Program Structure and Syllabus

for

M.Sc. Aquaculture

(Syllabus for Semesters I & II is common for M.Sc. Zoology and M.Sc. Aquaculture)

2019-2020

Department of Zoology

School of Life and Health Sciences

ADIKAVI NANNAYA UNIVERSITY

Rajamahendravaram

ADIKAVI NANNAYA UNIVERSITY: RAJAMAHENDRAVARAM
BOARD OF STUDIES METING - AQUACULTURE/ ZOOLOGY
Date: 04-04-2019

AGENDA:

1. Eligibility and Entrance Examinations
2. Revision of the Syllabus
3. Syllabus for practicals
4. Number of teaching hours / Periods theory / Practicals
5. Model Question Papers
6. Credits / Evaluation
7. Scheme of Valuation
8. List of Examiners for paper setting
9. List of Practical Examiners

Members:

Dr. D. Kalyani,
Convener, BoS – Aquaculture/Zoology

Prof. Pala Indira

Dr. A. Matta Reddy

Dr. K. Ramaneswari

Dr. P. Vijaya Nirmala

Dr. J. Lalitha Bharathi

20

Minutes of the meeting of Board of Studies held on 4/4/19 at 12.00 Noon at Department of Zoology, Adikavi Nannaya University, Rajamahendravaram

Board of Studies Meeting for Zoology / Aquaculture

Members Present:

1. Dr. D. Kalyani, Asst. Professor in Zoology, ANUR. Convenor 4/4/19
2. Prof. Pala Indira, Sri Krishna Devaraya University, Anantapur, Member
3. Dr. A. Malla Reddy, Associate Professor, ANUR. Member 4/4/19
4. Dr. K. Ramaneswari, Associate Professor, ANUR. Member 4/4/19
5. Dr. P. Vijaya Nirmala, Asst. Professor, ANUR. Member 4/4/19
6. Dr. T. Lalitha Bharathi, SKR, College for women, Rajamahendravaram, Member
7. Officer from Avanti Seeds, Bhi

RESOLUTIONS:

The common Board consisting of the above members have met in the Department of Zoology, Adikavi Nannaya University, Rajamahendravaram and considered the enclosed agenda. After thorough deliberations and discussions, the Board members have resolved the following.

1. A B.Sc graduate with "Zoology" as one of the subjects is eligible to apply for admission into M.Sc Zoology / Aquaculture.
2. The members formulated the syllabus for M.Sc Zoology and M.Sc Aquaculture a 2 year program on par with other Universities in the Country to be implemented from academic year 2019-20.
3. The syllabus for practicals of the above courses was formulated on par with UGC model curriculum.
4. There shall be 4 to 5 hours per week for each theory paper & 3 hrs for each practical.
5. I & II Semesters are common for M.Sc Zoology & Aquaculture whereas III & IV Semesters have separate syllabus for M.Sc Zoology & Aquaculture respectively.
6. Marks and credits are allotted to theory & practical papers in each semester. There will be 100 marks for each theory, and 200 marks for 4 practicals each 50 marks and total marks for each semester 600 x 4 semester 2400 marks.

7. **Examination pattern will be as follows.**
   a) Each theory paper will be evaluated for 100 marks out of which75% of marks, for Semester End Examination (SEE) while the remaining 25% marks for Continuous Internal Assessment(CIA)

Continuous Internal Assessment		
S.No	Scheme of Evaluation	Marks
1	Mid-Semester Examination	10M
2	Assignment/Seminar Presentation	5M
3	Attendance	5M
4	Swachhata Activity	5M
	Total	25M

Details of Attendance Marks		
S.No	Attendance	Marks Allotted
1	95% above	5
2	85-94%	4
3	75-84%	3
4	65-74%	2
5	55-64%	1
6	< 54%	0

b) The Semester End Examination question paper comprises of two sections –Section A & B, Section A consists of 4 questions one question from each unit of syllabus with internal choice ‘a’ or ‘b’. Section-B consists of 8 short questions two from each unit of the syllabus, with internal choice out of which only 5 are to be attempted

c) Similarly each practical will be evaluated for a total of 50 marks, out of which 75% of marks for Semester End Examination (38 Marks) and 25% (12 Marks) for Continuous Internal Assessment.

8. A comprehensive viva-voce will be conducted for students at the end of IV Semester for 100 marks carrying 4 credits.

M.Sc. AQUACULTURE

SEMESTER END EXAMINATION

Theory Model Question Paper pattern

Time: 3 hrs Max. Marks: 75

Section-A

Answer all questions. Each question carries 15 marks. 4x15=60

Q1. Unit-1

a or b

Q2. Unit-2

a or b

Q3. Unit-3

a or b

Q4. Unit-4

a or b

Section-B 5x3=15

Q5. It contains 8 short questions with at least two from each unit, carrying 3 marks.

5 questions are to be answered.

ADIKAVI NANNAYA UNIVERSITY
RAJAMAHENDRAVARAM

The Department of Zoology, Adikavi Nannaya University has been offering M.Sc. programs in Aquaculture & Zoology since 2016 and 2006 respectively. There is a need to envisage and accordingly revise syllabi so as to incorporate rising concepts / aspects in relevant subjects to be in sync with emerging national and global higher educational trends. These programs have been meticulously designed to enrich the students' theoretical knowledge in basic, core and specialized papers. Each theory paper is linked with practical's which gives them hands on experience and enhance their critical thinking, constructive planning and analytical skills. Thus by the end of the program students would be confident enough either in attaining higher studies or boldly face the competitive world and grab different job opportunities.

M.Sc. Aquaculture Program Structure

Code	Title of the paper	Total Marks	Credits	Teaching Hours / Week
	I SEMESTER			
A/Z 101	Tools and Techniques for Biology	100	4	4
A/Z 102	Biosystematics, Biodiversity and Evolution	100	4	4
A/Z 103	Biomolecules	100	4	4
A/Z 104	Molecular Cell Biology	100	4	4
	Lab Course			
A/Z 105	Tools and Techniques for Biology lab	50	2	3
A/Z 106	Biosystematics, Biodiversity and Evolution lab	50	2	3
A/Z 107	Biomolecules lab	50	2	3
A/Z 108	Molecular Cell Biology lab	50	2	3
	II SEMESTER			
A/Z 201	Biostatistics, Computation Biology & Bio-informatics	100	4	4
A/Z 202	Animal Physiology	100	4	4
A/Z 203	Immunology	100	4	4
A/Z 204	Molecular Biology	100	4	4
	Lab Course			
A/Z 205	Biostatistics, Computation Biology & Bio-informatics lab	50	2	3
A/Z 206	Animal Physiology lab	50	2	3
A/Z 207	Immunology lab	50	2	3
A/Z 208	Molecular Biology lab	50	2	3
	III SEMESTER			
A 301	Concepts of Aquatic Ecology	100	4	4
A 302	Principles of Aquaculture	100	4	4
A 303	Nutrition and Feed Technology	100	4	4
A304	Water Quality Management	100	4	4
	Lab Course			
A 305	Concepts of Aquatic Ecology Lab	50	2	3
A 306	Principles of Aquaculture Lab	50	2	3
A 307	Nutrition and Feed Technology Lab	50	2	3
A 308	Water Quality Management Lab	50	2	3
	IV SEMESTER			
A 401	Aquaculture	100	4	4
A 402	Fish Processing Technology	100	4	4
A 403	Fish Pathology	100	4	4
A 404	Aquaculture Biotechnology	100	4	4
	Lab Course			
A 405	Aquaculture lab	50	2	3
A 406	Fish Processing Technology Lab	50	2	3
A 407	Fish Pathology Lab	50	2	3
A 408	Aquaculture Biotechnology Lab	50	2	3
A 409	Comprehensive viva-voce	100	4	
	Total	**2500**	**100**	

M.SC. AQUACULTURE
I SEMESTER

A/Z 101 TOOLS AND TECHNIQUES FOR BIOLOGY

UNIT- I

Assay- Definition, Biological & Chemical assay. Microscopy- Principles and applications of light, dark field, phase contrast, fluorescence, transmission, electron, scanning electron microscopes. Different fixation and staining techniques for EM. Freeze-etch, freeze-fracture methods for EM, Image processing methods in microscopy. pH meter: Operation of pH electrodes, Principles and applications of Ion-selective and gas sensing electrodes, Oxygen electrodes.

