ANDHRA KESARI UNIVERSITY

M. Sc. Aquaculture

W.e.f., 2023 – 2024

SEMESTER –I

S. No.	Componentsof Study	Code	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/ week
1.	Mandatory Core	AC 1.1	Limnology	4	30	70	100	
2.		AC 1.2	Aquaculture Engineering	4	30	70	100	
3.	Compulsory Foundation	AC 1.3	Taxonomy and Functional Anatomy of Shellfish	4	30	70	100	
4.	Elective Foundation	AC 1.4 (A)	Taxonomy and Anatomy of Finfish	4	30	70	100	
		AC 1.4 (B)	Developmental Biology					
		AC 1.4 (C)	Molecular Cell Biology					
5.	Practical -I	AC 1.5P	Limnology and Aquaculture Engineering	4	30	70	100	
6.	Practical-II	AC 1.6P	Taxonomy and Anatomy of finfish and shellfish	4	30	70	100	
	TOTAL			**24**	**180**	**420**	**600**	
Elective Foundation – Choose one paper.								

SEMESTER –II

S.No.	Componentsof Study	Code	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/ week
1	MandatoryCore	AC 2.1	Marine and Brackish water Ecology	4	30	70	100	
2.		AC 2.2	Fish Physiology	4	30	70	100	
3.	Compulsory Foundation	AC 2.3	Aquaculture Microbiology	4	30	70	100	
4.	Elective Foundation	AC 2.4 (A)	Nutrition and Feed Technology	4	30	70	100	
		AC 2.4 (B)	Biodiversity					
		AC 2.4 (C)	Principles of Ecology					
5.	Practical -I	AC 2.5P	Marine and Brackish water Ecology and Fish Physiology	4	30	70	100	
6.	Practical-II	AC 2.6P	Aquaculture Microbiology and Feed Technology	4	30	70	100	
7.	Skill Development Course	AC 2.7	MOOCs/SDC		00			
TOTAL				**28**	**180**	**420**	**600**	
Elective Foundation – Choose one paper.								

SEMESTER –III

S.No	Component sof Study	Code	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/ week
1.	Mandatory Core	AC 3.1	Tools and Techniques in Biology	4	30	70	100	
2.		AC 3.2	Aquaculture Economics and Fisheries Extension	4	30	70	100	
3.	Elective-I	AC 3.3 (A)	Water quality management	4	30	70	100	
		AC 3.3 (B)	Aquatic Toxicology					
		AC 3.3 (C)	Animal Biotechnology and Microbiology					
4.	Elective-II	AC 3.4 (A)	Fish and Shellfish Pathology	4	30	70	100	
		AC 3.4 (B)	Ichthyology					
		AC 3.4 (C)	Environmental biology					
5.	Practical -I	AC 3.5P	Tools & Techniques and Aquaculture Economics	4	30	70	100	
6.	Practical-II	AC 3.6P	Water Quality Management and Fish Pathology	4	30	70	100	
7.	Skill Enhanced AC 3.7 MOOCs/SDC Course			4	00	00		
TOTAL				**28**	**180**	**420**	**600**	

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

SEMESTER –IV

S.No.	Components of Study	Code	Title of the Paper	No. of Credits	Internal Assessment Marks	Semester end Examinations Marks	Total Marks	No. of hours/ week
1.	Mandatory Core	AC 4.1	Principles and Practices of Aquaculture	4	30	70	100	
2.		AC 4.2	Fish Processing Technology	4	30	70	100	
3.	Elective-I	AC 4.3 (A)	Aquaculture Biotechnology	4	30	70	100	
		AC 4.3 (B)	Aquaculture in Reservoirs					
		AC 4.3 (C)	Aquaculture ecosystem management and climate change					
4.	Elective-II	AC 4.4 (A)	Fish and Shellfish Immunology	4	30	70	100	
		AC 4.4 (B)	Aquatic food safety &Quality Management					
		AC 4.4 (C)	Advances in Aquaculture					
5.	Practical -I	AC 4.54P	Aquaculture and Fish Processing Technology	4	30	70	100	
6.	Practical-II	AC 4.6P	Aquaculture Biotechnology and Immunology	4	30	70	100	
7.	AC 4.7 **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

M.Sc. AQUACULTURE

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) **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.*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.

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
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

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 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 cardiovasular, 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.

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

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 knowledgeto 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 tobiotechnology, 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 ANATOMY OF FINFISH AND SHELLFISH

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.

Second Semester

M.Sc. AQUACULTURE

SEMESTER-II

AC 2.1.: MARINRE 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.

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

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 phonoreceptor, 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 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. (A): AQUACULTURE MICROBIOLOGY

Course Type: Theory

Course Category: Compulsory 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

1) **Cell Structure:** Prokaryotic and eukaryotic cell structure; Cell membrane, cell wall, proteins, nucleic acids – structure, properties and interactions.
2) **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

1) **Microbial Growth:** Factors influencing microbial growth - Physical, chemical and biological conditions of the environment.
2) **Microbial interaction:** Role of microbial population in biogeochemical cycles (C, N, P, S, Si and Fe), xenobiotic and inorganic 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

1) **Bioprocesses:** Principles and applications of bioprocesses-Bioremediation, biofertilization, biofilms, bio-leaching, bio-corrosion, bio-fouling.
2) 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

1) Nutritional requirements of microorganisms – constituents of growth media. Sterilization and media preparation; Isolation, enumeration, preservation;
2) 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

1) Routine tests for identification of bacteria – morphological, cultural, biochemical and serological.
2) 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 & Goodheart 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

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.

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): BIODIVERSITY

Course Type: Theory

Course Category: Elective foundation

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

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. Analyse species area relationship.

