

ADIKAVI NANNAYA UNIVERSITY

RAJAMAHENDRAVARAM



School of Life and Health Sciences

M.Sc. Zoology & Aquaculture

Course Structure and Syllabus

**M.Sc. Aquaculture
2016-17 Onwards**

I and II Semester syllabus is common for both M.Sc Zoology and M.Sc Aquaculture.

ADIKAVI NANNAYA UNIVERSITY



M.Sc. DEGREE EXAMINATION IN ZOOLOGY & AQUACULTURE - SYLLABUS

(Effective from 2016-2017 Batch)

Synoptic note

- 1) Welcome PG courses affiliating college from this AY 2016-17
- 2) Syllabi last revised in 2012-13, three years ago
- 3) There about 25 different courses and BoS
- 4) Therefore there is need to revised syllabi to incorporate emerging concepts / aspects in relevant subject to be in sync with emerging national and global higher education trends

Proposed Guidelines:

- 5) All PG arts and commerce courses will have 5 subjects in each semester x 4 semester 20 subjects consisting total of 2000 marks. For science course there will be four theory each carries 100 marks and 200 marks for practical and total marks for each semester 600 x 4 semester 2400 marks. 100 marks for project works and presentation in all PG courses. Except MBA/MCA/MA(SW) and M.Tech.
- 6) Out of 100 marks for each subject, 75 marks (75%) marks in each paper are assigned for semester end examination and 25 marks (25%) for internal / continuous assessment for all PG courses.
- 7) Every subject of 100 marks will have 5 – 6 periods class load per week, 5 credits
- 8) Every subject will have four units of syllabus in PG courses except MBA, which will have five units of syllabus for each subject
- 9) Semester end examination question paper structure consists of two sections, viz. section A consist of four easy questions, one question from each unit of syllabus with internal choice a) or b). section B short answer questions 8 questions two from unit of syllabus, with choice to attempt any five out of 8 short answer questions given.

For MBA question paper consist of 3 sections; viz. section 'A' short answer questions 8 covering wholes syllabus, out which any five can be attempted and each question carry 4 marks $5 \times 4 = 20$ marks. Section 'B' consist of 5 long answer question for each question carries 8 marks, one question {with internal choice a) or b) } from each unit of syllabus, $8 \times 5 = 40$ marks and section 'C' is case study compulsory for 15 marks.

- 10) For all PG courses including MBA, the brake up 25 marks (25 %)for internal examination / continuous assessment will be;
- a) 15 marks for written examination, two written examinations are to be conducted average of both examinations is considered for awarding final score
 - b) 5 marks for attendance
 - c) 5 marks assignment preparation and presentation
(The proportionate may be followed for 50 marks paper / practical)
- 11) There will be project work for all PG courses except MBA, MCA, M.Tech and MA (Social work) for 100 marks (50 marks for dissertation and 50 marks for presentation and viva-voce. The project fieldwork is to be done during summer vacation i.e. after II semester and before III semester. Dissertation should be submitted by the student to the respective department during 2nd year study and presentation and viva-voce examination is to be held after IV semester examination. The project presentation and vive-voce examination is conducted by external examiner, for affiliating colleges University teachers will be external examiner for University Department external examiner from other university is to be invited. MCA / MBA /M.Tech/ MA (SW) will continue the extant system. The external examiner TA / DA and remuneration will be borne by the respective College / Department strictly as per the approved norms to be notified from time to time.
- 12) There may be comprehensive viva-voce at end of every semester being conducted by all subject teacher together assigning suitable credit from internal marks to be taken. This is intending to prepare and boost the student interview facing skills and comprehension of subject. This is proposed for PG courses.

M.Sc. AQUACULTURE
Scheme of Examination

Code	Title of the paper	Total Marks	Credits
I SEMESTER			
AQC 101	Biosystematics and Taxonomy	100	4
AQC 102	Tools and Techniques for Biology	100	4
AQC 103	General and Comparative Physiology	100	4
AQC 104	Molecular Cell Biology	100	4
	Lab Course		
AQC 105	Biosystematics and Taxonomy lab	50	2
AQC 106	Tools and Techniques for Biology lab	50	2
AQC 107	General and Comparative Physiology lab	50	2
AQC 108	Molecular Cell Biology lab	50	2
II SEMESTER			
AQC 201	Genetics and Evolution	100	4
AQC 202	Developmental Biology	100	4
AQC 203	Quantitative Biology	100	4
AQC 204	Immunology	100	4
	Lab Course		
AQC 205	Genetics and Evolution lab	50	2
AQC 206	Developmental Biology lab	50	2
AQC 207	Quantitative Biology lab	50	2
AQC 208	Immunology lab	50	2
III SEMESTER			
AQC 301	Concepts of Aquatic Ecology	100	4
AQC 302	Principles of Aquaculture	100	4
AQC 303	Nutrition and Feed Technology	100	4
AQC 304	Water Quality Management	100	4
	Lab Course		
AQC 305	Concepts of Aquatic Ecology Lab	50	2
AQC 306	Principles of Aquaculture Lab	50	2
AQC 307	Nutrition and Feed Technology Lab	50	2
AQC 308	Water Quality Management Lab	50	2
IV SEMESTER			
AQC 401	Aquaculture	100	4
AQC 402	Fish Processing Technology	100	4
AQC 403	Fish Pathology	100	4
AQC 404	Aquaculture Biotechnology	100	4
	Lab Course		
AQC 405	Aquaculture lab	50	2
AQC 406	Fish Processing Technology Lab	50	2
AQC 407	Fish Pathology Lab	50	2
AQC 408	Aquaculture Biotechnology Lab	50	2
AQC 409	Project work *	100	4
	Total	2500	100

