ACHARYA NAGARJUNA UNIVERSITY

A State Government University, Accredited with "A" Grade by NAAC

Nagarjuna Nagar - 522 510, Guntur, Andhra Pradesh, India.

M.Sc. ZOOLOGY

SYLLABUS

2022 - 2023 onwards

UNIVERSITY COLLEGE OF SCIENCES

PROGRAM CODE:

ANUCS18


ACHARYA NAGARJUNA UNIVERSITY
సత్యం సర్వం ప్రతిష్ఠితమ్

ABOUT UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY (ANU)

- A Brief Profile

Acharya Nagarjuna University, a State University established in 1976, has been constantly striving towards achieving progress and expansion during its existence for over four decades, in terms of introducing new courses in the University Colleges, affiliated colleges and professional colleges. Spread over 300 acres of land on the National High Way (NH-16) between Vijayawada and Guntur of Andhra Pradesh, the University is one of the front ranking and fastest expanding Universities in the state of Andhra Pradesh. The University was inaugurated on 11th September, 1976 by the then President of India, Sri Fakruddin Ali Ahmed and celebrated its Silver Jubilee in 2001. The National Assessment and Accreditation Council (NAAC) awarded "A" grade to Acharya Nagarjuna University and also has achieved 108 International ranks, 39 National ranks UI Green Metrics rankings and many more It is named after Acharya Nagarjuna – one of the most brilliant preceptors and philosophers, whose depth of thought, clarity of perception and spiritual insight were such that even after centuries, he is a source of inspiration to a vast number of people in many countries. The University is fortunate to be situated on the very soil where he was born and lived, a soil made more sacred by the aspiration for light and a state of whole someness by generations of students. With campus student strength of over 5000, the University offers instruction for higher learning in 68 UG & PG programs and guidance for the award of M.Phil. and Ph.D. in 48 disciplines spread over six campus colleges and one PG campus at Ongole. It also offers 160 UG programs in 440 affiliated colleges in the regions of Guntur and Prakasam Districts. It has a Centre for Distance Education offering 87 UG & PG programs. Characterized by its heterogeneous students and faculty hailing from different parts of the state and the country, the University provides most hospitable environment for pursuing Higher Learning and Research. Its aim is to remain connected academically at the forefront of all higher educational institutions. The University provides an excellent infrastructure and on- Campus facilities such as University Library with over one lakh books & 350 journals; Computer Centre; University Scientific Instrumentation Centre; Central Research Laboratory with Ultra-modern Equipment; Well-equipped Departmental Laboratories; Career Guidance and Placement Cell; Health Centre; Sports Facilities with Indoor & Outdoor Stadiums and Multipurpose Gym; Sports Hostel; Separate hostels for Boys, Girls, Research Scholars and International Students; Pariksha Bhavan (Examinations Building); Computers to all faculty members; Wi-Fi connectivity to all Departments and Hostels; Canteen, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichmann& Dr. S.John David Auditorium cum Seminar Hall; Post office; Telecom Centre; State Bank of India; Andhra Bank; Energy Park; Silver Jubilee Park; Fish ponds; internet center; xerox center; cooperative stores; Water harvesting structures.

VISION, MISSION & OBJECTIVES OF THE UNIVERSITY

ACHARYA NAGARJUNA UNIVERSITY

VISION

To generate sources of knowledge that dispels ignorance and establish truth through teaching, learning and research.

MISSION

To promote a bank of human talent in diversified faculties – Commerce & Management Studies, Education, Engineering & Technology, Humanities, Law, Natural Sciences, Pharmacy, Physical Education & Sports Sciences, Physical Sciences and Social Sciences that would become an investment for a prosperous society.

OBJECTIVES

- To inspire and encourage all who would seek knowledge through higher education and research.
- To provide quality instruction and research for the advancement of science and technology.
- To promote teaching and research studies in disciplines of societal relevance.
- To bridge the gap between theory and practice of the principles of higher education.
- To develop human talent necessary for the industry.
- To open up avenues of higher education and research through non-formal means.
- To invite and implement collaborations with other institutes of higher learning on a continuous basis for mutual academic progress.
- To motivate and orient each academic department/centre to strive for and to sustain advanced levels of teaching and research so that the university emerges as an ideal institute of higher learning.
- To focus specially on the studies involving rural economy, justifying its existence in the rural setting.

VISION

&

MISSION OF THE COLLEGE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

VISION OF THE COLLEGE:

University College of Sciences envisages to be a good team of people with scientific temperament, research bent and a flair for Teaching & Learning for the betterment of the Community, Society, State and the Country at large.

MISSION OF THE COLLEGE:

The College intends to incubate and nurture the Leaders, Mentors, Educators and researchers who can transform the country and contribute to advances in science while addressing the challenges faced by the society for the betterment of human life.

VISION & MISSION OF THE DEPARTMENT

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF ZOOLOGY & AQUACULTURE

M.Sc. ZOOLOGY

VISION OF THE DEPARTMENT:

"To be a leading center for excellence in Zoology research and education, with a focus on advancing our understanding of animal life and its interactions with the environment. We aim to provide students with a comprehensive understanding of Zoology and its applications, and to contribute to the conservation of animal species and their habitats through innovative research and community engagement."

MISSION OF THE DEPARTMENT:

"To provide an exceptional education and research experience in Zoology, with a focus onadvancingknowledgeofanimalbiology,ecology,andconservation.Ourdepartmentiscommitted to fostering an environment of intellectual curiosity, scientific rigor, and ethicalresponsibility.Westrivetoprepareourstudentstobecomeleadersinthefieldof Zoology,andto contributeto society through their research and outreach activities."

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF ZOOLOGY & AQUACULTURE

M.Sc. ZOOLOGY

PROGRAM OUTCOMES (PO's):

The program outcomes for a Master of Science (M.Sc.) in Zoology

PO1: Develop an understanding of the fundamental principles of zoology, including animal taxonomy, anatomy, physiology, and behavior.

PO2: Demonstrate advanced research skills in the field of Zoology, including experimental design, data collection and analysis and scientific communication.

PO3: Understand the principles of ecology, including population dynamics, community interactions and ecosystem processes and their application to current environmental challenges.

PO4: Analyze current research in Zoology, including primary research articles and scientific reviews and apply this knowledge to address scientific questions and solve problems.

PO5: Develop critical thinking skills in designing and evaluating experiments related to Zoology and applying ethical principles to animal research.

PO6: Communicate scientific ideas effectively in writing and oral presentations, using appropriate scientific terminology and referencing conventions.

PO7: Demonstrate the ability to work independently and collaboratively on research projects and to manage data and other resources effectively.

PO8: Understand the role of Zoology in addressing current environmental challenges, such as habitat loss, climate change invasive species, and the application of Zoology to conservation biology.

PO9: Demonstrate an understanding of the principles of evolution, including the mechanisms of natural selection, genetic drift, and speciation, and their application to animal behavior, physiology and morphology.

PO10: Apply knowledge and skills acquired in the program to a range of professional and academic settings, such as careers in academia, conservation biology, environmental consulting and science journalism.

PROGRAM SPECIFIC OUTCOMES (PSO's):

PSO1: Understanding of animal diversity and classification characteristics.

PSO2: Proficiency in various laboratory techniques and field and ability to identify and classify different animal species based on their morphological and molecular methods used in Zoology research, including molecular biology, ecology and animal behavior studies.

PSO3: Ability to critically analyze scientific literature and to design and conduct in dependent research projects in the field of Zoology.

PSO4: Knowledge of the conservation challenges facing different animal species and ecosystems and ability to develop effective conservation strategies.

PSO5: Understanding of the ethical and legal issues related to animal research and conservation, and ability to apply ethical principles to scientific research and professional practices.

Overall, the PSOs for an MSC Zoology course aim to provide students with a comprehensive understanding of Zoology and its applications, while also develop their critical thinking, research, and professional skills. By achieving these PSOs, students will be well-prepared for careers in a wide range of fields related to animal biology, conservation and research.

STRUCTURE

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF ZOOLOGY & AQUACULTURE

M.Sc. ZOOLOGY

COURSE STRUCTURE

SEMESTER-I

S. No.	Components of Study	Title of the Course	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/ week
1.	**Mandatory Core**	**ZOO 1.1 (22)**	Structure and Function of Invertebrates and Vertebrates	4	30	70	100	
2.		**ZOO 1.2 (22)**	Biodiversity and Systematics	4	30	70	100	
3.	**Compulsory Foundation**	**ZOO 1.3 (a) (22)**	Developmental Biology	4	30	70	100	
4.	**Elective Foundation**	**ZOO 1.4 (a) (22)**	Molecular Cell Biology	4	30	70	100	
		ZOO 1.4 (b) (22)	Endocrinology					
		ZOO 1.4 (c) (22)	Marine and Brackish water ecology					
5.	**Practical-I**	**ZOO 1.5 (22)**	Invertebrates, Vertebrates and Biodiversity	4	30	70	100	
6.	**Practical-II**	**ZOO 1.6 (22)**	Developmental Biology and Molecular Biology	4	30	70	100	
TOTAL				**24**	**180**	**420**	**600**	
Elective Foundation–Choose one paper.								

SEMESTER-II

S. No.	Components of Study	Title of the Course	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/week
1.	**Mandatory Core**	**ZOO 2.1(22)**	Genetics and Evolution	4	30	70	100	
2.		**ZOO2.2(22)**	Comparative Animal Physiology	4	30	70	100	
3.	**Compulsory Foundation**	**ZOO2.3 (a) (22)**	Principles of Ecology	4	30	70	100	
4.	**Elective Foundation**	**ZOO2.4 (a) (22)**	Tools and Techniques in Biology	4	30	70	100	
		ZOO2.4 (b) (22)	Fish Physiology					
		ZOO 2.4 (c) (22)	Aquatic microbiology					
5.	**Practical-I**	**ZOO2.5(22)**	Genetics and Animal Physiology	4	30	70	100	
6.	**Practical-II**	**ZOO2.6(22)**	Ecology and Tools & Techniques in Biology	4	30	70	100	
7.	**Skill Development ZOO 2.7 (22) MOOCs/SDC Course**			4	00			
	TOTAL			**28**	**180**	**420**	**600**	
Elective Foundation–Choose one paper.								

SEMESTER-III

S. No.	Components of Study	Title of the Course	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/week
1.	**Mandatory Core**	**ZOO 3.1(22)**	Animal Biotechnology and Microbiology	4	30	70	100	
2.		**ZOO 3.2(22)**	Ichthyology	4	30	70	100	
3.	**Elective-I**	**ZOO 3.3 (a) (22)**	Limnology	4	30	70	100	
		ZOO 3.3 (b) (22)	Water quality management					
		ZOO 3.3 (c) (22)	Environmental Biology					
4.	**Elective-II**	**ZOO 3.4 (a) (22)**	Aquatic Toxicology	4	30	70	100	
		ZOO 3.4 (b) (22)	Aquaculture Engineering					
		ZOO 3.4 (c) (22)	Taxonomy and Functional Anatomy of Shellfish					
5.	**Practical-I**	**ZOO 3.5(22)**	Biotechnology, Microbiology and Ichthyology	4	30	70	100	
6.	**Practical-II**	**ZOO 3.6(22)**	Limnology and Toxicology	4	30	70	100	
7.	**Skill Enhanced**	**ZOO 3.7 (22)**	**MOOCs/SDC Course**	4	00	00		
		TOTAL		**28**	**180**	**420**	**600**	

Elective I – Choose one paper
Elective II – Choose one paper.

SEMESTER-IV

S. No.	Components of Study	Title of the Course	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/week
1.	**Mandatory Core**	**ZOO 4.1(22)**	Fish Pathology	4	30	70	100	
2.		**ZOO 4.2(22)**	Immunology	4	30	70	100	
3.	**Elective-I**	**ZOO 4.3 (a)(22)**	Aquaculture	4	30	70	100	
		ZOO 4.3 (b)(22)	Taxonomy and Anatomy of Finfish					
		ZOO 4.3 (c)(22)	Fish Nutrition					
4.	**Elective-II**	**ZOO 4.4 (a)(22)**	Aquaculture Management	4	30	70	100	
		ZOO 4.4 (b)(22)	Fish processing technology					
		ZOO 4.4 (c)(22)	Economic Zoology					
5.	**Practical-I**	**ZOO 4.5(22)**	Fish Pathology and Immunology	4	30	70	100	
6.	**Practical-II**	**ZOO 4.6(22)**	Aquaculture and Aquaculture Management	4	30	70	100	
7.	**ZOO 4.7 (22)**	**Project**		4	00	00	100	
		TOTAL		**28**	**180**	**420**	**700**	
Elective I – Choose one paper Elective II – Choose one paper								

1. Slightly Justified
2. Moderately Justified
3. Substantially Justified

FIRST SEMESTER

ACHARYA NAGARJUNA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCES

DEPARTMENT OF ZOOLOGY & AQUACULTURE

M.Sc. ZOOLOGY

SEMESTER-I

Z 1.1. (22) STRUCTURE AND FUNCTION OF INVERTEBRATES AND VERTEBRATES

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

This course is designed to

CO1: Understand the general characteristics of all invertebrates of coelom and about the nutrition, digestion, respiration.

CO2: To discuss about Larval forms of free-living invertebrates and Minor phyla general characters.

CO3: Remembering the biology and life cycles of Parasites and insects and its importance in environment.

CO4: Elucidate the comparative accounts of respiratory and circulatory systems of vertebrates.

CO5: Comparative anatomy and function of Nervous, sensory and urinogenital systems among different vertebrates.

UNIT – I

Invertebrates: General characters of invertebrates; Coelom - Origin and functions, acoelomates, pseudocoelomates and coelomates (Protostomia andDeuterostomia).

Nutrition and Digestion: Patterns of feeding and digestion in Cnidarians; filter feeding in Polychaeta, Mollusca and Echinodermata.

Respiration: Structure and function of respiratory organs in Annelida, Arthropoda and Mollusca - gills, lungs and tracheae.

Learning Outcome:

Students will understand the General characteristics of all invertebrates, and origin, functions and types of Coeloms, Patterns of feeding and digestion, and structure and function of respiratory organs in invertebrates.

UNIT – II

Invertebrate Larvae: Larval forms of free-living invertebrates;

Larval forms of parasites.

Minor Phyla: Organization and general characters of Rotifera, Phoronida and Chetognatha.

Learning Outcome:

Students will be familiar with the Larval forms of free-living and parasitic invertebrates, Organization and general characters of minor phyla like Rotifera, Phoronida and Chaetognatha

UNIT – III

Parasites: Life cycle and biology of *Trypanosoma gambiense*, *Leishmania donovani*, *Wuchereria bancrofti* and *Schistosoma haematobium*.

Insects: Insects and diseases;

Economic importance of insects.

Learning Outcome:

Students will be familiar with the

Life cycle, biology and diseases caused by protozoan and helminthic parasites.

Diseases caused by harmful insects and economic importance of beneficial insects.

UNIT – IV

Vertebrates: Important characters, nature of vertebrate morphology.

Respiratory system: Comparative account of respiratory organs invertebrates.

Circulatory system: Evolution of heart among vertebrates; Evolution of aortic arches and portal systems among vertebrates.

Learning Outcome:

Students should be able to describe the

- Salient features and morphology of vertebrates
- Comparative account of respiratory organs; evolution of heart, aortic archesand portal systems among vertebrates.

UNIT – V

Nervous system: Comparative anatomy and function of brain and cranial nerves in vertebrates. Comparative anatomy of spinal cord, spinal nerves and autonomous nervous system invertebrates.

Urinogenital system: Evolution of urinogenital systems among vertebrates.

Sensory organs: Olfactory and taste organs in vertebrate series; Lateral line system in fishes.

Learning Outcome:

Students will have a knowledge on the

Anatomy and function of nervous system, evolution of urinogenital system and sensory organs among vertebrates.