UNIT – II

1) **Hierarchical components** of biodiversity: Species diversity, genetic diversity and ecosystem diversity.
2) **Biodiversity values:** Direct values and indirect values.
3) **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

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

2) **Identification:** Keys, biodiversity documentation, species identification and identification tools.
3) **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

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&OwenMc.*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 Paulami Maiti. 2011. *Biodiversity: Perception, Peril and Preservation*.
7) Saharia VV. 1982.*Wildlife in India.*Natraco Publishers, Dehradun.
8) TandonRK.1999. *Biodiversity, Taxonomy & Ecology.* Prithipalsingh 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

AC 2.4. (C): PRINCIPLES OF ECOLOGY

Course Type: Theory

Course Category: Elective 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:

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) **Trophic dynamics of ecosystem**: Energy flow; food chain; food web; trophic levels; ecological pyramids
2) **Limiting factors:** Liebig's law of the minimum and Shelford's law of tolerance.
3) **Habitat and niche:** Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource patitioning and character displacement.

Learning outcome:

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

UNIT – III

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;

3) Verhulst-Pearl logistic growth models; stochastic and time log models of population growth; net reproductive rate and reproductive value.
4) Stable distribution; population growth projection using Lesile Matrix method.
5) 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

1) **Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement
2) **Population regulation:** Inter specific relationships and intra specific relationships (extrinsic and intrinsic mechanism of population regulation).
3) 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

1) **Biological magnification**.
2) **Productivity:** Concept of productivity – primary, secondary, tertiary; Recycling of materials.
3) **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) TrivedyRK, 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

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.: AQUACULTURE MICROBIOLOGY AND NUTRITION & FEED TECHNOLOGY

Aquaculture Microbiology

1) Preparation of different types of media for bacterial cultures.
2) Standard Plate Count of Bacteria (SPC).
3) Isolation of bacteria – coliforms, *Staphylococcus aureus, Salmonella typhi, E. coli.*

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.

Third Semester

M.Sc. AQUACULTURE

SEMESTER-III

AC 3.1.: TOOLS AND TECHNIQUES IN BIOLOGY

Course Type: Theory

Course Category: Mandatory core

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 principles 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

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, poisson 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 distributon, 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:

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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

AC 3.2.: AQUACULTURE ECONOMICS AND FISHERIES EXTENSION

Course Type: Theory

Course Category: Mandatory core

Credits: 4

Course Objectives/ Course outcomes:

CO:1 The basic components in economics and their levels.

CO:2 To discuss about the food marketing and cost benefit ratio.

CO:3 Create awareness in carp and crustacean farm production.

CO:4 To discuss about the fisheries in extension in local and world wide facilities.

CO:5 To understand about the functioning and management of public organizations in fisheries.

UNIT- I: Economics

1) The basis of production; Interrelationships of aquaculture systems.
2) Production Economics: Basic economic principles applied to aquaculture production;
3) Input-output relationships, maximum level of input, least-cost combination of inputs,
4) Maximum level of out put, combination of products, Economies of size.
5) Cost-Benefit Analysis: Production costs - fixed costs, variable costs, estimation of total
6) gross revenue, economic analysis.
7) 4, Partial budget analysis; Cash flow analysis.

Learning outcome:

Students are able to understand the

- External and internal factors affecting the aqua production
- Basic economic principles of aquaculture
- Cost- return analysis in aquaculture.

UNIT-II

1) Marketing Economics: Fish marketing methods in India; Basic concepts in demand and
2) price analysis; demand, supply and fish prices, elasticity of demand (price elasticity of
3) demand, income elasticity of demand, cross eiasticity of demand).
4) Economic feasibility of investment: Analysis: Methods of feasibility analysis: the payback
5) period, average rate of return, discounting method, Net Present Value. Benefit-cost, Ratio,
6) Internal rate of Return.

Learning outcome:

Students are aware of

- Fish marketing methods in India.
- Economic feasibility investment analysis in aquaculture.

UNIT-III

1) Economics of carp production farm.
2) Economics of a shrimp farm and Economics of a freshwater prawn farm.

Learning outcome:

Students should aware of

- Economics of carp farm production.
- Economics of shrimp farm production.

UNIT - IV: Fisheries Extension

1) Fisheries training and Education in India: Training Institutes, Universities, Research organizations.
2) Institutional funding to fisheries and aquaculture sector,
3) Socio-economic conditions of fishermen and fish farmers.
4) Fishermen Co-operative societies.

Learning outcome:

Students are familiar with the

- Fisheries training centers and educational institutions
- Funding agencies to fisheries and aquaculture sectors
- Fishermen co-operative societies and their roles.

UNIT-V

1) Functions and Working of management systems of public service agencies like Fish Farmers Development Agency (FFDA), Brackish Water Fish Farmers Development Agency (BFDA), Marine Products Export Development Authority (MPEDA), National Bank for Agricultural Rural Development (NABARD), Fisheries Development Corporations (FDC)

Learning outcome:

Students are familiar with the

- Fisheries development sectors and agencies.

REFERENCE BOOKS:

1) Adcock, D, Bradfield, R, Halborg, A. & Ross, C. 1995. *Marketing Principles and Practice.* Pitman Publications.
2) Allen, *et al.* (Eds). 1984. *Bio-Economics of Aquaculture.* Elsevier PubI.
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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**	**2**
CO2	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**2**
CO3	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**1**	**2**	**1**
CO4	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**3**	**1**	**2**
CO5	**2**	**1**	**2**	**1**	**1**	**2**	**1**	**2**	**1**	**1**

AC 3.3. (A): 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
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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

AC 3.3. (B): AQUATIC TOXICOLOGY

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

Course Objectives/Course outcomes:

CO:1 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.

CO:3 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 chemicalcharacterization 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 ofsewage, 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

1) 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

1) 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

- The major sources of Thermal pollution from different industries and their control
- methods
- Sources of radiation pollution harmful effects of radiation pollution
- Monitoring of radiation pollution

UNIT – V

1) Environmental Impact Assessment (EIA) – Analysis: Introduction, EIA under National
2) Environmental Policy Act (NEPA), EIA in action, implementation of EIA, Case studies
3) –water quality impact analysis and nuclear power plant impact.
4) 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.