***2 months project work at the end of II Semester during summer and evaluation at the end of IV Semester.**

ADIKAVI NANNAYA UNIVERSITY: RAJAHMUNDRY

BOARD OF ZOOLOGY/ AQUACULTURE

Date: 08-07-2016

AGENDA:

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

Members present:

Dr. P Vijaya Nirmala

Prof. Pala Indira

Dr. A. Matta Reddy

Dr. K. Ramaneswari

Dr. D Kalyani

Dr. J. Lalitha Bharathi

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Minutes of the meeting of the Board of Studies held on 8-7-2016
at 11:00 AM at the Department of Zoology, Adikavi Nannaya University,
Rajahmundry, Rajamahendranagar.

Members present

1. Dr. P. Vijaya Nirmala, Assistant Professor, ANUR.
Convenor — P. Vijaya Nirmala, 8/7/16
2. Prof. Pala Indira; Sri Krishna Devaraya University,
Ananthapur; Member
3. Dr. A. Matta Reddy; Associate Professor; ANUR — Annareddy 8/7/16
4. Dr. K. Rameswari; Assistant Professor, ANUR — O.D.
5. Dr. D. Kalyani, Assistant Professor, ANUR — D. Kalyani 8/7/16
6. Dr. J. Lalitha Bharathi, SKR college for Women;
Rajamahendravaram; Member — J. Lalitha Bharathi
8-7-16
7. Officer from Avanti Seeds, Bhimavaram —

RESOLUTION:

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 as follows.

1. The members formulated the syllabus for M.Sc Zoology and M.Sc Aquaculture 2 years course on par with other Universities in the Country to be implemented from 2016-17 academic year.
2. The syllabus for practical for the above courses formulated on par with UGC model curriculum.
3. There shall be 4 to 5 hours per week for each theory paper & 3 hrs for each practical.
4. A B.Sc Graduate with Zoology as one of the subjects is eligible to apply for admission into M.Sc Zoology & Aquaculture.
5. Ist & IInd Semesters are common for M.Sc Zoology & Aquaculture IIIrd & IVth Semesters have separate syllabus for M.Sc Zoology & Aquaculture.
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. 100 marks for Project work.
7. **Examination pattern will be as follows.**
 - a) 75% of marks for Semester end Examination while the remaining 25 marks for continuous Internal assessment which includes 5 marks for attendance (5 marks 95 % above, 4 marks 85-94%, 3 marks 75 – 84%, 2 marks 65-74%, 1 mark 55-64%), 5 marks for Assignment and Presentation and 15 marks for Mid-Examination, with one (10 marks) & one short question (5 marks) with internal choice.
 - b) The Semester end Examination question paper comprise of two section –Section A & B ,
Section A consist of 4 questions one question from each unit, of syllabus with internal choice ‘a’ or ‘b’

Section-B consist of 8 short questions two from each unit of the syllabus, with internal choice to attempt only 5 out of 8 questions.
 - c) In practical 75% of marks for semester end Examination (38 Marks) and Internal Semester Examination 25% (12 Marks) for continuous assessment for Practical paper (9 + Record-3)
8. There will be Project work for Aquaculture & Zoology for 100 marks. (50 marks for Dissertation & 50 marks for Presentation & Viva-voce). The Project work is to be done during summer vacation i. e after II Semester & before III Semester. Dissertation should be submitted by the students, during 2nd year of study, Presentation and Viva-voce is to be conducted by External Examiner. For Affiliating Colleges University teachers of the concerned Department (or) External Examiner to other University will be invited. The External Examiner TA/DA & Remuneration will be borne by the respective College/Department as per the approved norms.
9. A comprehensive Viva-voce to be conducted for students at the end of every semester in the presence of all subject teachers with 20 marks in order to prepare & boost the students face the interview in future. Marks adjusted from the internal presentation marks (5 marks in each subject i.e 4x5=20 marks).

ADIKAVI NANNAYA UNIVERSITY
M.Sc. ZOOLOGY & AQUACULTURE

Examination pattern:

Theory: 75% is End Semester Examination

25% is Internal Assessment

Practical: 75% is End Semester Examination

25% is Internal Assessment – Continuous Assessment

ADIKAVI NANNAYA UNIVERSITY
M.Sc. ZOOLOGY & AQUACULTURE
END SEMESTER EXAMINATION

Model question paper

Time: 3 hrs

Max. Marks: 75

Answer all the questions. Each question carries 15 marks.

Section-A

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 at least one from each unit.

ADIKAVI NANNAYA UNIVERSITY
M.Sc AQUACULTURE
I SEMESTER
AQC 101. BIOSYSTEMATICS & TAXONOMY

UNIT-I

- 1.0. Definition and basic concepts of biosystematics and taxonomy
 - 1.1. Historical resume of systematics
 - 1.2. Importance and applications of biosystematics in biology
 - 1.3. Material basis of biosystematics – different attributes

UNIT-II

- 2.0. Trends in biosystematics – concepts of different conventional and aspects
 - 2.1. Chemotaxonomy
 - 2.2. Cytotaxonomy
 - 2.3. Molecular taxonomy
- 3.0. Molecular perspective on the conservation of diversity
 - 3.1. Diversity and ecosystem process: Theory, achievements and future directions

UNIT-III

- 4.0. Dimensions of speciation and taxonomy characters
 - 4.1. Dimensions of speciation- types of lineage changes, production of additional lineage
 - 4.2. Species concepts – species category, different species concepts: sub-species and other infra specific categories
 - 4.4. Theories of biological classification, hierarchy of categories
 - 4.5. Taxonomic characters – different kinds.

