Sea Grant

Sea Grant Contributions to the Nation in

Marine Biotechnology

Science Protecting and Creating New Value from Our Coastal Resources

Sea Grant's investments in biotechnology apply sophisticated biological and molecular methodologies to develop opportunities and solve problems along our coasts and Great Lakes. There is vast potential to discover new compounds with great therapeutic and industrial applications. Equally important is the need for new tools to monitor ecosystem health and find solutions for difficult environmental problems. By enlisting the talents of our nations universities and through industry and governmental partnerships at the national, state and local levels, Sea Grant's efforts in biotechnology have catalyzed both a greater understanding of our coastal resources and the development of novel products and processes with impacts that extend from the aquatic realm to human health.

A Record of Achievement

Recent accomplishments from Sea Grant's investment in biotechnology can be found nationwide.

Natural Products, Processes and Pharmaceuticals

- Research on the protein shell matrix of the Eastern oyster, *Crassostrea virginica*, has led to the discovery of polyaspartic acid, and, at present, more than two dozen patents for multiple uses as well as the creation of a multi-million-dollar company. Polyaspartic acid helps plants absorb additional nutrients from the soil, giving farmers greater crop yields with smaller amounts of fertilizer. It also is being used on offshore drilling platforms to reduce mineral growth.
- Researchers have mined the wealth of natural compounds found in marine organisms and discovered many with potential for use as life-saving drugs. A compound derived from mangrove tunicates holds promise as a potent anti-tumor treatment; those from corals have potent anti-cancer activity. Other researchers are licensing a process to manufacture anti-inflammatory agents. To conserve limited marine resources, researchers are developing ways to synthesize these products.
- In a surprising find, researchers have learned that bacteria living inside a small marine animal —a bryozoan called *Bugula neritina* —may be the source of a new family of drugs, bryostatins, being developed to fight a variety of cancers. While scientists previously thought the marine animal itself was the source of bryostatins, the discovery of this bacterium opens the door for production of the compounds on far greater scale. Bryostatin is now in clinical trials for use in humans.
- Microorganisms that inhabit extreme ocean environments—scalding hot or frigidly cold—are a biochemical treasure trove of novel enzymes for industry. Researchers are studying these extremophiles to discover new molecular resources and applications.
- Sea Grant-sponsored researchers and a multidisciplinary team of experts, ranging from industry to philosophy, examined the legal, ecological, ethical and safety concerns associated with marine biotechnology. They assessed how domestic and international regulations are evolving to meet these concerns. Sea Grant programs across the country have developed innovative education and outreach effort that use biotechnology to educate students and the general public on this vital, emerging science.

Environmental Monitoring and Ecological Health

- Northeast shellfish and tourism industries have suffered extensive losses due to harmful algal blooms. Now, highly sensitive molecular probes can detect the presence of just a few cells of these organisms. Molecular approaches are being used to detect species of concern such as the red-tide organism *Alexandrium* and the brown-tide organism *Aureococcus*—enabling resource managers to predict at-risk waters well before a bloom occurs.
- Solutions to the invasive and costly zebra mussel are in sight with two developments. One —a cost- effective "dipstick" for use in the field — employs a genetic probe that specifically identifies zebra mussel larvae. The second is a biotoxin, produced by a bacterial strain that is lethal to zebra mussels yet harmless to other mollusks.
- Toxic polyaromatic hydrocarbons (PAHs) originating from tar, wood preservatives, oil and other fossil fuels are found in highly industrialized estuaries. Using DNA-fingerprinting techniques, researchers have isolated marine bacteria that degrade PAHs. The team is working to learn if natural bacteria communities can detoxify PAH-contaminated areas.
- The need to improve aquatic contaminant risk assessments by state and federal agencies is being met by research in cellular biochemistry. Scientists examining the fundamental processes underlying dioxin toxicity have discovered that dioxin blocks development of the red blood cell production system in salmonid fishes.

Using cell culture assays, scientists have also studied dioxin sensitivity in several species of marine mammals. The results are being used to assess the risk of environmental contaminants to protected species

- Partnerships with private industry are developing markets for the use of a low-cost cleanup technology based on genetically modified plants. These transgenic plants have an increased ability to degrade highly toxic halogenated phenols. Scientists are currently working with private industry worldwide to develop business markets for the technology. In other work focused on developing new ways to protect and restore seashores, researchers are pioneering coastal-specific genetic selection of sea oats for erosion prevention and dune restoration efforts.

Human and Environmental Diseases

- Fast and effective tests that can help aquaculturists and fish pathologists minimize losses to farmed fish are now commercially available. Microbiologists have developed a diagnostic kit that uses monoclonal antibodies to diagnose infectious fish diseases caused by aquatic birnaviruses. Other studies have led to the first nucleic acid assay in which multiple fish pathogens can be identified simultaneously.
- Pioneering research into molecular methods to identify the human pathogen *Cryptosporidium parvum*, an aquatic protozoan, has revealed that the organism accumulates in oysters exposed to agricultural runoff. Advanced molecular studies of the physiology of *Cryptosporidium* cysts are providing key information to managers of municipal water supply systems.
- A new rapid DNA-fingerprinting technique has led to improved detection of the pathogenic bacterium *Listeria* and to a review of existing regulations. This technology is helping seafood-processing plants locate chronic contamination, while making effective control strategies possible.
- Researchers established strong circumstantial evidence linking cats to lethal sea otter disease, when they detected the presence of *Toxoplasma gondii* parasites in samples of free-living marine bivalves. The study, using molecular and bioassay based methods, implicated freshwater surface runoff as a source of *T. gondii* infection for sea otters and highlighted the importance of pathogen pollution in the marine ecosystem.

Investing for the Future

Sea Grant will build on its university base to make cost effective investments in biotechnology that will impact the needs of our nation. By seeking proactive partnerships with federal, state and local capability and maintaining an entrepreneurial focus, Sea Grant has established a clear path for future success. The problems in our coastal and Great Lakes regions are indeed large, but so too are the opportunities for new developments and contributions. Sea Grant's commitment to foster and employ innovative science and emerging technologies will ensure that we meet these challenges head on.

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