

ANDHRAKESARI UNIVERSITY: ONGOLE
(A State University, Recognised by UGC)
M.Sc. AQUACULTURE SYLLABUS
Course Structure as per National Educational Policy-2020 under CBCS
(For the students admitted from the academic year 2026-2027 onwards)
COURSE STRUCTURE & SCHEME OF MARKS

Semester	Components of Study	Course Code	Title of the Course	No.	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER - I	Mandatory Core	R26-AC 1.1	Limnology	4	4	30	70	100
		R26-AC 1.2	Aquaculture Engineering	4	4	30	70	100
	Foundation Course	R26-AC 1.3	Taxonomy and Functional Anatomy of Shellfish	4	4	30	70	100
	Foundation Elective (Opt' 1)	R26--AC 1.4 (A)	Taxonomy and Functional Anatomy of Finfish	4	4	30	70	100
		R26-AC 1.4 (B)	Developmental Biology					
		R26-AC 1.4 (C)	Molecular Cell Biology					
	Core Practical-I (Skill)	R26-AC 1.5P	Limnology and Aquaculture Engineering	4	6	30	70	100
	Core Practical-II (Skill)	R26-AC 1.6P	Taxonomy and Functional Anatomy of Shellfish and finfish	4	6	30	70	100
	Audit course	R26-AC 1.7	Human Values and Professional Ethics	*2*	*2*	*50*	-	-
	Sub-Total			**24**				**600**
SEMESTER - II	Mandatory Core	R26-AC 2.1	Marine and Brackish-water Ecology	4	4	30	70	100
		R26-AC 2.2	Fish Physiology	4	4	30	70	100
	Research Foundation	R26-AC 2.3	Research Methodology	4	4	30	70	100
	Foundation Elective (Opt'1)	R26-AC 2.4 (A)	Nutrition and Feed Technology	4	4	30	70	100
		R26-AC 2.4 (B)	Principles of Ecology and Biodiversity					
		R26-AC 2.4 (C)	Tools and Techniques in Biology					
	Core Practical -I (Skill)	R26-AC 2.5P	Marine and Brackish-water & Ecology and Fish Physiology	4	6	30	70	100
	Core Practical -II (Skill)	R26-AC 2.6P	Research Methodology and Nutrition and Feed Technology	4	6	30	70	100
	Skill Development	R26-AC 2.7	Skill Development MOOCs/SDC	*2*	*2*	*50*	–	–
	Sub-Total			**24**				**600**
SEMESTER - III	Mandatory Core	R26-AC 3.1	Aquaculture Microbiology	4	4	30	70	100
		R26-AC 3.2	Aquaculture Economics and Fisheries Extension	4	4	30	70	100
	Generic Elective-I (Opt' 1)	R26-AC 3.3 (A)	Water Quality Management	4	4	30	70	100
		R26-AC 3.3 (B)	Aquatic Toxicology					
		R26-AC 3.3 (C)	Animal Biotechnology and Microbiology					
	Open Elective-II (Opt' 1)	R26-AC 3.4 (A)	Fish and Shellfish Pathology	4	4	30	70	100
		R26-AC 3.4 (B)	Ichthyology					
		R26-AC 3.4 (C)	Environmental Biology					
	Core Practical -I (Skill)	R26-AC 3.5P	Aquaculture Microbiology & Aquaculture Economics and Fisheries Extension, Water quality Management & Fish and Shellfish Pathology	4	6	30	70	100
	Core Practical -II (Skill)	R26-AC 3.6	Industry Internship / Mini Research Project	4	6	30	70	100
	Skill Enhancement	R26-AC 3.7	Skill Development MOOCs/SDC	*2*	*2*	*50*	–	–
	Sub-Total			**24**				**600**
SEMESTER - IV	Mandatory Core	R26-A.C 4.1	Principles and Practicals of Aquaculture	4	4	30	70	100
		R26-AC 4.2	Fish Processing Technology	4	4	30	70	100
	Core Elective-I (Opt' 1)	R26-AC 4.3 (A)	Aquaculture Biotechnology	4	4	30	70	100
		R26-AC 4.3 (B)	Aquaculture in Reservoirs					
		R26-AC 4.3 (C)	Aquaculture ecosystem management and climate change					
	Open Elective-II (Opt' 1)	R26-AC 4.4 (A)	Fish and Shellfish Immunology	4	4	30	70	100
		R26-AC 4.4 (B)	Aquatic food safety and Quality Management					
		R26-AC 4.4 (C)	Advances in Aquaculture					
	Core Practical -I (Skill)	R26-AC 4.54P	Aquaculture Biotechnology and Fish and Shellfish Immunology	4	6	30	70	100
	Core Practical -II (Skill) (Multi-Disciplinary)	R26-AC 4.6	Project Work **(Dissertation + Seminar + Viva-voce)**	4	6	-	100 (50+20+30)	100
			Sub-Total	**24**				**600**
	Grand Total			**96**				**2400**

