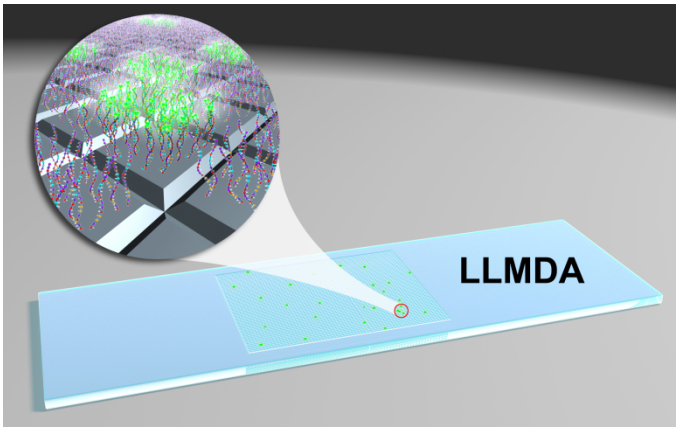
Rapid Detection of Viruses and Bacteria

Staying on the Cutting Edge of Innovation

Known pathogens and emerging unknown disease-causing agents create profound threats to public health. Tools for rapidly detecting these microbial agents are critically needed to prevent and respond to disease outbreaks. Law enforcement, medical professionals, and food-safety professionals need a tool for quick detection of pathogens.



A microbial detection array allows scientists to identify thousands of sequenced viruses and bacteria at the same time. Each square contains multiple strands of DNA or RNA. Squares are arrayed in orderly rows and columns on a one-inch-wide, three-inch-long glass slide. *(Rendering by Sabrina Fletcher.)*

To fill this requirement, Lawrence Livermore National Laboratory's scientists developed the Lawrence Livermore Microbial Detection Array (LLMDA), a technology that enables the detection within 24 hours of any bacteria or virus that has been sequenced and included among the array's probes. LLMDA currently contains probes that can detect more than 2,200 viruses and more than 900 bacteria. LLMDA detects viruses and bacteria with the use of 388,000 probes that fit in a checkerboard pattern in the middle of a one-inch wide, three-inch long glass slide.

A St. Louis, Mo.-based company, MOgene LC, a supplier of DNA microarrays and instruments, licensed LLMDA to get the technology out to the community. MOgene has been in the genomics service business since 2004.

In the LLMDA process, a sample's DNA or RNA is purified and placed on the microarray. If a DNA sequence from the sample matches a sequence on the microarray, the target DNA binds to the microarray and fluoresces. By examining the sequences that fluoresce, a researcher or technician can identify the virus or bacterium, sometimes down to the strain level.

LLMDA provides users with the capability of detecting pathogens over the entire range of known viruses and bacteria. Other detection technologies are based on nucleic acid amplification of sequences from one or a small set of organisms. While they are able to rapidly identify selected pathogens, they cannot be multiplexed to the degree required to detect hundreds to thousands of different organisms. Current multiplex polymerase chain reaction (PCR) techniques can at most offer detection from among 50 organisms in one test.

High-performance computing (HPC) has played a crucial role in meeting the requirements of designing the probe sequences and updating them regularly. In addition, raw data from the LLMDA scanner is analyzed using Laboratory-developed algorithms that run on HPC machines.

The Livermore team updates probes on the array with new sequences of bacteria, viruses and other microorganisms from GenBank and other public databases about once per year, in addition to using sequences obtained from collaborators.

Lawrence Livermore National Laboratory

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