UNIT-IV

- 5.0. Procedure keys in taxonomy
 - 5.1. Taxonomic procedures – taxonomic collections, preservation, curation process of identification
 - 5.2. Taxonomic keys – different kinds of taxonomic keys, their merits and demerits
 - 5.3. Systematic publications – different kinds of publications
 - 5.4. International Code of Zoological Nomenclature (ICZN) – its operative principles, interpretation and application of important rules, Zoological nomenclature.

Suggested Reading Material:

1. M. Kato. The Biology of Biodiversity, Springer.
2. J.C. Avise. 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. Mayer. Elements of Taxonomy.
6. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
7. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

AQC 102. TOOLS AND TECHNIQUES FOR BIOLOGY

UNIT-I

- 1.0. Assay
 - 1.1. Definition
 - 1.2. Chemical assay
 - 1.3. Biological assay
- 2.0. Principles and uses of analytical instruments
 - 2.1. pH meter
 - 2.2. Spectrophotometer
 - 2.3. Ultra-centrifuge
 - 2.4. Radio activity counter
 - 2.5. NMR Spectrophotometer

UNIT-II

- 3.0. Microscopy
 - 3.1. Principles of light, dark field, phase contrast, fluorescence, transmission electron, scanning electron microscope
- 4.0. Micro-biological Techniques
 - 4.1. Media preparation & sterilization
 - 4.2. Inoculation & Growth monitoring
 - 4.3. Use of fermentors
 - 4.4. Biochemical Mutants & their uses
 - 4.5. Microbial assays

UNIT-III

- 5.0. Cell culture techniques
 - 5.1. Laboratory facilities
 - 5.2. Substrates on which cells grow
 - 5.3. Treatment of substrate surfaces
 - 5.4. Feeder layers
 - 5.5. Culture Media

UNIT-IV

- 6.0. Separation Techniques in biology
 - 6.1. Molecular separation by chromatography and electrophoresis
 - 6.2. Organelle separation by centrifugation, density gradient separation
- 7.0. Radio Isotopes
 - 7.1. Sample preparation for radioactive counting
 - 7.2. G M Counter
- 7.3. Auto-radiography

Suggested Reading Material:

1. Animal cell culture – A practical approach, Ed. John R.W. Masters, IRI Press
2. Introduction to Instrumental Analysis. Robert Braun. McGraw Hill International Editions
3. A Biologist Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.

AQC 103. GENERAL AND COMPARATIVE PHYSIOLOGY

UNIT-I

- 1.1. Aims and scope of Comparative Physiology
- 1.2. Muscle structure and properties, Molecular basis of muscle contraction, sliding filament theory
- 1.3. Twitch Summation, Tetanus and Fatigue.
- 1.4. Nerve structure, nerve impulse, ionic basis of resting and action potentials
- 1.5. Synaptic transmission, Neurotransmitters
- 1.6. Blood coagulation - Factors affecting coagulation

UNIT-II

- 2.1. Osmoregulation in aquatic and terrestrial environments mechanism of ionic regulation
- 2.2. Thermoregulation
- 2.3. Homoeothermic animals
- 2.4. Poikilotherms
- 2.5. Hibernation and Aestivation

UNIT-III

- 3.1. Respiratory organs and respiratory pigments through different phylogenetic groups. Mechanisms of uptake of O₂ and CO₂
- 3.2. Circulation of fluids and their regulation.
- 3.3. Comparative physiology of digestion and absorption of carbohydrates
- 3.4. Patterns of excretion among different animal groups
- 3.5. Receptor physiology – Comparative study
- 3.6. Mechanoreceptors
- 3.7. Chemoreceptor

UNIT-IV

- 4.1. Physiological adaptations of animals to different environments
- 4.2. Marine environment
- 4.3. Shores and Estuaries
- 4.4. Fresh water environment
- 4.5. Terrestrial environment
- 4.6. Yoga, meditation and their effects

Suggested Reading Material:

1. Eckert, R. Animal Physiology: Mechanisms and adaptation, W.H. Freeman and Company, New York.
2. Hochachka, 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. Schiemdt Neisen, Animal Physiology, Adaptation and Environment, Cambridge
5. Stamd, F.L. Physiology: A regulatory systems approach, Macmillan Publishing Co., New York.
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, UK 539 pp.
11. Townsend, C.R. and P. Callow, Physiological Ecology An evolutionary approach to resource use, Blackwell Sci. Publication, Oxford, UK.