Note: Pass in Audit course, skill development and skill enhancement courses are mandatory

First Semester



M.Sc.

SEMESTER-I

AC 1.1.: Limnology

Course Type: Theory
Course Category: Mandatory core
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) **Inland water 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) **Carbon dioxide**: Sources, losses and distribution patterns; role of carbon dioxide 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.*StreamEcology: Structure and Function of Running Waters.* Chapman & Hall
2) ColeGA.1983. *Text book of Limnology,* C.V. Mosby Company, St.Louis, Missouri, USA.
3) Goldman CR. And Horne AJ.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*: Vol I. *Geography, physics and chemistry*. John Wileyand 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. McGraw-Hill BookCo., NewYork.
10) WetzelRG.1975.*Limnology,* W.B.Sanders Company, Philadelphia.

Prof. M. Jagadeesh

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



AC 1.2.: Aquaculture Engineering

Course Type: Theory

Course Category: Mandatory core

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 parameters. Integration of automated water intake gates and AI-controlled drainage networks.
2. **Brackish water Shrimp Farm:** Design and construction parameters. Engineering smart ponds equipped with IoT water quality sensor arrays (pH, DO, Salinity) connected to AI cloud platforms for automated aeration control and early warning anomaly detection.

Learning Outcome: Students will gain knowledge and skills to design and plan a freshwater fish farm and brackish water shrimp farm including site selection, pond design, and the structural integration of AI-managed automation loops.

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.

Prof. M. Jagadish

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



AC 1.3. (A): Taxonomy of and Functional Anatomy of Shell Fish

Course Type: Theory
Course Category: Compulsory foundation
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

Prof. M. Jagadeesh

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:
9) A.J. Marshall & W.D. Willimas), ELBS & McMillan & Co.
10) 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

AC 1.4. (A): Taxonomy of and Functional Anatomy of Fin Fish

Course Type: Theory
Course Category: Elective foundation
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 cardiovascular, 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 Ganado-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 gonad-somatic index 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	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

Prof. M. Jagadish

AC 1.4. (B): Developmental Biology

Course Type: Theory

Course Category: Elective 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:

1) Origin and migration of primordial germ cells (PGCs) to the genital ridges, differentiation of gonads in mammals.
2) Spermatogenesis: Sperm – formation, structure and types; Leydig cells – endocrine regulation of spermatogenesis.
3) 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:

1) Fertilization: Cell surface molecules in sperm-egg recognition in animals, mechanism of fertilization, molecular events during fertilization and post fertilization.
2) 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:

1) Cell aggregation and differentiation; axes and pattern formation in Drosophila, amphibian and chick.
2) Differentiation of neurons, post embryonic development.
3) 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:

1) Programmed cell death: Incidence of apoptosis, apoptosis during animal development;
2) apoptosis during limb development.
3) 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:

1) Potency, commitment, Specification, Induction, Competence, Determination and differentiation.
2) 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, 8 thEdition. 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



AC 1.4. (C): 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, Oxidative Phosphorylation.

