

Breaking The Code: Using Personalized Medicine For Environmental Cleanups

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Aaron Peacock

The term “personalized medicine” is becoming a popular description for determining and using a person’s own genetic code to prevent and treat diseases rather than relying on symptoms. Less known, however, is that this type of genetic testing is now helping to clean up environmentally contaminated sites such as old factories. As personalized medicine stands to have a profound impact on health, environmental molecular diagnostics offers significant implications for environmental management.

Environmental molecular diagnostics (EMDs) is a new term that describes emerging techniques used to analyze chemical and biological properties of soils, sediments, groundwater and surface water. While many of these techniques were first developed for applications in the medical, defense and industrial fields, over the last 10 years they are increasingly being applied to environmental cleanup.

Traditional environmental clean-up test results can often be confusing, and even contradictory, and while they can accurately quantify the amount of each contaminant, they provide little or no information about the probable fate of the contaminants. EMDs use powerful new analytical techniques based on the convergence of chemical, geochemical and microbiological evidence. While EMDs don’t take the place of standard environmental testing, they can remove ambiguity and provide a deeper understanding of natural biological processes that impact site cleanup.

Molecular Biology Techniques Leverage Existing Microbes

Within the EMDs field, there are various categories of tools, and Molecular Biology is a major application. Two common Molecular Biology techniques are quantitative polymerase chain reaction (qPCR), which allows DNA to be measured, and genetic microarrays (also commonly called a DNA chip or biochip), which measures the characteristics of large numbers of genes. Both tests are used in the personalized medicine field – and increasingly in environmental management.



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Microbes can essentially eat or breathe contaminants, breaking them down into non-toxic forms, and in many site cleanup initiatives, a portion of the remediation work always falls to the microbial community. As such, it is important to know “who the microbes are” and “how they make a living.” Unlike traditional methods, molecular biology EMDs do not measure soil or water properties directly; rather, they help determine the ability of these resident microbes to clean up contamination.

Bottoms Up and Top-Down View of Microbes at Work

An environmental remediation team could use qPCR to count the population of specific contaminant degrading microbes, or to assess the genetic biochemical pathways (e.g. microbial cellular machinery) that cause the degradation of environmental contaminants. This method can let the team know whether the contaminant-degrading microbes are healthy and growing, or, under some types of stress, possibly signal the need for more active remediation efforts at a site.

For example, [Methyl Tertiary Butyl Ether](#), the fuel additive to gasoline also called MTBE, is a potential human carcinogen that moves rapidly once released into groundwater from underground storage tanks. However, nature provides a microbe named [Methylibium petroleiphilum](#) strain PM-1, that eats MTBE. Molecular biology in action was evident during the use of qPCR tests for this microbe at a site in Southern California, where remediation professionals verified that MTBE degradation was taking place. This genetic analysis saved millions of gallons of groundwater that otherwise would have had to go down the drain.

In short the qPCR test can be considered a bottom up approach, while microarrays are more top down. Both methods can provide critical information regarding environmental cleanup – and empower remediation specialists in ways never before possible.

EMDs in Hands of Few

For most environmental testing, the [Environmental Protection Agency \(EPA\)](#) has a set of approved methods and testing procedures. At this time, there are no EPA specific methods for the use of EMDs. The [Interstate Technology & Regulatory Council \(ITRC\)](#) a public private coalition that works to reduce barriers to the use of innovative environmental technologies, [developed factsheets](#) that explain several EMD methods. The ITRC is also working to publish a comprehensive technical EMD document due this spring. Knowledge and use of EMDs is still small among remediation professionals and more education about these new techniques is needed.



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EMDs are bringing the power of “personalized medicine” to environmental cleanup, and providing detailed and in-depth information not otherwise available from standard tests. These methods are only becoming more sophisticated, and with technologies such as in depth DNA sequencing becoming more affordable, the future for environmental cleanup looks bright.