
III	Clinical biochemistry and quality assurance: Clinical chemistry/biochemistry: concept, definition and scope; Biological samples: types, collection, processing, stability and storage; Phlebotomy tubes; Serum and serum separator devices; Chemical composition of biological fluids: blood, urine and cerebrospinal fluid; Reference range	18	

<p>IV</p>	<p>Quality assurance: Accuracy and precision; Factors influencing the accuracy of results; Levy-Jennings's chart; Reliability of laboratory methods; Interferents; Responsibilities of a clinical biochemist. Biochemical tests in clinical practice, Biochemical tests in clinical practice: uses of a chemical/biochemical analysis; Criteria for selecting a method for biochemical analysis</p>	<p>18</p>
<p>V</p>	<p>Biochemical tests in clinical practice: Biochemical tests in clinical practice: uses of a chemical/biochemical analysis; Criteria for selecting a method for biochemical analysis; Enzymes as diagnostic tool; Advantages and disadvantages of enzyme assays; Isoenzymes and their diagnostic importance; Methods for the detection of isoenzymes; Organ function tests: clinical presentation and diagnosis of the diseases of the liver and kidney; Bilirubin metabolism and hyperbilirubinaemia; Acid base disorders.</p>	<p>18</p>
<p>References</p>	<p>Text Books:</p> <ol style="list-style-type: none"> 1.VENKATRAMAN SHREEMATHY, 2015.Nutrition and Biochemistry for Nurses 2nd Edition. Elsevier 2.SATYANARAYANAN. 2017. Biochemistry 5th Edition, Elsevier <p>Reference Books:</p> <ol style="list-style-type: none"> 1. SHARMA, DC., 2017.Nutritional Biochemistry by, CBS PUBLICATION 2. RAMNIK SOOD,2019. Textbook of Clinical Biochemistry, Atithi Medical Book Publisher 	
<p>Course Outcome</p>	<ul style="list-style-type: none"> • Understand the basic concept of nutritional requirement and its methods. • Know the nutrition in health and diseases and basic of nutrigenomics.. • Learn the clinical test sample collection, preservation and storage for further testing.. • Understand the quality assurance by criteria selection for biochemical analysis. • Getting hands on training in biochemical laboratory test methods 	

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	M	S	S	M	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE5 & ELECTIVE- V COASTAL AQUACULTURE		
Class	II M.Sc., Zoology	Semester	VI
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To know the criteria for selecting suitable site for aquaculture • Familiar with the major cultivable species • Hands on training in fish culture • Understand the physio chemical parameter maintenance in aquaculture • To know the coastal zone management legal issues and government policies 		
UNIT	Content		No. of Hours
I	Coastal Aquaculture : Definition,overview,status and importance. Criteria of selecting suitable site for aquaculture – fundamentals of survey, designing and lay out of aquaculture ponds. Seaweed Culture and major cultivable species of seaweeds		18
II	Biology of fin and shellfishes : freshwater prawns – shrimps – molluscs – fishes. Culture techniques – Traditional. extensive, modified extensive, semi intensive, intensive and super intensive. mono and poly culture, integrated and organic farming. Open sea farming – raceways – cages – pens – rafts – racks		18
III	Shellfish Culture : Shrimps,prawns,crabs, fattening of crabs,lobsters,oysters,mussels and cephalopods. Fish Culture : Milk fish,mulletts, Asian sea bass		18

<p>IV</p>	<p>Hatchery techniques – induced maturation and spawning – natural seed resources – hatchery production of fin and shellfish seeds. Farm management – Water quality management – Temperature – salinity – dissolved oxygen – pH – hardness – nutrients – ammonia – hydrogen sulphide. Feed management – feed ration – feeding schedule – feed broadcasting – partial feeding – feed acceptance – types of feeds – live and formulated feeds</p>	<p>18</p>
<p>V</p>	<p>Health management – disease diagnosis and treatment – prophylactic measures – probiotics – immunostimulants Role of R & D institutions . Coastal zone management – legal issues – Government policies – Aquaculture Authority of India</p>	<p>18</p>
<p>References</p>	<p>Text Books:</p> <ol style="list-style-type: none"> 1. V.B.SAKHARE . Reservoir fisheries and Ecology – Mangalam Publications,L- 21/1.St.No.5,Shivaji margnear Kali Mandir,Delhi- 53. 2. A.C.LORG.Fish feeding and Integrated fish farming,Cyber Tech Publications,New Delhi. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. BARDACH, J.E., J.H.RYTHER & W.O. MCLARNEY- Aquaculture, Wiley-Inter Science, 1972. 2. HUET, M & J. TIMMERMANS: Text Book of fish culture: Breeding and cultivation of fish, 2nd ed., fishing News Book Ltd., 1986. 3. PILLAY T.V.R. Aquaculture Principles and Practices, Fishing News Books, 1981. 4. ROBERT, R.STICKNEY. Principles of Aquaculture, John wiley & Sons Inc. 1984. 5. SANTANAM R, N. RAMANATHAM & G. JAGATHESAN. Coastal Aquaculture, CBS Publishers and Distributors, 1990 6. IMAI T. Aquaculture in shallow seas, Amerind Pub. Co.,1977. 	