REFERENCE BOOKS:

1) Barrington EJW. Invertebrate Structure and Function.1976.Thomas Nelson and Sons Ltd. London.
2) Hyman LH. The Invertebrates. 1955. Vol.1 to 8, McGraw Hill Co., NewYork.
3) Parker TJ and Haswell WA. 1972. Text Book of Zoology. Vol. 2, Vertebrates (Eds.), AJ. Marshall, ELPS and Mac Millan.
4) Read CP. 1972. Animal Parasitism. Prentice Hall, Inc. New Jersey.
5) Ruppert EE, Fox RS & Barnes RD. 2004. Invertebrates Zoology, 7thedition, Thomson, Brooks/Cole.
6) Young JZ. The Life of Vertebrates.1962. Marion Nixon fromAmazon.com
7) Young JZ.1966. The Life of Mammals, Clarendon Press.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	2	1	2	2	1	2	3
CO2	2	1	3	1	1	2	2	1	3	1
CO3	2	3	2	2	3	2	3	2	2	2
CO4	1	2	2	1	2	3	2	1	2	2
CO5	2	1	1	1	2	1	2	3	2	2

Z 1.2. (22): BIODIVERSITY AND SYSTEMATICS

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO-1: To introduce basic concepts and significance of biodiversity and distribution of world.

CO-2: To analyze Hierarchical components of biodiversity, values and losses.

CO-3: Create awareness about systematics and species identification scientifically.

CO-4: Create knowledge about biodiversity management; in-situ and ex-situ conservation through technical aspects.

CO-5: Applied biotechnology in biodiversity including molecular taxonomy, GIS.

UNIT –I

Biodiversity: Definition and significance; biodiversity at global, national and local levels; magnitude and distribution of biodiversity.

Patterns of biodiversity: Latitudinal and altitudinal gradients; species area relationship

Biogeographic realms of the world.

Biogeographic zones of India and faunal diversity; Hotspots in the world and in India.

Learning outcome:

- Being aware of the significance and faunal diversity, distribution of hotspots in biogeographic realms at international, national, local levels and their patterns in respect of their latitude and altitudinal gradients. Analyze species area relationship.

UNIT – II

Hierarchical components of biodiversity: Species diversity, genetic diversity and ecosystem diversity.

Biodiversity values: Direct values and indirect values.

Biodiversity in peril: Causes of biodiversity losses and extinction; anthropogenic impact on biodiversity.

Learning outcome:

- Students have a good understanding of the Hierarchical components of the biodiversity, analyse and evaluate the values of biodiversity and investigate the losses and extinction of biodiversity through anthropogenic activity.

UNIT – III

Systematics: Species concept. Taxonomy and its components–classification and phylogeny, Cladistic classification.

Identification: Keys, biodiversity documentation, species identification and identification tools.

Nomenclature: International Code of Zoological Nomenclature (ICZN); Types: Holotype, Paratype, Neotype, Lectotype, Syntype, Homonymy and Synonymy.

Learning outcome:

Upon completion of this unit Student be aware about systematics, concepts, classification and phylogeny. Examine and execute species identification through tools by follow ICZN.

UNIT – IV

Biodiversity management and conservation

IUCN classification of wildlife.

Biodiversity threats; *In-situ* conservation and *Ex-situ* conservation.

Gene banks; conservation of genetic resource; cryopreservation.

Wildlife protection acts; organizations involved in protection of Biodiversity.

Learning outcome:

Student will learn about status of biodiversity through IUCN classification and implementation of various wildlife protection acts for conservation and management.

UNIT- V

Biodiversity and biotechnology: DNA based wildlife forensics; genetically modified organisms (GMOs) and Bioremediation.

Molecular taxonomy: DNA fingerprinting.

Satellite Remote Sensing and GIS programs; Environmental Impact Assessment (EIA).

Learning outcome:

Knowledge applied through biotechnology helps the DNA based wildlife forensics, GMOs, molecular taxonomy and also GIS programmes helps in the observation of movement of wild animals and evaluate environmental problems through EIA.

REFERENCE BOOKS:

1) Agarwal KC. 1998. *Biodiversity*. India.
2) *International Code of Zoological Nomenclature.* 1985. Third edition adopted by XX General assembly of the International Union of Biological Sciences, University of California Press, Berkeley and Los Angeles Edition.
3) Kormondy EJ. 1996. *Concepts of Ecology.* Eastern Economy Edition.
4) Oliver S & Owen Mc. *Natural Resource Conservation: An Ecological Approach.* Macmillan Publ. Co. New York.
5) Peggy I. Fieldler and Perer M. Kareiva. 1997. *Conservation Biology.*
6) Prabodh K. Maiti and PaulamiMaiti. 2011. *Biodiversity: Perception, Peril and Preservation.*
7) Saharia VV. 1982.*Wildlife in India.* Natraco Publishers, Dehradun.
8) TandonRK.1999. *Biodiversity, Taxonomy & Ecology.* Prithipal singh Scientific Publishers, Jodhpur.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	2	1	2	2	1	2	3
CO2	2	1	3	1	1	2	2	1	3	1
CO3	2	3	2	2	3	2	3	2	2	2
CO4	1	2	2	1	2	3	2	1	2	2
CO5	2	1	1	1	2	1	2	3	2	2

Z 1.3. (A) (22): DEVELOPMENTAL BIOLOGY

Course Type: Theory

Course Category: Compulsory foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO 1: The students can be able to remember the process of gametogenesis, including mitosis, meiosis and gamete formation in males and females.

CO2: Understanding the genetic and phenotypic variation that can arise from gamete formation, fertilization and the role of gametes in sexual reproduction and inheritance.

CO 3: By applying the differences between gametes and somatic cells in terms of chromosome number and DNA content.

CO 4: To analyze the evolutionary changes of gamete size , shape, factors that can influence gamete competition and mate choice .

CO 5: The reproductive strategies of different organisms including mogamy, promiscuity, asexuality and the ethical social implications of technologies related to gamete and embryo manipulations such as IVF, cloning and gene making.

UNIT – I:

Origin and migration of primordial germ cells (PGCs) to the genital ridges, differentiation of gonads in mammals.

Spermatogenesis: Sperm – formation, structure and types; Leydig cells – endocrine regulation of spermatogenesis.

Oogenesis: Formation and maturation of ovum, previtellogenesis, vitellogenesis, formation of yolk, functions of egg and types of eggs.

Learning outcome:

From the topic's gametogenesis the gonadial action with dual origin which helps in the maternal gene product with germ cell speciation in all invertebrates and vertebrates, which they confined with cytoplasmic bridges the during the yolk formation and function.

UNIT – II:

Fertilization: Cell surface molecules in sperm-egg recognition in animals, mechanism of fertilization, molecular events during fertilization and post fertilization.

Early Development: Zygote formation, cleavage, blastulation, gastrulation and formation of germ layers in animals; Fate maps and cell lineage.

Learning outcome:

By learning the process of fertilization, the gametes play an important role in different mammals and insects with the formation (or) development during fertilization process in mammals and basic approach to life of gametes is the outcome work during fertilization process in animals.

UNIT – III:

Cell aggregation and differentiation; axes and pattern formation in Drosophila, amphibian and chick.

Differentiation of neurons, post embryonic development.

Larval formation, metamorphosis in insects and amphibians.

Learning outcome:

In cell aggregation and differentiation, the development of nervous system, embryos, larval development metamorphosis and the role of endocrine system play an important role regulation system in formation of Drosophila, amphibians, chick and mammals in development biology.

UNIT – IV:

Programmed cell death: Incidence of apoptosis, apoptosis during animal development; apoptosis during limb development.

Aging and senescence; Dietary restriction and anti-aging action; Age related diseases.

Learning outcome:

The detailed out come in this chapter with apoptosis in animal development and apoptosis role in development process with special reference to aging and senescence's with life expectancy disorders and to know the diseases in human related factors.

UNIT – V:

Potency, commitment, Specification, Induction, Competence, Determination and differentiation.

Hormonal regulation of Meta morphosis in insects and amphibians.

Learning outcome:

The detailed out come in this unit with potency and specification and hormonal regulation in insects and amphibians.

REFERENCE BOOKS:

1) Austen CR and Short RV. 1980. Reproduction in Mammals. Cambridge University Press.
2) Gilbert SF. 2006. Developmental Biology, 8th Edition. Sinauer Associates Inc., Publishers, Sunderland, USA.
3) Longo FJ. 1987. Fertilization. Chapman & Hall, London.
4) Rastogi VB and Jayaraj MS. 1989. Developmental Biology. Kedara Nath Ram Nath Publishers, Meerut, Uttar Pradesh.
5) Schatten H and Schatten G. 1989. Molecular Biology of Fertilization. Academic Press, New York.
6) Sreekrishna V. 2005. Biotechnology –I, Cell Biology and Genetics. New Age International Publ. New Delhi, India.
7) Subramonian T. 2008. Molecular Developmental Biology. Narosa Publishing House.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	1	2	1	2	2	1	2	3
CO2	2	2	2	1	1	2	2	1	3	1
CO3	2	3	2	2	3	2	3	2	2	2
CO4	1	2	2	1	2	3	2	1	2	2
CO5	2	1	2	1	2	3	2	2	2	2

Z 1.4. (A) (22): MOLECULAR CELL BIOLOGY

Course Type: Theory

Course Category: Elective foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: Understand the basic principles of molecular biology and how they apply to cellular processes.

CO2: Explain the molecular mechanisms of DNA replication, transcription and translation.

CO3: Analyze the structure and function of proteins, enzymes, and other macromolecules involved in cell signaling, metabolism, and regulation.

CO4: Understand the principles of genetic inheritance, including gene expression and regulation, and how these processes are involved in cellular differentiation and development.

CO5: Discuss current research in molecular cell biology and the applications of this knowledge to biotechnology, medicine, and other fields.

UNIT– I

Composition, Structure and Functions of Carbohydrates and Proteins.

Composition, Structure and Functions of Lipids and Nucleic Acids.

Learning outcome:

Students are able to understand the basic principles of molecular biology and cellular processes

UNIT– II

Membrane Structure and Function: Phospholipid Bilayer and Membrane Proteins, Diffusion, Osmosis, Active Transport, Ion channels, Ion pumps, Electrical Properties of Membrane.

Bioenergetics, Glycolysis, OxidativePhosphorylation.

Learning outcome:

Students are aware with molecular mechanisms of DNA replication, transcription and translation.

UNIT– III

RNA Synthesis and Processing: Transcription Factors and Machinery, Formation of Initiation Complex, Transcription Activators and Repressors, RNA Polymerases, Capping, Elongation and Termination (RNA Processing, RNA Editing, Splicing and Polyadenylation), RNA transport.

Protein Synthesis and Processing: Translation, Ribosome, Formation of Initiation Complex, Initiation Factors and their Regulation, Elongation and Elongation Factors, Termination, Aminoacylation of tRNA, Aminoacyl Trna Synthetase and Translational Proof reading, Translational Inhibitors: Antibiotics, Post-translational Modification of Proteins.

Learning outcome:

Students are able to understand the structure and function of proteins, enzymes, and other macromolecules involved in cell signaling, metabolism, and regulation.

UNIT– IV

Control of Gene Expression at Transcription and Translation Level: Prokaryotic and Eukaryotic Gene Expression.

Regulation of Expression of Viral and Phage Genes, Role of Chromatin in Gene Expression, Gene Silencing.

Learning outcome:

Students are aware with principles of genetic inheritance, including gene expression and regulation, and how these processes are involved in cellular differentiation and development.

UNIT– V

Organization of Gene and Chromosome: Structure of Gene and Chromosomes, Unique and Repetitive DNA, Heterochromatin vs. Euchromatin, Operon Concept, Interrupted Genes, Gene Families, Transposons.

Cell Cycle and Cell Division: Steps in Cell Cycle, Control of Cell Cycle, Mitosis and Meiosis.

Learning outcome:

Students are able to go for current research in molecular cell biology and the applications of this knowledge to biotechnology, medicine, and other fields.

REFERENCE BOOKS:

1) Bourne GH.1970.*Division of Labour in Cells* .Academic Press, New York.
2) DeRobertisRMFandSaezRDP.1970.*Cell Biology.* Academic Press, New York.
3) Gilman M, Witkowsk JA and WatsonMZJD.1992. *Recombinant DNA*.2nd Edition. Scientific American Books, W.H. Freeman and Company, New York.
4) LevineL.1973.*Biology of the Gene.* 2nd Edition.
5) Pragya Khanna.2008.*Cell and Molecular Biology.* I.K. International Publ. House Pvt. Ltd. New Delhi
6) WhiteMJD.1973.*Animal Cytologyand Evolution.* Cambridge University Press.
7) Weaver.1999.*Molecular Biology*.WCB McGraw Hill.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	1	2	2	2	2	1	3	3
CO2	1	2	2	2	3	1	1	2	2	2
CO3	2	2	1	3	1	2	1	3	1	2
CO4	1	2	2	1	2	3	2	1	2	2
CO5	2	1	1	1	2	1	2	3	2	3

Z 1.4. (B) (22): ENDROCRINOLOGY

Course Type: Theory

Course Category: Elective foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts about biosynthesis of hormones and the factors influencing the secretions.

CO2: To understand the Hormones as messengers and the evolution of essential endocrine glands and their structure.

CO3: Analyzing the evolution of structural and functional organization of thyroid hormone action in different phylum.

CO4: To discuss about the Evolution, Synthesis and structural diversity of steroid hormones on human health.

CO5: To understand the growth, development and reproductive regulation of hormones.

Unit 1:

Classification of hormones. Brief account of structural features of endocrine glands. Hormonal effects and regulation – basic concepts and methods

Biosynthesis and secretion of pituitary. Factors influencing secretion.

Endocrine disorders - brief description

Learning Outcome: Students will get awareness about the origin of Endocrine glands, Biosynthesis and influencing factors of Pituitary.

Unit 2:

Biosynthesis and secretion of pancreas, adrenal hormones. Factors influencing secretion.

Peptide hormones, Steroid hormones. Hormones as messengers. Cell surface receptors. Cascade of reaction linked to signal transduction.

Evolution of pituitary gland; Physiological actions of pituitary hormones. Urophysis and action of its hormone(s). Pancreatic hormones and glucose homeostasis.

Learning Outcome: Upon completion of the above unit they are able to understand the role of hormones in human physiology.

Unit 3:

Evolution, Biosynthesis and Secretion of thyroid gland.

Thyroid hormone synthesis and its regulation, paradigms of thyroid hormone action in poikilotherms and homeotherms.

A comparative account of parathyroid gland and ultimobranchial body/C cells, synthesis of parathyroid hormone, calcitonin and of vitamin D3.

Learning Outcome: On completion of this unit students are able to differentiate the hormonal synthesis and their functions.

Unit 4:

Evolution of discrete adrenal gland; Synthesis of corticosteroid

Structural diversity of glucocorticoids among vertebrates.

Hormones and human health

Learning Outcome: Students acquire knowledge about the evolution of adrenal gland, synthesis of different steroids and their regulation on human health.

Unit 5

Hormones growth and development.

Hormone's role in Reproduction.

Hormones regulating reproduction.

Learning Outcome: Significant role of hormones on growth, development and reproduction.

REFERENCE BOOKS:

1) Barrington. EJ.W. General and comparative Endocrinology Cambridge Press, Oxford.
2) Bentley, PJ. Comparative Vertebrate Endocrinology, Cambridge Press, Oxford.
3) Martin, C.R. Endocrine Physiology. Oxford Univ. Press, Oxford.
4) Prakash S. Lohar. Endocrionology-Hormones and human health-2005. MJP Publishers-Chennai.
5) Williams, R.H. Text Book of Endocrinology, W.B. Saunders Co., Philadelphia.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	3	3	1	2	3	2	2	1
CO2	2	1	2	2	3	2	2	2	2	1
CO3	3	2	1	1	1	1	2	2	1	2
CO4	2	1	3	2	2	2	2	2	2	2
CO5	2	1	2	1	1	2	2	2	1	1

Z 1.4. (C) (22): MARINRE AND BRACKISH WATER ECOLOGY

Course Type: Theory

Course Category: Elective foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To study the classification and distribution of life and their adaptations in marine environment.

CO2: To know about the organic production and Human impact in coastal ecosystem.

CO3: To discuss about the classification and Ecology of some typical brackish water habitats of India.

CO4: To create awareness about structure, functions and adaptations of fauna in estuarine ecosystem.

CO5: To know about the Human impact on coastal and estuarine management in the 21st century.

UNIT – I: Marine Ecology

Classification of the marine environment and salient features of different zones.

Classification of marine organisms and their characteristic features.

Shore environment: Physico-chemical and biological factors of intertidal zone; distribution of life on rocky, sandy, mud shores and their characteristic features; fauna and their adaptations.

