ACHARYA NAGARJUNA UNIVERSITY

CENTRE FOR DISTANCE EDUCATION

NAGARJUNA NAGAR,

GUNTUR

ANDHRA PRADESH

PROGRAM PROJECT REPORT

02. MASTER OF SCIENCE (ZOOLOGY)

Master of Science (Zoology)

PROGRAMME CODE: 2

MISSION :

Aims at promoting post-graduation education with distinctive features that could fill the needs and requirements of various organization in a global competitive environment.

OBJECTIVES :

The objectives of this course include to offer a modular course of lectures and associated seminars, research projects and practical classes, supported by supervisions where appropriate; to promote training in practical and conceptual skills in sub-disciplines ranging from molecular cell biology, through physiology and neurobiology, to the study of populations in both an ecological and evolutionary framework; to provide constructive feedback on their progress, individual students will be assessed throughout the year in their project work, participation in seminars and written work for supervisions; to provide an optional Zoology-based course in statistics in the Michaelmas Term enabling students to apply quantitative methods to complex biological problems; to provide professional training in effective verbal and written communication skills.

RELEVANCE :

The M.Sc. (Zoology) programme offered through Open and Distance Learning mode is purely relevant and aligned with the goals and mission of CDE, ANU. This programme is structued inorder to equip the learners with core competence in research and analytical aspects of scientific evolution there by new areas will be unfolded. This programme is helpful for enhancing the employability skills with the global perspective and conforming to the vision and mission of ANU.

NATURE OF PERSPECTIVE TARGET GROUP OF LEARNERS :

Aim of open and distance eduation is to enhance the academic competence in those who were deprived of higher education for various socio-economic reasons. This programme is designed for candidates which is helpful in their career advancement, updating the knowledge, upgrading their qualification for school teachers, Scientists, Laboratories, for getting jobs in health and medical organisations, pursue for research, Biotechnology companies, Zoos and National parks, Agricultural sector, Food parks etc.

SKILLS AND COMPETENCE OF THE PROGRAMME :

Inconsideration of the huge gap in education and industry and also in skill development now it is imperative on the part of every university to reach out every nooc and corner of the country where the institutions with significant infrastructure are not availble in order to elevate the status of the marginalised sections of the society especcially living in rural areas of the country. The only solution appears to be "open and distance education" and Acharya Nagarjuna University takes initiative by reaching out those unreached by ICT enabled blended mode of distance learning programmes. M.Sc. (Zoology) propgramme is an innovative programme. The learning outcomes of this programme are as follows:

- Professional development of teachers.
- Incorporating generic transferrable skills and competencies
- To develop critical learning, anylitical skills and research skills.

INSTRUCTIONAL DESIGN: Course structure and detailed syllabi

ACHARYA NAGARJUNA UNIVERSITY: CENTRE FOR DISTANCE EDUCATION

Master of Science (Zoology) - Program code: 02

Program Structure

Program code	Program	Internal assessment	External exams	Max. Marks	credits
SEMISTER 1					
101ZO24	Structure and Function of Invertebrates and Vertebrates	30	70	100	4
102ZO24	Biodiversity and Systematics	30	70	100	4
103ZO24	Developmental Biology	30	70	100	4
104ZO24	Molecular Cell Biology	30	70	100	4
	Practicals:				
105ZO24	Invertebrates, Vertebrates and Biodiversity	--	--	100	4
106ZO24	Developmental Biology and Molecular Biology	--	--	100	4
SEMISTER 2					
201ZO24	Genetics and Evolution	30	70	100	4
202ZO24	Comparative Animal Physiology	30	70	100	4
203ZO24	Principles of Ecology	30	70	100	4
204ZO24	Tools and Techniques in Biology	30	70	100	4
	Practicals:				
205ZO24	Genetics and Animal Physiology	--	--	100	4
206ZO24	Ecology and Tools & Techniques in Biology	--	--	100	4
SEMISTER 3					
301ZO24	Animal Biotechnology and Microbiology	30	70	100	4
302ZO24	Ichthyology	30	70	100	4
303ZO24	Limnology	30	70	100	4
304ZO24	Aquatic Toxicology	30	70	100	4
	Practicals:				
305ZO24	Biotechnology, Microbiology and Ichthyology	--	--	100	4
306ZO24	Limnology and Toxicology	--	--	100	4
SEMISTER 4					
401ZO24	Fish Pathology	30	70	100	4
402ZO24	Immunology	30	70	100	4
403ZO24	Aquaculture	30	70	100	4
404ZO24	Aquaculture Management	30	70	100	4
	Practicals:				
405ZO24	Fish Pathology and Immunology	--	--	100	4
406ZO24	Aquaculture and Aquaculture Management	--	--	100	4