Learning outcome:

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

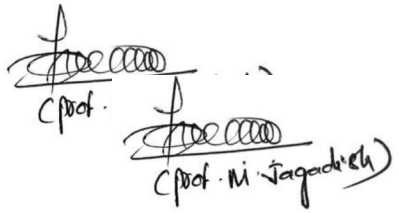
UNIT – III

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 Proofreading, 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) De Robertis RMF and Saez RDP. 1970. *Cell Biology.* Academic Press, New York.
3) Gilman M, Witkowski JA and Watson MZJD. 1992. *Recombinant DNA.*2nd Edition. ScientificAmerican Books, W.H. Freeman and Company, New York.
4) Levine L. 1973. *Biology of the Gene.* 2nd Editon.
5) Pragya Khanna. 2008. *Cell and Molecular Biology.* I.K. International Publ. House Pvt. Ltd. NewDelhi
6) White MJD. 1973. *Animal Cytology and 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

PRACTICAL – I:

ACP 1.5.: Limnology and Aquaculture Engineering

Limnology

1) Estimation of pH and turbidity.
2) Estimation of total alkalinity.
3) Estimation of dissolved oxygen.
4) Estimation of total hardness.
5) Estimation of phosphates.
6) Estimation of iron.
7) Estimation of primary productivity (light and dark bottle method).

Aquaculture Engineering

1) Design and layout of freshwater and brackish water farm.
2) Design and construction of Fish and shrimp hatchery.
3) Rates of calculation of water flow through pipes of different diameters and of pumps of
4) different HP (horse power).
5) Estimations and calculations of production costs of fish/shrimp farm.

PRACTICAL - II:

ACP 1.6.: Taxonomy and Functional Anatomy of Shellfish and Finfish

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 the stages of maturation of gonads in fishes.
4) Dissection and mounting of pituitary gland.
5) Dissection of digestive systems of fishes with different feeding habits.
6) Mounting of fish scales.
7) Identification and systematics of estuarine and marine shell fish of commercial importance.
8) Identification of different stages of shrimp/prawn seed.
9) Dissection of digestive system of shrimp/prawn. Identification and mounting of appendages of shrimp/prawn.



AC 1.7Audit Course: Human Values and Professional Ethics

Learning Objectives:

- ✓ To know the nature of ethics and goals.
- ✓ To know the basic moral concepts.
- ✓ To know the non-violence of non-possession.
- ✓ To know the crime and theories of punishment.
- ✓ To know the Bhagavd Gita, Buddhism, Jainism.

Unit-I: 6H

Definition and Nature of Ethics – Is relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics – Goals – Ethical Values in Various Professions.

Unit-II: 6H

Nature of Values-Good and Bad, Ends and Means, Actual and Potential Values, Objective and Subjective Values, Analysis of Basic Moral Concepts-Right, Ought, Duty, Obligation, Justice, Responsibility and Freedom, Good Behavior and Respect for Elders, Character and Conduct.

Unit-III: 6H

Individual and Society: Ahimsa (Non-Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non-Possession) and Aparigraha (Non-stealing). Purusharthas (Cardinal virtues) - Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

Unit-IV: 6H

Crime and Theories of Punishment – (a) Reformative, Retributive and Deterrent, (b) Views on Manu and Yajnavalkya.

Unit-V: 6H

Bhagavd Gita – (a) Niskama Karma, (b) Buddhism – The Four Nobel Truths – Arya astangamarga, (c) Jainism - Mahavratas and Anuvratas. Values Embedded in Various Religions, Religious Tolerence, Gandhian Ethics.



Reference Books:

1) Johns S Mackenjie: A Manual of ethics
2) "The Ethics of Management" by Larue Tone Hosmer, Richard D. Irwin Inc.
3) Management Ethics – Integrity at work by Joseph A. Petrick and John F. Quinn, Response Books, New Delhi.
4) "Ethics in Management" by S.A. Shelekar, Himalaya Publishing House.
5) Harold H. Titus: Ethics for Today
6) Maitra, S.K: Hindu Ethics
7) William Lilly: Introduction to Ethics
8) Sinha: A Manual of Ethics
9) Manu: Manava Dharma Sastra or the Institute of Manu: Comprising the Indian System of Duties: Religious and Civil (ed) G.C. Haughton.
10) Sasruta Samhita: Tr. KavirajKunjanlal, KunjanlalBrishagratha, Chowkamba Sanskrit Series, Vol I, II and III, Varanasi, Vol I PP, 16-20, 21-32 and 74-77 only.
11) Charaka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office. Varanasi I, II, III Vol I PP 183-191.
12) Ethics, Theory and Contemporary Issues. Barbara Mackinnon, Wadsworth/Thomson Learning, 2001.
13) Analyzing Moral Issues, Judith A. Boss, Mayfield Publishing Company, 1999.
14) An Introduction to Applied Ethics (Ed.,) John H. Piet and Ayodya Prasad, Cosmo Publications.
15) Text Book for Intermediate First Year Ethics and Human Values, Board of Intermediate Eduction – Telugu Academy, Hyderabad.
16) I.C. Sharma Ethical Philosophy of India. Nagin& Co Julundhar.