Learning Outcome: Students are able to learn about the classification of marine environment and characteristic features of shore environment.

UNIT – II

Organic production of the sea: Primary, secondary and tertiary production; factors affecting primary production; measurement of organic production.

Marine food chains and food webs.

Human impact and management of coastal ecosystems.

Learning Outcome: Upon completion of the above unit they are able to understand the organic production and Human impact and management of coastal ecosystem.

UNIT – III: Brackish water Ecology

Classification of brackish water habitats and salient features of different zones: Estuaries, Mangroves, lakes, lagoons and marshes/ wetlands.

Ecology of some typical brackish water habitats of India: Estuaries – Hooghly-Matlah, Mahanadi, Godavari, Krishna, Cauvery and west coast estuaries; lakes- Chilka, Pulicat.

Learning Outcome: Students are able to know about the classification and ecology of some typical brackish water habitats of India.

UNIT – IV

Structure and function of estuarine ecosystems: Physico-chemical features, mineral cycling (CNP), biotic communities, estuarine food webs and energy flow.

Estuarine fauna and their adaptations.

Learning Outcome: Students are able to understand the structure and function and faunal adaptations in estuarine ecosystem.

UNIT – V

Human impact and management of estuarine ecosystems.

Changes in Biotic structure due to harvest and introduction of new species.

Coastal and estuarine management in the 21st century.

Learning Outcome: Students are able to identify the human impact and significance of coastal and estuarine management in the 21st century.

REFERENCE BOOKS:

1) Balakrishnan Nair N and Thampi DM. 1980. *A Text Book of Marine Ecology*. Macmilaan Company of India Ltd. Delhi.
2) Clark JR. 1992. *Integrated Management of Coastal Zones*. FAO Fisheries Tech. No. 327, Rome.
3) Goudie A. 1993. *The Human Impact on the Natural Environment.* MIT Press.
4) Lewis JR. 1964. *The Ecology of Rocky Shores*. The English Universities Press Ltd. London.
5) Reid GK and Wood RD. 1976. *Ecology of Inland waters and Estuaries*. Van Nostrand Company.
6) Sverdrup HV, Johnson MW and Fleming RH.1942. *The Oceans: their physics, chemistry and general biology.* Prentice Hall, Inc. New York.
7) Santhanam R and Srinivasan A. 1994. *A Manual of Marine Zooplankton*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	2	2	1	1	2	2	1
CO2	1	2	1	2	1	2	3	1	2	1
CO3	1	2	1	2	1	1	2	2	3	2
CO4	2	1	2	3	3	2	1	2	1	1
CO5	1	2	1	2	3	2	1	1	2	1

PRACTICAL – I:

ZP 1.5 (22): INVERTEBRATES, VERTEBRATES AND BIODIVERSITY

INVERTEBRATES

1) Nervous system of *Squilla/Sepia*.
2) Digestive system of *Squilla/Sepia*.
3) Nervous system of Prawn.
4) Digestive system of Prawn.
5) Appendages of Prawn.
6) Sting of Honey bee.
7) Gnathochilarium of Millipede.
8) Museum specimens and slides relevant to the type study in theory.

VERTEBRATES

1) *Trichiurus* – IX and X cranial nerves.
2) Catfish – Weberian ossicles.
3) *Anabas* – Accessory respiratory organs.
4) Museum specimens and slides relevant to the type study in theory.

BIODIVERSITY

1) List of local fauna (invertebrates and vertebrates).
2) Faunal diversity of man-made ecosystem.
3) Endangered species of Indian sub-continent (invertebrates and vertebrates).

PRACTICAL - II:

ZP 1.6. (22): DEVELOPMENTAL BIOLOGY AND MOLECULAR CELL BIOLOGY

DEVELOPMENTAL BIOLOGY

1) Identification of shrimp larvae.
2) Frog developmental stages – egg, 4 and 8 celled stage, blastula, gastrula and tadpole larva.
3) Chick embryonic stages – 18hour, 24hour, 36hour, 48 hour and 72 hour embryo.
4) Embryos of rat, rabbit and pig.
5) Estimation of calcium and phosphorus in egg shell.
6) Estimation of carbohydrates and proteins in egg.

MOLECULAR CELL BIOLOGY

1) Identification of different stages of Mitosis and Meiosis.
2) Observation of Mitosis in Onion root-tip cells.
3) Observation of Meiosis in Cricket/ Grasshopper testis.
4) Preparation and Staining of Blood Smear.
5) Buccal Smear preparation for identification of Barr body.
6) Observation of permanent slides of Cytology.

SECOND SEMESTER

M.Sc. ZOOLOGY

SEMESTER-II

Z 2.1. (22): GENETICS AND EVOLUTION

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO :1. To provide fundamental knowledge in Mendelian principles.
CO :2 To evaluate human genome project quantitative and qualitative traits of human beings.
CO :3 Remembering the concepts of evolution, and hardy- Weinberg law of equilibrium.
CO :4 Elucidate the mega evolution and models of speciation.
CO :5 Analyse the convergent and divergent evolution and adaptive radiation in vertebrates.

UNIT – I

Genetic Principles: Mendelian principles; interaction of genes, linkage and crossing over, sex linkage and sex determination; Extrachromosomal inheritance.

Behavioral genetics in *Drosophila* and bees.

Learning Outcome: Students will be familiar with the Mendelian laws, other genetical processes common in animals and Behavioural genetics in insects.

UNIT – II

Human Genetics: Human Genome Project, Pedigree analysis, Quantitative and qualitative traits of human beings, blood group inheritance, concepts of eugenics.

Inborn errors of metabolism; Chromosomal abnormalities.

Learning Outcome: Students should be able to know the Human genetics including Human genome project and genetic disorders.

UNIT – III

Concepts of Evolution: Theories of organic evolution – Lamarckism, Darwinism, Modern synthetic theory, Mutations.

Hardy-Weinberg law of equilibrium; genetic drift – random genetic drift.

Learning Outcome: Students will understand the Theories of organic evolution, modern synthetic theory, mutations, Hardy-Weinberg law of equilibrium and genetic drift.

UNIT – IV

Mega Evolution: Isolation, pattern and mechanisms of reproductive isolation;

Mechanism of speciation, phylogenetic and biological concepts of species; models of speciation – allopatric, parapatric and sympatric.

Learning Outcome: Students will learn the Isolation, pattern, mechanisms and models of speciation

UNIT – V

Convergent and divergent evolution;

Adaptive radiation in amphibians, reptiles and mammals.

Learning Outcome: Students will learn the Convergent & divergent evolution and adaptive radiation in animals.

REFERENCE BOOKS:

1) Burns GW. 1972. *The Science of Genetics. An Introduction to Heredity*. Mac Millan Publ.Co.Inc.
2) Gardner EF. 1975. *Principles of Genetics.* John Wiley & Sons, Inc. NewYork.
3) Harth and Jones EW. 1998. *Genetics – Principles and Analysis.* Jones and Bar Hett Publ.Boston.
4) Levine L. 1969. *Biology of the Gene.*Toppan.
5) Pedder IJ. 1972. *Genetics as a Basic Guide*. W. Norton & Company, Inc.
6) Rastogi VB. 1991. *A Text Book of Genetics.* Kedar Nath Ram Nath Publications, Meerut, Uttar Pradesh, India.
7) Rastogi VB. 1991. *Organic Evolution.* Kedar Nath Ram Nath Publications, Meerut, UttarPradesh, India.
8) Stahl FW. 1965. *Mechanics of Inheritance.* Prentice-Hall.
9) White MJD. 1973. *Animal Cytology and Evolution.* Cambridge Univ.Press.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	1	2	2	1	2	1	1
CO2	1	2	1	1	2	1	3	1	2	1
CO3	2	1	2	1	2	2	3	1	2	2
CO4	2	1	1	2	1	1	2	3	2	1
CO5	1	2	2	3	2	1	2	1	1	2

Z 2.2. (22): COMPARATIVE ANIMAL PHYSIOLOGY

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: Ability to compare and contrast the physiological adaptations of different animals in different environments

CO2: Understanding the challenges in animals face in maintaining homeo- stasis such as thermo regulatory and various physiological such as metabolism, respiration, circulation, Osmo regulation and excretory system

CO 3: To recognize and analyze the mechanisms in animals to regulate their internal; environment in response to external stimuli.

CO 4: To integrate knowledge of molecular, cellular and organosomal physiology to understand the animal function.

CO 5: Appreciation of diversity of life and the remarkable adaptations that allow animals to survive and thrive in different environments.

UNIT – I

Transformation of energy in animals: Bio-energetics; diversity in operations, Factors regulating enzyme activity, energy producing reactions, proteolytic enzymes, pathways of cellular metabolism. Nutrition impairment and stress.

Learning outcome

In the topic of transformation of energy in the environment and diversity in operations can be regulation and the energy reactions with the enzymes in the cellular metabolic can be estimated in their unit.

UNIT – II

Digestion: Process of digestion and absorption; energy balance; Basal Metabolic Rate.

Respiration: Mechanism of gaseous exchange in animals; neural and chemical regulation.

Blood: Composition and function of blood; respiratory pigments and their functions.

Circulation: Comparative account of circulatory system in animals.

Learning outcome:

In the process of digestion, we can learn regarding the food digested in body, respiration through different necessary organs the way of circulation in different living organisms can be identified.

UNIT – III

Thermoregulation in poikilotherms and homeotherms.

Muscles: Structure and function of muscles; Theories of muscle contraction.

Nervous system: Neurons, action potential, neural control of muscle tone and posture; propagation of nerve impulse and synaptic transmission in animals.

Learning outcome

Thermoregulation is the process to different temperature adaptations in the environment that how living organisms can live in different environment conditions through movement and nervous system and propagation in different animals by the students can learn regarding the above said themes.

UNIT – IV

Excretion and Osmoregulation: Comparative account of structure and function of kidneys in animals; regulation of water and electrolyte balance.

Endocrinology and reproduction: Endocrine glands in animals, mechanism of hormonal action; Hormonal regulation in reproduction; growth and development – Regeneration, moulting and metamorphosis.

Learning outcome

The detailed out comes from thischapters in regarding sensory organs, excretory and osmoregulation and endocrinology and reproductive process in different living organisms which are confined to aquatic and terrestrial organisms

UNIT – V

Chromatophores and Significance of chromatophores and colour change in animals--Photo-receptors, Phono- receptors, Tango receptors, and Chemoreceptor's occurrence and Functional significance of Bioluminescence.

Learning outcome

The detailed out comes from this chapters in regarding sensory organs, excretory and osmoregulation and endocrinology and reproductive process in different living organisms which are confined to aquatic and terrestrial organisms.

REFERENCE BOOKS:

1) Eckert H. Animal Physiology: Mechanisms and Adaptation. W.H. Freeman & Company.
2) Floray E. An Introduction to General and Comparative Animal Physiology. W.B. Saunders Co., Philadelphia.
3) Goel KA and Satish KV. 1989. A Text Book of Animal Physiology, Rastogi Publications, Meerut, U.P.
4) Hoar WS. General and Comparative Physiology. Prentice Hall of India, New Delhi.
5) Lehninger AL. Nelson and Cox. Principles of Biochemistry. Lange Medical Publications, New Delhi.
6) Prosser CL and Brown FA. Comparative Animal Physiology. W.B. Saunders Company, Philadelphia.
7) Schmidt-Nielson K. Animal Physiology. Cambridge University Press, Cambridge.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	1	2	1	2	1	3	2	1
CO2	1	2	2	1	2	2	3	2	1	2
CO3	1	2	2	1	2	1	2	3	2	1
CO4	1	2	3	1	2	1	2	1	2	2
CO5	2	2	1	2	1	1	2	1	2	3

Z 2.3. (A) (22): PRINCIPLES OF ECOLOGY

Course Type: Theory

Course Category: Compulsory foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO-1: To introduce the scope, structure, function of composition of ecosystems.

CO-2: To understand the trophic dynamics of ecosystem, limiting factors and concept of habitat and niche.

CO-3: Understanding population ecology through applying mathematical methods.

CO-4: The course is also aimed to evaluate about the community ecology, population regulation, for sustainable development of ecosystems.

CO-5: To understand the concept of productivity, biomagnification, biomonitoring and conservation of ecosystems.

UNIT – I

Ecology: Nature and scope of ecology; ecosystem structure and function.

Composition: Abiotic and biotic components; classification of ecosystem with examples; feedback loop.

Major terrestrial biomes; ecotone, edge effect and advantages and disadvantages.

Learning outcome:

Acquire fundamental knowledge and understanding the important ecological components and their function. recognize terrestrial biomes.

UNIT – II

Trophic dynamics of ecosystem: Energy flow; food chain; food web; trophic levels; ecological pyramids

Limiting factors: Liebig's law of the minimum and Shelford's law of tolerance.

Habitat and niche: Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource patitioning and character displacement.

Learning outcome:

Acquire knowledgeabout the habitat and niche of organisms under different trophic levels of ecosystem the energy flow. Applying concept of limiting factors in ecosystem.

UNIT – III

Population ecology: Population characteristics – density, natality, mortality, immigration and emigration; life tables generation

Population growth: Population growth of organisms with non-overlapping generations;

Verhulst-Pearl logistic growth models; stochastic and time log models of population growth; net reproductive rate and reproductive value.

Stable distribution; population growth projection using Lesile Matrix method.

Life history strategies: *r-k* selection; survivorship curves.

Learning outcome:

Students shall acquire knowledge about population dynamics through mathematical, statistical analysis and understanding the critical stages of organisms in population growth.

UNIT – IV

Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement.

Population regulation: Inter specific relationships and intra specific relationships (extrinsic and intrinsic mechanism of population regulation).

An overview on **sustainable development** of ecosystems.

Learning outcome:

Students have a good Understanding the concept of community ecology, population regulation and acquire knowledge in sustainable development.

UNIT-V

Biological magnification.

Productivity: Concept of productivity – primary, secondary, tertiary; Recycling of materials.

Biomonitoring: Biological monitoring programme; principles of conservation and conservation of ecosystems.

Learning outcome:

Student have Learning the concepts of productivity, materials recirculation and ecosystem conservation.Create awareness about bio magnification and bio monitoring

REFERENCE BOOKS:

1) Chapman JL and Reiss MJ. 1995. *Ecology Principles and Application.* Cambridge Univ. Press.
2) Kormondy EJ. *Concepts of Ecology*. Eastern Economy Edition.
3) Krebs CJ. *Ecology.* Harper and row, New York.
4) Krebs CJ. *Ecological Methodology*. Harper and Row, New York.
5) Odum EP. 1983. *Basic Ecology.* Saunders Publishing.
6) Sharma PD. 1991. *Ecology and Environment.*
7) Trivedy RK, Goel and Trisa. 1997. *Practical methods in Ecology & Environmental Science.*

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	2	1	2	2	1	2	1	2
CO2	2	1	2	2	1	2	1	3	1	1
CO3	1	2	3	1	2	1	2	3	2	1
CO4	1	1	2	3	2	1	2	1	1	2
CO5	2	1	2	1	1	1	2	3	2	1

Z 2.4. (A) (22): TOOLS AND TECHNIQUES IN BIOLOGY

Course Type: Theory

Course Category: Elective foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To provide information regarding different types of Microscopies, principles involved and working conditions of Microscopes up to SEM TEM and STEM.

CO2: To make understand about different types of spectroscopies, and the related principles involved and working conditions and applications of these spectroscopies and the advantages in scientific investigations.

CO3: To learn about the importance of different types of chromatographic techniques and electrophoretic techniques the principle involved, applications as analytical tools and their uses in the biological sample analysis.

CO4: To impart knowledge on the nucleic acid blotting techniques, Sequences and nomenclature data information sources like NCBI, GDB, MGB, data retrieval tools in analyzing the biomolecules.

CO5: To provide about the statistical analysis processes involved in the data collection, Sampling

distribution, measures of central tendencies and probability distributions Standard deviation, standard error and confidence interval; Regression and Correlation. Different tests of significance and Usage of Statistical Package for Social Sciences (SPSS).

UNIT – I

Microscopies: Working principle and types of Optical Microscopy – dark-field, phase-contrast, interference, polarization and fluorescence microscopy; Working principle and types of Electron Microscopy – Transmission electron microscopy (TEM), Scanning electron microscopy (SEM) and Scanning-Transmission electron microscopy (STEM); Different fixation and staining techniques for electron microscopy.