Master of Science (Zoology) – Syllabus
SEMESTER 1
101ZO24 -STRUCTURE AND FUNCTION OF INVERTEBRATES AND VERTEBRATES

Course Objectives/Course outcomes:

This course is designed to

CO:1 Understand the general characteristics of all invertebrates of coelom and about the nutrition, digestion, respiration.

CO:2 To discuss about Larval forms of free-living invertebrates and Minor phyla general characters.

CO:3 Remembering the biology and life cycles of Parasites and insects and its importance in environment.

CO:4 Elucidate the comparative accounts of respiratory and circulatory systems of vertebrates.

CO:5 Comparative anatomy and function of Nervous, sensory and urinogenital systems among different vertebrates.

UNIT – I

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

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

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

Learning Outcome:

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

UNIT – II

Invertebrate Larvae: Larval forms of free-living invertebrates;

Larval forms of parasites.

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

Learning Outcome:

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

UNIT – III

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

Insects: Insects and diseases;

Economic importance of insects.

Learning Outcome:

Students will be familiar with the

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

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

UNIT – IV

Vertebrates: Important characters, nature of vertebrate morphology.

Respiratory system: Comparative account of respiratory organs invertebrates.

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

Learning Outcome:

Students should be able to describe the

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

UNIT – V

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

Urinogenital system: Evolution of urinogenital systems among vertebrates.

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

Learning Outcome:

Students will have a knowledge on the

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

REFERENCE BOOKS:

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

SEMESTER 1

102ZO24 -BIODIVERSITY AND SYSTEMATICS

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 systematic and species identification scientifically.

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

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

UNIT –I

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

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

Biogeographic realms of the world.

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

Learning outcome:

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

UNIT – II

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

Biodiversity values: Direct values and indirect values.

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

Learning outcome:

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

UNIT – III

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

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

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

Learning outcome:

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

UNIT – IV

Biodiversity management and conservation

IUCN classification of wildlife.

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

Gene banks; conservation of genetic resource; cryopreservation.

Wildlife protection acts; organizations involved in protection of Biodiversity.

Learning outcome:

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

UNIT- V

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

Molecular taxonomy: DNA fingerprinting.

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

Learning outcome:

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

REFERENCE BOOKS:

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

SEMESTER 1

103ZO24 -DEVELOPMENTAL BIOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I:

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

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

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

Learning outcome:

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

UNIT – II:

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

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

Learning outcome:

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

UNIT – III:

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

Differentiation of neurons, post embryonic development.

Larval formation, metamorphosis in insects and amphibians.

Learning outcome:

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

UNIT – IV:

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

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

Learning outcome:

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

UNIT – V:

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

Hormonal regulation of Meta morphosis in insects and amphibians.

Learning outcome:

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

REFERENCE BOOKS:

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

SEMESTER 1

104ZO24- MOLECULAR CELL BIOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT– I

Composition, Structure and Functions of Carbohydrates and Proteins.

Composition, Structure and Functions of Lipids and Nucleic Acids.

Learning outcome:

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

UNIT– II

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

Bioenergetics, Glycolysis, OxidativePhosphorylation.