Learning Outcomes:

- ✓ Students are able to understand relation to religion & ethical values.
- ✓ Students are able to understand to character & conduct.
- ✓ Students are able to understand to crime & theories of punishment.
- ✓ Students are able to understand to Gand
- ✓ hian ethics & values embedded in various religions.
- ✓ Studetns are able to understand various individuals of society.



Second Semester



M.Sc.

SEMESTER-II

AC 2.1.: Marine and Brackish Water Ecology

Course Type: Theory

Course Category: Mandatory core

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 study about the classification and Ecology of some typical brackish water habitats of India.

CO4: To study 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:

1) Classification of the marine environment and salient features of different zones.
2) Classification of marine organisms and their characteristic features.
3) 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

1) Organic production of the sea: Primary, secondary and tertiary production; factors affecting primary production; measurement of organic production.
2) Marine food chains and food webs.
3) 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

1) Classification of brackish water habitats and salient features of different zones: Estuaries, mangroves, lakes, lagoons and marshes/ wetlands.
2) 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

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

(Prof. M. Jagadish)

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

UNIT – V

1) Human impact and management of estuarine ecosystems.
2) Changes in Biotic structure due to harvest and introduction of new species.
3) 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

Prof. M. Jagadeesh

AC 2.2.: Fish Physiology

Course Type: Theory

Course Category: Mandatory core

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

1) 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.
2) Metabolism: Pathways of cellular metabolism.

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

UNIT – II

1) Respiration: Definition of respiration; external respiration and internal respiration.
2) Mechanism of gaseous exchange, CO_2 transport, countercurrent principle, water flow across the gills, respiratory pumps.
3) 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

1) Sensory organs: Structure and function of chemo-, photo- and photoreceptor, lateral line sense organs.
2) Action potential, synapse, neurotransmitters, impulse transmission.
3) 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

1) Excretion: Mechanism of excretion of nitrogenous waste, water and ionic balance.
2) 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

Prof. M. Jagadeesh

of Excretion, Reproduction and Development.

UNIT –V

1) Endocrine system in fishes: Endocrine organs in fishes; Regulation of hormonal control on Reproduction in fishes.
2) 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 andComparative physiology.Printice-Hall ofIndia 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



AC 2.3. Research methodology

Course Type: Theory

Course Category: Compulsory foundation

Credits: 4

Course Objectives/ Course outcomes:

CO1: To introduce the concepts, theoretical aspects, and instrumentation of Colorimetry, Electrophoresis, Chromatography, and Centrifugation.

CO2: To understand the concepts of Immunological reactions and systematic Research Methodology for scientific literature review.

CO3: To discuss about the Biostatistics principles and computer applications in biological data analysis.

CO4: To study the concepts of Limnological parameters, nutrient dynamics, and Planktonology extraction and identification techniques.

CO5: To study about the Biochemical Methods for quantitative estimation of macromolecules and specialized tissue micro-techniques.

UNIT – I

1. Colorimetry and Electrophoresis: Theoretical aspects, visual colorimetry, photoelectric colorimeters, methods of measuring the emitted light. Principle, stabilizing media, homogenization, preparation of homogenate.
2. Chromatography and Centrifugation: Advanced chromatography separation techniques; Principles and applications of centrifugation in biological research.

Learning Outcome: Students are able to distinguish the principles, instrumentation, and operations of colorimetry, electrophoresis, chromatography, and centrifugation.

UNIT – II

1. Immunological Reactions: Precipitin reaction and its biochemical applications; Agglutination reaction and its diagnostic applications.
2. Research Methodology: Reviewing of scientific information relevant to the topic of the candidate's research, collection of literature, reviewing of scientific information and preparation of manuscripts.

Learning Outcome: Upon completion of the above unit, they are able to understand the concepts of Immunological reactions and systemic collection, evaluation, and documentation of scientific literature.

UNIT – III

1. Biostatistics Foundations: The arithmetic mean, median and quintiles, mode; Measures of

Prof. M. Jagadish

dispersion and skewness-objectives, variation and standard deviation.

