

National Centre for Aquatic Animal Health
Cochin University of Science and Technology
Departmental Admission Test for PhD Programme
Scheme of Examination

Total Marks: 100

Duration: 3hours

I. Objective type questions: 10 Nos:	10 marks
II. Quiz: 10 Nos:	10 marks
III. Match the following: 10 Nos:	10 Marks
IV. State whether true or false. If false give the right answer 10 nos:	20 marks
V. Reason out 10 nos:	30 marks
VI. Write short notes on any four of the following:	10 Marks
VI. Write two short essays from the following:	10 marks

Syllabus

Stream 1. Marine Biotechnology

Marine Microbial Diversity - Methods and Tools

Microbial taxonomy and phylogeny; Bacterial Taxonomy According to Bergey's Manual; Fungal Taxonomy according to International Commission on Taxonomy of Fungi (ICTF); Protozoan Taxonomy according Integrated Taxonomic Information System (ITIS), Microalgal taxonomy according to Algal Base, Virus Taxonomy according to International Committee on Taxonomy of Viruses (ICTV), Conventional and molecular methods for assessing microbial diversity, Marine biodiversity data bases – GBIF, CoML, IO-CoML, Sequence data analysis-Pairwise Sequence Alignment; Basic concepts of sequence alignment; Needle man and Wunsch; Smith and Waterman algorithms for pair wise alignments ; Dynamic programming; Gap penalties; Use of pair wise alignments for the analysis of nucleic acid and protein sequences and interpretation of results; Tools for similarity search and sequence alignment – FASTA, BLAST, E- value; scoring matrices – BLOSUM, PAM matrices; Multiple sequence alignment and applications; Methods available – interactive alignment, progressive alignment – ClustalW, T-Coffe; profile methods – gribskov profile, PSI-BLAST, phylogenetic analysis (dendogram and cladogram) and tree building; Various methods used in generating evolutionary tree; tree evaluation; Hidden Markov Models (Hmms), Estimating biodiversity using next generation sequencing.

Genomic Techniques for Marine Genomics

Genomic libraries for marine organisms, Genomic mapping methods, Sequencing genomes- Classical and next generation sequencing methods; Assembly of DNA sequences- methods; Databases-; Primary Databases: Nucleic Sequence Databases – NCBI, EMBL, EBI, DDBJ, Genome databases; Comparative genomics, functional genomics – Transcriptomics; Computational functional genomics-, ORF and promoter predictions. Intron and exon predictions. Genome mining and gene and genome annotation, Genome mining for biosynthetic gene cluster identification and marine natural product discovery, Experimental-cDNA libraries of marine organisms, Assigning gene function; Differential gene expression, digital gene expression, DNA and cDNA micro arrays; Protein array; Gene silencing techniques; Mutation, Introduction to SiRNA technology; Micro RNA; Construction of SiRNA vectors; Gene knockouts; transgenics; Genomic engineering, Method in epigenomics.

Bioactive Compounds and Biomaterials from Marine Environment

Diversity of marine derived compounds- Alkaloid, Terpenoids and steroids, nucleoside, amino acids, peptides, decapeptides, polyketide, macrolide:

Marine toxins – Paralytic shellfish poisoning (PSP), Neurotoxic Shellfish Poisoning (NSP), Diarrhetic Shellfish poisoning (DSP), Ciguatera poisoning, Amnesic shellfish poisoning (ASP), azaspiracid Shellfish poisoning, tetrodotoxin, other miscellaneous toxins;

Marine biominerals; Biomineralized structures; Biocomposites, Biopolymers – polysaccharides, chitin, marine collagens.

Introduction to Bioinformatics: Definition; applications; Computer fundamentals- net working and hardware fundamentals, internet, world wide web, Web authoring, Wikipedia

page authoring; Introduction to biological data bases, protein data bases, protein and sequence data bases, sequence formats, primer design.

Aquatic Animal Cell Cultures and Biomedical Application

Aquatic animal cell lines – cell culture system from fine fishes, crayfish, sea urchin, mollusca, sponges, shrimp - hepatopancreas, ovary, haemocytes, lymphoid organ, In vitro testing of new substances/ drugs – cytotoxicity assays, lactate dehydrogenase (LDH), Sulforhodamine B (SRB), MTT, Neutral Red uptake, Glucose Uptake; Immunofluorescent staining; Assay for apoptosis and senescence; Fish and shell fish cell expression systems – tissue specific promoters, constitutive promoters; biomedical applications; aquatic animal cell cultured based vaccines.

Basic Concepts in Bioprocess

Need for biologist and engineers to work together; process flow diagram; media for industrial fermentation, medium optimization, growth kinetics, structured and unstructured model, stoichiometry of growth; elemental balances and degree of reduction.

References

1. Munn, C.B. 2004. Marine Microbiology. Ecology and Applications. Garland Science/ BIOS Scientific Publishers, Oxon and New York. 282 p.
2. David W. Mount Bioinformatics – Sequence and Genome analysis , Cold Spring Harbor Laboratory Press, New York, 2001
3. Green M.R. and Sambrook, J. 2012. Molecular Cloning: A Laboratory Manual Edn. 3. Vol. 1-III. Cold Spring Harbor
4. D.S. Bhakuni and D.S. Rawat 2005 Bioactive Marine Natural Products (Springer and Anamaya Publishers, New Delhi, India
5. Cock, JM, Tessmar-Raibe, K., Boyen,C., Viard F. (Eds). 2010.Introduction to Marine Genomics. Springer.
6. Freshney, R.I. 2000. Culture of animal cells- A manual of basic technique 4th Edition. John Wiley & Sons Inc. Publication.
7. Bioprocess Engineering-basic concepts, M.L. Shuler and F. Kargi, II edition, PHI

Syllabus

Stream 2. AQUATIC ANIMAL HEALTH

Introduction to Aquaculture

World aquaculture; Criteria for selection of organisms for aquaculture; Extensive, semi-intensive and intensive aquaculture practices; Running water aquaculture; Recirculating system; Cage culture and pen culture; Feed formulation in aquaculture; Broodstock management and hatchery technology for different finfish and shellfish species; Major cultured species in India; National and International Organizations in Aquaculture.

