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



COURSE STRUCTURE & SCHEME OF MARKS

Semester	Components of Study	Course Code	Title of the Course	No. of Credits	Hr/Week	Internal Assessment	Semester End Exams	Total
SEMESTER - I	Mandatory Core	R26-ZOO 1.1	Structure and Function of Invertebrates and Vertebrates	4	4	30	70	100
		R26-ZOO 1.2	Principles of Ecology and Biodiversity	4	4	30	70	100
	Foundation Course	R26-ZOO 1.3	Developmental Biology	4	4	30	70	100
	Foundation Elective (Opt' 1)	R26-ZOO 1.4 (A)	Molecular Cell Biology	4	4	30	70	100
		R26-ZOO 1.4 (B)	Endocrinology					
		R26-ZOO 1.4 (C)	Marine and Brackish water ecology					
	Core Practical-I (Skill)	R26-ZOO 1.5P	Structure and Function of Invertebrates and Vertebrates & Principles of Ecology and Biodiversity	4	6	30	70	100
	Core Practical-II (Skill)	R26-ZOO 1.6P	Developmental Biology and Molecular Cell Biology	4	6	30	70	100
	Audit course	R26-ZOO 1.7	Human Values and Professional Ethics	*2*	*2*	*50*	-	-
			Sub-Total	**24**				**600**
SEMESTER - II	Mandatory Core	R26-ZOO 2.1	Genetics and Evolution	4	4	30	70	100
		R26-ZOO2.2	Comparative Animal Physiology	4	4	30	70	100
	Research Foundation	R26-ZOO2.3	Research Methodology	4	4	30	70	100
	Foundation Elective (Opt' 1)	R26-ZOO2.4 (A)	Tools and Techniques in Biology	4	4	30	70	100
		R26-ZOO2.4 (B)	Fish Physiology					
		R26-ZOO 2.4 (C)	Aquatic microbiology					
	Core Practical-I (Skill)	R26-ZOO2.5P	Genetics and Evolution and Comparative Animal Physiology	4	6	30	70	100
	Core Practical-II (Skill)	R26-ZOO2.6P	Research Methodology & Tools and Techniques in Biology	4	6	30	70	100
	Skill Development	R26-ZOO 2.7	Skill Development MOOCs/SDC	*2*	*2*	*50*	–	–
			Sub-Total	**24**				**600**
SEMESTER - III	Mandatory Core	R26-ZOO 3.1	Animal Biotechnology and Microbiology	4	4	30	70	100
		R26-ZOO 3.2	Ichthyology	4	4	30	70	100
	Generic Elective-I (Opt' 1)	R26-ZOO 3.3 (A)	Limnology	4	4	30	70	100
		R26-ZOO 3.3 (B)	Water quality management					
		R26-ZOO 3.3 (C)	Environmental Biology					
	Open Elective-II (Opt' 1)	R26-ZOO 3.4 (A)	Aquatic Toxicology	4	4	30	70	100
		R26-ZOO 3.4 (B)	Aquaculture Engineering					
		R26-ZOO 3.4 (C)	Taxonomy and Functional Anatomy of Shellfish					
	Core Practical-I (Skill)	R26-ZOO 3.5P	Animal Biotechnology, Microbiology and Ichthyology & Limnology and Aquatic Toxicology	4	6	30	70	100
	Core Practical-II (Skill)	R26-ZOO 3.6P	Industry Internship / Mini Research project	4	6	30	70	100
	Skill Enhancement	R26-ZOO 3.7	Skill Development MOOCs/SDC	*2*	*2*	*50*	–	–
			Sub-Total	**24**				**600**
SEMESTER - IV	Mandatory Core	R26-ZOO 4.1	Fish Pathology	4	4	30	70	100
		R26-ZOO 4.2	Immunology	4	4	30	70	100
	Core Elective-I (Opt' 1)	R26-ZOO 4.3 (A)	Aquaculture	4	4	30	70	100
		R26-ZOO 4.3 (B)	Taxonomy and Anatomy of Finfish					
		R26-ZOO 4.3 (C)	Fish Nutrition					
	Open Elective-II (Opt' 1)	R26-ZOO 4.4 (A)	Aquaculture Management	4	4	30	70	100
		R26-ZOO 4.4 (B)	Fish processing technology					
		R26-ZOO 4.4 (C)	Economic Zoology					
	Core Practical-I (Skill)	R26-ZOO 4.5P	Fish Pathology and Immunology & Aquaculture and Aquaculture Management	4	6	30	70	100
	Core Practical-II (Skill)	R26-ZOO 4.6	Project Work **(Dissertation + Seminar + Viva-voce)**	4	6	-	100 (50+20+30)	100
			Sub-Total	**24**				**600**
			Grand Total	**96**				**2400**