AQC 104. MOLECULAR CELL BIOLOGY

UNIT-I

- 1.0. Introduction: Experimental system in Cell Biology
- 2.0. Biomembranes
 - 2.1. Molecular composition and arrangement, functional consequences
 - 2.2. Transport across cell membrane: diffusion, active transport, pumps, uniports, symports and antiports
 - 2.3. Membrane potential
 - 2.4. Co-transport by symporters or antiporters
 - 2.5. Transport across epithelia: Transport of macromolecules

UNIT-II

- 3.0. Cytoskeleton
 - 3.1. Microfilaments and microtubules – structure and dynamics
 - 3.2. Microtubules and mitosis
 - 3.3. Cilia and flagella
 - 3.4. Cell movements – intracellular transport, role and kinesin and dynein, signal transduction mechanisms

UNIT-III

- 5.0. Cell-Cell Signaling
 - 5.1. Cell surface receptors
 - 5.2. Second messenger system
 - 5.3. MAP kinase pathways
 - 5.4. Apoptosis: Definition, mechanism and significance
- 6.0. Cell-Cell adhesion and communication
 - 6.1. Ca^{++} dependent homophilic cell-cell adhesion
 - 6.2. Ca^{++} independent homophilic adhesion
 - 6.3. Gap junctions and connections
 - 6.4. Integrins
 - 6.5. Collagen

UNIT-IV

- 7.0. Cell cycle
 - 7.1. Cyclins and cyclin dependent kinases
 - 7.2. Regulation of CDK-cyclin activity
- 8.0. Genome organization
 - 8.1. Hierarchy in organization
 - 8.2. Chromosomal organization of genes and non-coding DNA
 - 8.3. Mobile DNA
 - 8.4. Morphological and functional elements of eukaryotic chromosomes
- 9.0. Intracellular protein traffic
 - 9.1. Protein synthesis on free and bound polysomes
 - 9.2. Uptake into ER
 - 9.3. Membrane proteins, Golgi sorting, post-translational modifications
 - 9.4. Biogenesis of mitochondria and nuclei
 - 9.5. 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

AQC 105-Biosystematics and Taxonomy lab:

1. A practical approach towards Biosystematics and taxonomy
2. Examples representing the different taxa in the order of evolution
3. Molecular perspective of diversity – Identification of species by molecular separation of proteins by examples
4. Diversity and similarity index.
5. Methods of collection, preservation and identification of plankton and representative forms of terrestrial and aquatic fauna

AQC 106-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. Demonstration and working of:
 - a) Atomic Absorption Spectrophotometer
 - b) High Pressure Liquid Chromatography
 - c) ELISA Reader
 - d) Liquid Scintillation counter
6. PH Meter – Preparation of Phosphate buffer
7. Microscope –
 - a) Demonstration of oil immersion – WBC & RBC
 - b) Preparation of tissue for SEM & TEM procedure
8. Cell culture -
 - a) Preparation of media
 - b) Inoculation

AQC 107-General and Comparative Physiology lab:

1. Metabolic rate of fish
2. Digestive enzymes
3. Oxygen consumption vs temperature
4. Oxygen consumption vs body weight
5. Osmotic regulation
6. Ion concentration measurements
7. Spotters

AQC 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

ADIKAVI NANNAYA UNIVERSITY
M.Sc AQUACULTURE
II SEMESTER
AQC 201. GENETICS AND EVOLUTION

UNIT-I

Mendelian principles Multiple Alleles; Lethality and interaction of genes; Linkage and crossing over; Sex determination, Sex linkage, Extra chromosomal inheritance Molecular Evolution, Gene and gene families, Molecular drive

UNIT-II

Concepts of evolution and theories of organic evolution with emphasis on Darwinism. Neo Darwinism, Hardy Weinberg law of genetic equilibrium, A detailed account of destabilizing forces (i) natural selection (ii) Mutation, (iii) Migration

UNIT-III

Quantifying genetic variability, Genetic structure of natural population, phenotypic variation, Models explaining changes in genetic structure of population, Genetic of quantitative traits in population. Analysis of quantitative traits, Quantitative traits and natural selection, Estimation of heritability, Genotype-environmental interactions.

UNIT-IV

Genetics of speciation, phylogenetics and biological concept of species. Models of speciation (Allopatric, Sympatric, Parapatric). Patterns and mechanisms of reproductive-isolation. Phylogenetic gradualism and punctuated equilibrium, Micro and macro evolution, Origin of higher categories.

Suggested Reading Material:

1. Dobzhansky, Th. Genetics and origin of species, Surjeet Publication, Delhi
2. Dobzhansky, Th., F.J. Ayala, G.L., Stebbens and J.M. Valentine Evolution, Surjeet Publication, Delhi
3. Futuyama, D.J. Evolutionary Biology, Suinuer Associates, INC, Publishers, Dunderland
4. Hartl. D.L.A. Primer of population Genetics, Sinauer Associates, INC Massachusetts.
5. Jha, A.P. Genes and Evolution, John Publication, New Delhi
6. King, M. Species Evolution - the role of chromosomal change. The Cambridge University Press, Cambridge.
7. Meerrer, D.J. Evolution and genetics. Oxford University Press, New York.
Strikberger, M.W. Evolution, Jones and Bartett Publishers, Boston London

AQC 202. DEVELOPMENTAL BIOLOGY

UNIT-I

Gametogenesis, Fertilization and Cleavage:

Introduction to animal development, pattern of embryonic development, Fertilization (species specific recognition of egg and sperm, acrosome reactions, fast and slow block to polyspermy); oogenesis & gameto genesis. Cleavage (patterns, molecular mechanism of cleavage)

UNIT-II

Early embryonic Development:

Gastrulation, Neurulation (Establishment of neural tube, Tissue architecture of CNS, cerebral organization, differentiation of neural tube, neurons and neural crest cells); Specification of cell fate and cellular basis of morphogenesis, Autonomous development, Regulative development, Syncytial development.

UNIT-III

Organogenesis:

Mechanism of cellular differentiation – Ectoderm (CNS and Epidermis), Mesoderm (Chorda Mesoderm, paraxial, intermediate and lateral plate mesoderm) and Endoderm (digestive tube and its derivatives), Cell-cell communication, Development during organ formation: introduction and competence, paracrine and other factors (the inducer molecules), Signal transduction cascades.