2. Computational Biology: Applications of computers in Biology-Collection of data bases and use of software in biological data analysis.

Learning Outcome: On completion of the unit, they are able to calculate statistical parameters and use data handling software tools for biological database analysis.

UNIT – IV

1. Limnological Methods: Water quality parameters, Dissolved Oxygen (DO), Alkalinity, Hardness. Micro nutrients such as carbon, phosphates, Nitrites & iron.
2. Planktonology: Plankton collection separation, preservation, identification, and mounting techniques.

Learning Outcome: To understand the assessment of water quality parameters, nutrient distributions, and identification techniques for plankton populations.

UNIT – V

1. Micro technique: Separation of organs, whole mounts, section cutting, dehydration and staining techniques.
2. Biochemicals Methods: Estimation of proteins (Lowry's method & Biuret method), carbohydrates (Kemp et al., method and Anthrone method), lipids (Vanillin method & chromic acid method), lactate (Barker & Summerson), pyruvate (Friedman & Haugen) amino acids (Ninhydrin method, Noor and Anatein, Colowick and Caplan) and Nucleic acids (Searchy and Macllinnis).

Learning Outcome: They are able to apply routine micro-techniques for organ processing and execute chemical tests for the accurate identification and estimation of biochemical compounds.

REFERENCE BOOKS:

1. Garvey JS, Gramer NR and Sussdorf DH. 1977. Methods in Immunology: A laboratory text for instruction and research, WA Benjamin, Inc. Advanced book programme, Massachusetts, 01867 USA.
2. Bharucha B. Hand book of medical laboratory technology, A.H. Press, Vellore, Tamil Nadu.
3. Williams BK and Willson K. A biological wide to principles and techniques of practical biochemistry, Butler and Tanner Ltd, London.
4. Bhat BR, Sri Venkataramana and Madhava Rao KS. Statistics (A beginner's text) volume I New Age International Publishers Ltd, New Delhi.
5. Joshi KR and Osamo NO. Immunology, Agro botanical publishers, Vyas Nagar, Bikaner 334 003.
6. Wetzel. 1972. Limnological methods, WB Saunders and co. Philadelphia.
7. Welch. 1962. Limnological methods, WB Saunders and co. Philadelphia.
8. Golterman and Clamo. 1969. Water analysis, Black well Scientific Publications Laboratory manual in Biochemical—New age International (Pvt) Ltd. Publishers.

Prof. M. Jagadish

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



AC 2.4. (A): Nutrition and Feed Technology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

Course Objectives/ Course outcomes:

CO:1 To remember the basic components of nutrients and their classification.

CO:2 To discuss about the nutritional requirements and their ratio

CO:3 Distinguish the nutrition and importance of feeds

CO:4 To discuss about the feed manufacturing and feed proximate composition

CO:5 To evaluate the feeding strategies and storage methods.

UNIT – I

1) **Fish Nutrition:** Principles of fish nutrition and terminologies; Nutritional requirements of cultivable finfish and shellfish.
2) **Nutritional Biochemistry:** Classification of nutrients, nutrient quality and evaluation of proteins, lipids and carbohydrates.

Learning outcome:

Students will get an understanding of principles of fish nutrition and nutritional biochemistry of nutrients

UNIT – II

Nutritional Bioenergetics

1) Energy requirement of fishes, protein to energy ratio
2) Digestible energy, Nitrogen balance index, protein sparing effect, high energy feeds isocaloric diets, metabolic rate
3) Energy budgets, Energy efficiency of fish production.

Learning outcome:

Students will get an understanding of various aspects of Nutritional Bioenergetics.

UNIT – III

1) **Natural food:** Importance in aquaculture; Fish food organisms – Bacterioplankton, phytoplankton and zooplankton and their role in larval nutrition.
2) **Supplementary feeds:** Types of feeds - Wet feed, moist feed, dry feed, mashes, pelleted feeds - floating and sinking pellets, microencapsulated diets.

Learning outcome:

Students will be familiar with various types of natural food, supplementary **feeds**.



UNIT – IV

1) **Feed additives:** Binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants; use of preservatives.
2) **Feed manufacture:** Feed formulation and processing; Feed machinery units: Pulverizer,
3) grinder, mixer, pelletizer, crumbler, drier, extruder/expander, vacuum coater and fat sprayer.