UNIT - II

Centrifugation -Basic principles of centrifugation, types of centrifuges, applications of preparative and analytical ultra-centrifuges. Principles and applications of sedimentation, lyophilization. Chromatography: Principles and applications of gel-filtration, ion-exchange and affinity chromatography; TLC, GC & HPLC.

UNIT - III

Properties of electromagnetic radiations; Principles, instrumentation and applications of UV, visible, infrared, NMR spectroscopy; Spectrofluorimetry and mass spectrometry. X-ray diffraction, Incorporation of radio-isotopes in biological tissues and cells.
Radiolabeling techniques: Detection and measurement of different types of radio-isotopes used in biology, Molecular imaging of radio-active material, safety guidelines.

UNIT - IV

Micro-biological Techniques: Media preparation & sterilization, Inoculation & Growth monitoring, Biochemical Mutants & their uses, Microbial assays.

Suggested Reading Material:

1. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Editions
2. A Biologist Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.

A/Z 102 BIOSYSTEMATICS, BIODIVERSITY AND EVOLUTION

UNIT - I

Biosystematics- Definition and basic concepts. Importance and applications of biosystematics. Material Basis of Biosystematics. Biological classification-Theories and objectives. Procedures in taxonomy - Taxonomic collections. taxonomic keys. Types of taxonomy-Conventional types, Cytotaxonmy. Chemotaxonomy and Molecular taxonomy. Concept of Zoological Nomenclature.

UNIT - II

Origin of basic biological molecules. Abiotic synthesis of organic monomers and polymers. Concept of Oparin and Haldane. Experiment of Miller. Evolutionary time scale – Eras, Periods and epochs. Origin and diversification of eukaryotes - Origin of cells and first organisms. Evolution of eukaryotic cell from prokaryotes. Evolution of eukaryotic genomes. duplication and divergence. Molecular divergences, molecular clocks and molecular drive. Phylogenetics- Molecular tools in phylogeny.

UNIT - III

Universal common ancestor and tree of life – three domain concepts of living kingdom. hierarchical components of bio-diversity. Evolutionary relationships among taxa. Concepts of species. Species category, subspecies and other infraspecific categories. Hierarchy of categories. Speciation- Genetics of speciation, modes of speciation, Patterns and mechanisms of reproductive isolation. Allopatry, sympatry, Convergent evolution, Sexual selection, Co-evolution.

UNIT - IV

Concepts of evolution – An overview of evolutionary biology, & theories of organic evolution. Concepts of Neutral Evolution, Population genetics- Populations, gene pool, Gene frequency; Hardy Weinberg law. Concepts and rate of change in gene frequency through Natural selection, mutation, migration and random genetic drift. Phylogenetic gradualism , punctuated equilibrium and origin of higher categories

Suggested Reading Material:

1. M. Kato. The Biology of Biodiversity, Springer.
2. J.C. Avice. Molecular Markers. Natural History and Evolution, Chapman & Hall, New York.
3. E.O. Wilson. Biodiversity, Academic Press, Washington.
4. G.G. Simpson. Principles of Animal Taxonomy. Oxford IBH Pub. Co.
5. E. Mayr. Elements of Taxonomy.
6. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
7. Dobzhansky, Th. Genetics and origin of species, Surjeet Publication, Delhi
8. Dobzhansky, Th., F.J.Ayala, G.L.,Stebbens and J.M. Valentine Evolution, Surjeet Publication, Delhi
9. Futuyama, D.J. Evolutionary Biology, Suinuer Associates, INC, Publishers, Dunderland
10. Hartl. D.L.A. Primer of population Genetics, Sinauer Associates, INC Massachusetts.
11. Jha, A.P. Genes and Evolution, John Publication, New Delhi
12. King, M. Species Evoluution -the role of chromosomal change. The Cambridge University Press, Cambridge.
13. Strikberger, M.W. Evolution, Jones and Bartett Publishers, Boston London
14. TandonRK.1999.Biodiversity, Taxonomy & Ecology. Prithipal singh Scientific Publishers, Jodhpur.

A/Z 103 BIOMOLECULES

UNIT - I

Chemical foundations of biology, Amino acids – classification, Peptide bond, Proteins – classification, structural organization of proteins, primary structure, secondary structure, tertiary structure, quaternary structure, Conformation of proteins (Ramachandran plot) - domains, motifs and folds. Denaturation & renaturation of proteins.

UNIT - II

Carbohydrates: Definition and classification of carbohydrates, nomenclature, Reaction of Mono-saccharides, Acid derivatives of Mono-saccharides, amino-sugars, Oligo-saccharides, structure and properties, Chemistry and biological roles of homo and hetero-polysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.

UNIT - III

Classification of Lipids & Fatty acids and their physicochemical properties, characterization of fats and oil; Structure, properties and biological roles of triacylglycerol, phospholipids, sphingolipids, Gangliosides, Prostaglandins, Thromboxanes, Leukotrienes and steroids.

UNIT - IV

Nucleic acids – nitrogen bases, nucleosides, nucleotides, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic and non-enzymatic methods, chemical synthesis of DNA; Nucleic acid sequencing, chromatin structure, Three dimensional structure of DNA; Types of RNA, Structure of RNAs – Secondary and Tertiary structure; DNA denaturation and renaturation.

Suggested Reading Material:

1. Nelson.D.L, Cox. M. M. Lehninger's Principle of Biochemistry. Freeman.
2. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper's Biochemistry, McGraw Hill.
3. Fundamentals of Biochemistry by Donald Voet.
4. Textbook of Biochemistry West, E.S., Todd, Mason &Vanbruggen, Macmillian&Co.
5. Biochemistry, Lubert Stryer.

A/Z 104 MOLECULAR CELL BIOLOGY

UNIT - I

Introduction: Experimental system in Cell Biology

Biomembranes

- Molecular composition and arrangement, functional consequences
- Transport across cell membrane: diffusion, active transport, pumps, uniports, symports and antiports
- Membrane potential
- Co-transport by symporters or antiporters
- Transport across epithelia: Transport of macromolecules

UNIT - II

Cytoskeleton

- Microfilaments and microtubules – structure and dynamics
- Microtubules and mitosis
- Cilia and flagella
- Cell movements – intracellular transport, role of kinesin and dynein, signal transduction mechanisms

UNIT - III

Cell-Cell Signaling

- Cell surface receptors
- Second messenger system
- MAP kinase pathways
- Apoptosis: Definition, mechanism and significance

Cell-Cell adhesion and communication

- Ca^{++} dependent homophillic cell-cell adhesion
- Ca^{++} independent homophillic adhesion
- Gap junctions and connections
- Integrins
- Collagen

UNIT - IV

Cell cycle

- Cyclines and cyclin dependent kinases
- Regulation of CDK-cycline activity

Genome organization

- Hierarchy in organization
- Chromosomal organization of genes and non-coding DNA
- Mobile DNA
- Morphological and functional elements of eukaryotic chromosomes

Intracellular protein traffic

- Protein synthesis on free and bound polysomes
- Uptake into ER
- Membrane proteins, Golgi sorting, post-translational modifications
- Biogenesis of mitochondria and nuclei
- Trafficking mechanisms

Suggested Reading Material:

1. Molecular Cell Biology, J. Darnell. H. Lodish and D. Baltimore, Scientific American Book INC, USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson Garland Publishing INC, New York.