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

Third Semester



DEPARTMENT OF ZOOLOGY & AQUACULTURE
M.Sc. ZOOLOGY
Semester-III

ZOO 3.1.: Animal Biotechnology and Microbiology

Course Type: Theory

Course Category: Mandatory core

Credits: 4

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT-I:

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

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

UNIT - II

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

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

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UNIT – III:

1) Microbiology: History and scope of microbiology: Microbial nutrition; growth and their control; normal microbial flora of human body - skin, nose, oral cavity, pharynx, respiratory tract, eye, ear, stomach, intestine and genitourinary tract.
2) Microbial diseases and their control: Bacterial diseases- tuberculosis, plague, anthrax, tetanus, cholera; Viral diseases- influenza, AIDS, rabies, hepatitis, poliomyelitis, ebola; Fungal diseases- superficial mycosis, cutaneous mycosis, subcutaneous mycosis, systemicmycosis;

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

UNIT – IV:

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

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

UNIT – V:

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

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

REFERENCE BOOKS:

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



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

ZOO 3.2.: Ichthyology

Course Type: Theory

Course Category: Mandatory core

Credits: 4

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

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

UNIT – IV

1) **Respiratory system:** Structure and functioning of gills and accessory respiratory organs.
2) **Circulatory system:** Structure and functioning of cardiovascular system.

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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, N.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



ZOO 3.3. (A): Limnology

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT– I

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

Learning outcome:

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

UNIT– II

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

Learning outcome:

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

UNIT– III

1) **Plankton:** Composition, classification and distribution patterns in lakes and rivers.
2) **Benthos:** Composition, classification and distribution of benthos in lakes and rivers.
3) **Nekton** and its significance.
4) **Large Aquatic Plants:** Classification, distribution and limnological significance.

Learning outcome:

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

UNIT– IV

1) **Productivity:** Concept of productivity; methods for the estimation of primary, secoı tertiary productivity; Classification of lakes based on productivity; indices of productivity
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.

REFERENCEBOOKS:

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

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

ZOO 3.3. (B): Water Quality Management

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

1) **Dynamics of dissolved oxygen:** Dial changes in dissolved oxygen concentration, oxygen budget of culture ponds; algal die-off, overturns, identification of oxygen problems.

2) Aeration: Principles of aeration, emergency aeration, destratification and practical considerations.

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

UNIT – III

Hatchery management: Fish / Shrimp hatchery

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

3) Water discharge standards; Effluent treatment in hatcheries.

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



UNIT – IV

Aquatic weed management:

1) Common weeds and problems in culture ponds
2) Chemical, biological and mechanical control methods and Algal bloom control

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

UNIT – V

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

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

REFERENCE BOOKS:

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

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

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ZOO 3.3. (c): Environmental Biology

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT-1:

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

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

UNIT-2:

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

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

UNIT-3:

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

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

UNIT-4:

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

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

UNIT-5:

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

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

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.
16) Pesticides in the environment - R White Stevenns, MarcelDekker Inc. New York, 1971.
17) Practical methods in Ecology & Environmental Science, RK. Trivedy, Goel, Trisal, 1997.
18) The Ecology of waste water treatment - H.A. Hawkes pergoman press, 1963.
19) Vol.5 Environmental dynamics of pesticides - R. Hague and V.H. Preed, 1975.

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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



ZOO 3.4. (A): Aquatic Toxicology

Course Type: Theory

Course Category: Elective -II

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

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

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UNIT-III

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

Learning Outcome:

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

UNIT – IV

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

Learning Outcome:

The students will understand the

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

UNIT – V

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

Learning Outcome:

The students will understand the

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

REFERENCE BOOKS:

1) Andrews HL. 1974. Radiation Bio-physics. Prentice Hall, Inc., New York, USA.
2) Chanlett ET. 1973. Environmental Protection. McGraw Hill, Inc., Japan.
3) Edwards CA. 1973. Environmental Pollution by Pesticides. Plenum Press, London/NY.
4) Khopkar SM. 2005. Environmental Pollution Monitoring and Control. New Age
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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



ZOO 3.4. (B): Aquaculture Engineering

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

Farm/Hatchery standards and Bio-security measures

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

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

UNIT – III

Design and construction: Fish and shrimp farm

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

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

UNIT – IV

Design and construction: Hatchery

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



Learning Outcome:

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

UNIT-V

Design and construction

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

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

REFERENCE BOOKS

1) Bose AN. *et al*., 1991. *Coastal Aquaculture Engineering*. Oxford & IBH Publishing Company, Pvt. Lt
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*
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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



ZOO 3.4. (C): Taxonomy of and Functional Anatomy of Shell Fish

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

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

UNIT – IV

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

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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



PRACTICAL – I:

ZOO P 3.5.: Animal Biotechnology, Microbiology and Ichthyology & Limnology and Aquatic Toxicology

Biotechnology

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

Microbiology

1) Isolation of bacteria from soil and Water
2) Media preparation for bacterial culture.
3) Standard plate count of bacteria (SPC).

Ichthyology

1) Collection, preservation and identification of a fish: general description of a fish, recording biometric data and identification up to genus level using taxonomic key.
2) Identification of stages of maturation of fish gonads.
3) Dissection and mounting of pituitary gland. Mounting of fish scales.

Limnology

1) Estimation of total alkalinity and total hardness.
2) Estimation of dissolved oxygen and free carbon dioxide & COD and BOD.
3) Estimation of phosphates and nitrites.

Toxicology

1) Determination of LC_{50} value and LD_{50} value.
2) Identification of pesticides in thin layer chromatography.
3) Histopathological study of toxicant exposed tissues.

PRACTICAL – II:

ZP 3.6.: Industry Internship /Mini Research Project

Fourth Semester



DEPARTMENT OF ZOOLOGY & AQUACULTURE
M.Sc. ZOOLOGY
Semester-IV

ZOO 4.1.: Fish Pathology

Course Type: Theory

Course Category: Mandatory core

Credits: 4

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

Fish Diseases:

History, species affected, **C**linical symptoms, pathology and control measures of Viral Hemorrhagic S e p t i c e m i a (VHS) and Infectious Hematopoietic Necrosis (IHN).

Shrimp Diseases:

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

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

UNIT – II:

Fish Diseases:

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

Shrimp Diseases:

3) History, species affected, Clinical symptoms, pathology, prevention and control measures of Black gill disease, Filamentous bacterial gill disease.
4) History, species affected, Clinical symptoms, pathology, prevention and control measures

of *Lagenidium* disease (Larval Mycosis) and Brown gill disease.

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

UNIT – III:

Fish Diseases:

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

Shrimp Diseases:

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

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

UNIT – IV:

Fish Diseases:

1) History, species affected, clinical symptoms, pathology and control measures of gas bubble disease and lack of oxygen.
2) 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.

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REFERENCE BOOKS:

1) Cheng TC. 1964. *The Biology of Animal Parasites*. W.B. Saunders Company, Philadelphia, Pennsylvania, USA.
2) Conroy CA and Herman RL. 1968. *Text book of Fish Diseases*.TFH (Great Britain) Ltd, England.

3) Lightner DV. 1996. *A Handbook of Shrimp Pathology and Diagnostic Procedures for Diseases of Cultured Penaeid Shrimp*. World Aquaculture Society, Lousiana, USA.

4) Reichenbach KH. 1965. *Fish Pathology.* TFH (Gt. Britain) Ltd, England.

5) Ribelin WE and Miguki G. 1975. *The Pathology of Fishes.* The Univ. of Wisconsin Press Ltd, Great Russel Street, London, UK.

6) Shuzo Egusa.1978. *Infectious Diseases of Fish.* Oxonian Press Pvt. Ltd. New Delhi.

7) Van Duijn, C. 1973. *Diseases of Fishes.* Cox and Wyman Ltd. London. Ltd, Great Russel Street, London, UK.

8) Shuzo Egusa.1978. *Infectious Diseases of Fish.* Oxonian Press Pvt. Ltd. New Delhi.

9) Van Duijn, C. 1973. *Diseases of Fishes.* Cox and Wyman Ltd. London.