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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

AC 3.3. (C): ANIMAL BIOTECHNOLY AND MICROBIOLOGY

Course Type: Theory

Course Category: Elective -I

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) 1.Biotechnology 1. Genetic Engineering: Recombinant DNA technology, tools of genetic engineering – Restriction endonucleases, DNAligases, 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 ovulation, embryo transfer, in-vitro fertilization (IVF), embryo cloning; transgenic animals.
2) Applications of biotechnology in medicine: Production of monoclonal antibodies (Hybridoma technology), production of vaccines and production of growth hormone.
3) 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.
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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

AC 3.4. (A): FISH AND SHELLFISH PATHOLOGY

Course Type: Theory

Course Category: Elective -II

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:

1) History, species affected, **C**linical symptoms, pathology and control measures of Viral Hemorrhagic Septicemia (VHS) and Infectious Hematopoietic Necrosis (IHN). **Shrimp Diseases:**
2) 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.
2) **Shrimp Diseases:** 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*
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5) Reichenbach KH. 1965. *Fish Pathology.* TFH (Gt. Britain) Ltd, England.
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7) 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	2	2	1	2	2	1	1	1	2	2
CO2	2	1	2	2	1	2	1	2	1	2
CO3	2	1	2	2	1	2	2	1	2	1
CO4	2	1	1	1	2	1	2	2	2	3
CO5	2	2	1	2	1	2	1	2	1	2

AC 3.4. (B): ICHTHYOLOGY

Course Type: Theory

Course Category: Elective -II

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, osmoregulatory 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

AC 3.4. (C): ENVIRONMENTAL BIOLOGY

Course Type: Theory

Course Category: Elective -II

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 productiviy 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.

SUGGESTED READING MATERIAL:

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. Vol.5 Environmental dynamics of pesticides - R. Hague and V.H. Preed, 1975.
19) 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

PRACTICAL – I:

ACP 3.5.: TOOLS AND TECHNIQUES IN BIOLOGY AND AQUACULTURE ECONOMICS

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).

Aquaculture Economics

1) Estimation of the unit cost of freshwater prawn farm.
2) Unit cost estimates for 1 ha shrimp farming.
3) Unit cost estimates for 1 ha carp farming.

PRACTICAL - II:

ACP 3.6.: WATER QUALITY MANAGEMENT AND FISH & SHELLFISH PATHOLOGY

Water Quality Management

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

Fish and Shrimp Diseases

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

Fourth Semester

M.Sc. AQUACULTURE

SEMESTER-IV

AC 4.1.: PRINCIPLES AND PRACTICES OF AQUACULTURE

Course Type: Theory

Course Category: Mandatory core

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, freshwater prawns and ornamental fish culture

CO4: To discuss about the culture economically important species.

CO5: To describe the culture practices of shrimp, , brackish water fishes pearl oysters and sea weeds of commercial importance.

UNIT - I

1) Basics of Aquaculture: Definition, significance and classification; History of aquaculture; Cultivable species – freshwater, brackish water and marine; A knowledge of inland 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
3) synthetic hormones.
4) Culture of Indian major carps – Preparation and management of 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 fresh water prawn, *Macrobrachium rosenbergii*
3) Culture of ornamental fishes.

Learning outcomes: Students will acquire knowledge on the culture of air-breathing fishes and freshwater prawn; maintenance of aquaria and breeding of ornamental fishes

UNIT-IV

1) Culture of milk fish, *Chanos chanos* and Asian sea bass, *Lates calcarifer*.
2) Culture of shrimp, *Penaeus monodon / Litopenaeus vannamei.*
3) Culture of crab, *Scylla serrata.*

Learning outcomes: Students will have fairly good knowledge on

- Culture of economically important fishes like *Chanos chanos* and *Lates calcarifer*
- culture of brackish water finfish and shell fish.

UNIT-V

1) Sewage-fed fish culture.
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 brackish water shrimp, and the culture of marine organisms like pearl oysters and sea weeds.

REFERENCES 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) Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
8) Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
9) MPEDA: *Handbooks on culture of carp, shrimp, etc*.
10) New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
11) Pillay TVR.1990. *Aquaculture-Principles and Practices*, Fishing News Books Ltd., London
12) Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. 2nd Ed. Blackwell
13) Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
14) Stickney RR. 1979. *Principles of Warmwater 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

AC 4.2.: FISH PROCESSING TECHNOLOGY

Course Type: Theory

Course Category: Mandatory core

Credits: 4

Course Objectives/Course outcomes:

CO-1: Introduce biomolecules, major and minor fish constituent's, biochemical changes in post mortem and toxic substances in fish.

CO-2: Create knowledge about chemical and microbial spoilage, pathogenic affect in fish products.

CO-3: To understand handling, transport methods as well as different preservative techniques of fresh fishes.

CO-4: Student will acquire knowledge quality management systems and certification procedure.

CO-5: creating knowledge in quality assessments and 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:

Students will able to understand fish constituent's, biochemical changes in fish after death also 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:

Students will learn about various aspects of biochemical and microbial spoilage of fish and 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:

Students will learn about methods of handling of fresh fish, including storage and transport, quality, and modern techniques applied for fish preservation fishery products.

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:

Students will learn about various quality management practices and certification for fishery products.

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 equipment's.

Learning outcome:

Upon completion of topics the student enriches in different fish quality assessments methods, by-products and processing equipment's.

REFERENCE BOOKS:

1) BalachandranKK.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*. PartsI,II.FAO.
4) Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR.
5) Govindan,TK. 1985.*Fish Processing Technology,* Oxford-IBH.
6) Hall G M.(Ed).1992. *Fish Processing Technology*. Blackie.
7) Huss HH,JakobsenM&ListonJ.1991.*Quality AssuranceintheFishIndustry.*Elsevier.
8) JohnDEV. 1985. *FoodSafety and Toxicity*.CRCPress.
9) KrenzerR.1971.*FishInspectionandQualityControl.*FishingNews.
10) LarousseJ&BrownBE. 1997. *FoodCanningTechnology*. WileyVCH.
11) NambudiriDD.2006.*Technologyof FisheryProducts*.FishingChimes.
12) RegensseinJM&RegensseinCE.1991.*Introduction toFishTechnology*.VanNostrandReinhold.
13) RudolfK.1969.*FreezingandIrradiationof Fish.*FishingNews(Books).
14) SenDP.2005.*AdvancesinFishProcessingTechnology*.AlliedPubl.