I SEMESTER PRACTICALS

A/Z 105 Tools and Techniques for Biology lab:

1. Spectrophotometer – Estimation of biomolecules
2. Centrifugation – Demonstration and working
3. Separation Techniques - Paper chromatography
4. Electrophoresis – Demonstration and usage
5. PH Meter – Preparation of Phosphate buffer Preparation
6. Microscope –
    a) Demonstration of oil immersion – WBC & RBC
    b) Preparation of tissue for SEM & TEM procedure

A/Z 106 Biosystematics, Biodiversity and Evolution Lab:

1. Invertebrate and Vertebrate Phyla
2. Types of Speciation-Models/Charts
3. Problems on Hardy-Weinberg law
4. Random genetic drift causing change in gene frequency-Practical demonstration.
5. Recent studies in Evolution- Examples

A/Z 107 Biomolecules lab:

1. Estimation of glycine by formal titration
2. Estimation of proteins by Lowry and Biurett methods
3. Analysis and identification of monosaccharides
4. Estimation of maltose by DNS method
5. Determination of Iodine value of oils
6. Estimation of Cholesterol
7. TLC of Amino acids

A/Z 108 Molecular cell Biology lab:

1. Light microscopic examination of tissues
2. Preparation of different cell – types Hepatic parenchymal cells, adipocytes, macrophages, neuronal cells, epithelial cells
3. Stages of Mitosis and Meiosis
4. Squash preparation
5. Sub-cellular fractionation – separation of macromolecules

M.Sc. AQUACULTURE
II SEMESTER

A/Z 201 BIOSTATISTICS & BIOINFORMATICS

UNIT - I

Biostatistics- Introduction and Scope of biostatistics, Sampling. Primary and Secondary data, Frequency distribution, Graphic representation of data- bar diagram, histograms, pie diagram, frequency polygon and Ogive. Measures of central tendency- mean, median, mode. Measures of Dispersion- variance, standard deviation, coefficient of variation

UNIT - II

Probability and probability distributions-definition of probability - Bernoulli, binomial, Poisson and normal distributions; Correlation and regression Tests of Significance - hypothesis, critical region and error probabilities, t- test, chi-square test for independence, one way and two- way analysis of variance.

UNIT - III

Basic components of computers– hardware (CPU, input, output, storage devices), Software (operating systems), Application software; Introduction to MS-EXCEL. Use of in-built statistical functions for computations of mean, SD, correlation, regression coefficients, Use of bar diagram, histogram, scatter plots, Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD, word processor- editing, copying, moving, formatting, table insertion, drawing flow charts etc; Introduction to Power Point, image and data handling.

UNIT - IV

Bio-informatics –Introduction, History, Internet, Knowledge. Review of relevant definitions in molecular biology. Biological Databases –introduction. Examples of databases together with steps involved in use and interpretation of results). Sequence alignment. Phylogenetic analysis with the program PHYLIP, Introduction to computational genomics and proteomics

Suggested Reading Material:

1. Batschelet, E., Introduction to Mathematics for Life Scientists. Springer- Verlag, Berling.
2. Principles of Biostatistics, Pagano M., Gauvreau, K, (2000), Duxbury Press, USA
3. Murray, J.D. Mathematical Biology. Springer – Verlag, Berlin.
4. T.K. Attwood & D.J. Parry-Smith 1999. Introduction to Bioinformatics. Pearson Education Asia.
5. Stephen Misener & S.A. Krawez 2000. Bioinformatics: Methods and Protocol.
6. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA
7. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA
8. Sokal, R.R. & F.J. Rohlf. Biometry. Freeman, San Francisco.
9. Snedecor, G.W. and W.G. Cochran, Statistical methods for environmental biologists. John Wiley Sons, New York.

A/Z 202 ANIMAL PHYSIOLOGY

UNIT - I

Muscle: Molecular Structure and properties of Muscle and muscle contraction , Sliding filament theory

Blood and Circulation – Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, Blood groups, Haemoglobin, immunity, haemostasis , factors affecting blood coagulation

Nerve impulses , Synaptic transmission & Neurotransmitters, **Nervous system :** Neurons, action potential, gross neuro anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture

UNIT - II

Thermoregulation: Comfort zone, body temperature- Physical, chemical, neural regulation, acclimatization.

Osmoregulation in aquatic and terrestrial Environments mechanism of ionic regulation

Stress Physiology: Responses to biotic and abiotic factors: Light, temperature, salts

UNIT – III

Digestion: absorption, energy balance of BMR

Respiratory system - comparison of respiration in different species, anatomical considerations, transport of gasses, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Excretory System : Comparative physiology of excretion, Kidney, Urine formation, Urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue ECG - its principle and significance, heart as a pump, blood pressure.

UNIT - IV

Sensory physiology: Photoreceptors, Auditory, Chemoreceptor, Mechanoreceptors

Physiological Adaptation: Marine environment, shores, Estuaries

Fresh water and Terrestrial environment

Role of Yoga and meditation on Health

Suggested Reading Material:

1) Eckert, R .Animal Physiology: Mechanisms and adaptation, W .H.Freeman and Company, New York
2) Hochackka,P.W. and Somero, G.N.Biochemical adaptation,Princeton,N.J.
3) Hoar,W.S.General and comparative Animal physiology prentice Hall of India.
4) Schimdt Neisen,Animalphysiology ,Adaptation and Environment,Cambridge.
5) Stamd,F.L.Physiology: A regulatory systems approach,Macmillan publishing Co., NewYork.
6) Punmer, L.Practical Biochemistry,Tata McGraw-Hill.
7) Prosser,C.L. and Brown .Comparative Animal physiology.
8) Wilson,K.and Walker, j.Practical Biochemistry.
9) Willmer, PIG Sone and 1.Johnson, Environmental physiology,BlackWell Science,Oxford, U.K .944p
10) Newell,R.C.(ed)1976.Adaptation to environment, Essays on the physiology of marine animals. Butterworths,London,UK539pp
11) Townsend ,C.R and P.Callow, physiological Ecology An evolutionary approach resource use, Blackwell Sci.publication, Oxford, UK.

A/Z 203 IMMUNOLOGY

UNIT - I

Immunity-innate and acquired, innate immune mechanisms, acute phase reactants, properties of acquired immunity

Immunogens and antigens- Properties, factors governing immunogenicity, haptens, epitopes size and identification. Adjuvants- properties and mechanism of action.
Immunoglobulins- structure, isotypes, allotypes and idiotypes. Functions of antibody in relation to structure

UNIT - II

Antigen-antibody interactions- affinity of antibody, avidity, bonus effect, classical precipitin reaction, antigen-binding site of antibody, forces involved in antigen - antibody complex formation.

Lymphoid tissue- primary and secondary lymphoid organs, structure and cellular organization. Lymphocyte traffic.

Cells involved in the immune response- T cells, B cells, CD antigens, neutrophils, eosinophils and natural killer cells.

Antigen presentation - pathways of antigen processing and presentation of intracellular and extracellular antigens.

UNIT - III

Antibody response - Primary and secondary antibody response, antibody response to haptens, enumeration of antibody-forming cells, T- dependent and T- independent antigens.
Macrophage- role in immune response and activation.
Cell mediated immunity- helper, cytotoxic, suppressor T cells. *In vivo* and *in vitro* assays for assessment of cell mediated immunity
Complement- classical and alternative pathways of activation. Regulation of complement activation and functions.
Antigen receptors -On T and B cells. Generation of receptor diversity.

UNIT - IV

Development of immune system- T cell ontogeny in thymus, thymic hormones, cell development. **Immunological tolerance -** pathways of tolerance and mechanisms of tolerance in T and B cells. **Immunological tests-** Immunodiffusion, immunoelectrophoresis, immunofluorescence, radioimmunoassay and enzyme-linked immunosorbent assay.