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



ZOO 4.2.: Immunology

Course Type: Theory

Course Category: Mandatory core

Credits: 4

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

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

UNIT–II

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

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

UNIT–III

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

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

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

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

UNIT – IV

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

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

UNIT - V

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

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

REFERENCE BOOKS:

1. Goldsby AR, Kindt TJ and Osborne BA. 2000. *KUBY Immunology.* W.H. Freeman and Company,NY.
2. Ivon M. Roitt. 2001. *Essential Immunology.* Blackwell Science Ltd, Mishawaka, IN, USA.
3. Joshi KR and Osamo NO. 1994. *Immunology.* Agro Botanical Publishers, India.
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CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	2	1	2	2	2
CO2	2	1	2	3	1	2	1	1	2	2
CO3	2	2	1	2	1	3	2	1	1	1
CO4	1	2	1	1	2	2	1	3	1	2
CO5	2	2	1	2	3	1	2	1	2	1



ZOO 4.3. (A): Aquaculture

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

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

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

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UNIT – III

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

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

UNIT – IV

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

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

UNIT – V

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

Learning outcomes: Students will have fairly good knowledge on

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

REFERENCES BOOKS:

1) Bardach, JE *et al*. 1972. *Aquaculture – The farming and husbandry of freshwater and marine organisms.* John Wiley & Sons, New York.
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4) Huet J. 1986. *A text Book of Fish Culture*. Fishing News Books Ltd.
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10) Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. 2nd Ed. Blackwell
11) Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
12) Stickney RR. 1979. *Principles of Warm water Fish Culture.* John Wiley & Sons.

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



ZOO 4.3. (B): Taxonomy and Anatomy of Finfish

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

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

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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.
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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

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ZOO 4.3. (C): Fish Nutrition

Course Type: Theory

Course Category: Elective -I

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

Unit 1: Composition of Fish

Introduction and Importance to biochemical composition of fish.

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

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

Unit 2: Amino Acids of Fish and Shell Fishes

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

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

Unit 3: Food and Fish Lipids

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

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

Unit 4: Vitamins in Fish

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

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

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Unit 5: Minerals in Fish

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

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

SUGGESTED READING MATERIAL:

1) Gopakumar,K. (2002). Text book of Fish Processing Technology, Indian Council of Agricultural Research, New Delhi.
2) Zen P. (2005). Advances in Fish Processing Technology, Allied Publishers Private Limited.
3) De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.
4) Halver J & Hardy RW. 2002. *Fish Nutrition*. Academic Press.
5) Halver JE & Tiews KT. 1979. *Finfish Nutrition and Fish feed Technology*. Vols. I, II Heenemann, Berlin.

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



ZOO 4.4. (A): Aquaculture Management

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/ Course outcomes:

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

CO2: To study about the management of fish ponds.

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

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

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

UNIT - I: Aquaculture Engineering

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

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

UNIT - II: Management of fish ponds

1) Management of fish production; Natural productivity of ponds; Biological means of increasing fish production.
2) Identification of oxygen depletion problems and control mechanisms in fish and shrimps ponds.
3) Liming, organic manures, chemical fertilizers and their implications in fish ponds.
4) Techniques and management practices adopted for the Reservoir Fisheries in India. **Learning Outcome:** Students will understand the concepts of Management of fish production, techniques and management practices adopted for the reservoir fisheries in India. **UNIT - III: Feed Management**

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

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

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UNIT - IV: Economics and Fish processing

1) Principles of aquaculture economics – Capital costs, Variable costs, Cost-benefit analysis.

2) Fish harvesting in ponds; Fish handling and packaging; methods of transport; fish marketing methods in India.

3) Methods of fish and shrimp preservation and processing; Fishery by-products.

4) Organic Aquaculture – Concept, Principles and Practices.

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

UNIT - V:

1) Methods of fish/shrimp preservation and processing

2) Principles and practices of organic aquaculture.

3) Impact of aquaculture on environment



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

REFERENCES BOOKS:

1) Bose AN. *et al*. 1991. *Coastal Aquaculture Engineering*. Oxford & IBH Publ. Co. Pvt. Ltd.

2) Boyd, CE. 1982. *Water Quality Management for Pond Fish Culture.* Elsevier Sci. Publ. Co.

3) Chakraborty C & Sadhu AK. 2000. *Biology Hatchery and Culture Technology of Tiger Prawn and Giant Fresh water Prawn.* Daya Publ. House.

4) CIFE. 1993. *Training Manual on Culture of Live Food Organisms for Aqua Hatcheries*. CIFE, Versova, Mumbai

5) De Silva SS & Anderson TA. 1995. *Fish Nutrition in Aquaculture*. Chapman & Hall Aquaculture Series.

6) Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR.

7) Govindan, TK. 1985. *Fish Processing Technology,* Oxford-IBH.

8) Ivar LO. 2007. *Aquaculture Engineering*. Daya Publ. House.

9) Jhingran VG. 1982. *Fish and Fisheries of India.* Hindustan Publishing Corporation, India.