7. JHINGRAN V.G . Fish and Fisheries of India,Hindustan Pub. corp., 1982.
8. MILNE P.H. Fish & Shellfish farming in Coastal waters, FNB Ltd., 1972.
- 9.SRIVASTA.C.B. Fisheries Science And Indian Fishery- Kital Mahal 22A- Sangai Nadu, Allahabad.
- 10.VENKATARAMANUJAM,N.RAMANATHAN.Introduction to Fishery Science- Janshi Publications 11-A. Palayamkottai Road Tuticorin – 628 008.
- 11.SHAMMI.Q.J. BHATINAGAR.A.S. Applied fisheries – Updesh Purohit for agrobios(Indian), Jodhpur.
- 12.YADAV.B.N. Fish and Fisheries – Daya Publishing house
- 13.ROUNSEFELL .G.A.HAMYEVERHART . Fishery Science. Method & Application – International Books & Periodicals supply services.
14. KURIAN.C.V. SEBATIAN.V.O. Prawns and Prawn fisheries of India. Hindustan Publishing corporation – Delhi.
15. SHAILENDRA GHOSH . Fisheries and aquaculture management – Adhyayan publication

**Course
Outcome**

- Understand the criteria for selecting species, survey and design layout for aqua pond construction.
- Study the biology of cultivable species and culture techniques..
- Learn shell fishes and culture methods..
- Skill develop for hatchery techniques and farm management.
- Know the farm disease management, treatment and coastal zone management

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	M	S	S	S	M	S
CO4	S	S	S	S	S	S	M	S	M	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZE5 ELECTIVE COURSE V COMPARATIVE ANIMAL PHYSIOLOGY		
Class	II M.Sc., Zoology	Semester	VI
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To understand and compare the early vertebrate developmental stages • Able to compare skeleton of vertebrate animals • Able to compare exoskeleton vertebrate animals • To compare and contrast internal organs of vertebrate • Able to compare endocrine system of vertebrate 		
UNIT	Content		No. of Hours
I	Early vertebrate morphogenesis- fertilization cleavage and blastula, formation of neural tube and notochord, mesoderm formation, fate of ectoderm, endoderm and embryonic membrane. Skin and pigment of fish's , cyclostomes, amphibian, reptiles and mammals		18
II	Introduction to Skelton and heterotopic bones and cartilage. Vertebrate ribs and sternum of fishes and tetrapods. Te vertebrate skull of bony fishes , amphibian reptiles and birds		18
III	Muscles of bony fishes and tetrapods. Appendicular muscle ans integumentary muscle and electric organs. Comparative digestive system of fishes, amphibian reptiles and birds.		18
IV	Comparative circulatory and nervous system of fishes, amphibian reptiles and birds. Comparative cstudy of sense organs.		18

V	Comparative study of endocrine glands and urinogenital system of fishes, amphibian reptiles, birds and mammals	18
References	<p>Text Books:</p> <ol style="list-style-type: none"> 1. Moyes, CD and Schulte, PM. Principles of Animal Physiology. Benjamin Cummings, New York, 1st Edition. 2. Randall, Burggren and French. Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York, 5th Edition, 2002. 3. Willmer, Stone and Johnston. Environmental Physiology of Animals. Blackwell Science Ltd. 2000. (QP82. W48 2000). 4).Schmidt-Nielsen. Animal Physiology: Adaptation and environment. Cambridge University Press. <p>Reference Books:</p> <ol style="list-style-type: none"> 1. Hill, Wyse, and Anderson 2008 . Animal Physiology Second Edition, Sinauer 2. Comparative Animal Physiology” by Philip C Withers 3. “Comparative Animal Physiology” by C Ladd Prosser 4. Comparative Physiology: Primitive Mammals” by Knut Schmidt-Nielsen and Liana Bolis 5. “Advances in Comparative and Environmental Physiology: Animal Adaptation to Cold” by J A Boulant and R J Brooks 6. Comparative Animal Physiology: Environmental and Metabolic Animal Physiology” by C Ladd Prosser 7. Principles of Zoology – Touching the Structure, Development, Distribution, and Natural Arrangement of the Races of Animals, Living and Extinct” by Louis Agassiz 8. “Advances in Comparative and Environmental Physiology” by J Machin and S H Wright. 9. “Comparative Physiology: Animals-Hormones and Regulation; Evolution of Physiological Mechanisms” by Open University 10. “Comparative Physiology of Animals: Environmental Approach” by Richard W Hill 11. The Comparative Physiology of the Pancreatic Islets (Zoophysiology)” by August Epple and Jack E Brinn. 	