Suggested Reading Material:

1. Immunology and Immunopathology by Stewart.
2. Cellular and Molecular Immunology by Abul K. Abbas *et. al*.
3. Textbook of Immunology by Barret.
4. Essential Immunology by Roitt, Brostoff, Male, Harcourt Brace & Company (5^{th} Ed), Mosby (6^{th} Ed).
5. Immunology by Kuby, Richard A. Goldsby, Thomas, J. Kindl, Barbara A.Osbome, Freeman & Company, Mosby publishers.
6. Immunobiology – The immune system in Health disease by Janeway and Travers.
7. Immunology – An introduction by Tizard.
8. Text book of Immunology by Unani and Benacerraf.
9. Fundamentals of Immunology by Paul.
10. Immunology – A short course by Benjaini, Sunshine and Lesrowitz.

A/Z 204 MOLECULAR BIOLOGY

UNIT - I

History and scope of Molecular Biology

DNA Structure and Replication

Prokaryotic and Eukaryotic DNA Replication

Mechanics of DNA Replication

Enzymes and accessory proteins involved in DNA Replication

UNIT - II

Transcription

Prokaryotic Transcription

Eukaryotic Transcription

RNA Polymerases

Post-transcriptional modifications in RNA

Cap formation

Transcription

Nuclear Export of m-RNA

UNIT - III

Translation

Genetic Code

Prokaryotic and eukaryotic Translation

Mechanisms of initiation, elongation and termination

Regulation of translation

Antisense and Ribozyme technology

Molecular mechanisms of antisense molecules

Inhibition of splicing, polyadenylation and translation

UNIT - IV

Recombination and Repair

Holiday junction, gene targeting and gene disruption

RecA and other Recombinases

DNA repair mechanisms

Molecular mapping of genome

Genetic and physical maps

Physical mapping and map-based cloning

Southern fluorescence insitu hybridization (FISH) for genome analysis

Suggested Reading Material:

1. J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular biology of Gene. The Benjamin/Cummings Pub. Co. Inc., California.
2. Alberts, B., D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Molecular Biology of the Cell. Garland Publishing Inc., New York.
3. Benjamin Lewin, Gene IV, Oxford University Press, U.K.
4. Meyers, R.A. (Eds.) Molecular Biology and Biotechnology : A comprehensive desk reference. VCH Publishers Inc., New York.
5. Sambrook, J., E.F. Fritch and T. Maniatis. Molecular cloning : A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York.
6. Daber, P.D. Introduction to practical Molecular Biology.John Wiley & Sons Ltd., New York.
7. Brown, T.a. (Eds.). Molecular Biology Lab Fax. Bios Scientific Publishers Ltd., Oxford.

II SEMESTER PRACTICALS

A/Z 205 Biostatistics & Bioinformatics lab:

1. Sampling and Frequency distribution
2. Graphical presentation of the data
3. Measures of Central Tendency – Mean, median and mode
4. Measures of Dispersion – Standard deviation and Coefficient of variation
5. Correlation and Regression
6. Nucleic acid and protein databases.
7. Retreval and analysis of DNA or protein sequence from NCBI
8. Sequence Alignment in excel sheet for data processing.

A/Z 206 Animal Physiology lab:

1. Digestive enzymes
2. Effect of body size vs oxygen consumption
3. oxygen consumption vs temperature
4. Osmotic regulation
5. Ion concentration measurements
6. Spotters
7. Dissection- Pituitary gland of fish
8. Dissection- Nervous system of prawn.

A/Z 207 Immunology lab:

1. Blood grouping
2. Widal test for detection of typhoid bacteria
3. VDRL Test
4. SRID
5. Ouchterlony DID
6. Immunoelectrophoresis
7. Blood clotting time and bleeding time.
8. RIA -Demonstration
9. ELISA - Demonstration

A/Z 208 Molecular Biology Lab:

1. Estimation of DNA (Colorimetric method)
2. Estimation of RNA in tissue (Colorimetric method)
3. Fulgen reaction method for DNA localization
4. Localization of RNA by methyl green pyronin – 'Y'
5. SDS PAGE of serum proteins.
6. Testing purity of DNA

M.Sc. AQUACULTURE
III – SEMESTER

A 301 CONCEPTS OF AQUATIC ECOLOGY

UNIT – I

Introduction: Definition of ecology, organism and environment; features of organism - environment relations; living and non - living environments; the ecosystem or habitat. **Aquatic Ecosystems :** Freshwater ecosystems - Lotic and Lentic ecosystems; Marine ecosystems - oceans and seas, zonation of the seas - rocky, sandy and muddy shores; classification of marine habitat - pelagic, benthic, neretic, oceanic, littoral and abyssal.

UNIT – II

Physical Characteristics of Water: Light - penetration of sunlight into aquatic media, effect of light on productivity, photoperiodicity in animals; Temperature - annual temperature cycles, thermal stratification of water bodies, water movements, periodic and aperiodic current systems; Turbidity - causes, variations and effects.

Chemical Characteristics of Water: Atmosphere and atmospheric gases dissolved in water; Oxygen - oxygen and life, hypoxia, anoxia and hyperoxia, adaptations of animals to varying oxygen tensions; Carbon dioxide - sources of Co_2, its ecological effects; pH or hydrogen ion concentration - its significance. Ecological effects of salinity; effect of salinity on animals

UNIT – III

Biogeochemical Cycles: Nitrogen cycle; phosphorus cycle; sulfur cycle; carbon cycle; trace elements - manganese and copper.

Organic Matter : Aquatic vegetation – zones of aquatic vegetation; Plankton - classification of plankton, factors affecting plankton distribution, plankton counting and sampling; phytoplankton - zooplankton relationship, plankton productivity; Benthos - phytobenthos and zoobenthos.

UNIT – IV

Productivity: Concept of productivity – standing crop, rate of production and rate of removal; primary and secondary productivity; classification of water bodies on the basis of productivity.

Dynamics of Aquatic Ecosystem: Principal steps and components – niches, trophic levels and relations; producers, consumers, decomposers and transformers; food chain and food web; pyramid of biomasses; pyramid of numbers; energy transfer in the ecosystem.

Suggested Reading Material:

1. Santhanam, R. 1993. A Manual of Fresh Water Ecology: An Aspect of Fishery Environment. Daya Publishing House, New Delhi.
2. Pillai, N. K. 1993. Marine Biology and Ecology. Daya Publishing House, New Delhi.
3. Reid, G. K. and R. D. Wood. 1976. Ecology of Inland Waters and Estuaries D. Van Nostrand Company.
4. Kormondy, E. J. 1996. Concepts of Ecology. Prentice Hall of India Pvt. Ltd. New Delhi.
5. Cole, G. L. 1954. Text Book of Limnology. The C. V. Mosloy Co.,
6. Odum, E. P. 1996. Fundamentals of Ecology. 3rd Edn. Natraj Publishers, Dehradun.
7. Santhanam, R. and A. Srinivasan. 1994. A Manual of Marine Zooplankton. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
8. Pillai, N. K. 1986. Introduction to Planktonology. Himalaya Publishing House, Mumbai.
9. Balakrishnan Nair, N and D. M. Thampy. 1980. A Text Book of Marine Ecology. Mc Millan Co. of India Ltd.

A 302 PRINCIPLES OF AQUACULTURE

UNIT – I

Aquaculture Systems And Methods: Scope and definition; origins and growth of aquaculture; biological and technological basis; Traditional, extensive, semi - intensive and intensive culture; monoculture, polyculture, composite culture, mixed culture, monosex culture; cage culture, pen culture, raft culture, race way culture, culture in recirculatory systems; warm water and cold water aquaculture; sewage – fed fish culture,

Selection of Sites: Survey and location of suitable site – topography; soil characteristics; acid sulphate soils; water source; hydrometerological data.

UNIT – II

Aquaculture Engineering: Design and construction of pond, lay out and design of aquaculture farm, construction, water intake system, drainage system; aeration and aerators; recent advances in aquaculture engineering; tips for better aquaculture practices; design and construction of hatcheries.