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

AC 4.3. (A): AQUACULTURE BIOTECHNOLOGY

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/ Course outcomes:

CO:1 To remember the basic components in biotechnology and genetic engineering.

CO:2 To discuss about the breeding techniques and conservation methods.

CO:3 create awareness by using nanobiotechnology in production of feed.

CO:4 To discuss about the animal health management and post harvesting methods

CO:5 To evaluate the disease identification by using advanced biotechnology instruments.

UNIT-I

1) **Biotechnology**: Origin, definition and knowledge of different branches.
2) **Genetic Engineering:** Recombinant DNA technology; Tools of genetic engineering - cloning vectors, restriction endonucIeases, DNA ligases, topoisomerases, methylases, nucleases, polymerases, reverse transcriptase and their functions.
3) Screening analysis of recomb inants: Colony hybridrization technique, immunological tests.
4) Transgenics: princiles of Transgenic technology and its applications in fisheries.

Learning outcome:

Students will be familiar with

- Genetic engineering tools and their functions
- R-DNA Technology, and Screening and analysis of recombinants
- Transgenic technology and its applications in fisheries.

UNIT-II

1) **Fish breeding**: Synthetic hormones for induced breeding, GnRH analogue structure and
2) function; Selective breeding for improving fish stocks - hybridization in Indian fishes.
3) Androgenesis, Gynogenesis, Polyploidy and Sex reversal.
4) Hormonal regulation of reproduction and molting inImportant cultivable crustaceans.
5) **Gene bank and Conservation**: Cryopreservation of gametes and embryos.
6) Embryo trasfer technology.

Learning outcome: Students will gain knowledge on

- Induced breeding technique by hypophysation and by using synthetic hormones in fish
- Selective breeding techniques for fish stock improvement
- Cryopreservation and embryo transfer technology

UNIT -Ill

1) **Feed technology**: Micro encapsulated feeds; micro coated feeds; micro particulate feeds and bio-encapsulated feeds; rnycotoxins and their effects on feeds.
2) **Algal biotechnology**: Biotechnological approaches for production of important microalgae; single cell protein from *Spirulina;* vitamins, minerals and omega3 fatty acids from micro algae; enrichment of micro algae with micronutrients.
3) Application of Nanotechnology in aquaculture: A general knowledge of tissue culture.

Learning outcome:

Students will be known about

- Feed technology for manufacturing different types of feeds
- Various aspects of algal biotechnology
- Role of nanotechnology in aquaculture

UNIT-IV

1) **Health management:** DNA and RNA vaccines; molecular diagnosis of viral diseases
2) Biofilms and its impact on health management; genetically modified microorganisms as
3) probiotics, immunostimulants, bioremediation of soil and water.
4) Nitrogen fixation in aquatic environment and biofertiizers.
5) Post-harvest biotechnology: Delaying of spoilage; biosensors.

Learning outcome:

Students get acquainted with

- Application of health management techniques like vaccines, diagnosis of viral diseases, biofilms, GMOs, probiotics, immunostimulants, biofertilers and bioremediation of soil and water in aquaculture
- Delaying of spoilage and biosensors as post-harvest biotechniques.

UNIT-V

1) Real time PCR: Molecular markers overview of Microassay and RNA sequence. Genomic Library, clone characterization, ELISA Blotting techniques.

Learning outcome:

Students acquire knowledge with

- Usage of different molecular techniques for analyse diseases, and screening chemical residues in food materials.

REFERENCE BOOKS

1) Bhattacharya, S. 1992. *Hormones in Pisciculture.* Biology Education,Vol. 9, No.1, pp.31-41.
2) CIFE. 1998. Summer School Manuals, Mumbai.
   a) *Recent Developments in Biotechnology: Applications to Aquaculture & Fisheries.*
   b) *Genetics and Biotechnological Tools in Aquaculture and Fisheries.*

3) Felixm S. 2007. *Molecular Diagnostic Biotechn: Biology in Aquaculture.* Daya Publ. House.
4) ICAR. 1992. *Biotechnology in Aquaculture.* Training Manua!, C.I.F.A, Kausalyaganga, Bhubaneswar, Orissa.
5) Lakra, W.S, Abidi SAH, Mukherjee SC & Ayyappan S. 2004. *Fisheries Biotechnology.* Narendra Publ. House.
6) Nagabhushanam R, Diwan AD, Zahurnec BJ & Sarojini R. 2004. *Biotechnology of Aquatic Animals.* Science Publ
7) Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture.* Dominant Publ.
8) Pandian TJ, Strilssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology.* Science Publ,
9) Ramesh RC. 2007. *Microbial Biotechnology in Agriculture and Aquaculture.* Vol. II. Science Publ.
10) Reddy, PVGK, Ayyappan S, Thampy D M & Gopalakrishna 2005. *Text Book of Fish Genetics and Biotechnol.* ICAR.
11) Singh B. 2006. *Marine Biotechnology and Aquculture* Development, Daya Publ. House
12) Green, M.R. and Sambrook (2012). Molecular Cloning: A Laboratory Manual, 4th edition, Vol.3, Cold Spring Harbor NY: USA.

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

AC 4.3. (B): AQUACULTURE IN RESERVOIRS

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/Course outcomes:

CO1: To introduce the basic concepts about Reservoir fisheries resources in India, their physico-chemical and biological features of reservoirs.

CO2: To discuss about the concept of reservoir ecosystem and climatic, morphometric and hydro-edaphic factors of reservoirs.

CO3: To study about reservoir fisheries management in India and Impact of culture based fisheries in small reservoirs.

CO4: To understand the concept of distribution status of reservoirs in Andhra Pradesh and fish production trends in reservoir fisheries.

CO5: To analyze the basic input parameters, collection of diet composition data, net system production and total biomass.