UNIT-IV

Gene expression during development:

Establishment of body axes. Anterior-posterior polarity-role of maternal effector, segmentation and homeotic selector genes, Dorso-Ventral polarity. Differential gene expression during animal development, Differential gene transcription, Selective nuclear RNA processing and mRNA translation. Differential protein modification. Regeneration of organs.

Suggested Reading Material:

1. Scott F. Gilbert (2006). Developmental Biology, 8th Edition, Sinauer Associates, Inc., Publishers Sunderland, Massachusetts, USA
2. L. Wolpert Rosa Beddington Thomas M. Jessell Peter Lawrence Elliot M. Meyerowitz and Jim Smith (2002) Principles of Development Second Edition Oxford University Press.
3. JMW Slack (2005) Essential Developmental Biology Second Edition Blackwell Publishing Australia.
4. Mac E. Hadley Endocrinology Sixth Edition Prentice hall International, Inc. Arizona (For Section 9).

AQC 203. QUANTITATIVE BIOLOGY

UNIT-I

1. Introduction – Scope and application of statistics in Biology
2. Sampling – Essentials, advantages and methods of sampling and sampling errors
3. Frequency distribution: Preparation of ordered, discrete and continuous tables
4. Diagrammatic presentation of data: Data presentation by diagrams, graphs and curves
5. Skewness and Kurtosis

UNIT-II

1. Measures of central tendency: Mean, median and mode
2. Measures of dispersion: Standard deviation, variance and coefficient of variance
3. Correlation and regression

UNIT-III

1. Laws of Probability: Measurement, terminology
2. Probability distributions: Binomial, Poisson and normal distributions
3. Tests of significance: Chi-square test, t-test
4. Analysis of variance

UNIT-IV

1. Fundamentals of computers – Hardware and Software
2. Computer-aided techniques for data presentation, data analysis and statistical techniques – Excel
3. Mathematical modeling – Types of models, building of a model
4. Examples of models from Biology: Growth of snail shell, morphogenesis

Suggested Reading Material:

1. Batschelet, E., Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.
2. Jorgensen, S.E., Fundamentals of Ecological Modelling, Elsevier, New York.
3. Swartzman, G.L. and S.P.O. Kaluzny. Ecological Simulation Primer. Macmillan, New York.
4. Lendren, D. Modeling in Behavioural Ecology. Chapman & Hal. London, UK
5. Sokal, R.R. & F.J. Rohlf. Biometry. Freeman, San Francisco.
6. Snedecor, G.W. and W.G. Cochran, Statistical methods for environmental biologists. John Wiley & Sons, New York.
7. Murray, J.D. Mathematical Biology. Springer – Verlag, Berlin.
8. Pielou, E.C. The Interpretation of Ecological Data. A Primer on Classification and Ordination.

AQC 204. 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 (5th Ed), Mosby (6th 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.

II SEMESTER PRACTICALS

AQC 205-Genetics and Evolution lab:

Population Genetics:

1. Calculating gene frequencies and genotype frequencies for Autosomal dominant traits, Autosomal recessive traits using Binomial distribution.
2. Quantitative Genetics: Mean, Median, Standard Deviation, Chi-Square & Variance.
3. Problems on related topics.
4. Multifactor of inheritance.

Ecology:

1. Ecosystems and observation of biodiversity – field visit
2. Population identification – rocky shore, estuarine interstitial
3. Estimation of primary productivity on land and water ecosystem.
4. Growth patterns under laboratory conditions.

AQC 206-Developmental Biology lab:

1. Estimation of shell calcium during the development of chick and its role
2. Estimation of phosphorus during the development of chick
3. Observation of spermatozoa in vertebrates

AQC 207-Quantitative Biology lab:

1. Vectors and Matrices - Problems
2. Sampling – Lottery method and Random digits
3. Frequency distribution
4. Graphical presentation of the data
5. Measures of Central Tendency – Mean, median and mode
6. Measures of Dispersion – Standard deviation and Coefficient of variation
7. Probability
8. Coefficient of Correlation
9. Circuit diagram – Examples of models
10. Ecological modeling – Case study

AQC 208-Immunology lab:

1. Western Blotting
2. SRID
3. DID
4. Immunoelectrophoresis
5. RIA
6. ELISA

M.Sc. AQUACULTURE
III – SEMESTER
AQC 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, thermal optimum, maximum and minimum, 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.

Inorganic Salts: Salts as liming factors; basic nutrient salts; ecological effects of salinity; effect of salinity on animals; total hardness and total alkalinity.

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:

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.

AQC 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, integrated fish farming.

Selection Of Sites : Survey and location of suitable site – topography; soil characteristics; acid sulphate soils; water source; hydrometeorological 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:

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.

AQC 303. NUTRITION AND FEED TECHNOLOGY

UNIT – I

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

UNIT – II

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

UNIT – III

1. **Natural food:** Importance in aquaculture; Fish food organisms – Bacterioplankton, phytoplankton and zooplankton and their role in larval nutrition.
2. **Supplementary feeds:** Types of feeds - Wet feed, moist feed, dry feed, mashes, pelleted feeds - floating and sinking pellets, microencapsulated diets.
3. **Feed additives:** Binders, antioxidants, enzymes, pigments, growth promoters, feed stimulants; use of preservatives.