Learning outcome:

Students will be familiar with

- Different types of Microscopies, their working principles and uses

UNIT-II

Spectroscopies: Working principle of UV-Visible spectrophotometry, IR spectroscopy, AtomicAbsorption Spectroscopy (AAS), Fluorescence and Phosphorescence spectroscopy, Electron Spin

Resonance (ESR) spectroscopy, mass spectrometry, X-ray crystallography and Nuclear Magnetic Resonance (NMR) spectroscopy.

Learning outcome:

Students will be familiar with

- Different spectroscopic methods, working principles and applications
- Recent advances in the existing instrumentation and their evolution

UNIT – III

Chromatography: Principles and applications of Gel filtration, Paper, Column, Ion-exchange, Affinity, Thin layer (TLC),Gas liquid (GLC) and High-Performance Liquid Chromatography (HPLC)

Electrophoresis: Agarose gel electrophoresis, Pulsed Field Gel Electrophoresis (PFGE), Polyacrylamide Gel Electrophoresis (PAGE), Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE), Two-dimensional electrophoresis - Iso-electric focusing (IEF).

Learning outcome:

Students will be familiar with

- Chromatographic techniques, their working principles, applications and uses
- Different electrophoretic methods, working principles and applications
- Recent advances in the existing instrumentation and their evolution

UNIT – IV

Nucleic acid blotting techniques: Southern blotting, Northern blotting and Western blotting; Polymerase Chain Reaction (PCR); DNA fingerprinting; Genomics and Proteomics.

Sequences and nomenclature: IUPAC symbols, nomenclature of DNA sequences, nomenclature of protein sequences, directionality of sequences, types of sequences used in bioinformatics.

Information sources: NCBI, GDB, MGB, data retrieval tools, database similarity searching, resources for gene level sequences, use of bioinformatics tools in analysis.

Learning outcome:

Students will be familiar with

- Blotting techniques, their working principles, applications and uses in analysis of Nucleicacids
- Nomenclature of DNA sequences, nomenclature of protein sequences types of sequences used inbioinformatics.
- Data retrieval tools, database similarity searching, resources for gene level sequences, use of bioinformatics tools in analysis.

UNIT – V

Bio-statistics: Measures of central tendency and dispersal – mean, median and mode; Probability distributions - binomial, poisson and normal; Sampling distribution.

Standard deviation, standard error and confidence interval; Regression and Correlation.

Tests of significance: Levels of significance, X 2 test, t-test and Analysis of Variance (ANOVA).

Usage of Statistical Package for Social Sciences (SPSS).

Learning outcome:

Students will be familiar with

- Sampling distribution, measures of central tendencies and probability distributions
- Standard deviation, standard error and confidence interval; Regression and Correlation.
- Different tests of significance and Usage of Statistical Package for Social Sciences (SPSS).

REFERENCE BOOKS:

1) Brewer JM, Pesce AJ & Ashworth RB. 1974. Experimental Techniques in Biochemistry. Prentice-Hall.
2) Diamond PS & Denman RF. 1966. Laboratory Techniques in Chemistry and Biochemistry. Butterworths
3) Dubey, R.C., 2006. A Text Book of Biotechnology. S. Chand & Company Ltd., New Delhi.
4) Eaton AD, Clesceri LS, Rice EW & Greenberg AE. 2005. Standard Methods for the Examination of Water and Wastewater. APHAAWWA-WEF, Washington DC.
5) Fishbein L. 1973. Chromatography of Environmental Hazards: Metals, Gaseous andIndustrial Pollutants. Elsevier.
6) 6 Jeffery GH, Basset J, Mendham J & Denney RC.(Eds.).1989. Vogel's Textbook of Quantitative Chemical Analysis. Longman.
7) Nelson DL and Cox MM. 2005. Lehninger Principles of Biochemistry. WH Freeman.
8) Murray RK, Granner DK, Mayes PA & Rodwell VW. 2000. Harper's Biochemistry. Appleton & Lange.
9) Narayanan, P. 2005. Essentials of Biophysics, New Age International (P) Ltd., New
10) Delhi, India.
11) Satyanarayana, U. 2005. Biotechnology. Books and Allied (P) Ltd., Kolkata, India.
12) Sparks DL, Page AL, Helmke PA, Loeppert RH, Soltanpour PN, Tabatabai MA, Johnston CT & amp; Sumner ME.(Eds.). 1996. Methods of Soil Analysis: Part 3.Chemical Methods. SSSA-ASA, Madison.
13) Welch PS. 2003. Limnological Methods. Narendra Publ. House.
14) Wilson K & Walker J. 2002. Practical Biochemistry: Principles and Techniques. Cambridge University Press, Oxford.
15) Anderson TW.1984. An Introduction to Multivariate Statistical Analysis. Wiley Series in Probability and Statistics, Singapore
16) Biradar RS. 2002. Course Manual on Fisheries Statistics. 2nd Ed. CIFE, Mumbai.
17) Ghosh S. 1999. Multivariate Analysis, Design of Experiments and Survey Sampling. Marcel Dekker.
18) Keller G. 2001. Applied Statistics with Microsoft Excel. Duxbury.
19) William RD & Matthew G. 1984. Multivariate Analysis, Methods and Applications.
20) John Wiley & Sons.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	1	2	1	2	1	1	2
CO2	1	2	1	2	1	2	1	3	2	1
CO3	2	1	2	1	1	2	1	1	3	2
CO4	1	2	2	3	2	1	2	2	1	1
CO5	1	2	1	3	2	1	1	2	1	3

Z 2.4. (B) (22): FISH PHYSIOLOGY

Course Type: Theory

Course Category: Elective foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts about Digestion, role of hormones in regulation of digestion and metabolism.

CO2: To study about the concepts of Respiration, Mechanism of gaseous exchange and Circulation.

CO3: To discuss about Sensory organs and Osmoregulation.

CO4: To study the concepts of Excretion, Reproduction and Development in Fishes.

CO5: To study about the Endocrine Organs in fishes and Neuro-Endocrine system in Crustaceans.

UNIT – I

Digestion: Digestion of carbohydrates, lipids and proteins; Digestive enzymes and regulation of their secretions; Absorption and assimilation of nutrients; Role of hormones in the regulation of digestion; Factors affecting digestion and transport of nutrients.

Metabolism: Pathways of cellular metabolism.

Learning Outcome: Students are able to learn about the concepts of Digestion and Pathways of cellular metabolism

UNIT – II

Respiration: Definition of respiration; external respiration and internal respiration.

Mechanism of gaseous exchange, CO_2 transport, countercurrent principle, water flow across the gills, respiratory pumps.

Circulation: Role of blood in transport of gases; composition and function of blood.

Learning Outcome: Upon completion of the above unit students get awareness about Respiration, Mechanism of Gaseous Exchange and Circulation.

UNIT – III

Sensory organs: Structure and function of chemo-, photo- and photoreceptor, lateral line sense organs.

Action potential, synapse, neurotransmitters, impulse transmission.

Osmoregulation: Mechanism of osmotic and ionic regulation; endocrine control of Osmoregulation

Learning Outcome: On completion of the unit students are able to identify the structure and function of Sensory Organs and the significance of Action potential and Osmoregulation.

UNIT – IV

Excretion: Mechanism of excretion of nitrogenous waste, water and ionic balance.

Reproduction and Development: Reproductive structure in fishes, Development of gonad: oogenesis, spermatogenesis, metabolic changes during oogenesis and spermatogenesis

Learning Outcome: Upon completion of the above unit students are able to understand the concepts of Excretion, Reproduction and Development.

UNIT –V

Endocrine system in fishes: Endocrine organs in fishes; Regulation of hormonal control on Reproduction in fishes.

Neuro-endocrine system in crustacean and its role in the regulation of reproduction.

Learning Outcome: To understand the Endocrine system in fishes and Neuro-endocrine system in crustaceans.

REFERENCE BOOKS:

1) Adiyodi KG & Adiyodi RG. 1971. Endocrine Control of Reproduction in Decapod Crustacea. Biology Reviews.
2) Agarwal NK. 2008. Fish Reproduction. APH Publ.
3) Brown ME. 1966. Physiology of fishes. Vol. I and II Academic Press. New York.
4) Halver JE. 1972. Fish nutrition. Acaemic Press, New York.
5) Hoar WS. 1984. General and Comparative physiology. Printice-Hall of India Pvt. Ltd. New Delhi.
6) Hoar WS, Randall DJ & Donaldson EM. 1983. Fish Physiology. Vol. IX. Academic Press, New York
7) Lagler KF, Bardach, JE, Miller, RR, Passino DRM. 1977. Ichthyology, 2nd Ed. John Wiley & Sons, New York.
8) Matty AJ. 1985. Fish Endocrinology. Croom Helm.
9) Mente E. 2003. Nutrition, Physiology and Metabolism in Crustaceans. Science Publ.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	1	1	2	2	1	2	2
CO2	2	2	1	1	2	2	1	3	1	2
CO3	1	2	1	2	1	2	1	2	3	1
CO4	3	2	1	2	2	1	2	1	2	1
CO5	3	1	2	1	2	1	2	2	1	2

Z 2.4. (C) (22): AQUATIC MICROBIOLOGY

Course Type: Theory

Course Category: Elective foundation

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the concept of cell structure.

CO2: To understand the concept of Microbial growth and Microbial Interaction in various Biogeochemical cycles.

CO3: To discuss about the Bioprocesses and Microbial Biomass Production.

CO4: To study the concepts of Nutritional requirements of Microorganisms and maintenance of cultures and population estimation techniques.

CO5: To study about the tests for identification of Bacteria and Basics of Mycological and Virological techniques.

UNIT – I

Cell Structure: Prokaryotic and eukaryotic cell structure; Cell membrane, cell wall, proteins, nucleic acids – structure, properties and interactions.

Distribution and classification: Microbial community in freshwater, estuary and marine environment - types and abundance.

Learning Outcome: Students are able to distinguish the cell structure, Microbial community in fresh water, estuary and marine environment.

UNIT – II

Microbial Growth: Factors influencing microbial growth - Physical, chemical and biological conditions of the environment.

Microbial interaction: Role of microbial population in biogeochemical cycles (C, N, P, S, Si and Fe), xenobiotic and in organic pollutants.

Learning Outcome: Upon completion of the above unit they are able to understand the concepts of Microbial growth and Role of microbial population in Biogeochemical cycles.

UNIT – III

Bioprocesses: Principles and applications of bioprocesses - Bioremediation, biofertilization, biofilms, bio-leaching, bio-corrosion, bio-fouling.

Microbial biomass production – single cell protein; Bioprospecting.

Learning Outcome: On completion of the unit they are able to differentiate Bioprocesses and Microbial Biomass Production.

UNIT – IV

Nutritional requirements of microorganisms – constituents of growth media.

Sterilization and media preparation; Isolation, enumeration, preservation; Maintenance of cultures – growth curve, different types of cultures, population estimation techniques.

Learning Outcome: To understand the Nutritional requirements of microorganisms and Maintenance of cultures.

UNIT – V

Routine tests for identification of bacteria – morphological, cultural, biochemical and serological.

Basics of mycological and virological techniques. Introduction to molecular techniques in microbiology.

Learning Outcome: They are able to apply routine tests for identification of bacteria and basics of mycological and virological techniques.

REFERENCE BOOKS:

1) Dhevendaran K. 2008. Aquatic Microbiology, Daya Publ. House.
2) Frobisher M, Hinsdill RD, Crabtree KT & Good heart CR. 1974. Fundamentals of Microbiology. WB Saunders.
3) Geesey G, Lewandowski Z & Flemming HC. (Eds.). 1994. Biofouling and Biocorrosion in Industrial Water Systems. CRC Press.
4) Prasad AB & Vaishampayan A. 1994. Nitrogen Fixing Organisms – Problems and Prospects. Scientific Publ.
5) Rao AS. 1997. Introduction to Microbiology. Printice-Hall, New Delhi.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	1	2	1	2	2	1	2
CO2	2	2	1	2	1	1	2	1	3	1
CO3	1	3	2	1	2	1	2	1	1	2
CO4	1	2	1	3	2	1	1	2	1	1
CO5	2	1	2	3	1	2	1	2	1	2

PRACTICAL – I:

ZP 2.5. (22): GENETICS AND ANIMAL PHYSIOLOGY

GENETICS

1) Genetic disorders – photographs.
2) Genetic exercises/problems based on:
   i) Dihybrid cross.
   ii) Law of independent assortment.
   iii) Multiple alleles.
   iv) Interaction of genes.

ANIMAL PHYSIOLOGY

1) Estimation of glycogen.
2) Estimation of proteins.
3) Estimation of lipids.
4) Estimation of haemoglobin.
5) Qualitative identification and estimation of ammonia and urea.

PRACTICAL – II:

ZP 2.6. (22): ECOLOGY AND TOOLS & TECHNIQUES IN BIOLOGY

ECOLOGY

1) Area species curve.
2) Quadrate species curve.
3) Determination of frequency.
4) Analysis of soil – temperature, colour, texture, pH, moisture content, phosphorus content,
5) Carbonate content and nitrate content.
6) Estimation of primary productivity (light and dark bottle method).

TOOLS AND TECHNIQUES IN BIOLOGY

1) Microscopy - description and working methodology.
2) Spectrophotometry - principle and working methodology.
3) Paper chromatography - separation of molecules.
4) Thin layer chromatography - isolation of molecules.
5) Calculation of mean, median, mode, standard deviation and standard error.
6) Analysis of Variance (ANOVA).

THIRD SEMESTER

M.Sc. ZOOLOGY

SEMESTER-III

Z 3.1. (22): ANIMAL BIOTECHNOLGY AND MICROBIOLOGY

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts about genetic engineering and cloning vectors.

CO2: To study about applications of biotechnology in veterinary science and medicine and gene therapy.

CO3: To discuss about the concept of microbiology, microbial, viral diseases and their control measures.

CO4: To understand microbiology of fermented food and industrial microbiology.

CO5: To analyze the recombinants-colony hybridization techniques, immunological tests in-situ hybridization and protozoan diseases.

UNIT-I:

1) Biotechnology: Genetic Engineering: Recombinant DNA technology, tools of genetic engineering – Restriction endonucleases, DNA ligases, topoisomerases, methylases, nucleases, polymerases, reverse transcriptase and their properties and functions.
2) Cloning vectors: Bacterial plasmid vector – pBR322 and its derivatives; bacteriophage vectors – SV40, phage λ, phage M13; cosmids; viral vectors; shuttle vectors.

Learning Outcomes: Upon completion of the above unit they are able to understand the concept of recombinant DNA technology and cloning vectors.

UNIT - II

1) Applications of biotechnology in veterinary science: Artificial insemination, multiple ovulations, embryo transfer, in-vitro fertilization (IVF), embryo cloning; transgenic animals. Applications of biotechnology in medicine: Production of monoclonal antibodies (Hybridoma technology), production of vaccines and production of growth hormone.
2) Gene therapy: Adenosine Deaminase (ADA) deficiency, Duchenne Muscular Dystrophy (DMD), haemophilia, phenylketonuria and thalassaemia.

Learning Outcomes: Students are able to apply the concepts of biotechnology in veterinary science, medicine and in gene therapy.

UNIT – III:

1) Microbiology: History and scope of microbiology: Microbial nutrition; growth and their control; normal microbial flora of human body - skin, nose, oral cavity, pharynx, respiratory tract, eye, ear, stomach, intestine and genitourinary tract.

2) Microbial diseases and their control: Bacterial diseases- tuberculosis, plague, anthrax, tetanus, cholera; Viral diseases- influenza, AIDS, rabies, hepatitis, poliomyelitis, ebola; Fungal diseases- superficial mycosis, cutaneous mycosis, subcutaneous mycosis, systemicmycosis;

Learning Outcomes: Students are able to understand the history, scope and significance of microbiology in controlling various microbial, bacterial and viral diseases.

UNIT – IV:

1) Microbiology of fermented food: Diary products, meat and fish.
2) Industrial microbiology: Types of fermentation process; alcoholic beverages.

Learning Outcomes: On completion of the above unit students will get awareness about microbiology of fermented food and industrial microbiology.

UNIT – V:

1) Cloning and selection and screening analysis of recombinants-colony hybridization techniques, immunological tests in-situ hybridization.
2) **Protozoan diseases**- Ameobiosis, Malaria, Typhoid.