UNIT-I: Nature and extent of Reservoirs in India

1) Reservoir Fisheries Resources of India; Classification of Reservoirs.
2) Physico-chemical Features of Reservoirs; Chemical Characteristics; Physical characteristics of water; Nutrient Status.
3) Biological Features of Reservoirs; Fish Production Trends.

Learning Outcome: Upon completion of the above unit they are able to understand the concept of Classification, physico-chemical and biological features and fish production trends of reservoirs in India.

UNIT-II: Trophic Phases in Reservoir

1) Reservoir Ecosystem;
2) Determinants of Reservoir Productivity; Climatic Factors; Morphometric Factors.
3) Hydro-edaphic Factors.

Learning Outcome: Students will get awareness about reservoir ecosystem, reservoir productivity, climatic, morphometric and hydro-edaphic factors of reservoir.

UNIT-III: Management of Small, Medium and Large Reservoirs

1) Reservoir Fisheries Management in India;
2) Reservoir Fisheries Management;
3) Pre and Post Impoundment Changes in improving reservoir Fisheries;
4) Culture based Fisheries in Small Reservoirs; Stocking Size; Period of Growth and Size at
5) Harvesting; Staggered stocking and harvesting.
6) Impact of Culture Based Fisheries in Small reservoirs.
7) Environmental Management;
8) Selection of Species for Stocking Small, Medium and Large Reservoirs.

Learning Outcome: Upon completion of the above unit they are able to understand reservoir fisheries management in India, Pre and post impoundment changes in improving reservoir fisheries and impact of culture based fisheries in small and large reservoirs.

UNIT-IV: Fisheries of Important Reservoirs

1) Distribution Status of Reservoirs in Andhra Pradesh;
2) Scientific Investigation of Reservoirs;
3) Fisheries Management;
4) Fish production trends in Reservoir Fisheries.

Learning Outcome: Students will get awareness about Fisheries management, fish production trends and distribution status of reservoirs in Andhra Pradesh.

UNIT-V: Recent Advancements in Reservoir fisheries Management

1) Basic Input Parameters; Collection of Diet Composition Data; Balancing the Model;
2) Ecosystem Indicators;
3) Net system Production;
4) Total Primary Production/Total Biomass.

Learning Outcome: On completion of the above unit they are able to understand ecosystem indicators and analyze the collection of diet composition data, net system production and total primary production.

REFERENCE BOOKS:

1) Pillay, T.V.R. 1990. *Aquaculture Principles and Practices*, Fishing New Books Ltd., Oxford.
2) Jhingran, V.G. 1991. *Fish and fisheries of India*. Hindustan Publishing Corporation (India), Delhi.
3) Pandian T.J. (Ed) 2001. *Sustainable Indian Fisheries*, National Academy of Agricultural Sciences, India.
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5) Huet, j. 1986. *A Text Book of Fish Culture.* Fishing News Books, Oxford.
6) Stickney, R.R. 1979. *Principles of Warm water Fish Culture,* John Wiley & Sons, New York.
7) Bardach, J.E., J.H. Ryther and W.O. McLarney. 1972. *Aquaculture,* Wiey- Interscience, New York.

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

AC 4.3. (C): AQUACULTURE ECOSYSTEM MANAGEMENT AND CLIMATE CHANGE

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/Course outcomes:

CO1: To introduce the basic concepts about Aquaculture and Ecosystem Relationship, productivity and biotic interactions within the ecosystem.

CO2: To discuss about Green house gases, global warming, impact of environment on aquaculture.

CO3: To study about Impact of aquaculture on environment, Environment monitoring, Environmental Impact Assessment and Environmental Audit.

CO4: To understand the concepts of Sensor based monitoring, Toxicity Assessment and Environment management.

CO5: To analyze the Environment threats, role of microbes in aquatic environment and Assessment of probiotic impact in aquaculture.

UNIT – I:

1) Aquaculture and ecosystem relationship: Ecosystems and productivity.
2) Biotic interaction within ecosystems and ecological homeostasis, climate;
3) Weather elements of concern in aquaculture.

Learning Outcome: Students will get awareness about Ecosystem and productivity, ecological homeostasis and weather elements of concern in aquaculture.

UNIT – II:

1) Greenhouse gases, Global warming and their impact on aquaculture.
2) Impact of environment on aquaculture: Raw water source, Physical and Chemical characteristics.
3) Contaminants and pollutants (algae, pathogens, heavy metals, pesticides) and their effect on productivity.

Learning Outcome: Upon completion of the above unit they are able to understand the concept of Green house gases, global warming and their impact on aquaculture, contaminants and pollutants and their effect on productivity..

UNIT – III:

1) Impact of aquaculture on environment: Waste water discharge, its quality and quantity. Impacts of effluents on ecosystems, chemical degradation of soil and water.
2) Environment monitoring: Problems and preventive measures of antibiotic and drug residues, Salinization of soil and water, Eutrophication.

3) Environment impact assessment and environmental audit.

Learning Outcome: Students acquire knowledge about Impact of aquaculture on environment, environment monitoring, Environment Impact Assessment and environmental audit.

UNIT – IV:

1) Sensor based monitoring: Biosensors in aquatic environment.
2) Toxicity assessment, eco-labeling and traceability.
3) Environment management.

Learning Outcome: Students are able to understand Sensor based monitoring, toxicity assessment, eco-labeling and traceability and environment management.

UNIT – V:

1) Environment threats: Introduction of exotics and escape of farmed fish, Pathogens in aquatic environment, Safety of aquaculture products.
2) Role of microbes in aquatic environment.
3) Assessment of probiotic impact in aquaculture.

Learning Outcome: Upon completion of the above unit they are able to analyze the environment threats, role of microbes in aquatic environment and assessment of probiotic impact in aquaculture.