Hydrology of Ponds: Types of ponds; sources of water – precipitation, direct run off, stream inflow, ground water inflow, regulated inflow; losses of water– evaporation, seepage, outflow, consumptive use, water budgets of embankment ponds; water budget of an excavated pond; water exchange.

UNIT – III:

Selection of Species: Biological characteristics of aquaculture species; economic and market considerations; seed resources, collection and transportation.

Pre Stocking Management: Sun drying, ploughing / tilling, desilting, liming and fertilization, eradication of weed fishes.

Stocking: Acclimatization of seed and release; species combinations; stocking density; ratio.

UNIT – IV:

Post Stocking Management: Water and soil quality parameters required for optimum production, control of aquatic weeds and aquatic insects, algal blooms; specific food consumption, food conversion ratio (FCR), protein efficiency ratio, true net protein utilization, apparent net protein utilization, biological value of protein.

Growth: Measurement of growth; length - weight relationship; methods of determination of age in fishes and shellfish based on length data and growth checks; ponderal index; growth hormones.

Suggested Reading Material:

1. Mathew Landau. 1995. Introduction to Aquaculture. Daya Publishing House, New Delhi.
2. Pillay, T. V. R. 1993. Aquaculture: Principles and Practices. Fishing News Books. Black Well Scientific Publications.
3. MPEDA, 1991. Hand Book on Shrimp Farming, Kochi, India.
4. Jhingran, V. G. 1982. Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi. Chakrabarti, N. M. 1998. Biology, Culture and Production of Indian Major Carps. Narendra Publishing House, New Delhi.
5. Coche, A. G. and J. F. Muir. 1996. Pond Construction and Fresh Water Fish Culture – Pond Farm Structures and Layouts – Simple Methods for Aquaculture. FAO. Daya Publishing House, New Delhi. Upadhyay, A. S. 1995. A Hand Book on Design, Construction and Equipments in Coastal Aquaculture (Shrimp Farming). Daya Publishing House, New Delhi.
6. Wheaton, F. W. 1985. Aquaculture Engineering. MPEDA, Cochin.
7. MPEDA 1990. Aquaculture Engineering and Water Quality Management. Cochin, India.

A 303 NUTRITION AND FEED TECHNOLOGY

UNIT – I

Fish Nutrition: Principles of fish nutrition and terminologies; Nutritional requirements of cultivable finfish and shellfish.

Nutritional Biochemistry: Classification of nutrients, nutrient quality and evaluation of proteins, lipids and carbohydrates.

UNIT – II

Nutritional Bioenergetics: Energy requirement of fishes, protein to energy ratio, digestible energy, nitrogen balance index, protein sparing effect, high energy feeds, isocaloric diets. Metabolic rate; Energy budgets; Energy efficiency of fish production.

UNIT – III

Natural food: Importance in aquaculture; Fish food organisms – Bacterioplankton, phytoplankton and zooplankton and their role in larval nutrition.

Supplementary feeds: Types of feeds - Wet feed, moist feed, dry feed, mashes, pelleted feeds - floating and sinking pellets, microencapsulated diets.

Feed additives: Binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants; use of preservatives.

UNIT – IV

Feed manufacture: Feed formulation and processing; Feed machinery units: Pulverizer, grinder, mixer, pelletizer, crumbler, drier, extruder/expander, vacuum coater and fat sprayer.

Feeding strategies: Feeding devices, feeding schedules and ration size.

Feed evaluation: Feed conversion efficiencies and ratios. Feed storage methods.

Suggested Reading Material:

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

A 304 WATER QUALITY MANAGEMENT

UNIT – I

Water quality: Constituents of water, Water quality parameters – optimal levels and their management in freshwater fish and brackish water shrimp culture.

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.

Liming: Properties of liming materials, lime requirements and application of liming materials to ponds, effects of liming on pond ecosystem.

UNIT – II

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

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

UNIT – III

Hatchery management: Fish hatchery - Hatchery protocols, seed rearing technology; Packaging and transport of seed. Shrimp hatchery – Larval rearing; culture and use of different live feed; different chemicals and drugs used; water quality and feed management. Water discharge standards; Effluent treatment in hatcheries.

Aquatic weed management: Common weeds and problems in culture ponds; Chemical, biological and mechanical control methods; Algal bloom control.

UNIT – IV

Chemical treatments: Potassium permanganate, hydrogen peroxide, calcium hydroxide; Chlorination and De chlorination; piscisides, methods of applying chemicals.

Waste water discharge, waste water analysis and toxicity assessment, Pollution in relation to aquaculture practices.

Suggested Reading Material:

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*
10. Sharma LL, Sharma SK, Saini VP & Sharma BK. 2008. *Management of Freshwater Ecosystems.* Agrotech Publ. Academy.
11. Stickney RR. 1979. *Principles of Warm water Aquaculture*. John-Willey & sons Inc.
12. Tucker C.S. 1985. *Channel Catfish Culture*. Elsevier.

III SEMESTER PRACITICALS

A 305 Concepts of Aquatic Ecology Lab:

1. Identification of phytoplankton and zoo plankton – Fresh water and Brackish water.
2. Predaceous freshwater insects.
3. Identification of common fresh water benthic organisms Macrophytes in freshwater.
4. Shore fauna.
5. Estimation of Primary Productivity
6. Estimation of Co2

A 306 Principles of Aquaculture Lab:

1. Design and layout of fresh water and brackish water farms, fish and shrimp hatcheries
2. Visit to farms and hatchery.
3. Estimation and calculations of production costs of fish/shrimp farm.
4. Different types of filters.
5. Length weight relationship
6. Ponderal index.
7. Cultivable importance of fish & Shell fish Species

A 307 Nutrition and Feed Technology Lab:

1. Methods in feed formulation
2. Proximate composition of aquaculture feeds – Proteins, carbohydrates, lipids, moisture, ash content
3. Qualitative determination of carbohydrates proteins and lipids.
4. Calculation PER, FCR. SGR.

A 308 Water Quality Management Lab:

1. Determination of Temperature, pH, Salinity, Turbidity.
2. Total Alkalinity and total Hardness.
3. Dissolved Oxygen, Phosphates, CO2 and BOD
4. Nitrites and Nitrates.
5. Estimation of soil organic carbon
6. Estimation of nitrogen in soil.

M.Sc. AQUACULTURE
IV- SEMESTER

A 401 AQUACULTURE

UNIT – I

Major cultivable species for aquaculture; A knowledge of inland water bodies suitable for culture in India.

Culture of Indian Major Carps: exotic carps of Fish Hatcheries and their management.

Bundh breeding and Induced breeding of carp by hypophysation and use of synthetic hormones.

Preparation and Management of Indian major carp culture ponds – nursery, rearing and production ponds.

UNIT – II

Culture of Giant fresh water prawn, *Macrobrachium rosenbergii* - seed collection formation sources. Hatchery management.

Culture of tiger shrimp, *Penaeus monodon* and Litopenaeus Vannamei

UNIT – III

Culture of brackish water fish – *Chanos* and *Lates*, *Osteobrama belangeri*.

Culture of pearl oysters.

UNIT – IV

Culture of sea weeds: Major commercial importance seaweed species.

Methods of Crab culture

Culture of ornamental fishes.

Culture of air-breathing fishes in India.

Culture of Molluscs,

Suggested Reading Material:

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. FAO. 2007. *Manual on Freshwater Prawn Farming*.
3. Huet J. 1986. *A text Book of Fish Culture*. Fishing News Books Ltd.
4. ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
5. Jhingran V.G. 1991. *Fish and Fisheries of India*. Hindustan Publ. Corporation, India.
6. Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
7. Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
8. MPEDA: *Handbooks on culture of carp, shrimp, etc*.
9. New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
10. Pillay TVR. 1990. *Aquaculture- Principles and Practices.* Fishing News Books Ltd.,
11. London. Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*.2nd Ed.
12. Blackwell Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
13. Stickney RR. 1979. *Principles of Warmwater Fish Culture.* John Wiley & Sons.