UNIT – IV

1. **Feed manufacture:** Feed formulation and processing; Feed machinery units: Pulverizer, grinder, mixer, pelletizer, crumbler, drier, extruder/expander, vacuum coater and fat sprayer.
2. **Feeding strategies:** Feeding devices, feeding schedules and ration size.
3. **Feed evaluation:** Feed conversion efficiencies and ratios. Feed storage methods.

REFERENCE BOOKS

1. ADCP(AquacultureDevelopment&Co-ordinationProgram).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 Rouge.
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.

AQC 304. WATER QUALITY MANAGEMENT

UNIT – I

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

UNIT – II

1. **Dynamics of dissolved oxygen:** Daily changes in dissolved oxygen concentration, oxygen budget of culture ponds; algal die-off, overturns, identification of oxygen problems.
2. **Aeration:** Principles of aeration, emergency aeration, destratification and practical considerations.

UNIT – III

1. **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.
2. **Aquatic weed management:** Common weeds and problems in culture ponds; Chemical, biological and mechanical control methods; Algal bloom control.

UNIT – IV

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

REFERENCE BOOKS

1. Adhikari S & Chatterjee DK. 2008. *Management of Tropical Freshwater Ponds*. Daya Publ.
2. Boyd CE and Tucker CS. 1992. *Water Quality and Pond Soil Analyses for Aquaculture*. Alabama Agricultural Experimental Station, Auburn University.
3. Boyd CE. 1979. *Water Quality in Warm Water Fish Ponds*. Auburn University
4. Boyd, CE. 1982. *Water Quality Management for Pond Fish Culture*. Elsevier Sci. Publ. Co.
5. Hephner B & Pruginin Y. 1981. *Commercial Fish Farming*. John-Wiley & Sons Inc.
6. Jhingran VG. 1982. *Fish and Fisheries of India*. Hindustan Publishing Corporation, India.
7. Midlen & Redding TA. 1998. *Environmental Management for Aquaculture*. Kluwer.
8. Pillay TVR & Dill WMA. 1979. *Advances in Aquaculture*. Fishing News Books, Ltd. England.
9. Rajagopalsamy CBT & Ramadhas V. 2002. *Nutrient Dynamics in Freshwater Fish Culture System*. Daya Publ.
10. Sharma LL, Sharma SK, Saini VP & Sharma BK. 2008. *Management of Freshwater Ecosystems*. Agrotech Publ. Academy.
11. Stickney RR. 1979. *Principles of Warm water Aquaculture*. John-Wiley & sons Inc.
12. Tucker C.S. 1985. *Channel Catfish Culture*. Elsevier.

M.Sc. AQUACULTURE
III- SEMESTER PRACTICALS

AQC 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.

AQC 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.

AQC 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.

AQC 308. Water Quality Management Lab:

1. Determination of Temperature, pH, Salinity.
2. Total Alkalinity and total Hardness.
3. Dissolved Oxygen, Phosphates, COD and BOD
4. Estimation of Primary Productivity, Nitrites and Nitrates.

M.Sc. AQUACULTURE
IV- SEMESTER
AQC 401. AQUACULTURE

UNIT – I

1. Major cultivable species for aquaculture; A knowledge of inland water bodies suitable for culture in India.
2. Culture of Indian Major Carps: exotic carps of Fish Hatcheries and their management.
3. Bundh breeding and Induced breeding of carp by hypophysation and use of synthetic hormones.
4. Preparation and Management of Indian major carp culture ponds – nursery, rearing and production ponds.

UNIT – II

1. Integrated fish farming.
2. Culture of Giant fresh water prawn, *Macrobrachium rosenbergii* - seed collection formation sources. Hatchery management.
3. Culture of tiger shrimp, *Penaeus monodon* and *Litopenaeus Vannamei*

UNIT – III

1. Culture of brackish water fish – *Chanos* and *Lates*.
2. Culture of pearl oysters.

UNIT – IV

1. Culture of sea weeds: Major seaweed species of commercial importance; methods of culture. Crab – Culture.
2. Culture of ornamental fishes.
3. Culture of air-breathing fishes in India. Molluscs, Ornamental fish culture of seaweeds.

REFERENCES BOOKS

- Bardach, JE *et al.* 1972. *Aquaculture – The farming and husbandry of freshwater and marine organisms*. John Wiley & Sons, New York.
- 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*.
- Huet J. 1986. *A text Book of Fish Culture*. Fishing News Books Ltd.
- ICAR. 2006. *Hand Book of Fisheries and Aquaculture*. ICAR.
- Jhingran V.G. 1991. *Fish and Fisheries of India*. Hindustan Publ. Corporation, India.
- Landau M. 1992. *Introduction to Aquaculture*. John Wiley & Sons.
- Mcvey JP. 1983. *Handbook of Mariculture*. CRC Press.
- MPEDA: *Handbooks on culture of carp, shrimp, etc.*
- New MB. 2000. *Freshwater Prawn Farming*. CRC Publ.
- Pillay TVR. 1990. *Aquaculture- Principles and Practices*. Fishing News Books Ltd., London.
- Pillay TVR & Kutty MN. 2005. *Aquaculture- Principles and Practices*. 2nd Ed. Blackwell
- Rath RK. 2000. *Freshwater Aquaculture*. Scientific Publ.
- Stickney RR. 1979. *Principles of Warmwater Fish Culture*. John Wiley & Sons.

