

## CONTENTS

## VOLUME IX

<b>Marine Biotechnology</b>	<b>1</b>
-----------------------------	----------

Indrani Karunasagar, *University of Agricultural Sciences, India*

1. Scope of Marine Biotechnology
2. Industries Based on Marine Biotechnology
3. Scientific Studies with a Commercial Potential

<b>Molecular Aspects of Steroid Action in Marine Fishes</b>	<b>14</b>
---	-----------

Brian S. Nunez, *The University of Texas at Austin, USA*  
 S.L. Applebaum, *The University of Texas at Austin, USA*  
 A.H. Berg, *The University of Texas at Austin, USA*  
 G.E. Dressing, *The University of Texas at Austin, USA*  
 A.N. Evans, *The University of Texas at Austin, USA*  
 C.W. Tubbs, *The University of Texas at Austin, USA*  
 T.P. Barry, *University of Wisconsin, USA*

1. Introduction
2. Steroid Classes
  - 2.1. Progestins
    - 2.1.1. Corticosteroids
    - 2.1.2. Maturation Inducing Steroids
  - 2.2. Androgens
  - 2.3. Estrogens
  - 2.4. Neurosteroids
3. Steroidogenesis
  - 3.1. Cholesterol Transfer
  - 3.2. Cytochromes P450
    - 3.2.1. CYP11A (Cholesterol Side Chain Cleavage)
    - 3.2.2. CYP17 (17-hydroxylase; 17,20-lyase)
    - 3.2.3. CYP21 (21-hydroxylase)
    - 3.2.4. CYP11B (11 $\beta$ -hydroxylase)
    - 3.2.5. CYP19 (Aromatase)
    - 3.2.6. CYP1 $\alpha$  (1 $\alpha$ -hydroxylase)
  - 3.3. Hydroxysteroid dehydrogenases (HSDs)
    - 3.3.1. HSD3
    - 3.3.2. HSD11
    - 3.3.3. HSD17
    - 3.3.4. HSD20
4. Steroid Binding Proteins
  - 4.1. Sex Hormone Binding Globulin
  - 4.2. Corticosteroid Binding Globulins
  - 4.3. Albumin
5. Steroid Inactivating Enzymes
  - 5.1. Cytochromes P450
  - 5.2. Hydroxysteroid Dehydrogenases
  - 5.3. Steroid Reductases
  - 5.4. Sulfotransferase
  - 5.5. UDP-Glucuronosyltransferases
6. Steroid Hormone Receptors
  - 6.1. Nuclear Steroid Hormone Receptors
    - 6.1.1. Progestin receptors

- 6.1.2. Corticosteroid receptors
- 6.1.3. Androgen Receptors
- 6.1.4. Estrogen Receptors
- 6.1.5. Membrane Localized Nuclear Steroid Receptors
- 6.2. Novel Membrane Steroid Receptors
  - 6.2.1. Novel Membrane Progesterin Receptor
  - 6.2.2. Novel membrane Androgen Receptor
  - 6.2.3. Novel Membrane Estrogen Receptor
- 7. Examples of Processes Governed by Steroid Hormones
  - 7.1. Oocyte Growth and Vitellogenesis
  - 7.2. Regulation of Oocyte Maturation
  - 7.3. Regulation of Spermatogenesis
  - 7.4. Hydromineral Balance
  - 7.5. Development
- 8. Concluding Remarks

### Marine Microbial Enzymes

47

S. Rajeev Kumar, *Cochin University of Science and Technology, India*  
 M. Chandrasekaran, *Cochin University of Science and Technology, India*

- 1. Introduction
- 2. Role of Microbial Enzymes in Marine Environment
- 3. Enzymes from Marine Microorganisms
  - 3.1. Polysaccharases
    - 3.1.1. Starch Hydrolyzing Enzymes
      - 3.1.1.1.  $\alpha$ -Amylase (EC-3.2.1.1)
      - 3.1.1.2.  $\alpha$ -Glucosidase (EC-3.2.1.2)
      - 3.1.1.3. Pullulanases (EC-3.2.1.41)-Debranching Enzymes
      - 3.1.1.4. Cyclomaltodextrin-glucanotransferase (CGase EC-2.4.1.19)
    - 3.1.2. Agarase (EC-3.2.1.81)
    - 3.1.3. Alginate-lyase (EC-4.2.2.3)
    - 3.1.4.  $\kappa$ -carrageenanase (EC-3.2.1.83)
    - 3.1.5.  $\alpha$ -Galactosidase (EC-3.2.1.22)
    - 3.1.6. Cellulases and Related Enzymes
    - 3.1.7. Glucanases
    - 3.1.8. Chitinases (EC-3.2.1.14)
    - 3.1.9. Other Polysaccharases
  - 3.2. Laccase (LC) (EC-1.10.3.2)
  - 3.3. Proteases
  - 3.4. Lipase (EC-3.1.1.3)
  - 3.5. Other Known Enzymes
    - 3.5.1. Amido Hydrolases
      - 3.5.1.1. L-asparaginase (EC-3.5.1.1)
      - 3.5.1.2. L-glutaminase
    - 3.5.2. Tyrosinase (EC-1.14.18.1)
    - 3.5.3. Hydrogenase
    - 3.5.4. Superoxide-dismutase (SOD, EC-1.15.1.1)
    - 3.5.5. Glucose-dehydrogenase
  - 3.6. Extremozymes (Enzymes from extremophiles)
    - 3.6.1. Thermostable Enzymes
    - 3.6.2. Cold Adapted Enzymes
    - 3.6.3. Alkalophilic Enzymes
    - 3.6.4. Halophilic and Halo Tolerant Enzymes
  - 3.7. Recognition of Valuable Extremozymes
- 4. Enzymes as Tools in Biotechnology
  - 4.1. Restriction Enzymes from Marine Bacteria
  - 4.2. Other Nucleases from Marine Bacteria