A 402 FISH PROCESSING TECHNOLOGY

UNIT – I

Process Biochemistry

Major and minor constituents of fish, their distribution and function - moisture, proteins, lipids, carbohydrates, vitamins and minerals.

Post-mortem biochemical changes in fish - rigor mortis, autolysis, auto-oxidation and their significance.

Toxins and toxic substances in fish.

UNIT – II

Microbiology

Biochemical and microbial spoilage of fish; factors affecting spoilage of fish.

Role of bacteria and moulds in fish preservation - pathogenic organisms encountered in fish products, faecal indicator organisms.

UNIT – III

Handling and Fish Preservation

Handling, storage and transport of fresh fish, sanitary and phyto-sanitory requirements for maintenance of quality.

Principles of fish preservation; preservation of fish by curing, drying, salting and smoking; chilling and freezing of fish; canning of fish and fish products.

Modern techniques employed in fish preservation: Accelerated Freeze Drying (AFD), Irradiation.

Fishery by-products and waste utilization.

UNIT – IV

Quality Management and Certification

HACCP (Hazard Analysis and Critical Control Points) and Good Manufacturing Practices: HACCP Principles, Practical aspects of planning and implementation, Verification, Validation and Audit. Development of value add products.

National and International Standards - ISO 9000 Series, 2000 Series of Quality Assurance System, Codex Alimentarius Commission, Food Safety and Standards Act of India 2006.

Suggested Reading Material:

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 GM. (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. Krenzer R. 1971. *Fish Inspection and Quality Control.* Fishing News.
10. Larousse J & Brown BE. 1997. *Food Canning Technology*. Wiley VCH.
11. Nambudiri DD. 2006. *Technology of Fishery Products*. Fishing Chimes.
12. Regenssein JM & Regenssein 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.

A 403 FISH PATHOLOGY

UNIT – I Viral diseases

Fish Diseases: Clinical symptoms, pathology and control measures of Viral Hemorrhagic Septicemia (VHS) and Infectious Hematopoietic Necrosis (IHN).

Shrimp Diseases: 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.

UNIT – II Bacterial and Fungal diseases

Fish Diseases: Clinical symptoms, pathology, prevention and control measures of Bacterial Hemorrhagic Septicemia (BHS), Bacaterial gill disease and Tail and fin rot.

Pathology, clinical symptoms, prevention and control measures of Saprolegniasis and Branchiomycosis.

Shrimp Diseases: Clinical symptoms, pathology, prevention and control measures of Black gill disease and filamentous bacterial gill disease.

Clinical symptoms, pathology, prevention and control measures of *Lagenidium* disease (Larval Mycosis) and Brown gill disease.

UNIT – III Protozoan, Helminthic and Crustacean diseases

Fish Diseases: Clinical symptoms, pathology and control measures of Ichthyophthiriasis, Enterococcidiasis, Whirling disease and Nodular disease.

Clinical symptoms, pathology and control measures of Enterocytozoan hepato penaei.

Clinical symptoms, pathology and control measures of Argulosis and Lernaeasis.

Shrimp Diseases: Etiology, morphology and control measures of ectocommensal protozoa – *Zoothamnium* and *Acineta.*

Clinical symptoms, pathology and control measures of Microsporidiasis.

UNIT – IV Nutritional and Ecological diseases

Fish Diseases: Diseases of vitamin deficiency and Fatty liver degeneration.

Clinical symptoms, pathology and control measures of gas bubble disease and lack of oxygen.

Shrimp Diseases: Clinical symptoms, pathology and control measures of Cramped tails, Muscle Necrosis, Gas bubble disease, Black death disease, Chronic soft shell syndrome and Blue shell syndrome. White Feces Syndrome (WFS)

Suggested Reading Material:

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.

A 404 AQUACULTURE BIOTECHNOLOGY

UNIT – I

Biotechnology: Origin, definition and knowledge of different branches.

Genetic Engineering: Recombinant DNA technology; Tools of genetic engineering – cloning vectors, restriction endonucleases, DNA ligases, topoisomerases, methylases, nucleases, polymerases, reverse transcriptase and their functions.

Screening analysis of recombinants: Colony hybridrization technique, immunological tests.

Transgenics: Principles of Transgenic technology and its applications in fisheries.

UNIT – II

Fish breeding: Synthetic hormones for induced breeding – GnRH analogue structure and function; Selective breeding for improving fish stocks - hybridization in Indian fishes.

Androgenesis, Gynogenesis, Polyploidy and Sex reversal.

Hormonal regulation of reproduction and molting in important cultivable crustaceans.

Gene bank and Conservation: Cryopreservation of gametes and embryos.

Embryo transfer technology.

UNIT – III

Feed technology: Micro encapsulated feeds; micro coated feeds; micro particulate feeds and bio-encapsulated feeds; mycotoxins and their effects on feeds.

Algal biotechnology: Biotechnological approaches for production of important microalgae; single cell protein from *Spirulina;* vitamins, minerals and omega3 fatty acids from micro algae; enrichment of micro algae with micronutrients.

Application of Nanotechnology in aquaculture; A general knowledge of tissue culture.

UNIT – IV

Health management: DNA and RNA vaccines; molecular diagnosis of viral diseases; Biofilms and its impact on health management; genetically modified microorganisms as probiotics, immunostimulants, bioremediation of soil and water.

Nitrogen fixation in aquatic environment and Biofertiizers.

Post-harvest biotechnology: Delaying of spoilage; biosensors.

Suggested Reading Material:

1. Bhattacharya S.1992.*Hormones in Pisciculture*. Biology Education,Vol. 9 No.1 pp.31- 41.
2. CIFE. 1998. Summer School Manuals, Mumbai.
   i). *Recent Developments in Biotechnology: Applications to Aquaculture & Fisheries.* ii). *Genetics and Biotechnolical Tools in Aquaculture and Fisheries.*
3. Felix S. 2007. *Molecular Diagnostic Biotechnology in Aquaculture*. Daya Publ. House.
4. ICAR. 1992. *Biotechnology in Aquaculture.* Training Manual. C.I.F.A, Kausalyaganga, Bhubaneswar, Orissa.
5. Lakra WS, Abidi SAH, Mukherjee SC & Ayyappan S. 2004. *Fisheries Biotechnology*. Narendra Publ. House.
6. Nagabhushanam R, Diwan AD, Zahurnec BJ & Sarojini R. 2004. *Biotechnology of Aquatic Animals.* Science Publ.
7. Nair PR. 2008. *Biotechnology and Genetics in Fisheries and Aquaculture.* Dominant Publ.
8. Pandian TJ, Strüssmann CA & Marian MP. 2005. *Fish Genetics and Aquaculture Biotechnology*. Science Publ.
9. Ramesh RC. 2007. *Microbial Biotechnology in Agriculture and Aquaculture*. Vol. II. Science Publ.
10. ReddyPVGK, AyyappanS, ThampyDM & Gopalakrishna 2005.*Text Book of Fish Genetics and Biotechnol.*ICAR
11. Singh B. 2006. *Marine Biotechnology and Aquculture* Development. Daya Publ. House

IV- SEMESTER PRACITICALS

A 405 Aquaculture lab:

1. Identification of major cultivable species - fin fish and shell fish, molluscs.
2. Pituitary gland extract preparation.
3. Visit to hatcheries and grow out farms.

A 406 Fish Processing Technology Lab:

1. Analysis of fish for Biochemical constituents.
2. Visit to fish processing unit.
3. Method of evaluation of freshness of fish.
4. Fishery by products.

A 407 Fish Pathology Lab:

1. Identification of Fish and Shrimp disease.
2. Examination of normal and diseased fish.
3. External examination on diseased fish diagnostic features and procedure.
4. Atrophy of organ of diseased fish, Host examination – collection of parasites Histopathology of organs of diseased fish. Slides of fish parasites.