Learning outcome:

Students will learn about important steps involved in the feed additives and manufacture of feeds, feeding strategies & feed evaluation.

UNIT – V

1) **Feeding strategies:** Feeding devices, feeding schedules and ration size.
2) **Feed evaluation:** Feed conversion efficiencies and ratios. Feed storage methods.

Learning outcome:

Students will able to evaluate steps involved in the feeding strategies & feed evaluation.

REFERENCE BOOKS:

1) ADCP (Aquaculture Development & Co-ordination Program).1980.*Fish Feed Technology*. ADCP/REP/80/11FAO
2) Cyrino EP, Bureau D & Kapoor BG. 2008. *Feeding and Digestive Functions in Fishes*. Science Publ.
3) D' Abramo LR, Conklin DE & Akiyama DM. 1977. *Crustacean Nutrition: Advances in Aquaculture.* Vol. VI. World Aquaculture Society, Baton Roughe.
4) De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
5) Elena M. 2003. *Nutrition, Physiology and Metabolism in Crustaceans*. Science Publishers.
6) Guillame J, Kaushik S, Bergot P & Metallier R. 2001. *Nutrition and Feeding of Fish and Crustaceans.* Springer Praxis Publ.
7) Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
8) Halver JE & Tiews KT. 1979. *Finfish Nutrition and Fish feed Technology*. Vols. I, II Heenemann, Berlin.
9) Hertrampf JW & Pascual FP. 2000. *Handbook on Ingredients for Aquaculture Feeds*. Kluwer.
10) Houlihan D, Boujard T & Jobling M. 2001. *Food Intake in Fish*. Blackwell.
11) Jobling M. 1994. *Fish Bioenergetics*. Chapman & Hall.
12) Lavens P & Sorgeloos P. 1996. *Manual on the Production and Use of Live Food for Aquaculture.* FAO Fisheries Tech. Paper 361, FAO.
13) Nelson DL & Cox MM. 2005. *Lehninger Principles of Biochemistry*. WH Freeman.

Prof. M. Jagadeesh

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	1	2	1	2	1	1	3	1	1
CO3	2	1	2	2	1	2	1	2	2	1
CO4	1	2	2	1	2	1	2	1	3	2
CO5	2	2	1	3	2	1	2	2	1	2



AC 2.4. (B): Principles of Ecology and Biodiversity

Course Type: Theory

Course Category: Elective foundation

Credits: 4

Course Objectives/ Course outcomes:

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

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

CO-2: Understanding population ecology through applying mathematical methods.

CO-3: To introduce basic concepts and significance of biodiversity and distribution of world.

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

1. **Ecology:** Nature and scope of ecology; ecosystem structure and function.
2. **Composition:** Abiotic and biotic components; classification of ecosystem with examples; feedback loop.
3. **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

1. **Population ecology:** Population characteristics—density, natality, mortality, immigration and emigration; life tables generation.
2. **Population growth:** Population growth of organisms with non-overlapping generations; Verhulst-Pearl logistic growth models; stochastic and time lag models of population growth; net reproductive rate and reproductive value.
3. **Stable distribution,** population growth projection using Leslie Matrix method.
4. **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 – III

1. **Biodiversity:** Definition and significance; biodiversity at global, national and local levels; magnitude and distribution of biodiversity.
2. **Patterns of biodiversity:** Latitudinal and altitudinal gradients; species area relationship.



3. **Biogeographic realms** of the world.
4. **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. Analysis species area relationship.

UNIT – IV

Biodiversity management and conservation

1. **IUCN classification** of wildlife.
2. **Biodiversity threats;** *In-situ* conservation and *Ex-situ* conservation.
3. **Gene banks;** conservation of genetic resource; cryopreservation.
4. **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

1. **Biodiversity and biotechnology:** DNA based wildlife forensics; genetically modified organisms (GMOs) and Bioremediation.
2. **Molecular taxonomy:** DNA fingerprinting.
3. **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 L. Fiedler and Perer M. Kareiva. 1997. *Conservation Biology*.
6. Prabodh K. Maiti and Paulami Maiti. 2011. *Biodiversity: Perception, Peril and Preservation*.
7. Saharia VV. 1982. *Wildlife in India*. Natraco Publishers, Dehradun.
8. Tandon RK. 1999. *Biodiversity*

Prof. M. Jagadish

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



AC 2.4. (C): Tools and Techniques in Biology

Course Type: Theory

Course Category: Elective foundation

Credits: 4

Course Objectives/ Course outcomes:

CO:1 To provide information regarding different types of Microscopies, principles involved and working conditions of Microscopes up to SEM TEM and STEM.