- 4.3. Bacteriolytic Enzyme by Bacteriophage from Seawater
- 5. Innovations in Enzyme Technology
  - 5.1. Enzyme Engineering
  - 5.2. Immobilization Technology
  - 5.3. Gene Cloning for Marine Enzymes
- 6. Future Prospects

**Biotechnological Tools in fish health Management**

**81**

Indrani Karunasagar, *University of Agricultural Sciences, India*

- 1. Microbial Disease Problems in Aquaculture
- 2. Strategies for Health Management
- 3. Biotechnological tools in health management
  - 3.1. Pathogen detection and disease diagnosis
  - 3.2. Biocontrol of pathogens through probiotics
  - 3.3. Protection of hosts through immunoprophylaxis
  - 3.4. Bioremediation of aquaculture environment

**Molecular Tools for Improving Seafood Safety**

**106**

Iddya Karunasagar, *University of Agricultural Sciences, India*

- 1. Introduction
- 2. Bacterial Pathogens Associated with Seafoods
  - 2.1. *Vibrio* spp
  - 2.2. *Salmonella*
  - 2.3. *Listeria monocytogenes*
- 3. Viruses
  - 3.1. Hepatitis A Virus
  - 3.2. Norwalk and Norwalk-like Viruses
- 4. Biotechnological Tools in Safety Assurance
  - 4.1. Biotechnological Tools for Bacterial Identification and Detection
    - 4.1.1. *Vibrio cholerae*
    - 4.1.2. *Salmonella*
    - 4.1.3. *Listeria monocytogenes*
    - 4.1.4. *Vibrio vulnificus*
    - 4.1.5. *Vibrio parahaemolyticus*
  - 4.2. Biotechnological Tools for the Detection of Pathogenic Viruses
- 5. Antibiotic Resistant Bacteria in Aquatic Systems and Monitoring their Presence by Molecular Methods

**Marine Natural Products Biotechnology**

**121**

Russell T. Hill, *University of Maryland, USA*

- 1. Historical Development
- 2. Present Development
  - 2.1. Introduction and Scope
  - 2.2. Pharmaceuticals
  - 2.3. Microbiological Aspects of Marine Natural Products Discovery
  - 2.4. Production Issues
  - 2.5. Enzymes
  - 2.6. Other Products
  - 2.7. Environment
  - 2.8. Social Aspects
- 3. Future Development

**Molecular Tools for the Study of Marine Microbial Diversity****139**

Klaus-Ulrich Valentin, *Alfred Wegener Institute for Polar and Marine Research, Germany*  
 Rene Groben, *Lancaster Environment Center, Lake Ecosystem Group, United Kingdom*  
 Linda Karen Medlin, *Alfred Wegener Institute for Polar and Marine Research, Germany*

1. The Importance of Biodiversity Research in the Marine Environment
2. What Questions can be Answered Using Molecular Biology Techniques?
3. Evaluating Marine Biodiversity by Sequence Analysis and Fingerprinting Methods
  - 3.1. Sequence Analysis
    - 3.1.1. Which Genes to Select?
    - 3.1.2. How to Generate Sequence Data?
    - 3.1.3. Determining Biodiversity in an Environmental Sample by Sequence Analysis
    - 3.1.4. Analysing Sequences for Determining Phylogenies and Biodiversity
    - 3.1.5. DNA Barcoding
  - 3.2. Fingerprinting Methods
4. Analysis of Population Structure Using Molecular Markers
5. Molecular Probes for Identification and Characterisation of Marine Phytoplankton
  - 5.1. Introduction
  - 5.2. Probe Design
  - 5.3. Detection Methods
6. Conclusions

**Bioremediation in the Marine Environment****172**

Iddya Karunasagar, *University of Agricultural Sciences, India*

1. Introduction
2. Types of Pollutants in the Marine Environment
  - 2.1. Petroleum Hydrocarbons
  - 2.2. Xenobiotics
  - 2.3. Heavy Metals
3. Pathways for Bioremediation
  - 3.1. Biodegradation of Petroleum Hydrocarbons
  - 3.2. Biodegradation of Xenobiotics
  - 3.3. Bioremediation of Heavy Metal Pollutants
4. Genetic Engineering and Bioremediation