Learning Outcomes: Upon completion of the above unit, they are able to understand the techniques of Cloning, selection and screening analysis of colony hybridization techniques, immunological tests in in-situ hybridization and protozoan diseases.

REFERENCE BOOKS:

1) Anathnarayan R and Jayaram Panikar CK. 1990. Text Book of Microbiology. 4 th Ed. Orient Longmen, Hyderabad, India.
2) Balasubramanian D et al. 2005. Concepts in Biotechnology. Universities Press (India) Pvt. Ltd., Hyderabad.
3) Dubey RC. 2006. A Text Book of Biotechnology. S. Chand & Company Ltd. New Delhi.
4) Pelzar MJJr and Chan ECS. 1981.General Microbiology. International Students Edition, McGrawHill International Book Co., New Delhi.
5) Range MM. 2000.Animal Biotechnology. Agrobios, India.
6) Satyanarayana U. 2005. Biotechnology. Books and Allied (P) Ltd. Kolkata, India.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	1	2	1	2	1	2	1
CO2	2	1	2	1	2	2	1	2	1	2
CO3	2	2	1	2	1	2	1	2	3	1
CO4	2	1	2	1	2	1	2	3	1	2
CO5	1	2	1	3	1	2	1	2	2	1

Z 3.2. (22): ICHTHYOLOGY

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To demonstrate the basic knowledge on the classification of major groups of fishes and the structure and function of skin and scales having taxonomic importance in classifying the fishes.

CO2: To understand the natural food of different groups of fishes, their feeding habits and adaptations with application of this knowledge to aquaculture

CO3: To explain the major groups of fishes and their geographical distribution, the methods of studying age and growth in fishes with their importance in fisheries and aquaculture.

CO4: To provide knowledge on the structure and function of respiratory, circulatory, osmo regulatory and excretory systems in various groups of fishes.

CO5: To describe the structure and function of brain, endocrine glands, and several aspects of reproductive biology to be useful and applicable for fisheries and aquaculture.

UNIT – I

1) **Classification of fishes**: Major groups up to subclass and their important characters.
2) **Skin:** Structure and function of skin in fishes.
3) **Scales:** Structure of placoid, cycloid, ctenoid, cosmoid and ganoid scales.

Learning outcomes: Students will be familiar with the major groups of fishes and their characters, and the structure and function of skin and scales of fishes.

UNIT – II

1) **Feeding in fishes:** Natural food of fishes.
2) **Feeding habits:** Predators, grazers, strainers, suckers and parasites.
3) **Feeding adaptations** and stimuli for feeding in fishes.

Learning outcomes: Students have a good understanding on the natural food of various kinds of fishes, and feeding habits and concurrent feeding adaptations in different groups of fishes.

UNIT – III

1) **Zoogeography:** Major groups of freshwater fish and their distribution.
2) **Age:** Methods of determination of age.
3) **Growth:** Methods for studying growth. Length-Weight relationship and Condition factor

Learning outcomes: Students will understand the zoogeographical realms and the distribution of fish fauna, and various methods of determination of age and growth in fishes.

UNIT – IV

1) **Respiratory system:** Structure and functioning of gills and accessory respiratory organs.
2) **Circulatory system:** Structure and functioning of cardiovascular system.
3) **Osmoregulation:** Ionic regulation in freshwater, marine and diadromous fishes.
4) **Excretory system:** Structure and function of kidneys in fishes.

Learning outcomes: Students will have a knowledge on the structure and function of respiratory organs such as gills and accessory respiratory organs in various groups of fishes; structure of heart and vascular systems in fishes; mechanism of osmoregulation in fishes of different aquatic habitats, and structure and function of kidneys in fishes.

UNIT – V

1) **Nervous system:** Structure and function of brain in elasmobranchs and teleosts.
2) **Endocrine glands:** Structure and function of pituitary gland, thyroid gland, ultimobranchial glands, chromaffin tissue, adrenocortical tissue and corpuscles of stannius.
3) **Reproduction:** Reproductive structures in elasmobranchs and teleosts; maturity stages of gonads.
4) Oviparity, ovoviviparity and vivipartiy; parental care in fishes; fecundity; gonadosomatic index.

Learning outcomes: Students will understand the structure and function of brain in fishes; structure and function of endocrine glands and especially their significance in reproduction and growth of fishes, and various aspects of reproductive biology in fishes.

REFERENCE BOOKS:

1) Bond E. Carl. 1979. *Biology of Fishes*, Saunders.
2) Halver JE. 1972. *Fish Nutrition.* Academic Press.
3) Hoar WS and Randall DJ. 1970. *Fish Physiology*, Vol. I-IX, Academic Press, New York.
4) Lagler KF, Bardach, JE, Miller, RR, Passino DRM. 1977. *Ichthyology*, 2nd Ed. John Wiley & Sons, New York.
5) Lovell J. 1989. *Nutrition and Feeding of Fish.* Van Nostrand Reinhold, New York.
6) Moyle PB and Joseph J. Cech Jr. 2004. *Fishes: An Introduction to Ichthyology.* 5th Ed. Prentice Hall.
7) Nikolsky GV. 1963. *Ecology of Fishes*, Academic Press.
8) Norman JR and Greenwood PH. 1975. *A History of Fishes*, Halsted Press.
9) Potts GW and Wootten RJ. 1984. *Fish Reproduction: Strategies and Tactics*, Academic Press.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	2	1	2	1
CO2	3	2	1	1	2	1	2	1	1	2
CO3	2	1	2	1	1	2	1	3	2	1
CO4	2	1	2	1	2	1	2	1	2	3
CO5	1	2	1	2	1	2	1	2	3	2

Z 3.3. (A) (22): LIMNOLOGY

Course Type: Theory

Course Category: Elective -I

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO-1: To introduce the concepts about limnology and different inland water bodies and anomalous properties of water**.**

CO-2: This course will make the suitable knowledgeable to undertake water quality management in a culture system.

CO-3: To understand the classification, distribution and significance of biological components in inland water bodies.

CO-4: Analyzing concept of productivity, turbidity of inland water bodies and bio-manipulation of zooplankton in the management of ponds and lakes.

CO-5: Creating awareness about physicochemical, bio-geochemical cycles and eutrophication.

UNIT– I

1) **Definition and facets** of Limnology; Limnology as an applied science.
2) **Inlandwater types:** Lentic and lotic habitats–their identities and distribution, ponds and lakes,streams and rivers; Major rivers and lakes of India.
3) Origin and classification of lakes.
4) **Anomalous properties of water**, their influence on biota in inland waters.

Learning outcome:

Students acquire knowledge about facets of limnology and classification of inland waters bodies and its values.

UNIT– II

1) **Dissolved oxygen:** Sources, losses and distribution patterns.
2) Identification of oxygen depletion problems and control mechanisms in fish ponds.
3) **Carbondioxide**: Sources, losses and distribution patterns; role of carbondioxide in chemical buffering**.**

Learning outcome:

Students are able to understand the application and effect of dissolved oxygen and carbon dioxide in inland water bodies and fish ponds.

UNIT– III

1) **Plankton:** Composition, classification and distribution patterns in lakes and rivers.
2) **Benthos:** Composition, classification and distribution of benthos in lakes and rivers.

3) **Nekton** and its significance.
4) **Large Aquatic Plants:** Classification, distribution and limnological significance.

Learning outcome:

Students will be Awareness with the, concept and significance of biological components of inland water bodies.

UNIT– IV

1) **Productivity:** Concept of productivity; methods for the estimation of primary, secondary and tertiary productivity; Classification of lakes based on productivity; indices of productivity in lakes.
2) **Turbidity:** Causes, consequences and control.
3) **Bio-manipulation Concept:** Zooplankton as a tool in lake management.

Learning outcome:

Students are able to differentiate and recognize the lakes, through productivity. Acquire knowledge about bio manipulation and role of turbidity

UNIT- V

1) **Temperature and Light:** Thermal stratification and its overall impact, thermal classification of lakes; Factors affecting light penetration in natural waters.
2) **Bio-geochemical cycles:** General account of nutrients; Nitrogen and Phosphorus cycles.
3) **Eutrophication:** Causes, consequences and control mechanisms.

Learning outcome:

Students are able to understand the importance physicochemical factors, essential cycles and Causes, consequences of water bodies.

REFERENCE BOOKS:

1) Allan JD.1995. *Stream Ecology: Structure and Function of Running Waters.* Chapman & Hall
2) Cole GA.1983.*Text book of Limnology*, C.V Mosby Company, St.Louis, Missouri, USA.
3) Goldman CR.andHorneAJ.1983.*Limnology*.McGraw-Hill International Book Company.
4) Golterman, HL.1975.*Physiological Limnology*. Elsevier Publishing Co., Amsterdam.
5) Hutchinson, GE. 1957. *A Treatise on Limnology*: ol I. *Geography, physics and chemistry*. John Wiley and Sons, Inc., New York.
6) Hutchinson GE.1967. *A Treatiseon Limnology*, VolII. *Introduction to lake Biology and the Limnoplankton.* John Wiley and Sons, Inc., NewYork.
7) ReidGR.1961. *Ecology and Inland waters and Estuaries*. Rein Hold Corp., NewYork.
8) RuttnerF.1953. *Fundamentals of Limnology*, Uni.of Toronto press, Toronto.
9) WelchPS.1952. *Limnology*, 2nd Ed. Mc Graw-Hill Book Co., NewYork.
10) WetzelRG.1975.*Limnology*, W.B.Sanders Company, Philadelphia.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	1	2	2	1	2
CO2	2	1	2	1	1	2	1	1	2	3
CO3	2	2	1	2	1	1	2	1	3	2
CO4	1	2	1	3	2	1	2	1	2	1
CO5	3	2	1	2	1	2	1	2	1	2

Z 3.3. (B) (22): WATER QUALITY MANAGEMENT

Course Type: Theory

Course Category: Elective -I

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts about Water quality, Fertilizers and manures and Liming.

CO2: To understand the Dynamics of dissolved Oxygen and Principles of Oxygen.

CO3: To discuss about the hatchery management, water discharge standards and effluent treatment in hatcheries.

CO4: To study about the concept of Aquatic weed management.

CO5: To analyze the methods of applying chemicals and pollution in relation to aquaculture practices.

UNIT – I

1) **Water quality:** Constituents of water, Water quality parameters – optimal levels and their management in freshwater fish and brackish water shrimp culture.
2) **Fertilizers and manures:** Different kinds of fertilizers and manures, fertilizer grade, source, rate and frequency of application; Ecological changes taking place after fertilizing; Biofertilizers; Role of inorganic, organic and biofertilizers in aquaculture practices; Utilization of bioactive compounds by microorganisms.
3) **Liming:** Properties of liming materials, lime requirements and application of liming materials to ponds, effects of liming on pond ecosystem.

Learning Outcome: To understand the basic concepts of Water quality parameters, Fertilizers and manures and Liming

UNIT – II

1) **Dynamics of dissolved oxygen:** Dial changes in dissolved oxygen concentration, oxygen budget of culture ponds; algal die-off, overturns, identification of oxygen problems.
2) **Aeration:** Principles of aeration, emergency aeration, destratification and practical considerations.

Learning Outcome: Upon completion of the unit, they are able to learn about the dynamics of dissolved oxygen and Principles of aeration.

UNIT – III

Hatchery management: Fish / Shrimp hatchery

1) Hatchery protocols, seed rearing technology, Packaging and transport of seed.
2) Larval rearing-culture and use of different live feed; different chemicals and drugs used; water quality and feed management.

3) Water discharge standards; Effluent treatment in hatcheries.

Learning Outcome: They are able to identify the significance of Hatchery management, Water discharge standards and effluent treatment in hatcheries.

UNIT – IV

Aquatic weed management:

1) Common weeds and problems in culture ponds

2) Chemical, biological and mechanical control methods and Algal bloom control

Learning Outcome: Upon completion of the unit they are able to understand the concept of Aquatic weed management.

UNIT – V

1) **Chemical treatments:** Potassium permanganate, hydrogen peroxide, calcium hydroxide; reduction of pH, control of turbidity, salinity, hardness, chlorides, water exchange, chlorine removal; rotenone, formalin and malachite green; methods of applying chemicals.
2) Pollution in relation to aquaculture practices.

Learning Outcome: Upon completion of the unit, they analyze the chemical treatment and Pollution in relation to aquaculture practices.

REFERENCE BOOKS:

1) Adhikari S & Chatterjee DK. 2008. *Management of Tropical Freshwater Ponds.* Daya Publ.
2) Boyd CE and Tucker CS. 1992. *Water Quality and Pond Soil Analyses for Aquaculture.* Alabama Agricultural Experimental Station, Auburn University.
3) Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University
4) Boyd, CE. 1982. *Water Quality Management for Pond Fish Culture.* Elsevier Sci. Publ. Co.
5) Hepher B & Pruginin Y. 1981. *Commercial Fish Farming*. John-Willey & Sons Inc.
6) Jhingran VG. 1982. *Fish and Fisheries of India.* Hindustan Publishing Corporation, India.
7) Midlen & Redding TA. 1998. *Environmental Management for Aquaculture*. Kluwer.
8) Pillay TVR & Dill WMA.1979.*Advances in Aquaculture*. Fishing News Books, Ltd.England.
9) Rajagopalsamy CBT & Ramadhas V. 2002. *Nutrient Dynamics in Freshwater Fish Culture System*. Daya Publ.
10) Sharma LL, Sharma SK, Saini VP & Sharma BK. 2008. *Management of Freshwater*
11) *Ecosystems.* Agrotech Publ. Academy.
12) 11.Stickney RR. 1979. *Principles of Warm water Aquaculture*. John-Willey & sons Inc.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	2	2	1	2
CO2	2	1	2	1	2	2	1	3	1	2
CO3	2	1	2	2	1	1	3	1	2	1
CO4	1	2	1	2	1	1	3	2	1	1
CO5	2	1	2	3	2	2	2	1	2	2

Z 3.3. (C) (22): ENVIRONMENTAL BIOLOGY

Course Type: Theory

Course Category: Elective -I

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts about Classification and Characteristics of Fresh water and marine water and terrestrial region.

CO2: To understand the concept of Ecological Energetics and productivity of ecosystems and Impact of environmental factors on Energy flow.

CO3: To discuss about Air pollution, water pollution and environmental health hazards.

CO4: To study about the concept of Biomonitoring, Environmental Impact Assessment and natural calamities and disaster management.

CO5: To discuss about the concept of Bioaccumulation, Biomagnification, Bioremediation and Environmental laws in India.

UNIT-1:

1) A general account on Biomes and their environments.
2) Fresh Water: Classification and Characteristics, eutrophication, seasonal changes.
3) Marine: Classification and Characteristics.
4) Terrestrial: Forests – Grass lands – Tundra – Desert.

Learning Outcome: On completion of the above unit students will come to know about the concept of Biomes, classification and characteristics of fresh water and marine water and terrestrial region.

UNIT-2:

1) Trophic dynamic view of ecosystem and energy flow.
2) Ecological Energetics and productivity of ecosystems.
3) Impact of environmental factors on Energy flow.

Learning Outcome: Understanding the trophic dynamic view of ecosystem, ecological energetic and productivity of ecosystem and Impact of environmental factors on energy flow.

UNIT-3:

1) Air Pollution: Criteria and standards in India, health hazards and Toxicology – Green house gases and Green House Effect.
2) Water Pollution: Criteria and standards in India, health hazards and toxicology.
3) Role of environmental epidemiological studies and health indices in evaluation of environmental health hazards: environmental epidemiological episodes in India and Abroad.

Learning Outcome: Students are able to understand the concept of Air pollution, Water pollution and Environmental health hazards in India and Abroad.

UNIT-4:

1) Biomonitoring.
2) Bio indicators and environmental monitoring, Environmental impact assessment.
3) Natural calamities and disaster management.

Learning Outcome: Upon completion of the above unit students are able to understand Biomonitoring, Environmental Impact Assessment, Natural calamities and disaster management.

UNIT-5:

1) Bioaccumulation and Biological magnification.
2) Bioremediation: Need and scope of bioremediation, Environmental applications of bioremediation. Future outlook of Bioremediation: Phytoremediation, Biotechnological cleaning up of the environment by plants.
3) Environmental Laws; Environmental Laws in India – legislation and Execution.

Learning Outcome: Students are able to understand the concept of Bioaccumulation, Biomagnification, Bioremediation and Environmental laws in India.