10) Lovell RT. 1998. *Nutrition and Feeding of Fishes*. Chapman & Hall.

11) MPEDA: *Handbooks on culture of carp, shrimp, etc*.

12) Pillay TVR. 1990. *Aquaculture- Principles and Practices*, Fishing News Books Ltd., London.

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

ZOO 4.4. (B): Fish Processing Technology

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT– I: Process Biochemistry

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

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

UNIT– II: Microbiology

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



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

UNIT– III: Handling and Fish Preservation

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

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

UNIT–IV: Quality Management and Certification

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

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

UNIT- V

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



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

REFERENCE BOOKS:

1) Balachandran KK.2001. *Post-harvest Technology of Fish and Fish Products*. Daya Publ.
2) Bond, et al.1971.*Fish Inspection and Quality Control.* Fishing News Books, England.
3) Clucas IJ.1981.*Fish Handling, Preservation and Processing in the Tropics*. Parts I, II.FAO.
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, Jakobsen M & Liston J.1991. *Quality Assurance in the Fish Industry.* Elsevier.
8) John DEV. 1985. *Food Safety and Toxicity*.CRC Press.
9) KrenzerR.1971.*Fish Inspection and Quality Control.* FishingNews.
10) Larousse J & Brown BE. 1997. *Food Canning Technology*. Wiley VCH.
11) Nambudiri DD.2006.*Technologyof Fishery Products*. Fishing Chimes.
12) Regenssein JM & Regensse in CE.1991.*Introduction to Fish Technology*. Van Nostrand Reinhold.
13) Rudolf K.1969. *Freezing and Irradiation of Fish.* Fishing News (Books).
14) Sen DP.2005. *Advances in Fish Processing Technology*. Allied Publ.

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



ZOO 4.4. (C): Economic Zoology

Course Type: Theory

Course Category: Elective -II

Credits: 4

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT-1:

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

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

UNIT-2:

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

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

UNIT-3:

1) Types of honey bees.
2) Life cycle, culture of honey bees using movable frame hive.
3) Methods of bee keeping, enemies of bees.
4) Bye products of Honey bees and its economic importance.

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

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UNIT-4:

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

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

UNIT-5:

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

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



SUGGESTED READING MATERIAL:

1) Sukla, G.S. and Upadhyay, V.B., 2000 Economic Zoology – ISBN – 81-7133-137-8 Rastogi Publications, Meerut, India.
2) Jawaid Ahsan and Subhas Prasad Sinha, 2000 A Handbook on Economic Zoology-ISBN-81-219-0876-O S. Chand & Co., Ltd., New Delhi.
3) Ashok Kumar and Prem mohan Nigam, 1991 Economic and Applied Entomology Emkay Publications, New Delhi.
4) Shammi, Q.J. and Bhatnagar, S., 2002 Applied Fisheries: ISBN-81-7754-114-5 Agrobios (India), Jodhpur – India.
5) Major Hall, C.B. 2005 Ponds and Fish culture - ISBN-81-7754-146-3 Agrobios (India), Jodhpur – India.
6) Keith Wilson, N.D.P., 2005 A Handbook of Poultry Practice – ISBN-81-7754-O-69-6 Agrobios (India), Jodhpur – India.
7) Banerjee, G.C. 1992 Poultry – III- Edition – ISBN-81-204-008-4 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. B.Sc. Zoology: Syllabus (CBCS) 45
8) Banerjee, 1988 A Text Book of Animal husbandry-VIII-Edition-ISBN-81-204-1260-5 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9) Kaushish, S.K., 2001 Trends in Livestock Research – ISBN-81-7754-112-9 Agrobios (India), Jodhpur – India.
10) Ismail, S.A. 1997. Vermicology the Biology of Earth worm Orient Longman, India 11. A. Mary violet Christy 2008 vermy technology MJP Publ. Chennai

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



PRACTICAL – I:

ZOO P 4.5.: Fish Pathology and Immunology

Fish Pathology

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

Immunology

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

PRACTICAL - II:

ZP 4.6.: Aquaculture and Aquaculture Management

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

* * * * *



ZOO 1.1

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

I - SEMESTER

PAPER I: Structure and Function of Invertebrates and Vertebrates

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)

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5. a)

(or)

b)

ZOO 1.2

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

I - SEMESTER

PAPER II: Biodiversity and Systematics

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)

ZOO 1.3

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

I - SEMESTER

PAPER III: DEVELOPMENTAL BIOLOGY

w.e.f., 2023 – 2024

Time :3 Hours Max. Markas :70

Answer ALL Questions

All question carries equal marks.

