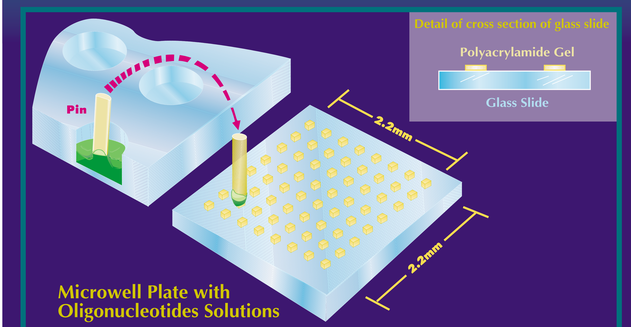
Biochips: Designed for Sequencing but Applied to Identification...

Identification of *Bacillus anthracis* using Biochip Technology

The genetic material of all organisms contains unique DNA "signatures" that can be used for identification purposes. Argonne National Laboratory, using a biochip technology platform funded by the Department of Energy, has created biochips that can detect the presence of such signatures for a variety of applications. One such biochip application is a system dedicated to the detection of *B. anthracis*. This system includes a biochip containing DNA signatures optimized to maximize detection efficiency, a rapid and efficient sample preparation protocol and a compact biochip reader.

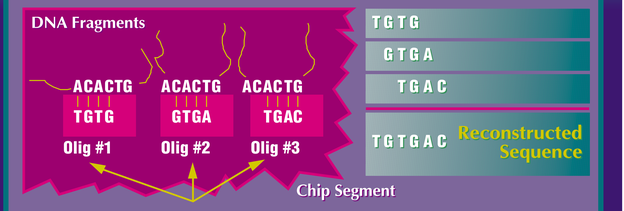


Microwell Plate with Oligonucleotides Solutions

The biological microchip is a glass surface covered by an array of tiny gel pads (40x40x20 μm and larger). Each gel pad (64 shown here) represents an individual microchip element and contains a specific, presynthesized oligonucleotide immobilized through a covalent chemical bond.

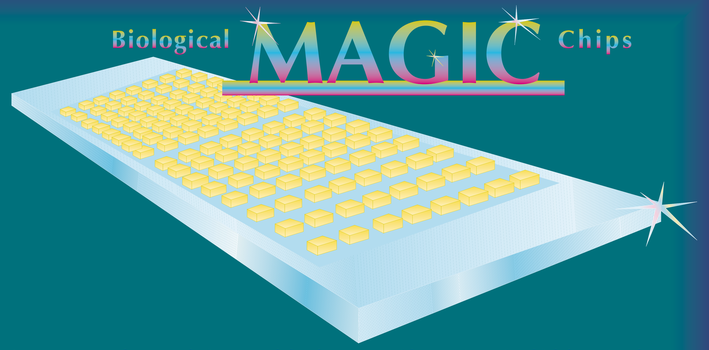
Microchips containing hundreds to thousands of different immobilized oligonucleotides can be manufactured by using a robot specifically designed and developed for their production.

A scientist examines and "reads" a biological microchip using a fluorescence microscope with a charge-coupled-device (CCD) camera, computer, and appropriate software. These microchips can detect a ***single*** base change among the billions of bases of the human genome.



Sequencing by hybridization with oligonucleotide microchips (SHOM): DNA sequence recognition is based on hybridization of unknown nucleic acids with a micro array of gel-immobilized oligonucleotides of known sequence. Presynthesized oligonucleotides immobilized on the microchip elements specifically interact with complementary sequences in the unknown sample and automatically reconstitute the sequence through the designed software program.

Biological MAGIC Chips



Argonne researchers are designing and developing a rapid, sensitive, microbial detection device – a Micro Array of Gel-Immobilized Compounds or MAGIC microchip. Like electronic microchips that treat huge volumes of computer data, these new biological microchips can be built and calibrated to collect and analyze vast amounts of biological information in just a few simple experiments. Argonne microchips will prove extremely useful in:

Biology
- Gene expression, especially responses to mutation
- Comparative sequencing
- Protein identification, especially in response to specific stimuli
- DNA fractionation

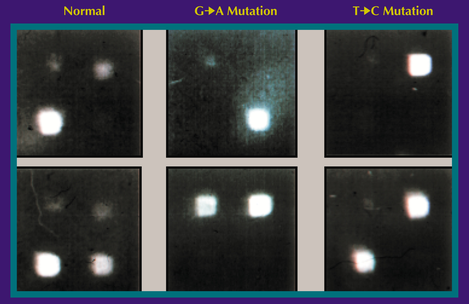
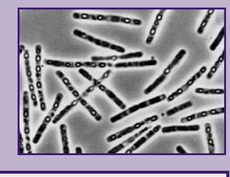
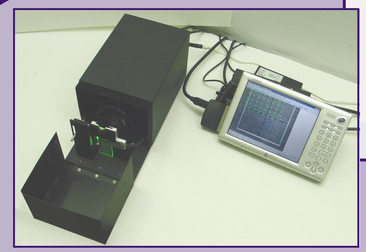
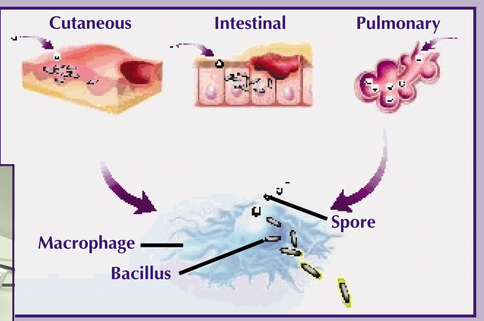
Environment
- Bioremediation/environmental cleanup, especially of microbes
- Agricultural applications (microbial analyses, genetic engineering)

Forensics
- Crime analysis (gene sequence comparisons)

Medicine
- Mutation analysis to diagnose and monitor genetic diseases
- Gene polymorphism studies to match alleles and project disease potential
- Microbial/viral infection (in-hospital, food control, and terrorism)
- Protein analysis on blood and urine (routine health exams)

Space
- Space station microbial/viral control
- Exploration for life forms in outer space

DNA samples from normal individuals clearly hybridize with (and make fluorescent) the lower left element of the 2x2 matrix. In contrast, the fluorescence patterns from β–thalassemia patients (anemics) demonstrate the presence of specific single-base mutations. Individuals may be heterozygotes, with two different genes on each chromosome, or homozygotes.



...Especially to Identify Organisms such as Anthrax