REFERENCE BOOKS:

1) Black KD 2001 *Environmental Impacts of Aquaculture. CRC Press*
2) Holmer M, Black K, Durate CM, Marba N and Karakassis I(Eds), 2008. *Aquaculture in the Ecosystem*, Daya Publ. House.
3) Midlen, A and Redding, t., 1998. *Environmental Management for Aquaculture*, Chapman and hall.
4) Mischke, C.C., 2014 *Aquaculture and Pond Fertillization- Impacts of Nutrients Input on Production.*
5) Mustafa, S, and Shapawi, r. (Eds.), 2015. *Aquaculture Ecosystems*. *Adapatability and Sustainability*. Wiley Blackwell.
6) Phillips BF, Ramirez, M.P. (Eds.) 2018. *Climate Change Impacts on Fisheries and Aquaculture a Global Analysis*. Vol. I. Wiley Blackwell.
7) Rajagopalsamy CBT and Ramadhas V. @002. *Nutrient Dynamics in Freshwater Fish Culture System*, Daya Publ.

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

AC 4.4. (A): FISH AND SHELLFISH IMMUNOLOGY

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/Course outcomes:

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

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

CO3: Understand the principles of immunological memory, including how it develops and howit 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 in humans – Thymus, Bone marrow; Secondary lymphoid organs in humans – Spleen, Lymphnodes, Mucosa Associated Lympoid Tissue (MALT), Gut Associated Lympoid Tissue (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.

Learning Outcome: Students are able to Understand the basic principles of the immune system, including the different types of immune responses, immune cells, and molecules involved in immunity.

UNIT -II

1) **Antibody molecules/ Immunoglobulins:** Basic structure of the immunoglobulin molecule; Structure and function of human immunoglobulins - IgG, IgA, IgM, IgE and IgD; **Major Histocompatibility Complex (MHC):** Structure of MHC molecules, Antigen processing and presentation by MHC molecules.

2) **Complement System:** Classical and Alternative Pathways; Biological functions of complement.

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

UNIT–III

1) **Cytokines:** Interleukins (ILs), Interferons (INFs), Tumor Necrosis Factors (TNFs), Colony Stimulating Factors (CSFs) and Chemokines.
2) **Innate Immunity:** Phagocytosis- intracelllular killing, Humoral and Cellular components.
3) **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) **Lymphoid organs in fish** – Thymus, Kidney, Spleen and MALT.
2) **Structure and functions of fish immunoglobulins** – IgM, IgD and IgT/Z.
3) **Fish Immunology:** Innate and Adaptive immune mechanisms in fish.
4) **Crustacean Immunology:** Pattern Recognition-Lectins; Haemocytes and Haematopoiesis; Immune mechanisms – Antiviral reaction, Clotting, Synthesis of Antimicrobial Proteins and Melanisation.

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) **Immunodiffusion:** Simple diffusion, Radial immunodiffusion and Double immunodiffusion.
2) **Immunoelectrophoresis:** Counter and Rocket immunoelectrophoresis.
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: 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, New York.
2) Ivon M. Roitt. 2001. *Essential Immunology*, Blackwell Science Ltd, Mishawaka, IN, USA.
3) Iwama G & Nakanishi T. 1996. *The Fish Immune System. Organism, Pathogen and Environment*. Acad. Press.
4) Joshi KR and Osamo NO. 1994. *Immunology,* Agro Botanical Publishers, India.
5) Manning MJ and Tatner MF. 1985. *Fish Immunology,* Academic Press, London, UK.
6) Nandini Shetty. 2008. *Immunology Introductory Text*, Wiley Eastern Limited, New Age International Publishers, New Delhi.
7) Swain P, Sahoo PK & Ayyappan S. 2005. *Fish and Shellfish Immunology: An Introduction*. Narendra Publications.

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

AC 4.4. (B): AQUACULTURE FOOD SAFETY AND QUALITY MANAGEMENT

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/Course outcomes:

CO1: To introduce the basic concepts about Uniqueness of Seafood quality control and its management.

CO2: To discuss about fish spoilage and quality assessment; enzymic and non-enzymatic deteriorations.

CO3: To study about Recognized Specific spoilage organisms and Mechanism of Microbial Spoilage.

CO4: To understand the Methods of Quality Assessment of Fish and Fishery Products and changes during spoilage.

CO5: To study about Traditional Quality Control and Food Safety with Special Reference to HACCP System.

UNIT-I: Quality control

1) Quality Control; Uniqueness of Seafood quality control; Quality management/assurance.
2) Intrinsic quality, Species, Size, Sex, Condition and composition; Parasities and other organisms; Naturally toxic fish; Contamination with pollutants; Occasional Peculiarities
3) Extrinsic quality; Quality Deterioration and Extrinsic Quality defects in fish (Raw material).

Learning Outcome: Upon completion of the above unit they are able to understand the concept of Uniqueness of Seafood quality control and its management.

UNIT-II: Microbial Spoilage

1) Fish spoilage and Quality Assessment
2) Enzymic Action, Non- enzymatic Deteriorations
3) Microbial Spoilage

Learning Outcome: Students will get awareness about fish spoilage and quality assessment and enzymic and non-enzymatic deteriorations.

UNIT-III: Quality Problems in Seafood Industry

1) Poor Quality Raw Materials;
2) Recognized Specific spoilage organisms (SSOs);
3) Mechanism of Microbial Spoilage; Spoilages and Quality Indices in Frozen Fish; Freezing Process; Frozen Storage.

Learning Outcome: Upon completion of the above unit, they are able to understand the recognized specific spoilage organisms and mechanism of microbial spoilage.

UNIT-IV: Quality Assessment of Fish and Fishery Products

1) Methods of Quality Assessment; Organoleptic/Sensory-Subjective and Objective; a. appearance; b. Flavor; c. Taste; d. Odour; e. Texture; Interaction of Taste, Odour, Texture and Flavor; Sensory Testing Methods.
2) Selection of Test Subjects; i) Discrimination Tests ii) Preference Tests; iii) Training of Panel Members; iv) Presentation of samples.
3) Changes during Spoilage; i) Condition of the Skin (Sight and Touch); ii) Appearance of the Eye (Sight); iii) Condition of the Gills (Sight and Smell); iv) Condition of the Flesh (Touch and Sight).

