GENOMICS & ENVIRONMENT

ADVANCED TOOLS FOR MONITORING AND MANAGEMENT

1344 Summer Street
Halifax, NS B3H 0A8

GenomeAtlantic
Life Sciences. Life Solutions.

genomeatlantic.ca
902.421.5683

GENOMICS & ENVIRONMENT

Barely a day passes without a news item regarding 'the environment'. Globally, researchers, citizens and governments are grappling with ways to keep up with our growing demand for '"goods" while preserving the health and balance of the earth's ecosystem.

From more environmentally sound production of energy and food (see the Energy and Agriculture sections) to more specific applications such as bioremediation, genomics applications are playing a significant role in this sector.

MONITORING IMPACTS OF TOXIC SUBSTANCES

Industrial, agricultural and consumer activities release thousands of synthetic chemicals into the environment, many of which can be toxic for living things, including humans.

The testing of substances for potential toxicity and the monitoring of ecosystems for toxic impacts, both areas under government regulation, are benefiting from advances in a new field termed eco-toxicogenomics. This emerging science uses molecular tests of genome function to examine the toxic effects of chemicals on different species and to monitor ecosystem health by testing plants, animals and microbes for gene markers of toxicity.

While still in early stages, eco-toxicogenomics research involving academics, governments and private companies is cataloguing the types of changes in genome function that are produced by different toxins in different species, including model organisms like microbes or mice as well as wild species like fish and birds. Continued progress in this field will lead to rapid, low-cost and high-information genomics testing methods that will improve toxicity screening and risk assessment for toxic substances, provide detailed information on how ecosystems respond to toxic chemicals and potentially reveal early warning signs of environmental impacts to inform conservation and regulatory responses.

A real-life example involving research from Environment Canada is using Gene Expression Tests (which genes are turned on or off) in liver of rainbow trout to identify gene markers of the fish 'stressor' response to environmental pollutants like pulp and paper effluents. Such tests could one day be used to routinely monitor the health of aquatic ecosystems that are impacted by industrial activities.

1344 Summer Street
Halifax, NS B3H 0A8

genomeatlantic.ca
902.421.5683

BIOREMEDIATION OF TOXIC POLLUTANTS

Bioremediation refers to the neutralization of toxic pollutants in the environment through the biological action of living organisms, primarily microbes or plants (the latter referred to as phytoremediation).

The organisms can be naturally occurring, as in the case of the ocean-living, oil-eating microbes that are considered largely responsible for the breakdown of petroleum released in the Exxon Valdez and BP Gulf of Mexico oil spills. Such *in situ* bioremediation takes advantage of the natural ability of certain microbes to digest carbon-based chemicals and can be accelerated by providing nutrients (like phosphorous) to help stimulate growth and multiplication of the indigenous microbes. Bioaugmentation aims to accelerate the remediation process by adding the specific toxin-degrading microbe(s) grown in culture directly to the polluted site.

In the cases above, genomics tools can be used to identify those natural microbes best suited to degrade specific pollutants and contribute to improving and accelerating remediation. Canadian researchers working with industry are using this approach to optimize microbial cultures that degrade and detoxify an important pollutant from the dry cleaning industry. These microbe cultures have already been used to remediate contaminated groundwater at over 200 sites in the US, Europe and Canada.

Phytoremediation takes advantage of the ability of certain plants to absorb heavy metals like nickel and cadmium from the soil and thereby detoxify contaminated sites. Genomics is being used to improve this ability further by identifying microbe genes that are able detoxify metals like mercury and introducing these genes into certain plants by genetic modification. The transgenic plant is thus better able to phytoremediate metal-contaminated sites. Continued research efforts in bioremediation genomics will provide new and improved methods to remove contaminants already present in soil and water.

WILDLIFE AND BIODIVERSITY CONSERVATION

Genomics tools are being embraced for the identification, monitoring and protection of wild species that comprise the biodiversity of global ecosystems.

Canadian researchers are key partners in the international Barcode for Life program that aims to develop simple and inexpensive DNA Barcode tests for all of the earth's species. Such DNA marker tests are being used to control the traffic in endangered species, enforce wildlife harvesting regulations and map the distribution of wildlife species across different ecosystems. ExxonMobil is working with Canadian scientists to catalogue and eventually monitor biodiversity in sensitive ecosystems representing business opportunities, such as the Arctic Ocean.

Genomics tools can also support efforts in wildlife and conservation enforcement. For instance, genomics tools can prove the genetic identity of an organism so they can be used to prove that an animal has been unlawfully harvested.

For example, genomics can help determine if meat in a freezer is an endangered species. Or, it could prove that moose meat in a freezer was actually from two separate animals, not one, providing evidence that a hunter harvested more than their license allowed.

PCR

PCR: Polymerase Chain Reaction (PCR), is a biochemical technique of amplifying a specific piece of DNA or RNA. Results show whether the DNA or RNA is present or absent.

QPCR

QPCR: Quantitative Real-Time Polymerase Chain Reaction (QPCR or qPCR), is a biochemical technique of amplifying DNA or RNA. Results show how much of the DNA or RNA is present.