**Biotechnology of Archaea****187**

Costanzo Bertoldo, *Technical University Hamburg-Harburg, Germany*  
 Garabed Antranikian, *Technical University Hamburg-Harburg, Germany*

1. Introduction
  - 1.1. Archaea Living at the Boiling Point of Water
  - 1.2. Archaea Growing at Extremes of pH
  - 1.3. Halophilic Microorganisms
2. Cultivation of Extremophilic Archaea
3. Molecular Basis of Heat Resistance
4. Screening Strategies for the Detection of Novel Enzymes from Archaea
5. Starch Processing Enzymes
  - 5.1. Heat Stable Amylases and Glucoamylases
  - 5.2.  $\alpha$ -Glucosidases
  - 5.3. Thermoactive Pullulanases and CGTases
6. Cellulose and Hemicellulose Hydrolyzing Enzymes
7. Chitin Degradation
8. Proteolytic Enzymes
9. Alcohol Dehydrogenases and Esterases
10. DNA Processing Enzymes

- 10.1. Polymerase Chain Reaction (PCR)
- 10.2. DNA Sequencing
- 10.3. Ligase Chain Reaction
- 11. Archaeal Inteins

**Viable But NonCulturable Bacteria in the Marine Environment and the Biotechnological Tools to Detect Them** **220**

Rita R. Colwell, *University of Maryland, USA*

- 1. Introduction
- 2. History of the Viable but Nonculturable Phenomenon in Bacteria

**Extending Integrated Fish Farming Technologies to Mariculture in China** **233**

Li Kangmin, *Asia Pacific Regional Research & Training Center for Integrated Fish Farming No. 9 Shanshui West Road Wuxi 214081 China*

- 1. Introduction
- 2. Rationale of Integrated Aquaculture and Mariculture
  - 2.1. Chinese Philosophy and ZERI Concept
  - 2.2. New Natural Philosophy and the Five Kingdoms
- 3. Integrated Fish Farming
  - 3.1. Historical Records of Integrated Fish Farming
    - 3.1.1. Yu Hu Bing
    - 3.1.2. The Development of Inland Aquaculture Depended upon Natural Seed Supply in Long Period of Time
    - 3.1.3. The Third Stage
  - 3.2. Characteristics of Integrated Fish Farming
    - 3.2.1. Integrated Fish Farming Models vary from Different Natural Conditions and Diversified Economy
    - 3.2.2. Recycling Agricultural Wastes into Things of Value
    - 3.2.3. With Rational Utilization of Natural Resources Integrated Fish Farming is being called as Food-saving, Water-saving, Land-saving and Energy-saving Type of Fish Farming
  - 3.3. Contents of Integrated Fish Farming Systems
  - 3.4. Models of integrated fish farming systems
  - 3.5. Expansion of IFF in Reservoir Fisheries
  - 3.6. Constraints
- 4. Successful Models in New Stages
  - 4.1. A new Integrated Fish Farming Model
    - 4.1.1. Beneficial Microorganism Remediation
    - 4.1.2. Aquatic Vascular Plant Remediation
    - 4.1.3. Aquatic Filter-feeding Animal Remediation
  - 4.2. New model of Rice Fish: Weeding and Eradicating Harmful Insects in paddies by fry
  - 4.3. Pearl mussel *Hyriopsis cumingii* culture and processing industry
  - 4.4. Crab Island Circular Economy Model
- 5. Mariculture
  - 5.1. Oceanic resources in China
  - 5.2. Status Quo of Mariculture Development in China
  - 5.3. Extending Integrated Fish Farming Technologies to Mariculture
    - 5.3.1. Induced Breeding in Mariculture
    - 5.3.2. Integration of Mollusks and Seaweed
    - 5.3.3. Di-species Polyculture and Multiple Species Polyculture
    - 5.3.4. Integrated pest/disease management on the basis of 5 kingdom
- 6. Eight New Concepts or Trends of Integrated Aquaculture and Mariculture
  - 6.1. Polyculture practiced from mere Fish Species (4-7 cultivated species) to Fish/Turtle, Fish Mollusks to Multiple Aquatic Species (Fish, Shrimps, Mollusks and Algae); from Complementary to Predator-prey
  - 6.2. Some Euryhaline Species in Mariculture can be cultured in Brackish Water, even in Freshwater

- 6.3. Some Eurythermal Organisms in the South can be cultured in the North vice versa
- 6.4. Integration of Culture Fisheries within Macro Agriculture
- 6.5. Integration of Culture Fisheries with Industries
- 6.6. Artificial Breeding is to turn Wild Species into be Cultured Species
- 6.7. Hybridization Utilization
- 6.8. Circular Aquaculture and Mariculture

**Index** **269**

**About EOLSS** **275**