Fish and Shellfish Immunology

Finfish Immunology: Organs and cells of immune system; Non-specific defense mechanisms- surface barriers, Non-specific humoral factors-cytokines, lysozymes, lectins, antimicrobial peptides, C-reactive proteins, interferon and other molecules, Complement system; Non-specific cellular factors; Inflammation; Specific defense mechanisms- Humoral immunity - B lymphocytes, Structure and function of immunoglobulins (Igs), different classes of Igs, Cell mediated immunity - T lymphocytes, MHC molecules

Shellfish Immunology: Crustacean Defense Mechanisms: Hemocytes, Hematopoiesis; Hemocyte-mediated effector responses-Phagocytosis, Nodulation and encapsulation; Clotting Reaction; ProPhenol Oxidase (proPO) system; Proteinase inhibitor, Agglutinin; Lectin system; Anti Microbial peptides; Reactive Oxygen Intermediates;

Molluscan Defense Mechanisms: Molluscan hemocytes; Cellular Defense Mechanisms- Leucocytosis, Chemotaxis, Recognition, Contact and Adherence; Lectins and Opsonins; Phagocytosis and Modulation of Phagocytosis; Intracellular degradation; Encapsulation and Nacrezation; Reactive Oxygen species (ROS); Anti-oxidants; Antibacterial and Ant-parasitic activities; Nitricoxides; Mytilins and Myticins; Lysosomes; Humoral Immune system- Prophenoloxidase activating system, Cytokines, Complement-like Molecules, C-reactive proteins, α -2 Macroglobulins.

Diseases of Fin-fishes

OIE listed diseases - Clinical signs, aetiology, prophylaxis and therapy.

Emerging pathogens/diseases in Asia Pacific region in Fin fishes: 1. *Streptococcus iniae*, 2. *Streptococcus agalactiae*, 3. *Edwardsiella tarda*, 4. *Nocardia seriolae*, 5. *Tenacibaculum maritimum*, 6. *Flavobacterium columnare*, 7. *Francisella sp.*, 8. Big belly syndrome, 9. Loss of mucus and septicemia syndrome;

Diseases of Shell Fishes

OIE listed diseases in shellfishes - Clinical signs, aetiology, prophylaxis and therapy.

Emerging pathogens/diseases in Asia Pacific region in shell fishes: 1. Tegumental Gland Associated Virus (TGAV); 2. Laem Singh Virus (LSNV); 3. Monodon Slow Growth Syndrome (MSGs); 4. Bamboo Shrimp Syndrome (BSS).

Diagnostics Technology

Microscopy based (both light and electron microscopy), histology and histopathology based diagnosis. Antibody based diagnostics – monoclonal and polyclonal antibodies; precipitation reactions; Mancini radial immunodiffusion; Ouchterlony double immunodiffusion; Immuno-electrophoresis; Rocket electrophoresis; agglutination reactions; radio-immunoassay; ELISA; Immunofluorescence; Flow cytometry. Nucleic acid based diagnostics – PCR and its modifications, RT-PCR, Nested PCR, Real Time PCR, Multiplex PCR, Loop-mediated isothermal amplification (LAMP); Nucleic acid probes; DNA Microarrays.

Disease Management

Aquaculture environment Management: Water and sediment quality; Bioremediation in aquaculture- concept of bioremediation, detritus management, nitrification, denitrification and H₂S removal; Recirculating aquaculture systems - concept and designs, bioreactor technology in RAS, zero water exchange culture system; Organic Aquaculture - concept, principles and practices.

Aquatic animal health management: Antimicrobials and chemotherapeutics in aquaculture; Probiotics; Immunostimulation and immunomodulation in finfish and shellfishes; Vaccination in finfishes use of adjuvants, DNA and recombinant vaccines; Alternative methods for disease control- bacterial antagonism, phage therapy, antimicrobial peptides, quorum sensing inhibition; Anesthetics in aquaculture- commercially available anesthetics and anti-stress compounds, mode of action; Drug residues in aquaculture products; Residue monitoring and regulations.

References

1. Swain, P.; P K Sahoo and S Ayyappan. 2006. Fish and Shellfish Immunology : An Introduction. Narendra Pub, Delhi.
2. Roberts, R.J. (Ed), 2001, Fish Pathology, W.B. Saunders, P. 672
3. Coll, M.J. and Dominguez-Juncal J. 1995. Applications Of Monoclonal Antibodies In Aquaculture. *Biotech. Adv.* Vol. 13, pp. 45-73.
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5. Luis Balcazar, J., de Blas, I Ruiz-Zarzuela I., Cunningham, D., Vendrell, D., Luis Mu'zquiz, J. 2006. The role of probiotics in aquaculture. *Veterinary Microbiology* 114: 173–186
6. OIE Listed Diseases, Infection and Infestations in force in 2017-
<http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2017/>
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8. Bright Singh, I.S and Y.S. Yadava(Eds). 2005. Aquaculture Medicine and Aquatic Animal Health management. Aquaculture Authority and National Centre for Aquatic Animal Health, P. 254.