AQC 402. FISH PROCESSING TECHNOLOGY

UNIT – I:

Process Biochemistry

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

UNIT – II:

Microbiology

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

UNIT – III:

Handling and Fish Preservation

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

UNIT – IV:

Quality Management and Certification

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

REFERENCE BOOKS

1. Balachandran KK. 2001. *Post-harvest Technology of Fish and Fish Products*. Daya Publ.
2. Bond, et al. 1971. *Fish Inspection and Quality Control*. Fishing News Books, England.
3. Clucas IJ. 1981. *Fish Handling, Preservation and Processing in the Tropics*. Parts I, II. FAO.
4. Gopakumar K. (Ed.). 2002. *Text Book of Fish Processing Technology*. ICAR.
5. Govindan, TK. 1985. *Fish Processing Technology*, Oxford-IBH.
6. Hall 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.

AQC 403. FISH PATHOLOGY

UNIT – I: Viral diseases

1. **Fish Diseases:** Clinical symptoms, pathology and control measures of Viral Hemorrhagic Septicemia (VHS) and Infectious Hematopoietic Necrosis (IHN).
2. **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

1. **Fish Diseases:** Clinical symptoms, pathology, prevention and control measures of Bacterial Hemorrhagic Septicemia (BHS), Bacterial gill disease and Tail and fin rot.
2. Pathology, clinical symptoms, prevention and control measures of Saprolegniasis and Branchiomycosis.
3. **Shrimp Diseases:** Clinical symptoms, pathology, prevention and control measures of Black gill disease, Filamentous bacterial gill disease.
4. Clinical symptoms, pathology, prevention and control measures of *Lagenidium* disease (Larval Mycosis) and Brown gill disease.

UNIT – III: Protozoan, Helminthic and Crustacean diseases

1. **Fish Diseases:** Clinical symptoms, pathology and control measures of Ichthyophthiriasis, Enterococcidiasis, Whirling disease and Nodular disease.
2. Clinical symptoms, pathology and control measures of Gyrodactylosis and Dactylogyrosis.
3. Clinical symptoms, pathology and control measures of Argulosis and Lernaeiasis.
4. **Shrimp Diseases:** Etiology, morphology and control measures of ectocommensal protozoa – *Zoothamnium* and *Acineta*.
5. Clinical symptoms, pathology and control measures of Microsporidiasis.

UNIT – IV: Nutritional and Ecological diseases

1. **Fish Diseases:** Diseases of vitamin deficiency and Fatty liver degeneration.
2. Clinical symptoms, pathology and control measures of gas bubble disease and lack of oxygen.
3. **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.

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, Louisiana, 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.

AQC 404. AQUACULTURE BIOTECHNOLOGY

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT – IV

1. **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.
2. Nitrogen fixation in aquatic environment and Biofertilizers.
3. **Post-harvest biotechnology:** Delaying of spoilage; biosensors.

REFERENCE BOOKS

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

M.Sc. AQUACULTURE
IV- SEMESTER PRACTICALS

AQC 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.

AQC 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. Estimation of chitin.

AQC 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.

AQC 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.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY

M.Sc Aquaculture -I Semester

Model Question Paper: Paper-I

AQC 101-Biosystematics and taxonomy

Time: 3hours

Max. Marks: 75

**Answer ALL questions.
All questions carry equal marks**

Section-A

1. a) Define Biosystematics. Explain the importance and applications of biosystematics.
(OR)
b) What is the material basis for biosystematics?
2. a) Explain the various new aspects adopted in biosystematics
(OR)
b) Explain the diversity and ecosystem processes involved in conservation of biodiversity
3. a) What is speciation? Explain the mechanism of speciation.
(OR)
b) What is species? Discuss the various concepts of species
4. a) What are the different taxonomic procedures and explain the different taxonomic keys.
(OR)
b) Discuss ICZN

Section-B

5. Answer any **FIVE** of the following:
 - a) Reproductive isolation
 - b) Systema Natura
 - c) Holotypes
 - d) Panmictic species
 - e) Lineage
 - f) Publication
 - g) Darwin.
 - h) Subspecies.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY

M.Sc Aquaculture -I Semester

Model Question Paper: Paper-II

AQC 102-Tools and Techniques for Biology

Time: 3hours

Max. Marks: 75

**Answer ALL questions.
All questions carry equal marks**

Section-A

1. a) Describe the principle and applications of spectrophotometer.
(OR)
b) What is an assay? Explain different types of assays
2. a) Write the principle and types of microscopy and elaborate dark field microscopy.
(OR)
b) Describe the process of inoculation and growth monitoring.
3. a) Write an essay on laboratory facilities required for cell cultures.
(OR)
b) Give an account on various culture media required for the growth of animal cells.
4. a) Describe various types of chromatographic techniques to separate molecules.
(OR)
b) What is autoradiography? Give an account on its biological applications.

Section-B

5. Answer any **FIVE** of the following:
 - a) pH meter.
 - b) Biochemical mutants and their uses.
 - c) Feeder layers.
 - d) GM counter.
 - e) Density gradient centrifugation.
 - f) Treatment of substrate surfaces.
 - g) Use of fermenters.
 - h) Radio active counter.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc Aquaculture -I Semester
Model Question Paper: Paper-III
AQC 103-General and comparative physiology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Write about the molecular basis of muscle contraction and sliding filament theory.
(OR)
b) Explain the nerve impulse transmission and add note on neurotransmitters.
2. a) Write briefly about osmoregulation in aquatic and terrestrial animals.
(OR)
b) Explain thermoregulation with suitable examples.
3. a) Write an essay on comparative physiology of digestion and absorption of carbohydrates.
(OR)
b) Write an essay on mechanisms of uptake of O₂ and CO₂.
4. a) Write briefly the physiological adaptation of Marine and sandy shore environment.
(OR)
b) Write briefly the fresh water and terrestrial environment adaptations

Section-B

5. Answer any **FIVE** of the following:
 - a) Muscle twitch
 - b) Tetanus and fatigue
 - c) Poikilotherms
 - d) Homoeotherms
 - e) Mechanoreceptors
 - f) Bioluminescence
 - g) Parasitic habits
 - h) Yoga

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc Aquaculture -I Semester
Model Question Paper: Paper-IV
AQC 104-Molecular Cell Biology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

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) Cyclins and cyclin dependent kinases regulate cell cycle, Justify.