REFERENCE BOOKS:

1) Animal Physiology - Adaptation & Environment. 4th EditionKnut Schmidt - Nielsen - Cambridge University Press.
2) Biochemical ecology and water pollution - PR Dugan, plenum press, London, 1972.
3) Biodegradation & Bioremediation - 2nd editon, Martein Alexander - Academic Press, 1999 USA.
4) Chemical and biological methods for water pollution studiesR.K. Trivedy and P.K. Goel, 1984.
5) Current pollution researches in India - RK. Trivedy and P.K. Goel. Karad.
6) Ecology & Environment - P.D. Sharma, 1991.
7) Ecotechnology for pollution control and environmental management, enviromedia, Karad, RK. Trivedi.
8) Encyclopedia of environmental pollution and control, enviromedia, Karad, Vol. 1 &2, R.K Trivedi.
9) Environmental Biology and Toxicology-P.D. Sharma, Rastogi Publications, Meerut (India), 1998.
10) Environmental Physiology of desert organism. Ed.by N.F. Hadley - Dowden Huchinson and Ross, Inc.Penn.USA.
11) Environmental Science Research Volumes: Vol.1. Indicators of environmental quality - W.A. Thomas, 1972. Vol.3. Environmental pollution by pesticides - C.A. Edwards, 1974.
12) Field Biology & Ecology - Allen H Benton & E. Werner, JR, 1980.

13) Health hazards and human environment, World Health Organization (WHO) 1972.
14) Industrial Pollution - VP. Kudesia, 1990.
15) Methods in Environmental Analysis - Water soil and air by P.K. Gupta - Agrobios (India), Jodhpur, 2001
16) Pesticides in the environment - R White Stevenns, MarcelDekker Inc. New York, 1971.
17) Practical methods in Ecology & Environmental Science, RK. Trivedy, Goel, Trisal, 1997.
18) The Ecology of waste water treatment - H.A. Hawkes pergoman press, 1963.
19) Vol.5 Environmental dynamics of pesticides - R. Hague and V.H. Preed, 1975.
20) Water Treatment and purification technology - W.J. Ryan, Agrobios (India), Jodhpur, 2002.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	1	1	1	2
CO2	1	2	1	2	1	1	2	3	2	1
CO3	2	1	2	1	2	1	2	3	1	2
CO4	2	2	1	2	1	2	1	2	1	3
CO5	1	2	1	2	1	2	1	3	2	1

Z 3.4. (A) (22): AQUATIC TOXICOLOGY

Course Type: Theory
Course Category: Elective -II
Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To make understand about different sources of water pollution in general and sewage pollution in particular.

CO: 2 To analyze the different industrial effluents and their impact on the aquatic organisms.

CO3: To provide information regarding different classes of pesticides, their entry in to the aquatic ecosystems and their accumulation in the aquatic bodies in general and food chain in particular.

CO4: To explain about sources of thermal pollution and radiation pollution in to the aquatic environment and the consequences of these pollutions to the aquatic organisms.

CO5: For creation of awareness regarding Environmental Impact Assessment policies and analysis processes can also be made. The regulations and acts enacted to prevent pollution.

UNIT – I

1) Water pollution and analysis: Sources of water pollution, physical and chemical characterization of water, minor components of water, important trace elements in water; biological investigation of water – DO, BOD; microbiological examination of water, water pollution and diseases.
2) Sewage treatment and analysis: Treatment of domestic sewage, primary treatment of sewage, chemical treatment of sewage, biological treatment, tertiary treatment of sewage, disposal of sewage, characterization and analysis of sewage – DO, COD, BOD.

Learning Outcome:

The students will understand the

- The major sources of pollution
- Water characterization and minor elements of water
- Microbial contamination and the resultant diseases
- Sewage pollution treatment and disposal

UNIT – II

Industrial pollution: Effluent from chemical industries, apparel industries, energy industry and service industries; waste water from food processing and material industry; analysis of metal pollutants, non-metal pollutants and gases, waste water treatment.

Learning Outcome:

The students will understand the

- The major sources of industrial pollution from different industries
- Analytical methods of metallic and non-metallic pollutants, gases

UNIT-III

Pesticide pollution: Classification of pesticides, bio-concentration, bioaccumulation, sources of contamination, bio-magnification, effects on non-target organisms, metabolites – uptake and depuration of toxic chemicals, control of pesticide pollution.

Learning Outcome:

- History of pesticide usage
- Different classes of pesticides and their impacts on non-target organisms
- Pesticide pollution sources, bioaccumulation and bio-concentration

UNIT – IV

1. Thermal pollution: Source of thermal pollution, effects of discharge of heat, control of thermal pollution – artificial lakes or cooling ponds, cooling towers and improved electric generating plants.
2. Radiation pollution: Sources of radiation, effects of ionizing radiation on life, nuclear energy, the most dangerous radioactive pollutants, harmful effects of radiation and monitoring of radiation.

Learning Outcome:

The students will understand the

1) The major sources of Thermal pollution from different industries and their control methods
2) Sources of radiation pollution harmful effects of radiation pollution
3) Monitoring of radiation pollution

UNIT – V

1) Environmental Impact Assessment (EIA) – Analysis: Introduction, EIA under National Environmental Policy Act (NEPA), EIA in action, implementation of EIA, Case studies– water quality impact analysis and nuclear power plant impact.
2) Pollution control Acts and Laws of India; The Environment (Protection) Act, 1986.

Learning Outcome:

The students will understand the

- EIA in action, Case studies
- Water quality impact analysis and nuclear power plant impact Monitoring of radiation pollution
- Pollution control Acts and Laws of India

REFERENCE BOOKS:

1) Andrews HL. 1974. Radiation Bio-physics. Prentice Hall, Inc., New York, USA.

2) Chanlett ET. 1973. Environmental Protection. McGraw Hill, Inc., Japan.
3) Edwards CA. 1973. Environmental Pollution by Pesticides. Plenum Press, London/NY.
4) Khopkar SM. 2005. Environmental Pollution Monitoring and Control. New Age
5) International (P) Limited, New Delhi, India.
6) Laws EA. 1981. Aquatic Pollution. Wiley & Sons, New York.
7) Mohammad Abdul Quadden Khan. 1978. Pesticides in Aquatic Environment. Plenum Press, New York/London.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	3	2	1	2	2	1	1	2
CO2	1	2	1	3	2	1	2	1	2	1
CO3	2	1	2	1	2	1	2	3	2	1
CO4	3	2	1	2	1	2	1	2	1	2
CO5	2	2	1	1	2	2	1	3	2	1

Z 3.4. (B) (22): AQUACULTURE ENGINEERING

Course Type: Theory

Course Category: Elective -II

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts about Planning and Aquaculture Development

CO2: To discuss about the farm standards and bio-security measures.

CO3: To introduce about the concepts of design and construction of fish and shrimp farms.

CO4: To study about significance of design and constructing fish and shrimp hatcheries.

CO5: To learn about the design and construction of cages, rafts, pens, enclosures and raceways.

UNIT – I

1) **Planning and Aquaculture Development:** Priorities, resources, technology, human resources, legal and environmental factors and organization of aquaculture.
2) **Selection of Sites for Aquaculture:** Criteria for site selection of fresh water and brackish water farms - land based and open water farms; quantity and quality of water, sources of pollution and conflicts.

Learning Outcome: On completion of the above unit they are able to understand the planning and aquaculture development and criteria for selection of sites for aquaculture.

UNIT – II

Farm/Hatchery standards and Bio-security measures

1) Sanitary and Phyto-Sanitary (SPS) measures
2) Better Management Practices (BMP's)

Learning Outcome: Students will get awareness about Sanitary and Phyto-sanitary measures and Better management Practices.

UNIT – III

Design and construction: Fish and shrimp farm

1) **Freshwater Fish Farm** - Design and construction
2) **Brackish water Shrimp Farm** - Design and construction

Learning Outcome: Students will gain knowledge and skills to design and plan a freshwater fish farm and brackish water shrimp farm and including site selection, pond design, water supply, and stocking.

UNIT – IV

Design and construction: Hatchery

1. **Fish Hatchery -** Design, construction: Criteria for site selection of hatchery and nursery; Design and construction of Jar hatchery and Chinese hatchery system.
2. **Shrimp Hatchery** - Design and construction: Site selection and facilities required – maturation tanks, spawning tanks, larval rearing tanks, live food culture tanks, water storage and filtration tank, aeration, seawater supply and piping system; Lay-out and construction.

Learning Outcome:

- Students will gain knowledge and skills to design and plan a fish hatchery, including criteria for site selection, hatchery and nursery design, jar hatchery, and Chinese hatchery system.
- Students will gain knowledge and skills to design and plan a shrimp hatchery, including site selection, facilities required such as maturation tanks, spawning tanks, larval rearing tanks, live food culture tanks, water storage and filtration tank, aeration, seawater supply, and piping system.

UNIT-V

Design and construction

1) **Cages and Rafts:** Design and construction
2) **Pens and Enclosures:** Design and construction
3) **Raceway Farms:** Design and construction.

Learning Outcome:

Students will gain knowledge and skills to design and plan cage, raft systems, pen and enclosure for aquaculture, including site selection, materials selection, and engineering considerations.

REFERENCE BOOKS:

1) Bose AN. *et al*., 1991. *Coastal Aquaculture Engineering*. Oxford & IBH Publishing Company, Pvt. Ltd.
2) Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn*. Daya Publ. House
3) CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries*. CIFE, Versova, Mumbai
4) FAO. 2007. *Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery*
5) Hepher B & Pruginin Y. 1981. *Commercial Fish Farming.* John-Willey & Sons Inc.
6) ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
7) Ivar LO. 2007. *Aquaculture Engineering*. Daya Publ. House.

8) Jhingran VG & Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.

9) Misra R and Dora KC. 2015. A text Book on Aquaculture Engineering, Narendra Publishing House, New Delhi.

10) MPEDA. 1993. *Handbook on Aqua Farming - Live Feed. Micro Algal Culture.* MPEDA Publication

11) Pilley, TVR & Dill, WMA. 1979. *Advances in Aquaculture*. Fishing News Books, Ltd. England.

12) Stickney RR. 1979. *Principles of Warm water Aquaculture*. John-Willey & sons Inc.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	1	2	1	2
CO2	2	2	3	1	2	1	1	1	2	1
CO3	1	3	2	2	1	2	2	1	2	2
CO4	2	3	2	1	1	2	1	2	1	2
CO5	2	1	2	1	3	1	2	2	1	2

Z 3.4. (C) (22): TAXONOMY OF AND FUNCTIONAL ANATOMY OF SHELL FISH

Course Type: Theory

Course Category: Elective -II

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To discuss about the classification of Crustacea and Mollusca.

CO2: To understand the concepts of Feeding in Crustacea and Mollusca.

CO3: To study about the respiratory and digestive systems in Crustacea and Mollusca.

CO4: To discuss about the Endocrine system in Crustacea and Reproductive system in Crustacea and Mollusca.

CO5: To understand the concepts of Nervous and Excretory systems in Crustacea and Mollusca.

UNIT – I

1) **Classification of Crustacea:** Major groups up to orders and their important characters.
2) **Classification of Mollusca:** Major groups up to orders and their important characters.

Learning Outcome: Students will be able to identify the major groups of Crustacea and Mollusca and their distinguishing features.

UNIT – II

1) **Feeding in Crustacea:** Food and feeding habits of cultured crustaceans – Branchiopoda and Malacostraca.
2) **Feeding in Mollusca:** Food and feeding habits of cultured molluscs – Gastropoda and Bivalvia.

Learning Outcome: Students are able to understand the concepts of food and feeding habits of cultured crustaceans and molluscs.

UNIT – III

1) **Respiratory System in Crustacea:** Structure and function of respiratory organs.
2) **Respiratory System in Mollusca:** Structure and function of respiratory organs.
3) **Digestive System in Crustacea:** Structure and function of digestive organs.
4) **Digestive System in Mollusca:** Structure and functions of digestive organs.

Learning Outcome: Students will get awareness about respiratory and digestive systems in Crustacea and Mollusca.

UNIT – IV

1) **Endocrine System in Crustacea:** Structure and function of endocrine organs and their role in reproduction.
2) **Reproductive System in Crustacea:** Reproductive patterns, reproductive organs, gonad maturity, spawning and fertilization.
3) **Reproductive System in Mollusca:** Reproductive patterns, reproductive organs, gonad maturity, spawning and fertilization.

Learning Outcome:

- Students will understand how hormones produced by the endocrine organs regulate the growth, development, and reproduction of Crustacea.
- Students will understand the reproductive organs in Crustacea and Mollusca, including the gonads, genital openings, and copulatory organs.

UNIT -V

1) **Nervous system in Crustacea:** Structure and functions of brain and nerves.
2) **Nervous system in Mollusca:** Structure and functions brain and nerves.
3) **Excretory System in Crustacea:** Structure and function of excretory organs.
4) **Excretory System in Mollusca:** Structure and function of excretory organs

Learning Outcome: Upon completion of the above unit they are able to understand Nervous and excretory systems in Crustacea and Mollusca.

REFERENCE BOOKS:

1) Barrington EJW. *Invertebrate Structure and Function.* 1976. Thomas Nelson and Sons Ltd. London s
2) Hyman LH. *The Invertebrates*, 1955. Vol.1 to 8, McGrw Hill Co., New York.
3) Borradile & RA Potts. 1962. *The Invertebrates*. Asia Publishing House.
4) Kaestner A. 1967. *Invertebrate Zoology*. Vol. I - III. John Willey & Sons.
5) Barrington EJW. 1971. *Invertebrates: Structure and Function*. ELBS.
6) Kurian CV & Sabastian VO. 1976. *Prawns and Prawn Fisheries of India*. Hindustan Publ.Co.
7) Fretter V & Graham A. 1976. *The Functional Anatomy of Invertebrates*. Academic Press Inc.
8) Parker TJ & Haswell WA. 1992. *The Text Book of Zoology. Vol. I. Invertebrates*. (Eds: A.J. Marshall & W.D. Willimas), ELBS & McMillan & Co.
9) Ruppert EE, Fox RS & Barnes RD. 2004. *Invertebrates Zoology,* 7th edition, Thomson, Brooks

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	1	2	2	1
CO2	2	1	2	1	1	2	1	3	1	1
CO3	3	2	1	2	2	1	2	1	2	2
CO4	2	1	2	1	2	2	1	2	3	1
CO5	2	1	2	2	1	2	2	3	2	2

PRACTICAL – I:

ZP 3.5. (22): BIOTECHNOLOGY, MICROBIOLOGY AND ICHTHYOLOGY

BIOTECHNOLOGY

1) Isolation of DNA from blood sample.
2) Isolation of DNA from saliva.
3) Cloning vectors – diagrams, properties and functions.
4) Transgenic animals – photographs.

MICROBIOLOGY

1) Isolation of bacteria from soil.
2) Isolation of bacteria from water.
3) Media preparation for bacterial culture.
4) Standard plate count of bacteria (SPC).
5) Soil, water and air borne microbes – slides/photographs.

ICHTHYOLOGY

1) Collection, preservation and identification of a fish: general description of a fish, recording biometric data and identification up to genus level using taxonomic key.
2) Identification of commercially important freshwater, brackish water and marine water fishes.
3) Identification of stages of maturation of fish gonads.
4) Study of the guts in fish with different feeding habits.
5) Dissection and mounting of pituitary gland.
6) Mounting of fish scales.

PRACTICAL – II:

ZP 3.6. (22): LIMNOLOGY AND TOXICOLOGY

LIMNOLOGY

1) Determination of temperature, pH and salinity in the pond water sample.
2) Estimation of total alkalinity and total hardness.
3) Estimation of dissolved oxygen and free carbondioxide.
4) Estimation of phosphates and nitrites.
5) Estimation of COD and BOD.

TOXICOLOGY

1) Determination of LC_{50} value.
2) Determination of LD_{50} value.
3) Identification of pesticides in thin layer chromatography.
4) Acute toxicity tests – design and experiment.
5) Histopathological study of toxicant exposed tissues.

FOURTH SEMESTER

M.Sc. ZOOLOGY

SEMESTER-IV

Z 4.1. (22): FISH PATHOLOGY

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To get awareness about the concept of viral diseases in fish and shrimp.