<p>Course Outcome</p>	<ul style="list-style-type: none"> • Understand the early vertebrate morphogenesis.. • Understand and learn to compare endoskeleton of vertebrates.. • Understand and know to compare exoskeleton of vertebrates. • Ability to compare and understand circulatory and nervous system of vertebrates.. • Skill to compare endocrine system and urinogenital system of vertebrates
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Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	M	S	S	M	S	S	M
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation

Course code & Title	MZNY & CORE COURSE XIV PRACTICAL IV ENVIRONMENTAL BIOLOGY & EVOLUTON		
Class	II M.Sc., Zoology	Semester	VI
Cognitive Level	K-1 Acquire/Remember K2-Understand K3-Apply K-4 Analyze K-5 Evaluate K-6 Create		
Course Objectives	Course Aims: <ul style="list-style-type: none"> • To learn the community structure and its functions • Understand the habited ecology in different eco system • Learn the advanced technical remote sensing and radar image analysis • Understand the basic and modern concept of origin of life • Understand the evolution process of population at molecular level 		
UNIT	Content		No. of Hours
I	ENVIRONMENTAL BIOLOGY Report on ecological collection representing different habitats and their adaptations – sandy, muddy, rocky shores, Deep sea		18
II	Hydrological studies of water samples with special reference to pollution		18
III	Water quality index (WQI) calculation using 9 parameters such as pH, Temperature, Turbidity, Conductivity, Total solids, Dissolved Oxygen, BOD, Nitrate and Phosphate		18
IV	Qualitative and Quantitative estimation of Marine & Freshwater plankton		18
V	Spotters: stick insect, leaf insect, fossil records, Archaeopteryx, Mimicry and colouration. Student activity: observation on the locomotion of earthworm in different places and has to submit a case study report.		18

References**Text Books:**

1. BISWARUP MUKERJEE – Fundamentals of Environmental Biology –Silverline Publications – Allahabad.
2. AGARWAL – Environmental Biology – AgroBotanical Publishers (India)-New Delhi.

Reference Books:

1. ODUM, E.P. (1996) Fundamentals of Ecology (III Edn), Nataraj Publishers, Dehradun.
2. SHARMA, B.K. and KAUR, H. (1997). Environmental Chemistry, Goel Publishing House, Meerut.
3. TACCONI, L. (2000) . Biodiversity and Ecological Economics : Participation, Values and Resource Management . Earthscan Publications Ltd., London.
4. CASTRI, F.D. and YOUNES, T. (1996). Biodiversity : Science and Development. CAB Int., Wallingford, U.K.
5. CHAPMAN, J.L., and REISS, M.J. (1997). Ecology – Principles and Applications, CAMBRIDGE University Press, U.K.
6. CLARKE, G.L. (1963). Elements of Ecology, John Wiley and Sons, Inc., New York.
7. GHOSH, G.K. (1992). Environmental Pollution, Ashish Publishing house, New Delhi.
8. SHARMA, B.K. and KAUR, H. (1997). An Introduction to Environmental pollution, Goel Publishing House Meerut.
9. SINHA, R.K. (1996) Biodiversity (Global Concerns), Commonwealth Publishers, New Delhi.
10. MUNN, R.E. (1975) . Environment Impact Assessment, Principles and Procedures, John Wiley and Sons, Toronto.
11. AHMAD, Y.J and SAMMY, G.K. (1985). Guidelines to Environmental Impact Assessment in Developing Countries. Hodder and Stoughton, London.
12. KANNAN. K. (1991) . Fundamentals of Environmental pollution. S.Chand & Co., Ltd., New Delhi
13. KRISHANAN, N.T. (1994). Environmental Biology. JJ Publication, Madurai.

	14 .VERMA, S.R. , SHARMA, R.S. and RANI, G. (1988). Ecology and Animal behaviour. Jaiprakash Nath & Co., Meeru
Course Outcome	<ul style="list-style-type: none"> • Able to demonstrate broad based knowledge of the fundamentals of environmental biology and evolution.. • Ability to demonstrate skills in the observation and experimental study of organisms using both field based and laboratory based approach. • Understand in identifying analyzing, hypotheses, interpreting results and conclusions, and evaluating quality through critique.. • Hands on training in identification of plankton . • Have preparation of case study report and the scientific document preparation.

Mapping of COs with POs & PSOs

CO/PO	PO					PSO				
	1	2	3	4	5	1	2	3	4	5
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

S- Strongly correlating

M-Moderately Correlating

W-Weakly Correlating

N-No Correlation