Learning Outcome: Students will get awareness about Methods of quality assessment and changes during spoilage.

UNIT-V: Concept of Quality Management

1) Traditional Quality Control; Modern Safety and Quality Assurance Methods and Systems; Methods to Manage Quality and Safety; i) Good Hygienic Practices/ Good Manufacturing Practices; ii) Hazard Analysis Critical Control Point; iii) Quality Control (QC); iv) Quality Management; v) Quality Systems; vi) Total Quality Management (TQM); vii) Good Manufacturing Practices in Fish Handling
2) Food Safety with Special Reference to HACCP System; i) The HACCP Concept; ii) Advantages of HACCP; iii) Applications of HACCP
3) Determine Critical Control Points.

Learning Outcome: On completion of the above unit they are able to understand the traditional quality control and food safety with special reference to Hazard Analysis Critical Control Point and its applications.

REFERENCE BOOKS:

1) Bond, et al.1971.*Fish Inspection and Quality Control.* Fishing News Books, England.
2) Huss HH,JakobsenM&ListonJ.1991.*Quality AssuranceintheFishIndustry.*Elsevier.
3) JohnDEV. 1985. *FoodSafety and Toxicity*.CRCPress.
4) KrenzerR. 1971.FishInspectionandQualityControl. Fishing News.
5) RegensseinJM&RegensseinCE.1991.*Introduction to Fish Technology*. Van No strand Reinhold.
6) Govindan,TK. 1985.*Fish Processing Technology,* Oxford-IBH.

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

AC 4.4. (C): ADVANCES IN AQUACULTURE

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/ Course outcomes :

CO1: To introduce the basic concepts about overview of aquaculture production systems and sustainable aquaculture.

CO2: To discuss about Shrimp Hatchery, strategies to control diseases in hatcheries and seed transportation methods.

CO3: To study about advances in design, construction, framing systems and different culture systems.

CO4: To understand the code of conduct responsible for sustainable aquaculture and principles of fish nutrition.

CO5: To study about supplementary feeds and significance of fish diseases in relation to Aquaculture.

UNIT-I:

1) An overview of aquaculture production systems: Present status, constraints and future perspectives of culture production systems in India and the world.
2) Criteria for selection of a species for culture, sustainable aquaculture.

Learning Outcome: Upon completion of the above unit they are able to understand the present status, future perspectives of culture production systems in India and world; criteria for selection of a species and sustainable aquaculture.

UNIT-II:

1) Shrimp Hatchery: Water quality management in hatcheries–nutritional requirement of
2) larvae and post larvae, live feed culture.
3) Strategies to control diseases in hatcheries, use of probiotics and immunostimulants in
4) hatcheries, SPF and SPR.
5) Effluent treatment in hatcheries.
6) Seed transportation methods.

Learning Outcome: Students will get awareness about Shrimp hatchery, Strategies to control diseases, effluent treatment in hatcheries and seed transportation methods.

UNIT-III:

1) Advances in design and construction: earthen ponds, concrete tanks, pens and cages.
2) Advances in farming systems: Enhancing carrying capacity, integrated farming systems,
3) semi-intensive and intensive culture systems, recirculatory system, flow-through system.

Learning Outcome: Upon completion of the above unit they are able to understand the advances in design, construction, framing systems and different culture systems.

UNIT-IV:

1) Code of conduct for responsible and sustainable aquaculture. Cluster farming, organic farming, satellite farming and co-operative farming.
2) Fish Nutrition: Principles of fish nutrition, Bio-chemical composition of fish, nutritional requirements of fish and shrimp; Natural food- Bacterio plankton, phytoplankton and zooplankton.

Learning Outcome: Students will get awareness about Code of conduct responsible for sustainable aquaculture, Principles of fish nutrition and Biochemical composition of fish.

UNIT-V:

1) Supplementary feeds: Types of feeds – wet feed, moist feed, dry feed, ashes, pelleted feeds –floating and sinking pellets, microencapsulated diets.
2) Significance of Fish Diseases in Relation to Aquaculture; Fish Vaccination.

Learning Outcome: On completion of the above unit they are able to understand the types of supplementary feeds, significance of fish diseases in relation to aquaculture and fish vaccination.

REFERENCE BOOKS:

1) CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries*. CIFE, Versova, Mumbai
2) FAO. 2007. *Manual for Operating a Small Scale Recirculation Freshwater Prawn Hatchery*
3) Hepher B & Pruginin Y. 1981. *Commercial Fish Farming.* John-Willey & Sons Inc.
4) ICAR. 2006. *Handbook of Fisheries and Aquaculture*. ICAR.
5) Midlen& Redding TA. 1998. *Environmental Management for Aquaculture*. Chapman & Hall.
6) Jhingran VG &Pullin RSV. 1985. *Hatchery Manual for the Common, Chinese and Indian Major Carps*. ICLARM, Philippines.
7) Pillay TVR &Kutty MN. 2005. *Aquaculture- Principles and Practices*. Blackwell.
8) Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
9) Selvamani BR &Mahadevan RK. 2008. *Aquaculture, Trends and Issues*. Campus Books
10) Agarwal SC. 2008. *A Handbook of Fish Farming*. 2nd Ed. Narendra Publ. House.

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

PRACTICAL - I:

ACP 4.5: AQUACULTURE AND FISH PROCESSING TECHNOLOGY

Practices of Aquaculture

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.

Fish Processing Technology

1) Evaluation of fish/ fishery products for organoleptic, chemical and microbial quality.
2) Spoilage microorganisms: isolation of pathogenic bacteria associated with fish and fishery products.
3) Design and maintenance of fish processing plants.

PRACTICAL – II:

ACP 4.6: AQUACULTURE BIOTECHNOLOGY AND IMMUNOLOGY

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.

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.

* * * * *

A C 1.1

M.Sc. Degree Examinations – 2023
Subject: AQUACULTURE
First Semester
Paper: I: LIMNOLOGY
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a) What is Limnology? give an account on limnology as an applied science.