CO2: To understand the basic knowledge about bacterial and fungal diseases in fish and shrimp.

CO3: To discuss about Protozoan, Helmenthic and Crustacean diseases in fish and Shrimp.

CO4: To understand the concepts of Gas bubble disease in fish and blue shell syndrome in Shrimps

CO5: To discuss Epizootic Ulcerative syndrome in fish and Muscle Necrosis, Gas bubble disease, Black Death disease and chronic soft-shell syndrome in Shrimps.

UNIT – I

Fish Diseases:

History, species affected, **C**linical symptoms, pathology and control measures of Viral Hemorrhagic Septicemia (VHS) and Infectious Hematopoietic Necrosis (IHN).

Shrimp Diseases:

History, species affected, Pathology, clinical symptoms, prevention and treatment of Monodon Baculoviral disease (MBV), Infectious Hypodermal and Hematopoietic Necrosis (IHHN), Hepato Pancreatic Parvovirus disease (HPPV), Yellow-head virus disease, Taura syndrome and White spot syndrome.

Learning Outcomes: Upon completion of the above unit they are able to learn about viral diseases in fish and shrimp.

UNIT – II:

Fish Diseases:

1) History, species affected, Clinical symptoms, pathology, prevention and control measures of Bacterial Hemorrhagic Septicemia (BHS), Bacaterial gill disease and Tail and fin rot.
2) Pathology, clinical symptoms, prevention and control measures of Saprolegniasis and Branchiomycosis.

Shrimp Diseases:

3) History, species affected, Clinical symptoms, pathology, prevention and control measures of Black gill disease, Filamentous bacterial gill disease.
4) History, species affected, Clinical symptoms, pathology, prevention and control measures of *Lagenidium* disease (Larval Mycosis) and Brown gill disease.

Learning Outcomes: Students are able to understand the concept of Bacterial diseases in fish and shrimp.

UNIT – III:

Fish Diseases:

1) History, species affected, Clinical symptoms, pathology and control measures of Ichthyophthiriasis, Enterococcidiasis, Whirling disease and Nodular disease.
2) History, species affected, Clinical symptoms, pathology and control measures of Gyrodactylosis and Dactylogyrosis.
3) History, species affected, Clinical symptoms, pathology and control measures of Argulosis and Lernaeasis.

Shrimp Diseases:

4) History, species affected, History, Etiology, morphology and control measures of *Zoothamnium* and *Acineta.*

Learning Outcomes: Upon completion of the above unit they are able to get awareness about Protozoan, Helmenthic and Crustacean diseases in fish and shrimp.

UNIT – IV:

Fish Diseases:

1) History, species affected, clinical symptoms, pathology and control measures of gas bubble disease and lack of oxygen.

Shrimp Diseases:

2) History, species affected, Clinical symptoms, pathology and control measures of Cramped tails, and Blue shell syndrome.

Learning Outcomes: Students acquire knowledge about gas bubble disease in fish and cramped tails, blue shell syndrome in shrimp.

UNIT – V:

Fish Diseases:

1) History, species affected, clinical symptoms, pathology, prevention and control measures of Epizootic Ulcerative syndrome.

Shrimp Diseases:

2) History, species affected, Clinical symptoms, pathology and control measures of Muscle Necrosis, Gas bubble disease, Black Death disease and chronic soft-shell syndrome.

Learning Outcomes: On completion of the unit, they are able to understand the Epizootic Ulcerative syndrome in fish and Muscle Necrosis, Gas bubble disease, Black Death disease and chronic soft-shell syndrome in shrimp.

REFERENCE BOOKS:

1) Cheng TC. 1964. *The Biology of Animal Parasites*. W.B. Saunders Company, Philadelphia, Pennsylvania, USA.
2) Conroy CA and Herman RL. 1968. *Text book of Fish Diseases*.TFH (Great Britain) Ltd, England.
3) Lightner DV. 1996. *A Handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp*. World Aquaculture Society, Lousiana, USA.
4) Reichenbach KH. 1965. *Fish Pathology.* TFH (Gt. Britain) Ltd, England.
5) Ribelin WE and Miguki G. 1975. *The Pathology of Fishes.* The Univ. of Wisconsin Press Ltd, Great Russel Street, London, UK.
6) Shuzo Egusa.1978. *Infectious Diseases of Fish.* Oxonian Press Pvt. Ltd. New Delhi.
7) Van Duijn, C. 1973. *Diseases of Fishes.* Cox and Wyman Ltd. London. Ltd, Great Russel Street, London, UK.
8) Shuzo Egusa.1978. *Infectious Diseases of Fish.* Oxonian Press Pvt. Ltd. New Delhi.
9) Van Duijn, C. 1973. *Diseases of Fishes.* Cox and Wyman Ltd. London.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	1	2	1	2	1	2	1
CO2	3	2	1	2	1	1	2	1	1	2
CO3	2	1	2	1	2	2	1	3	2	1
CO4	2	1	2	1	2	1	1	2	1	2
CO5	1	2	1	1	2	1	2	2	1	2

Z 4.2. (22): IMMUNOLOGY

Course Type: Theory

Course Category: Mandatory core

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: Understand the basic principles of the immune system, including the different types of immune responses, immune cells, and molecules involved in immunity.

CO2: Analyze the molecular mechanisms of antigen recognition, processing, presentation and how they lead to the activation of the immune system.

CO3: Understand the principles of immunological memory, including how it develops and how it can be exploited in vaccination.

CO4: Analyze the role of the immune system in the pathogenesis of infectious and autoimmune diseases, and how this knowledge can be used in the development of therapies.

CO5: Evaluate current research in immunology, including primary research articles and scientific reviews, and apply this knowledge to address scientific questions and solve problems.

UNIT – I

1) **Antigens:** Chemical nature of Antigens, Haptens, Epitopes, Paratopes; Binding forces of antigen-antibody interactions – Affinity, Avidity and Cross reactivity; Antigenicity and Immunogenicity.
2) **Lymphoid Organs**: Primary lymphoid organs – Thymus, Bone marrow and Bursa of fabricius; Secondary lymphoid organs – Spleen, Lymphnodes, MALT and GALT.
3) **Cells of the immune system:** Origin of the cells - Stem cells; Lymphoid lineage –T-lymphocytes, B-lymphocytes, Null cells; Myeloid lineage – Monocytes, Polymorphonuclear (PMN) leukocytes; Accessory cells.
4) **Learning Outcome:** Students are able to Understand the basic principles of the immune system, including the different types ofimmune responses, immune cells, and molecules involved in immunity.

UNIT–II

1) **Antibody molecules/Immunoglobulins:** Basic structure of the immunoglobulin molecule; Structure and function of IgG, IgA, IgM, IgE and IgD molecules.
2) **Major Histocompatibility Complex (MHC):** Structure of MHC molecules, Antigen processing and presentation by MHC molecules.
3) **Complement System:** Classical and Alternative Pathways; Biological functions of complement.

Learning Outcome: Students are able to analyze the molecular mechanisms of antigen recognition, processing, presentation and how they lead to the activation of the immune system.

UNIT–III

Cytokines: Interleukins (ILs), Interferons (INFs), Tumor Necrosis Factors (TNFs), Colony Stimulating Factors (CSFs) and Chemokines.

Innate Immunity: Phagocytosis- intracellular killing, Humoral and Cellular components

Acquired Immunity: Humoral immunity, Cell-mediated immunity; Primary and Secondary immune response, Memory function; Active and Passive immunity, Types of Vaccines.

Learning Outcome: Students are able to understand the principles of immunological memory, including how it develops and howit can be exploited in vaccination.

UNIT – IV

1) **Hypersensitivity:** Types of Hypersensitivity reactions and Regulatory mechanisms.
2) **Tolerance:** Immune and Self Tolerance; Autoimmunity and Autoimmune disorders.
3) **TumorImmunology:** Immunity to tumours, tumour-specific antigens; Immuno surveillance

Learning Outcome: Students are able to Analyze the role of the immune system in the pathogenesis of infectious and autoimmune diseases, and how this knowledge can be used in the development of therapies.

UNIT - V

1) **Immuno diffusion:** Simple diffusion, Radial immune diffusion an Double immune diffusion.
2) **Immunoelectrophoresis:** Counter and Rocket immune electrophoresis.
3) **Radioimmunoassay (RIA):** Competitive R.I.A, and Excess Reagent R.I.A.
4) Enzyme Linked Immuno Sorbent Assay (ELISA).
5) **Hybridoma Technology** – Production of monoclonal antibodies.

Learning Outcome: Students are able to Evaluate current research in immunology, including primary research articles and scientific reviews, and apply this knowledge to address scientific questions and solve problems.

REFERENCE BOOKS:

1) Goldsby AR, Kindt TJ and Osborne BA. 2000. *KUBY Immunology.* W.H. Freeman and Company,NY.
2) Ivon M. Roitt. 2001. *Essential Immunology.* Blackwell Science Ltd, Mishawaka, IN, USA.
3) Joshi KR and Osamo NO. 1994. *Immunology.* Agro Botanical Publishers, India.
4) Nandini Shetty. 2008. *Immunology Introductory Text.* Wiley Eastern Limited, New AgeInternational Publishers, New Delhi.
5) Rajasekara Pandian M and Senthil Kumar B. 2007. *Immunology and Immunotechnology.* PanimaPublishing Corporation, New Delhi, India.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	1	2	2	2
CO2	2	1	2	3	1	2	1	1	2	2
CO3	2	2	1	2	1	3	2	1	1	1
CO4	1	2	1	1	2	2	1	3	1	2
CO5	2	2	1	2	3	1	2	1	2	1

Z 4.3. (A) (22): AQUACULTURE

Course Type: Theory

Course Category: Elective -I

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To provide fundamental knowledge about the principles and practices of aquaculture, cultivable species, aquatic resources and various types of culture practices

CO2: To understand the concepts of different types of cultures, techniques of induced breeding and management of carp culture ponds

CO3: To acquire knowledge on the culture of air-breathing fishes, brackish water fishes and freshwater prawns

CO4: To describe the culture practices of shrimp, pearl oysters and sea weeds of commercial importance.

CO5: To explain the ornamental fish culture and for understanding various biotechnological approaches for the improvement of fish stocks and advanced culture techniques for higher and profitable yields.

UNIT – I

1) History, Significance and Classification of Aquaculture; Major cultivable species for aquaculture; A knowledge of in land water bodies suitable for culture in India.
2) Criteria for the selection of a species for culture.
3) Culture practices of fish and shrimp: Traditional, extensive, modified extensive, semi-intensive and intensive cultures.

Learning outcomes: Students will get essential knowledge about the basics of aquaculture, cultivable species, and the inland water bodies suitable for culture in India; criteria for the selection of species for culture, and various culture practices of fish and shrimp.

UNIT – II

1) Concept of Monoculture, polyculture and integrated fish farming.
2) Bundh breeding and Induced breeding of carp by hypophysation and use of synthetic hormones.
3) Preparation and Management of Indian major carp culture ponds – nursery, rearing and production ponds.

Learning outcomes: Students would be able to understand the concepts of different types of culture; become familiar with the induced breeding techniques of carp in bundhs and in hatcheries, and get acquainted with the preparation and management of carp nursery, rearing and production ponds

UNIT – III

1) Culture of air-breathing fishes in India.
2) Culture of Giant freshwater prawn, *Macrobrachium rosenbergii*
3) Culture of brackish water fish – *Chanos* and *Lates*.

Learning outcomes: Students will acquire knowledge on the culture of air-breathing fishes and freshwater prawn; culture of brackishwater fish and shrimp, and culture of marine organisms like pearl oysters and sea weeds.

UNIT – IV

1) Culture of shrimp, *Penaeus monodon /Litopenaeus vannamei*.
2) Culture of pearl oysters.
3) Culture of sea weeds: Major seaweed species of commercial importance; methods of culture

Learning outcomes: Students will understand the culture of brackishwater shrimp, and the culture of marine organisms like pearl oysters and sea weeds.

UNIT – V

1) Culture of ornamental fishes.
2) Improvement of fish stocks: Genetic improvement/Hybridization of fish – Indian studies.
3) Biotechnological approaches: Gynogenesis, Androgenesis, Polyploidy, Transgenic fish and Cryopreservation of fish gametes.

Learning outcomes: Students will have fairly good knowledge on

- Maintenance of aquaria and breeding of ornamental fishes, and
- Advanced biotechnological approaches for the improvement of fish stocks and production.

REFERENCE BOOKS:

1) Bardach, JE *et al*. 1972. *Aquaculture – The farming and husbandry of freshwater and marine organisms.* John Wiley & Sons, New York.
2) Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Freshwater Prawn.* Daya Publ. House.
3) FAO. 2007. *Manual on Freshwater Prawn Farming.*
4) Huet J. 1986. *A text Book of Fish Culture*. Fishing News Books Ltd.
5) ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
6) Jhingran V.G. 1991. *Fish and Fisheries of India*. Hindustan Publ. Corporation, India.
7) MPEDA: *Handbooks on culture of carp, shrimp, etc*.
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9) Pillay TVR. 1990. *Aquaculture- Principles and Practices.* Fishing News Books Ltd., London.
10) Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. 2nd Ed. Blackwell
11) Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
12) Stickney RR. 1979. *Principles of Warm water Fish Culture.* John Wiley & Sons.

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	1	2	1	2
CO2	3	1	2	1	2	1	1	2	1	2
CO3	2	1	2	1	2	1	2	1	2	3
CO4	2	1	3	2	1	2	1	2	2	1
CO5	2	1	1	2	1	2	2	3	1	2

Z 4.3. (B) (22): TAXONOMY AND ANATOMY OF FINFISH

Course Type: Theory

Course Category: Elective -I

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To impart knowledge on the classification of major groups of fishes and their important characters and demonstrate the structure and function of skin and scales having taxonomic importance in fishes.

CO2: To understand the natural food of different groups of fishes, their feeding habits and adaptations with application of this knowledge to aquaculture

CO3: To explain the methods of determining age and growth in fishes, and the respiratory system in various groups of fishes with their importance in aquaculture.

CO4: To demonstrate the structure and function of cardio vasular, nervous, excretory and osmo regulatory systems in various groups of fishes.

CO5: To describe the structure and function of endocrine glands with their significance in reproduction and growth of fishes, and various aspects of reproductive biology to be useful and applicable for aquaculture.

UNIT – I

1) **Classification of fishes:** Major groups up to subclass and their important characters.
2) **Skin:** Structure and function of skin in fishes.
3) **Scales:** Structure of placoid, cosmoid, ganoid, cycloid and ctenoid scales.

Learning outcomes: Students will understand the major groups of fishes and their characters, and the structure and function of skin and scales of fishes

UNIT – II

1) **Feeding in fishes:** Natural food of fishes.
2) **Feeding habits:** Predators, grazers, strainers, suckers and parasites.
3) **Feeding adaptations** and stimuli for feeding in fishes.

Learning outcomes: Students become familiar with the natural food, feeding habits and concurrent feeding adaptations of fishes applicable to aquaculture practices.

UNIT – III

1) **Age:** Methods of determination of age.
2) **Growth:** Methods for studying growth. Length-Weight relationship and Condition factor.
3) **Respiratory system:** Structure of gills and accessory respiratory organs.

Learning outcomes: Students will be able to know the methods of determination of age and growth in fishes, and structure of respiratory organs in various groups of fishes.

UNIT – IV

1) **Cardiovascular system:** Structure of cardiovascular system in fishes.
2) **Nervous system:** Structure and function of brain and cranial nerves.
3) **Excretory system and Osmoregulation:** Structure and function of kidneys in fishes.

Learning outcomes: Students will be familiar with the structure and function of heart and vascular systems; brain and cranial nerves; kidneys and osmoregulation in fishes.

UNIT – V

1) **Endocrine system:** Structure and function of pituitary gland, thyroid gland, ultimobranchial glands, chromaffin tissue, adrenocortical tissue and corpuscles of stannous.
2) **Reproductive system:** Reproductive structures in teleosts; maturity stages of gonads.
3) Fecundity and Gonado-somatic Index (GSI).

Learning outcomes: Students have a better understanding on the significance of hormones secreted by various endocrine glands in reproduction and growth of fishes, and the reproductive structures and importance of fecundity and gonado-somatic index in fishes.