Learning outcome:

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

UNIT– III

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

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

Learning outcome:

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

UNIT– IV

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

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

Learning outcome:

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

UNIT– V

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

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

Learning outcome:

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

REFERENCEBOOKS:

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

SEMESTER 1

PRACTICAL – I

105ZO24- INVERTEBRATES, VERTEBRATES AND BIODIVERSITY

Invertebrates

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

Vertebrates

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

Biodiversity

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

SEMESTER 1

PRACTICAL - II

106ZO24- DEVELOPMENTAL BIOLOGY AND MOLECULAR CELLBIOLOGY

Developmental Biology

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

Molecular Cell Biology

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

SEMESTER 2

201ZO24- GENETICS AND EVOLUTION

Course Objectives/Course outcomes:

CO :1. To provide fundamental knowledge in Mendelian principles.

CO :2 To evaluate human genome project quantitative and qualitative traits of human beings.

CO :3 Remembering the concepts of evolution, and hardy- Weinberg law of equilibrium.

CO :4 Elucidate the mega evolution and models of speciation.

CO :5 Analyse the convergent and divergent evolution and adaptive radiation in vertebrates.

UNIT – I

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

Behavioral genetics in *Drosophila* and bees.

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

UNIT – II

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

Inborn errors of metabolism; Chromosomal abnormalities.

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

UNIT – III

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

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

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

UNIT – IV

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

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

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

UNIT – V

Convergent and divergent evolution;

Adaptive radiation in amphibians, reptiles and mammals.

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

REFERENCE BOOKS:

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

SEMESTER 2

202ZO24-COMPARATIVE ANIMAL PHYSIOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

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

Learning outcome

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

UNIT – II

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

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

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

Circulation: Comparative account of circulatory system in animals.

Learning outcome:

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

UNIT – III

Thermoregulation in poikilotherms and homeotherms.

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

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

Learning outcome

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

UNIT – IV

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

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

Learning outcome

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

UNIT – V

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

Learning outcome

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

REFERENCE BOOKS:

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

SEMESTER 2

203ZO24- PRINCIPLES OF ECOLOGY

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 ofhabitat and niche.

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

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

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

UNIT – I

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

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

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

Learning outcome:

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

UNIT – II

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

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

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

Learning outcome:

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

UNIT – III

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

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

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

Stable distribution; population growth projection using Lesile Matrix method.

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

Learning outcome:

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

UNIT – IV

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

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

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

Learning outcome:

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

UNIT-V

Biological magnification.

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

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

Learning outcome:

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

REFERENCE BOOKS

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

SEMESTER 2

204ZO24-TOOLS AND TECHNIQUES IN BIOLOGY

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 principle 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

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

Learning outcome:

Students will be familiar with

- Different types of Microscopies, their working principles and uses

UNIT-II

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

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

Learning outcome:

Students will be familiar with

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

UNIT – III

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

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

Learning outcome:

Students will be familiar with

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

UNIT – IV

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

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

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

Learning outcome:

Students will be familiar with

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

UNIT – V

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

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

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

Usage of Statistical Package for Social Sciences (SPSS).

Learning outcome:

Students will be familiar with

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

REFERENCES BOOKS:

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

SEMESTER 2

PRACTICAL – I

205ZO24- GENETICS AND ANIMAL PHYSIOLOGY

Genetics

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

Animal Physiology

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

SEMESTER 2

PRACTICAL – II

206ZO24- ECOLOGY AND TOOLS & TECHNIQUES IN BIOLOGY

Ecology

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

Tools and Techniques in Biology

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

SEMESTER 3

301ZO24- ANIMAL BIOTECHNOLGY AND MICROBIOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT-I:

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

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

UNIT - II

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

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

UNIT – III:

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

Learning Outcomes: Students are able to understand the history, scope and significance of

microbiology in controlling various microbial, bacterial and viral diseases.

UNIT – IV:

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

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

UNIT – V:

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

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

REFERENCE BOOKS:

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

SEMESTER 3

302ZO24- ICHTHYOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

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

UNIT – IV

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

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

UNIT – V

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

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

REFERENCE BOOKS:

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

SEMESTER 3

303ZO24 LIMNOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT– I

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

Learning outcome:

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

UNIT– II

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

Learning outcome:

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

UNIT– III

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

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

Learning outcome:

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

UNIT– IV

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

Learning outcome:

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

UNIT- V

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

Learning outcome:

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

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.