A 408 Aquaculture Biotechnology Lab:

1. Molecular diagnosis of disease- PCR method.
2. Cell density of algal culture.
3. Eyestalk ablation procedure in crustaceans.
4. Use of probiotics in aquaculture farms.
5. Induced breeding

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - I Semester

Model Question Paper: Paper - I

A/Z 101 Tools and Techniques for Biology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) What is an assay? Explain different types of assays.

(OR)

b) Write the principle and types of microscopy and elaborate on dark field microscopy.

2. a) Describe the principle and applications of centrifuges with an emphasis on ultracentrifuge.

(OR)

b) Describe various types of chromatographic techniques to separate molecules.

3. a) Describe the principle and applications of spectrophotometer.

(OR)

b) What is autoradiography? Give an account on its biological applications.

4. a) Describe the process of inoculation and growth monitoring.

(OR)

b) Explain in detail about microbial assays.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) pH meter.

b) Biochemical mutants and their uses.

c) TLC.

d) Spectrofluorimetry.

e) Density gradient centrifugation.

f) Treatment of substrate surfaces.

g) Oxygen electrode.

h) Radio active counter.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - I Semester

Model Question Paper: Paper -II

A/Z 102 Biosystematics, Biodiversity & Evolution

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Define Biosystematics. Explain in detail the importance and applications of Biosystematics.

(OR)

b) Discuss about the different taxonomic procedures.

2. a) Discuss in detail about the origin of basic biological molecules.

(OR)

b) Explain about the evolution of eukaryotic genome.

3. a) What is the three domain concept of living kingdom. Discuss.

(OR)

b) What is Speciation. Explain the mechanism involved in speciation.

4. a) Discuss in detail about the theories of Organic Evolution.

(OR)

b) What is Hardy Weinberg Law. Discuss.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Chemotaxonomy
b) ICZN
c) Molecular Clocks
d) Eras
e) Subspecies
f) Hierarchy of categories
g) Punctuated equilibrium
h) Gene pool

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - I Semester

Model Question Paper: Paper - III

A/Z 103 Biomolecules

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Describe the structure, classification and properties of amino acids.

   (OR)

   b) Explain about structural characterization of proteins.

2. a) Write about the classification, structure, properties and functions of monosaccharides.

   (OR)

   b) Explain about polysaccharides and their occurrence in nature.

3. a) Discuss about the classification, structures, properties and biological functions of fatty acids.

   (OR)

   b) Explain about phospholipids, sphingolipids, prostaglandins, and steroids with their biological role.

4. a) Explain about the structure, types and physicochemical properties of Nucleic acids.

   (OR)

   b) Write in detail about RNA and its functions.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

   a) Peptide bond.
   b) Glycoproteins.
   c) fatty acids.
   d) Chitin.
   e) Ramachandran plot.
   f) Leukotrienes.
   g) mRNA.
   h) Denaturation of DNA.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - I Semester

Model Question Paper: Paper - IV

A/Z 104 Molecular Cell Biology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Describe in detail about the transport across the cell membrane.

(OR)

b) Explain the transport of macromolecules across the epithelial layer.

2. a) Explain the role of cytoskeletal elements in defining the structure of a cell.

(OR)

b) Enumerate the role of cytoskeletal elements in mitosis.

3. a) Write in detail about cell adhesion and communication mechanisms.

(OR)

b) Elaborate on the second messenger system in cell signaling.

4. a) Cyclines and cyclin dependent kinases regulate cell cycle, Justify.

(OR)

b) Describe various post-translational mechanisms in protein synthesis.

Section-B 5X3=15

5. Answer any **FIVE** of the following

a) Membrane potential.

b) Cilia and flagella.

c) Integrins and collagen.

d) Chromosomal organization of genes.

e) Mobile DNA.

f) Symportes and antiports.

g) Microtubules.

h) Apoptosis.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - II Semester

Model Question Paper: Paper - I

A/Z 201- Biostatistics and Bio-informatics

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A 4X15=60

1. a) What is Sampling. Discuss.

(OR)

b) Discuss in detail about the Measures of Central tendency.

2. a) Explain in detail about the bivariate analysis.

(OR)

b) What is test of significance. Discuss in detail.

3. a) Describe about the Basic components of the Computer.

(OR)

b) Explain the use of MS excel in for data presentation.

4. a) What are biological databases? Explain.

(OR)

b. Discuss in detail about sequence alignments.

Section-B 5X3=15

5. Answer any **FIVE** of the following

a) Frequency distribution.
b) Ogive.
c) Poisson distribution.
d) Chisquare test.
e) MS word.
f) Power point.
g) Genomics.
h) Phylogenetic analysis.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY

M.Sc. Aquaculture - II Semester

Model Question Paper: Paper-II

A/Z 202 Animal Physiology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A 4X15=60

1. a) Write briefly molecular structure and properties of muscle, Add note on sliding filament theory.

(OR)

b) Write about haemopoiesis, Haemoglobin, and haemostasis. Add note on factors affecting blood coagulation.

2. a) Write about osmoregulation in aquatic Environments.

(OR)

b) Write about response to biotic and abiotic factors.

3. a) Write about the comparative physiology of excretion, Urine formation, Urine concentration, and waste elimination.

(OR)

b) Write about comparative anatomy of heart structure, myogenic heart. Add a note on blood pressure.

4. a) Write about photoreceptors, Auditory, Mechanoreceptors.

(OR)

b) Explain fresh water and terrestrial environment

Section-B 5X3=15

5. Answer any **FIVE** of the following:
   a) Synaptic transmission & Neurotransmitters.
   b) Neural control of muscle tone and posture.
   c) Yoga and meditation.
   d) Chemoreceptor.
   e) Acclimatization.
   f) Micturition.
   g) BMR.
   h) ECG.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - II Semester

Model Question Paper: Paper - III

A/Z 203 - Immunology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) What is innate immunity? Describe various innate immune mechanisms.

(OR)

b) Describe the structure and functions of various types of immunoglobulins.

2. a) Write an essay on antigen-antibody interactions.

(OR)

b) What are the cells involved in immune response? Describe their role.

3. a) Elucidate the mechanisms of antibody response to antigens.

(OR)

b) Write about Classical and alternative activation of complement.

4. a) What is immune tolerance? Elucidate the mechanisms of tolerance in T and B cells.

(OR)

b) Write an essay on immunological tests used in molecular and diagnostic laboratories.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Acquired immunity.

b) Haptens.

c) Lymphocyte traffic.

d) Antigen presenting cells.

e) Cytotoxic T-cells.

f) Antigen receptors.

g) ELISA.

h) Thymic hormones.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM
M.Sc. Aquaculture - II Semester
Model Question Paper: Paper - IV
A/Z 204- Molecular Biology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A 4X15=60

1. a) Explain the prokaryotic and eukaryotic DNA replication.

   (OR)

   b) Explain the mechanics of DNA replication.

2. a) Explain the post transcription in prokaryote and eukaryotic transcription.

   (OR)

   b) Explain the post transcriptional modifications in RNA.

3. a) Explain the mechanisms of prokaryotic and eukaryotic translation.

   (OR)

   b) Explain the molecular mechanism of the antisense molecules and add a note on inhibition of splicing.

4. a) Write about gene targeting and DNA repair.

   (OR)

   b) Explain the types of mapping and molecular mapping of genome.

Section-B 5X3=15

5. Answer any **FIVE** of the following:
   a) Enzymes involved in DNA replication.
   b) RNA polymerases.
   c) Genetic code.
   d) FISH.
   e) Necessary proteins involved in DNA replication.
   f) Genetic map.
   g) Cap formation in post-translational modifications.
   h) Structure of DNA.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM
M.Sc. Aquaculture - III Semester
Model Question Paper: Paper-I
A 301 Concepts of Aquatic Ecology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A 4X15=60

1. a) What is Ecology? Explain the features of organism and environment and their relationships.

(OR)

b) Discuss about the Marine Ecosystem.

