Services Provided by Marine Genetic Resources

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Marine organisms produce approximately half of the oxygen in the atmosphere, assimilate enormous quantities of carbon dioxide, and are a critical source of food. Modern molecular methods, including whole-genome sequencing, are shedding new light on the wealth of genetic resources in the sea. As our knowledge of the marine genetic inventory increases, so also does our access to new molecular tools for human health, technology, and ecosystem management.

Over 15,000 unique marine metabolites, which are gene products, have been discovered from diverse marine organisms, including sponges, tunicates, mollusks, fungi, and bacteria. Many of these metabolites possess potent activities in biomedical assays, and therefore have been investigated as new medicines. Others have provided novel templates for drug design or have been used as chemical probes to help dissect cellular processes. As of 2005, clinical trials were underway with at least twenty marine molecules. Of exceptional interest is the recent discovery of new actinomycetes that reside exclusively in the oceans. These bacteria are close relatives of terrestrial organisms that have yielded many of our most clinically important antibiotics. Initial investigations have demonstrated that marine actinomycetes are chemically prolific and produce structurally unprecedented molecules. Salinosporamide, one of the first compounds discovered from this group, is currently in Phase I clinical trials for the treatment of cancer. Marine metabolites may have additional commercial applications, such as non-toxic anti-fouling agents to protect ships and undersea instrumentation.

Marine proteins are additional gene products that can be developed into molecular tools. For example, the deep-sea bacterium *Thermococcus litoralis* produces the enzyme Vent$_R$®-polymerase used by biotechnology researchers to replicate DNA. Genes that assemble fluorescent proteins in corals and jellyfish have been developed into reporter systems to study cell regulation. In the future, marine enzymes and other biopolymers will likely be used for widespread commercial applications, including the manufacture of specialty chemicals, pharmaceuticals, and textiles.

Biotechnology is also being applied to aquaculture. Fueled by a rising demand for seafood that the fisheries sector is unable to supply, aquaculture has become the fastest growing segment of world agriculture. The numbers of domesticated aquatic species are rising exponentially. More than 400 species of aquatic animals and plants have been domesticated in the last few decades and the numbers are likely to continue growing, considering that more than 3000 marine species are used as food worldwide. This rapid growth in aquaculture production is occurring in both developing and developed countries. Organism traits such as growth factors and defense molecules are being studied with the hope of increasing production and improving product quality.

Advancements in culturing techniques are further enabling researchers to develop new uses for marine microorganisms. Examples include the degradation of hazardous waste and pollutants, probiotics to protect aquaculture species against disease, and as fuel cells to power remote underwater instruments.