CO:2 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.

CO:3 To learn about the importance of different types of chromatographic techniques and electrophoretic techniques the principals involved, applications as analytical tools and their uses in the biological sample analysis.

CO:4 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.

CO:5 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

1) 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 Microscopy, their working principles and uses.

UNIT-II

Spectroscopies: Working principle of UV-Visible spectrophotometry, IR spectroscopy, Atomic Absorption 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

Prof. M. Jagadeesh

UNIT – II

1) Chromatography: Principles and applications of Gel filtration, Paper, Column, Ion-exchange, Affinity, Thin layer (TLC), Gas liquid (GLC) and High-Performance Liquid Chromatography (HPLC)
2) Electrophoresis: Agarose gel electrophoresis, Pulsed Field Gel Electrophoresis (PFGE),
3) Polyacrylamide Gel Electrophoresis (PAGE), Sodium Dodecyl Sulphate Polyacrylamide Gel
4) 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 – III

1) Nucleic acid blotting techniques: Southern blotting, Northern blotting and Western blotting; Polymerase Chain Reaction (PCR); DNA fingerprinting; Genomics and Proteomics.
2) Sequences and nomenclature: IUPAC symbols, nomenclature of DNA sequences, nomenclature of protein sequences, directionality of sequences, types of sequences used in bioinformatics.
3) 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 Nucleic acids
- Nomenclature of DNA sequences, nomenclature of protein sequences types of sequences used in bioinformatics.
- Data retrieval tools, database similarity searching, resources for gene level sequences, use of bioinformatics tools in analysis.

UNIT – IV

1) Bio-statistics: Measures of central tendency and dispersal – mean, median and mode; Probabity
2) distributions - binomial, poison and normal; Sampling distribution.
3) Standard deviation, standard error and confidence interval; Regression and Correlation.
4) 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

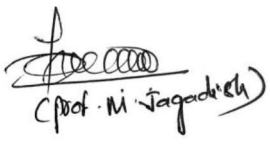
- Sampling distribution, measures of central tendencies and probability distributions
- Standard deviation, standard error and confidence interval; Regression and Correlation.
- Different tests of significance and Usage of Statistical Package for Social Sciences (SPSS).



REFERENCES 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 and Industrial Pollutants. Elsevier.
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 & 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.

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



PRACTICAL – I:

ACP 2.5.: Marine and Brackish Water Ecology and Fish Physiology

Marine and Brackish Water Ecology

1) Analysis of soil-determination of soil texture, soil pH, conductivity, available nitrogen, available phosphorus and organic carbon.
2) Estimation of water salinity and ph.
3) Estimation of primary productivity (light and dark bottle method).
4) Estimation of COD and BOD.
5) Estimation of oxygen consumption.

Fish Physiology

1) Qualitative identification and estimation of ammonia and urea.
2) Estimation of glycogen.
3) Estimation of proteins.
4) Estimation of lipids.
5) Estimation of hemoglobin.
6) Estimation of tissue somatic index.

PRACTICAL - II:

ACP 2.6.: Research Methodology and Nutrition & Feed Technology

Research Methodology

1) **Proteins:** Estimation using the standard Lowry's or Biuret colorimetric assay method.
2) **Carbohydrates:** Estimation using the Anthrone colorimetric method.
3) **Lipids:** Determination of biological lipid quantity via the Sulfophosphovanillin method.
4) Paper chromatography - separation of molecules.
5) Thin layer chromatography - isolation of molecules.
6) Calculation of mean, median, mode, standard deviation and standard error. Analysis of Variance (ANOVA).

Nutrition and Feed Technology

1) Proximate composition of aquaculture feeds – Proteins, carbohydrates, lipids, moisture, ash content.
2) Calculation of surface area and calorific needs of fish, calculation of feed rations, dosage of chemicals etc. for treatment in culture ponds and cost estimates.
3) Estimation of amylase and lipase activity.