(or)

b) Write short notes on:
i. Lentic and lotic habits
ii. classification of lakes

2. a) Define identification of oxygen depletion problems and control mechanisms in fish ponds

(or)

b) Write short notes on:
i. Role of Co2in chemical buffering
ii. Bio geochemical cycles.

3. a) Describe the mechanism and distribution patterns of lake systems.

(or)

b) Describe the mechanism of Nekton significance in Aquatic Environments

4. a) Describe the mechanism of limnological significance.

(or)

b) Describe the Process of concepts of productivity.

5. a) Describe the Regulation of Turbidity consequences.

(or)

b) Describe the mechanism of Eutrophication

A C 1.2

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

First Semester

Paper: II: Aquaculture Engineering

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 1.3

M.Sc. Degree Examinations – 2023
Subject: AQUACULTURE
First Semester
Paper: III: Taxonomy and Functional Anatomy of Shellfish
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 1.4 (A)

M.Sc. Degree Examinations 2023
Subject: AQUACULTURE
First Semester
Paper: IV (A): Taxonomy and Anatomy of Finfish
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions
All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 1.4 (B)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

First Semester

Paper: IV (B): Developmental Biology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 1.4 (C)

M.Sc. Degree Examinations – 2023
Subject: AQUACULTURE
First Semester
Paper: IV (C): Molecular Cell Biology
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions
All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.1

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Second Semester

Paper: I: Marine and Brackish water Ecology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.2

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Second Semester

Paper: II: Fish Physiology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.3

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Second Semester

Paper: III: Aquaculture Microbiology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.4 (A)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Second Semester

Paper: IV (A): Nutrition and Feed Technology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.4 (B)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Second Semester

Paper: IV (B): Biodiversity

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.4 (C)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Second Semester

Paper: IV (C): Principles of Ecology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 2.2

M.Sc. Degree Examinations – 2023
Subject: AQUACULTURE
Second Semester
Paper: II: FISH PHYSIOLOGY
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a) What is Digestion? give an account on physiology of digestion of Carbohydrates and Proteins.

(or)

b) Write short notes on:
i. Absorption of Nutrients
ii. Cellular metabolism

2. a) What is Respiration? Give detail account on external and internal respiration

(or)

b) Write short notes on:
i. composition of blood in fishes
ii. Water flow across the gills.

3. a) Describe the mechanism of lateral sense organ in fishes.

(or)

b) Describe the mechanism of ionic regulation in Aquatic Environments

4. a) Describe the mechanism of excretion of nitrogenous waste in fishes.

(or)

b) Describe the Process of oogenesis in mammals.

5. a) Describe the Regulation of Hormones in reproduction in fishes.

(or)

b) Describe the Neuro-endocrine system in crustacean and its role in the regulation of reproduction

AC 3.1

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: I: TOOLS&TECHNIQUES IN BIOLOGY

w.e.f., 2023 – 2024

Time :3 Hours Max.Markas :70

Answer ALL Questions

All question carries equal marks.

1. a) What is THE WORKING PRINCIPLES OF OPTICAL MICROSCOPY.

(or)

b)Write short notes on:

i. TEM

ii. STEM

2. a) Give detail account on principles of UV Spectroscopy

(or)

b) Write short notes on:

i. ESR

ii. NMR.

3. a) Describe the mechanism of Principles of Chromatography.

(or)

b) Describe the mechanism of Electrophoresis

4. a) Describe the Principles of Nucleic acid blotting Techniques.

(or)

b) Describe the Process of PCR.

5. a) Describe the Regulation ofNCBI

(or)

b) Describe the ANOVA test.

AC 3.2

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: II : Aquaculture Economics and Fisheries Extension

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 3.3 (A)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: III (A): Water Quality Management

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 3.3 (B)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

IV Semester

Paper: III (B): Aquatic Toxicology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 3.3 (C)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: III (C): Animal Biotechnology and Microbiology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 3.4 (A)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: IV (A): Fish and Shellfish Pathology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 3.4 (B)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: IV (C): Ichthyology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 3.4 (C)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Third Semester

Paper: IV (C): Environmental biology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.1

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Fourth Semester

Paper: I: Principles and Practices of Aquaculture

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.2

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Fourth Semester

Paper: II: Fish Processing Technology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.3 (A)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Fourth Semester

Paper: III (A): AQUACULTURE BIOTECHNOLOGY

w.e.f., 2023 – 2024

Time :3 Hours Max.Markas :70

Answer ALL Questions

All question carries equal marks.

1. a) Describe in detail about the strategies of R-DNA technology.

(or)

b) Write short notes on:
i.PBR-322
ii. Restriction Endonuclease

2. a) Give an account on Hybridoma Technology

(or)

b) Write short notes on:
i. IVF
ii.Haemophilia.

3. a) Describe the Various Bacterial and viral diseases which you have studied.

(or)

b) Describe the mechanism of Microbial growth and their control

4. a) Describe the microbiology of fermented foods.

(or)

b) Describe the Process of batch and fed batch fermentation.

5. a) Describe the techniques used preparation of DNA&RNA Vaccines.

(or)

b) Describe in brief account on post-harvest technology.

A C 4.3 (B)

M.Sc. Degree Examinations – 2023
Subject: AQUACULTURE
Fourth Semester
Paper: III (B): Aquaculture in Reservoirs
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.3 (C)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Fourth Semester

Paper: III (C): aquaculture ecosystem management and climate change

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.4 (A)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Fourth Semester

Paper: IV (A): Fish and shellfish Immunology

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.4 (B)

M.Sc. Degree Examinations – 2023

Subject: AQUACULTURE

Fourth Semester

Paper: IV (B): Aquatic food safety & Quality Management

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)

A C 4.4 (C)

M.Sc. Degree Examinations – 2023
Subject: AQUACULTURE
Fourth Semester
Paper: IV (C): Advances in Aquaculture
w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a)

(or)

b)

2. a)

(or)

b)

3. a)

(or)

b)

4. a)

(or)

b)

5. a)

(or)

b)