(OR)

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

Section-B

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) Symporters and antiports

g) Microtubules.

h) Apoptosis

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc Aquaculture -II Semester
Model Question Paper: Paper-I
AQC 201- Genetics and Evolution

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Write in detail genetic mapping of chromosomes and sex determination.
(OR)
b) Write the fine structure of the gene. Add a note on multiple alleles

2. a) Write in detail about Hardy-Weinberg law of genetic equilibrium.
(OR)
b) Write the concept of evolution and theories of organic evolution with emphasis on Darwinism.

3. a) Write the genotype and environmental interaction. Add a note on factors effecting human disease frequency.
(OR)
b) Write in detail the genetic structure of natural population and models explaining changes in genetic structure if population

4. a) What is speciation? Write about phylogenetic and biological concepts of species
(OR)
b) Explain macro and micro evolution.

Section-B

5. Answer any **FIVE** of the following:
 - a) A genetic imprinting.
 - b) Karyotyping
 - c) Mutation.
 - d) Migration.
 - e) Phenotypic Variation.
 - f) Analysis Of Quantitative Traits.
 - g) Sympatric speciation.
 - h) Allopatric Speciation.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc Aquaculture -II Semester
Model Question Paper: Paper-II
AQC 202- Developmental Biology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) Describe in detail about the process of fertilization.
(OR)
b) Write an account on molecular mechanism of cleavage and cleavage patterns.
2. a) Give a detailed account on chick gastrulation.
(OR)
b) What is neurulation .Explain the process of neurulation with an example,
3. a) Explain the mechanism of cellular differentiation of ectoderm into CNS & Epidermis.
(OR)
b) How does cell to cell communication help in organ formation during development?
4. a) How does differential gene expression occurs during animal development.
(OR)
b) Write about selective nuclear RNA processing and mRNA translation.

Section-B

5. Answer any **FIVE** of the following:
 - a) Blocking of polyspermy.
 - b) Regulative development.
 - c) Endoderm derivatives.
 - d) Homeotic selector genes.
 - e) Structure of sperm.
 - f) Autonomous development.
 - g) Signal transduction cascades.
 - h) Regeneration of organs.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc Aquaculture -II Semester
Model Question Paper: Paper-III
AQC 203-Quantitative Biology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

1. a) What is Sampling? Write the different methods of sampling.
(OR)
b) What is frequency distribution? Explain the process of formation of frequency distribution in different series.
2. a) What are Measures of Central tendency? Explain
(OR)
b) Write about correlation
3. a) Write about Probability distributions
(OR)
b) What is test of significance? Write about 't' test
4. a) What are the computers aided techniques used for data analysis?
(OR)
b) Write about mathematical modeling giving an example.

Section-B

5. Answer any **FIVE** of the following:
 - a) Skewness
 - b) Graphs
 - c) Standard deviation
 - d) Chi-square test
 - e) Software
 - f) Standard error
 - g) Design of experiment
 - h) Regression

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc Aquaculture -II Semester
Model Question Paper: Paper-IV
AQC 204- Immunology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

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

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, RAJAHMUNDRY
M.Sc. Aquaculture-III Semester
Model Question Paper: Paper-I
AQC 301. Concepts of Aquatic Ecology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks
Section-A

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

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

- a) Habitat
- b) Lentic ecosystem
- c) Turbidity
- d) Photoperiod.
- e) Alkalinity.
- f) dissolved oxygen.
- g) Eutrophication
- h) Niche.

ADIKAVI NANNAYA UNIVERSITY, RAJAHMUNDRY
M.Sc. Aquaculture-III Semester
Model Question Paper: Paper-II
AQC 302. Principles of Aquaculture

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks
Section-A

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

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, RAJAHMUNDRY
M.Sc. Aquaculture-III Semester
Model Question Paper: Paper-III
AQC 303. Nutrition and Feed Technology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks
Section-A

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

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, RAJAHMUNDRY
M.Sc. Aquaculture-III Semester
Model Question Paper: Paper-IV
AQC 304. Water Quality Management

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks
Section-A

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 fertilizers 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

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, RAJAHMUNDRY
M.Sc. Aquaculture-IV Semester
Model Question Paper: Paper-I
AQC 401. Aquaculture

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks
Section-A

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

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, RAJAHMUNDRY
M.Sc. Aquaculture-IV Semester
Model Question Paper: Paper-II
AQC 402. Fish Processing Technology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

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

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, RAJAHMUNDRY
M.Sc. Aquaculture-IV Semester
Model Question Paper: Paper-III
AQC 403. Fish Pathology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks

Section-A

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

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, RAJAHMUNDRY
M.Sc. Aquaculture-IV Semester
Model Question Paper: Paper-IV
AQC 404. Aquaculture Biotechnology

Time: 3hours

Max. Marks: 75

Answer ALL questions.
All questions carry equal marks
Section-A

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

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