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CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	2	1	2	1
CO2	2	2	3	2	2	1	1	2	1	2
CO3	2	1	3	1	2	1	2	1	2	1
CO4	3	1	2	1	1	1	2	1	2	2
CO5	1	3	1	2	1	2	2	1	2	1

Z 4.3. (C) (22): FISH NUTRITION

Course Type: Theory

Course Category: Elective -I

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To analyze the concepts of Biochemical and Proximate composition of fish.

CO2: To introduce the basic concept of Amino Acids of Fish and Shell Fishes.

CO3: To discuss about the saturated and unsaturated fats and Fish lipids.

CO4: To study about classification of vitamins, vitamin content of edible flesh of fish and its significance.

CO5: To understand the function and classification of minerals and fish as mineral source.

Unit 1: Composition of Fish

Introduction and Importance to biochemical composition of fish.

1) Proximate Analysis of Foods; Proximate composition of fish.
2) Significance of Chemical composition of fish.

Learning Outcome: Students will get awareness about the analysis and importance of biochemical and proximate composition of fish.

Unit 2: Amino Acids of Fish and Shell Fishes

1) Introduction and classification of Amino Acids.
2) Role of Amino Acids in Human Health.
3) Fish as Amino Acid source.
4) Shell fish as Amino Acid source.

Learning Outcome: Upon completion of the above unit they are able to understand Amino Acids of fish and shell fishes and their role in human health.

Unit 3: Food and Fish Lipids

1) Introduction and types of fats-Predominantly Saturated Fats (Solid at room temperature), Predominantly Unsaturated and remain liquid at room temperature.
2) Saturated fats and Unsaturated Fats
3) Fish Lipids.

Learning Outcome: On completion of this unit students are able to differentiate Saturated and Unsaturated fats and fish lipids.

Unit 4: Vitamins in Fish

1) Introduction and Classification of Vitamins- Fat soluble vitamins, Water soluble vitamins.
2) Vitamin content of edible flesh of fish.
3) Vitamins and its significance- Fat soluble vitamins and Water-soluble vitamins.

Learning Outcome: Students are able to differentiate fat-soluble, water-soluble vitamins and their significance and edible flesh of fish.

Unit 5: Minerals in Fish

1) Introduction of mineral and Fish as Mineral source.
2) Function of Minerals.
3) Classification- Major/Macro Minerals like Calcium, Minor Minerals and Trace Elements.
4) Digestion and absorption of Minerals.
5) Electrolytes and trace elements.

Learning Outcome: Upon completion of the above unit, they are able to understand the significance of major, minor minerals and trace elements.

REFERENCE BOOKS:

1) Gopakumar,K. (2002). Text book of Fish Processing Technology, Indian Council of Agricultural Research, New Delhi.
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3) De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
4) Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
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CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	3	2	1	2	1	2	1
CO2	3	2	1	2	1	2	1	2	1	2
CO3	2	1	3	2	1	2	2	1	2	2
CO4	1	2	3	1	2	2	1	1	2	1
CO5	2	1	2	2	1	2	1	3	2	2

Z 4.4. (A) (22): AQUACULTURE MANAGEMENT

Course Type: Theory

Course Category: Elective -II

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To study about the types of culture systems, design and construction of fresh water fish farm, shrimp farm and hatcheries.

CO2: To study about the management of fish ponds.

CO3: To discuss about the Natural food, culture of live food, supplementary feeds, feed formulation, manufacturing and feeding strategies.

CO4: To study about the principles of aquaculture economics, Fish harvesting in ponds and Organic Aquaculture.

CO5: To understand the Methods of fish/shrimp preservation and processing, Principles and practices of organic aquaculture and Impact of aquaculture on environment.

UNIT - I: Aquaculture Engineering

1) Types of culture systems: Open culture system (cages, pens, rafts and racks); semi-closed culture system (Ponds and Raceways) and closed culture system (Tanks, Water recirculation systems).
2) Design and construction of a freshwater fish farm and hatchery.
3) Design and construction of a shrimp farm and hatchery.

Learning Outcome: Upon completion of the above unit students will get awareness about types of aquaculture systems and fresh water fish farm, shrimp farm and hatcheries.

UNIT - II: Management of fish ponds

1) Management of fish production; Natural productivity of ponds; Biological means of increasing fish production.
2) Identification of oxygen depletion problems and control mechanisms in fish and shrimps ponds.
3) Liming, organic manures, chemical fertilizers and their implications in fish ponds.
4) Techniques and management practices adopted for the Reservoir Fisheries in India.

Learning Outcome: Students will understand the concepts of Management of fish production, techniques and management practices adopted for the reservoir fisheries in India.

UNIT - III: Feed Management

1) Natural food, culture of live food – *Spirulina, Chaetoceros, Brachionus, Artemia*for hatcheries.

2) Supplementary feeds: Types of feeds– wet, moist and dry feeds, mashes, pelleted feeds-floating and sinking pellets; Feed additives- binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants. Use of preservatives.
3) Feed formulation and manufacturing. Feed storage methods.
4) Feeding strategies: Feeding devices, feeding schedules and ration size. Feed evaluation - feed conversion efficiencies and ratios.

Learning Outcome: On completion of the above unit they will understand Natural food, culture of live food, Supplementary feeds, feed formulation and manufacturing and feeding strategies.

UNIT - IV: Economics and Fish processing

1) Principles of aquaculture economics – Capital costs, Variable costs, Cost-benefit analysis.
2) Fish harvesting in ponds; Fish handling and packaging; methods of transport; fish marketing methods in India.
3) Methods of fish and shrimp preservation and processing; Fishery by-products.
4) Organic Aquaculture – Concept, Principles and Practices.

Learning Outcome: Students acquire knowledge about Principles of aquaculture economics, Fish harvesting in ponds, Fish handling, packaging and methods of transport and Organic aquaculture.

UNIT - V:

1) Methods of fish/shrimp preservation and processing
2) Principles and practices of organic aquaculture.
3) Impact of aquaculture on environment

Learning Outcome: Students are able to understand the methods of fish/shrimp preservation, processing; principles and practices of organic aquaculture and Impact of aquaculture on environment.

REFERENCE BOOKS:

1) Bose AN. *et al*. 1991. *Coastal Aquaculture Engineering*. Oxford & IBH Publ. Co. Pvt. Ltd.
2) Boyd, CE. 1982. *Water Quality Management for Pond Fish Culture.* Elsevier Sci. Publ. Co.
3) Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Fresh water Prawn.* Daya Publ. House.
4) CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries*. CIFE, Versova, Mumbai
5) De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
6) Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR.
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9) Jhingran VG. 1982. *Fish and Fisheries of India.* Hindustan Publishing Corporation, India.

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CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**2**	**3**	**1**	**2**	**1**	**2**	**1**	**2**	**2**	**1**
CO2	**1**	**2**	**1**	**1**	**3**	**2**	**1**	**2**	**1**	**2**
CO3	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**
CO4	**2**	**1**	**3**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
CO5	**1**	**2**	**2**	**2**	**1**	**1**	**2**	**3**	**2**	**1**

Z 4.4. (B) (22): FISH PROCESSING TECHNOLOGY

Course Type: Theory

Course Category: Elective -II

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To understand the concepts of Major and Minor constituents of fish, Post-mortem biochemical changes, Toxins and toxic substances in fish.

CO2: To study about the biochemical and microbial spoilage of fish and role of bacteria and moulds in fish preservation.

CO3: To discuss about Handling, storage and transport of fresh fish, Principles of fish preservation and Modern techniques employed in fish preservation .

CO4: To study about the HACCP and National and International Standards.

CO5: To understand the Methods of fish quality assessment, fishery and byproducts and major fish processing equipment's.

UNIT– I: Process Biochemistry

1) Major and minor constituents of fish, their distribution and function-moisture, proteins, lipids, carbohydrates, vitamins and minerals.
2) Post-mortem biochemical changes in fish-rigor mortis, autolysis, auto-oxidation and their significance.
3) Toxins and toxic substances in fish.

Learning Outcome: On completion of the above unit they are able to analyze the major and minor constituents of fish, significance of post-mortem biochemical changes in fish-rigor mortis, autolysis, auto-oxidation; toxins and toxic substances in fish.

UNIT– II: Microbiology

1) Biochemical and microbial spoilage of fish; factors affecting spoilage of fish.
2) Role of bacteria and moulds in fish preservation-pathogenic organisms encountered in fish products, faecal indicator organisms.

Learning Outcome: To understand the biochemical and microbial spoilage of fish and the role of bacteria and moulds in fish preservation.

UNIT– III: Handling and Fish Preservation

1) Handling, storage and transport of fresh fish, sanitary and phyto-sanitory requirements for maintenance of quality.
2) Principles of fish preservation; preservation of fish by curing, drying, salting and smoking; chilling and freezing of fish; canning of fish and fish products.
3) Modern techniques employed in fish preservation: Accelerated Freeze Drying (AFD), Irradiation.

Learning Outcome: Upon completion of the above unit they are able to understand the handling, storage and transport of fresh fish; Principles and modern techniques employed in fish preservation.

UNIT–IV: Quality Management and Certification

1) HACCP (Hazard Analysis and Critical Control Points) and Good Manufacturing Practices: HACCP Principles, Practical aspects of planning and implementation, Verification, Validation and Audit.
2) National and International Standards - ISO 9000 Series, 2000 Series of Quality Assurance System, Codex Alimentarius Commission, Food Safety and Standards Act of India 2006.

Learning Outcome: On completion of the above unit they are able to analyze Hazard analysis and critical control points; National and International Standards and Food safety and standards act of India 2006

UNIT- V

1) Methods of fish quality assessment- Sensory method, physical/mechanical methods, biochemical/chemical method and microbiological method.
2) Fishery by-products and waste utilization.
3) Major fish processing equipments.

Learning Outcome: Upon completion of the above unit they are able to get awareness about methods of fish quality assessment; fishery byproducts and waste utilization; major fish processing equipment.

REFERENCE BOOKS:

1) Balachandran KK.2001. *Post-harvest Technology of Fish and Fish Products*. Daya Publ.
2) Bond, et al.1971.*Fish Inspection and Quality Control.* Fishing News Books, England.
3) Clucas IJ.1981.*Fish Handling, Preservation and Processing in the Tropics*. Parts I, II.FAO.
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6) Hall G M. (Ed).1992. *Fish Processing Technology*. Blackie.
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CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	2	1	2	1	1	2
CO2	2	1	2	2	1	1	2	3	2	1
CO3	1	2	2	1	2	3	2	1	2	3
CO4	2	1	2	1	2	1	1	3	2	1
CO5	2	1	2	3	1	2	1	2	1	2

Z 4.4. (C) (22): ECONOMIC ZOOLOGY

Course Type: Theory

Course Category: Elective -II

Credits: 4

COURSE OBJECTIVES / COURSE OUTCOMES:

CO1: To introduce the basic concepts of Aquarium fish keeping, potential scope of Aquarium fish Industry and Biology of aquarium fishes

CO2: To study the scope, status and economic importance of sericulture in India.

CO3: To discuss about apiculture, methods of bee keeping, byproducts of honey bees and its economic importance.

CO4: To study about Lac culture, Pearl culture, Vermiculture and compost technologies.

CO5: To understand the basic concepts of Economics of poultry keeping and Dairy farm management.

UNIT-1:

1) Introduction to Aquarium Fish Keeping The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes
2) Biology of Aquarium Fishes Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish, Use of live fish feed organisms. Preparation and composition of formulated fish feeds
3) Fish Transportation and Aquarium Maintenance Live fish transport - Fish handling, packing and forwarding techniques. General Aquarium maintenance–budget for setting up an Aquarium Fish Farm as a Cottage Industry.

Learning Outcome: Students will get knowledge about technical practices of aquaculture disease management technologies and their adaptation in fisheries.

UNIT-2:

1) History, scope and status of Sericulture Industry in India.
2) Species of silkworm, life history of mulberry silkworm and tasar silk worm(Eri0.
3) Silk worm diseases-.
4) Brief idea of cocoon processing for silk fabric - cocoon boiling, reeling, rereeling, winding, doubling, twisting and weaving.

Learning Outcome: Upon completion of the above unit students are able to understand the scope and status of sericulture industry in India.

UNIT-3:

1) Types of honey bees.
2) Life cycle, culture of honey bees using movable frame hive.

3) Methods of bee keeping, enemies of bees.
4) Bye products of Honey bees and its economic importance.

Learning Outcome: On completion of the unit students will get awareness about Apiculture, By products of honey bees and its economic importance.

UNIT-4:

1) Lac culture – Lac insect, Laccifera lacca - Life cycle, Lac processing, Lac products and Economic Importance.
2) Pearl culture and Pearl Industry.
3) Vermiculture and Composting technologies.

Learning Outcome: Students are able to understand the technical practices and economic importance of Lac culture, Pearl culture and vermicompost.

UNIT-5:

1) Economics of Poultry keeping: Morphology of different breeds of Chicken-Brooding and Rearing of Chicks-Processing of Egg, Meat and By-Products of Poultry.
2) Dairy farm management, Milch breeds. Draught breeds, Dual purpose breeds and New Cross breeds of Cows and Buffaloes in India.

Learning Outcome: Upon completion of the above unit they are able to understand the technologies pertaining to Poultry keeping and Dairy farm management.

REFERENCE BOOKS:

1) Sukla, G.S. and Upadhyay, V.B., 2000 Economic Zoology – ISBN – 81-7133-137-8 Rastogi Publications, Meerut, India.
2) Jawaid Ahsan and Subhas Prasad Sinha, 2000 A Handbook on Economic Zoology-ISBN-81-219-0876-O S. Chand & Co., Ltd., New Delhi.
3) Ashok Kumar and Prem mohan Nigam, 1991 Economic and Applied Entomology Emkay Publications, New Delhi.
4) Shammi, Q.J. and Bhatnagar, S., 2002 Applied Fisheries: ISBN-81-7754-114-5 Agrobios (India), Jodhpur – India.
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6) Keith Wilson, N.D.P., 2005 A Handbook of Poultry Practice – ISBN-81-7754-O-69-6 Agrobios (India), Jodhpur – India.
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8) Banerjee, 1988 A Text Book of Animal husbandry-VIII-Edition-ISBN-81-204-1260-5 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9) Kaushish, S.K., 2001 Trends in Livestock Research – ISBN-81-7754-112-9 Agrobios (India), Jodhpur – India.
10) Ismail, S.A. 1997. Vermicology the Biology of Earth worm Orient Longman, India 11. A. Mary violet Christy 2008 vermy technology MJP Publ. Chennai

CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	1	1	2	1
CO2	2	2	1	1	2	1	2	1	1	2
CO3	1	2	3	1	2	1	2	1	2	2
CO4	2	1	2	1	2	1	3	2	1	2
CO5	2	1	3	1	2	1	2			

PRACTICAL – I:

ZP 4.5. (22): FISH PATHOLOGY AND IMMUNOLOGY

FISH PATHOLOGY

1) External examination of the diseased fish – diagnostic features and procedure.
2) Exploration of the skin smear.
3) Exploration of the gill smear.
4) Autopsy of fish – examination of the internal organs.
5) Maceration and squash preparation of organs for microscopic observation of pathogens.
6) Collection and mounting of some important ecto and endoparasites of fish.
7) Identification of fish diseases.
8) Identification of common shrimp diseases.
9) Preparation of paraffin blocks and the study of histology of internal organs - gills, kidney and intestine.

IMMUNOLOGY

1) Haemagglutination – detection of blood group antigens.
2) Immunodiffusion –detection of antigen-antibody reaction.
3) Estimation of total RBC count.
4) Estimation of total WBC count.
5) Estimation of differential leucocytes count (DLC).
6) ELISA test – qualitative determination of antigens or antibodies.

PRACTICAL - II:

ZP 4.6. (22): AQUACULTURE AND AQUACULTURE MANAGEMENT

1) Identification of important cultivable species of fin fish and shell fish.
2) Common unwanted (weed and predatory) fishes in culture ponds – identification and their impact in aquaculture.
3) Dissection of pituitary gland and preparation of pituitary extract, method of dosage
4) preparation and injection of pituitary extract for induced breeding of fish.
5) Collection, preservation and identification of common phytoplanktonic organisms in ponds.
6) Collection, preservation and identification of common zooplanktonic organisms in ponds-
7) Rotifers, Cladocerans and Copepods.
8) Identification of aquatic insects and molluscs in ponds.
9) Common floating, emergent and submerged aquatic vegetation in ponds.

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