SEMESTER 3

304ZO24-AQUATIC TOXICOLOGY

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

UNIT-III

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

Learning Outcome:

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

UNIT – IV

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

Learning Outcome:

The students will understand the

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

UNIT – V

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

Learning Outcome:

The students will understand the

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

REFERENCE BOOKS:

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

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

SEMESTER 3

PRACTICAL – I:

305ZO24- BIOTECHNOLOGY, MICROBIOLOGY ANDICHTHYOLOGY

Biotechnology

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

Microbiology

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

Ichthyology

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

SEMESTER 3

PRACTICAL – II:

306ZO24 LIMNOLOGY AND TOXICOLOGY

LIMNOLOGY

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

Toxicology

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

SEMESTER-4

401ZO24- FISH PATHOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

Fish Diseases:

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

Shrimp Diseases:

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

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

UNIT – II:

Fish Diseases:

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

Shrimp Diseases:

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

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

UNIT – III:

Fish Diseases:

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

Shrimp Diseases:

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

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

UNIT – IV:

Fish Diseases:

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

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.

SEMESTER-4

402ZO24 -IMMUNOLOGY

Course Objectives/Course outcomes:

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

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

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

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

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

UNIT – I

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

UNIT–II

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

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

UNIT–III

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

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

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

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

UNIT – IV

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

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

UNIT - V

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

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

REFERENCE BOOKS:

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

SEMESTER-4

403ZO24- AQUACULTURE

Course Objectives/ Course outcomes:

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

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

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

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

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

UNIT – I

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

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

UNIT – II

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

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

UNIT – III

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

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

UNIT – IV

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

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

UNIT – V

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

Learning outcomes: Students will have fairly good knowledge on

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

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) MPEDA: *Handbooks on culture of carp, shrimp, etc*.
8) New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
9) Pillay TVR. 1990. *Aquaculture- Principles and Practices.* Fishing News Books Ltd., London.
10) Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. 2nd Ed. Blackwell
11) Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
12) Stickney RR. 1979. *Principles of Warm water Fish Culture.* John Wiley & Sons.

SEMESTER-4

404ZO24- AQUACULTURE MANAGEMENT

Course Objectives/ Course outcomes:

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

CO2: To study about the management of fish ponds.

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

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

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

UNIT - I: Aquaculture Engineering

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

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

UNIT - II: Management of fish ponds

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

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

UNIT - III: Feed Management

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

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

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

UNIT - IV: Economics and Fish processing

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

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

UNIT - V:

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

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

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) New MB. 1987. *Feed and Feeding of Fish and Shrimp. A Manual on the Preparation and Preservation of Compound Feeds for Shrimp and Fish in Aquaculture.*FAO – ADCP/REP/87/26.
13) Pillay TVR. 1990. *Aquaculture- Principles and Practices*, Fishing News Books Ltd., London.

SEMESTER-4

PRACTICAL – I

405ZO24- 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, kidneyand intestine.

Immunology

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

SEMESTER-4

PRACTICAL - II

406ZO24- 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 theirimpact 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 inponds.
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.

* * * * *

Duration of the Programme:

Minimum: Two Academic Years from the year of joining of the course (Four Semesters). **Maximum:** Five Academic Years from year of joining of the course for securing First Class or Second Class.

INSTRUCTIONAL DESIGN :

Instructional delivery mechanism: University has its own faculty for M.Sc. Zoology department and all the faculty members will act as resource persons. Our University has blended mode delivery mechanism i.e., ICT and Conventional modes.

Media of delivery mechanisms:

- **Printing:** The study material delivery media include Printing of books which are issued to the students who are enrolled for the programme.

- **Online:** On line PDF format content is also given access to the students who wish to study through online mode.

- **Interactive sessions, and Discussion boards:** In distance Education, face to face contact between the learners and their tutors is relatively less and therefore interactive sessions are conducted. The purpose of such interactive session is to answer some of the questions and clarify doubts that may not be possible in other means of communication. This programme provides an opportunity to meet other fellow students. The Counsellors at the study centres are expected to provide guidance to the students. The interactive sessions are conducted during week ends and vacations to enable the working students to attend.