1. a) Give an account on various types of eggs and function og egg.

(or)

b)Write short notes on:
i.Leydig cells
ii.Vitellogenesis

2. a) What is Gastrulation and formation of germ layers

(or)

b) Write short notes on:
i. Determination and differentiation
ii. Molecular events during fertilization.

3. a) Describe the mechanism ofHormonal regulation in insects.

(or)

b) Describe the mechanism of Defferintation of Neurons

4. a) Whatis apoptosis? Explain apoptosis in limb development.

(or)

b) Describe the Process of oogenesis in mammals.

5. a) Describe the Regulation Anti-aging action.

(or)

b) Describe the mechanism of Metamorphosis in insects and amphibians

ZOO 1.4 (A)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

I - SEMESTER

PAPER IV (A): 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)

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ZOO 1.4 (B)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

I - SEMESTER

PAPER IV (B): Endocrinology

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)

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ZOO 1.4 (C)

M.Sc. Degree Examinations – 2023

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I - SEMESTER

PAPER IV (C): 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)

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ZOO 2.1

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER PAPER I: Genetics and Evolution

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)

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ZOO 2.2

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER

PAPER – II: COMPARATIVE ANIMAL PHYSIOLOGY

w.e.f., 2023 – 2024

Time :3 Hours Max.Markas :70

Answer ALL Questions

All question carries equal marks.

1. a) Explian brief account on Bio-energetics and discuss the role of TCA Cycle in metabolism.

(or)

b) Write short notes on:
i. Proteo lytic enzymes
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 mamals
ii. Respiratory pigments.

3. a) Describe the mechanism ofNeuro transmitters and sense organ inanimals

(or)

b) Describe the mechanism of Gaseous exchange in terestrial Environments

4. a) What is thermoregulation and add a note on Poikolotherms in mammals.

(or)

b) Describe the Process of ultrafiltration in kidneys and urine formations in mammals.

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

(or)

b) Describe the function of Estrogen and Progesterone on Reproduction

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ZOO 2.3

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER PAPER III: 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)

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4. a)

(or)

b)

5. a)

(or)

b)

ZOO 2.3

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER PAPER III: 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)

ZOO 2.4 (A)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER PAPER IV (A): Tools and Techniques in 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)

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4. a)

(or)

b)

5. a)

(or)

b)

ZOO 2.4 (B)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER PAPER IV (B): 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)

ZOO 2.4 (C)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

II - SEMESTER PAPER IV (C): Aquatic 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)

ZOO 3.1

ZOO 3.1

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III- SEMESTER PAPER

I: ANIMAL BIOTECHNOLOGY AND MICROBIOLOGY

w.e.f., 2023 – 2024

Time :3 Hours Max.Markas :70

Answer ALL Questions

All questions carry equal marks.

2. 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 in immunological tests in-situ hybridization.

(or)

b) Describe in brief account on function of **Protozoan diseases**-Amoebiasis, and Malaria.

ZOO 3.2

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER II: 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)

Prof. M. Jagadeesh

b)

5. a)

(or)

b)

ZOO 3.3 (A)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER III (A): Limnology

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)

ZOO 3.3 (B)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER III (B): 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)

Prof. M. Jagadeesh

5. a)

(or)

b)

ZOO 3.3 (C)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER III (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)

Prof. M. Jagadish

5. a)

(or)

b)

ZOO 3.4 (A)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER IV (A): 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)

ZOO 3.4 (B)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER IV (B): 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)

Prof. M. Jagadish

5. a)

(or)

b)

ZOO 3.4 (C)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

III - SEMESTER PAPER IV (C): 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)

ZOO 4.1

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER I: Fish 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)

(Prof. M. Jagadish)

ZOO 4.2

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER II: 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)

ZOO 4.3 (A)

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER IIIA: 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)

ZOO 4.3 B

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER IIIB: Taxonomy & Anatomy of Fish

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)

ZOO 4.3 C

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER IIIC: Fish Nutrition

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)

ZOO 4.4 A

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER IVA: Aquaculture 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)

ZOO P4.4 B

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER IV B: 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)

ZOO 4.4 C

M.Sc. Degree Examinations – 2023

M.Sc. ZOOLOGY

Fourth - SEMESTER PAPER IV C: Economic Zoology

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)

b)

Prof. M. Jagadish