2. a). Explain light as factor of the environment.

(OR)

b) Discuss about the gases dissolved in water.

3. a) Write in detail about the Nitrogen cycle and its importance.

(OR)

b) Discuss about the aquatic fauna.

4. a) What is productivity? Explain.

(OR)

b) Discuss about ecological pyramids.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Habitat.
b) Lentic ecosystem.
c) Turbidity.
d) Photopaeriod.
e) Alkalinity.
f) disolved oxygen.
g) Eutrophication.
h) Niche.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - III Semester

Model Question Paper: Paper-II

A 302 Principles of Aquaculture

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) What is scope and basis of Aquaculture.

   (OR)

   b) Describe how do you select a site for construction of a fish farm.

2. a) Explain the details in designing and construction of a hatchery.

   (OR)

   b) Discuss about water intake system into the farms and hatcheries. Add a note on water consumption and water budgets involved.

3. a) What are the criteria for selection of Aquaculture species.

   (OR)

   b) Discuss about the pa management practices.

4. a) Explain about the factors involved in post stocking management of ponds.

   (OR)

   b) What is growth? Discuss about different methods of age determination in fishes.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

   a) Poly culture.

   b) Integrated fish farming.

   c) Acid sulphate soils.

   d) Types of ponds.

   e) Aeration.

   f) Seed resourses.

   g) Stocking density.

   h) FCR.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - III Semester

Model Question Paper: Paper-III

A 303 Nutrition and Feed Technology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Write in detail the principles of fish nutrition. Add a note on nutritional requirements of fin fish & shell fish?

(OR)

b) Classify the nutrients. Write the quality & evaluation of proteins & lipids.

2. a) Explain the energy requirements of fishes with reference of protein to energy ratio?

(OR)

b) Write in detail the metabolic rate of fish. Adding a note on energy budgets & efficiency of fish production.

3. a) Write in detail the importance of natural food in aquaculture. Add a note on fish food organisms & their role in larval nutrition.

(OR)

b) Explain the types of supplementary feeds and also the mode of feeding.

4. a) Write the different methods in feed formulation and processing.

(OR)

b) Write in detail the feeding strategies, feed conversion efficiencies & feed storage methods.

Section-B 5X3=15

5. Answer any **FIVE** of the following:
   a) Nutrient quality of carbohydrates.
   b) Nitrogen balance index.
   c) Isocaloric diets.
   d) Microencapsulated diets.
   e) Bridgers & Antioxidants.
   f) Pigments & growth promoters.
   g) Use of preservation.
   h) Fin fish & Shell fish.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM
M.Sc. Aquaculture - III Semester
Model Question Paper: Paper-IV
A 304 Water Quality Management

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A 4X15=60

1. a) Write in detail the management of water quality in fresh water fish & brackish water shrimp culture.

(OR)

b) Discuss about the different kinds of fertilizes and measures used in aquaculture. Add a note on use of bioactive compounds by microorganisms.

2. a) Write the reasons for changes in dissolved oxygen concentration. Add a note on identification of oxygen problems.

(OR)

b) What are the principles of aeration, emergency aeration & add a note on desertification and practical considerations.

3. a) Write in detail about the seed rearing technology. Add a note on packing and transportation of seed.

(OR)

b) Write the problems control methods for Aquatic weed management.

4. a) What are the different methods for applying and treatment of chemicals.

(OR)

b) Write in detail about pollution caused in relation to Aquaculture practices.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Effect of liming on pond ecosystem.
b) Bio fertilizers In aquaculture.
c) Oxygen budget of culture ponds.
d) Desertification.
e) Effluent treatment in hatcheries.
f) Algal bloom.
g) Turbidity & salinity.
h) Control of hardness and chlorides.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - IV Semester

Model Question Paper: Paper-I

A 401 Aquaculture

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Discuss in detail about Carp culture in India.

   (OR)

   b) Explain breeding of fish and shell fish in Aquaculture.

2. a) Explain integrated fish farming.

   (OR)

   b) Discuss the culture of Litopenaeus vannamei.

3. a) Write detailed notes on the crab culture.

   (OR)

   b) Discuss about culture of pearl ysters.

4. a) What are ornamental fishes? Explain their culture.

   (OR)

   b) Explain sea weed culture.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

   a) Inland water bodies.

   b) Hypophysation.

   c) Macrobrachium rosenbergii.

   d) Airbreathing fishes.

   e) Rearing pond.

   f) Harvest of Chanos speices.

   g) Thallus.

   h) Live bearers.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM
M.Sc. Aquaculture - IV Semester
Model Question Paper: Paper-II
A 402 Fish Processing Technology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.
All questions carry equal marks

Section-A 4X15=60

1. a) Explain the biochemical constituents of fish. Add a note on their distribution and function.

(OR)

b) Discuss about the post mortem biochemical changes in fish and their significance.

2. a) Discuss about spoilage of fish. What are the factors that affect spoilage.

(OR)

b) Discuss the role of microorganism in fish preservation.

3. a) Explain the different methods of fish preservation.

(OR)

b) Write notes on fishery by products.

4. a) Discuss HACCP and good Manufacturing Practices in Fish processing technology.

(OR)

b) Explain the international standards in food safety and standards.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Toxins in fish.

b) Indicator organism.

c) Bio chemical constituents.

d) Microbial spoilage

e) Sanitary requirements for maintenance of quality.

f) Validation.

g) Assurance system.

h) AFD.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture - IV Semester

Model Question Paper: Paper-III

A 403 Fish Pathology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Write in detail the symptoms of pathology and control of viral hemorrhagic septiceamia (vhs) & (hn).

(OR)

b) Write in detail the symptoms, treatment and preservation of bacullovirus disease

2. a) What are the symptoms of pathology, prevention and control causes of bacterial diseases in fish.

(OR)

b) What are the symptoms, pathology preservation & control measures of shrimp diseases.

3. a) Write the symptoms pathology and control measures of protozoan and helminthic diseases in fish.

(OR)

b) Write the symptoms pathology and control measures of shrimp diseases caused due to protozoa and helminthes parasites.

4. a) Write the clinical symptoms pathology control measures of vitamin deficiency diseases and bubble disease in fishes.

(OR)

b) Write in detail the clinical symptoms, pathology and control measures of muscle narcosis, gas bubble diseases black death diseases in shrimp.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Taura syndrome.
b) White spot syndrome.
c) Control measure of saprolegniasis disease.
d) Lagenidium disease.
e) Gyrodactylosis and Dactylogyrosis.
f) Ecto commensal protozoan diseases in shrimps.
g) Fish diseases due to lack of oxygen.
h) Blue shell syndrome.

ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM

M.Sc. Aquaculture-IV Semester

Model Question Paper: Paper-IV

A 404 Aquaculture Biotechnology

Time: 3hours **Max. Marks: 75**

Answer ALL questions.

All questions carry equal marks

Section-A 4X15=60

1. a) Write in detail about the recombinant DNA Technology.

(OR)

b) Write the principles of genetic technology and its application in fisheries.

2. a) Write in brief about the synthesis hormones used in induced breeding. Add a note on hormone in reproduction and molting in cultivation of crustaceans.

(OR)

b) Write about the cryo preservation of gametes. Add a note on embryo transfer technology.

3. a) Write about different types of feed used in aquaculture.

(OR)

b) Discuss about the applications of nanotechnology in aquaculture.

4. a) Write in detail about DNA & RNA Vaccines. Add a note on Molecular *diagnosis* of viral diseases in aquaculture.

(OR)

b) Write in brief the process in delaying of spoilage & use of biosensors in aquaculture.

Section-B 5X3=15

5. Answer any **FIVE** of the following:

a) Immunological tests.

b) Reverse transcription.

c) Androgenesis & Gynogenesis.

d) Hybridization in India fishes.

e) Bio- encapsulated feeds.

f) Omega & fatty acids from micro algae.

g) Probiotics.

h) Bioremediation.