- **Student support services:** Student support services include Internet enabled student support services like e-mails, SMS and even an app is planned. Student feed back mechanism is created and feed back is designed. Student Learning Managemnet Sysyem (LMS) is customized to every student. For every student customized examination management system (EMS) is also created facilitationg self evaluation, demo tests, model question papers and periodical Internal Assessments.

- **Credit System:** University has adopted Choice Based Credit System (CBSE) under semester mode from 2013. The same has been approved by relevant Statuatory boards in Distance mode also.

- **Admission procedure:** In M.Sc. (Zoology) programme candidates can take admission directly. For this purpose, CDE, ANU will advertise for admissions. Then candidates should apply in prescribed format of the CDE after publication of the advertisement.

- **Eligibility Criteria:** The eligibility for admission into this course is a pass in B.Sc with Zoology as one of the subjects of study.

- **Fee Structure:** The total course fee is Rs.29,900/-.

- **Policy of programme delivery:** Our University has blended mode delivery mechanism i.e., ICT and Conventional modes. In conventional mode printed material is given and also online mode of delivery with learning management system is adopted.

• **Activity planner:** There is an yearly academic plan and as per plan interactive sessions, assignments, examinations etc are conducted to the candidates.

• **Evaluation System:** Periodical progress of learning is evaluated by web based feed back mechanism in the Learning Management System. Evaluation of learner progress is conducted as follows:
(i) The examination has two components i.e., continuous evaluation by way os assignments (30 %) and term end University Examination (70 %).
(ii) Each student has to complete and submit assignment in each of the theory paper before appearing to the term end examination. The term end examination shall be of 3 hours duration.
(iii) Minimum qualifying marks in each paper is 40 % indivually in internal and term end examination. The candidates who get 60 % and above will be declared as passin First Division, 50 % to below 60 % as Second Division and 40 % to below 50 % as Third Division.
(iv) THe Centre for Distance Education, Acharya Nagarjuna University will conduct the examinations, evaluations and issue certificates to the successful candidates.
(v) All the term end examinations will be conducted at the examination centres fixed by the CDE.
(vi) Qualitatively the examinations conducted for the students of the Distance Education are on par with the examinations conducted for the regular University students.

LIBRARY SUPPORT AND LIBRARY RESOURCES :

The M.Sc. (Zoology) program is based on the theory and practical papers. Laboratory support is available to students. Further, entire University Library is accessble to all the students of distance education. Additionally every department in the University has a well equipped library which is accessable to all the students. CDE also provides a compendium of web resources to every student to support learning.

COST ESTIMATE :

The Programme fee for I year is Rs.14,300/-, and II year is Rs. 15,600/-. The university will pay the remuneration to Editors and lesson writers as per university norms. DTP charges, Printing of books and Examination fees will be paid by the ANUCDE as per prescribed norms. This institution is providing high quality programmes at low cost.

QUALITY ASSURANCE :

Quality assurance comprises the policies, procedures and mechanisms which that specified quality specifications and standards are maintained. These include continuous revision and monitoring activities to evaluate aspects such as suitability, efficiency, applicability and efficacy of all activities with a view to ensure continuous quality improvement and enhancement. The programme is designed with a focus on the proposed learning outcomes aimed at making the learner industry ready also for career advancement, enterprenureal development, and as wealth creators. There is a continuous evaluation of learning and of competence internally and also by ICT enabled feed back mechanism and Centre for Internal Quality Assurance (CIQA). The University ensures maintaining quality in education provided through open and diatance learning mode. As per the need of the information society and professional requirement, the University ensures to change the mechanism from time to time along with enhancement of standard in course curriculum and instructional design. Therefor, the outcomes of the programme can meet the challenges in the changing society.

DIRECTOR
Centre for Distance Education
Acharya Nagarjuna University
Nagarjuna Nagar,
GUNTUR-522 510.

REGISTRAR
ACHARYA NAGARJUNA UNIVERSITY
NAGARJUNA NAGAR - 522 510.
GUNTUR (A.P.) INDIA.