Synthetic Nanopores for DNA Sequencing

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Human Genome Project

- Completed in April 2003 a 3-billion base pair human genome reference DNA sequence

- Disorders Cystic Fibrosis and Sickle Cell Anemia

- DNA sequence affects responses medicines, resistance to infections and toxins.
Why Nanopores?

- Low Cost
- Fast
- Versatile
- Improve human life:
  
  Directly
  ✓ Early detection of potential threats

  Indirectly
  ✓ Correcting harmful mutations
  ✓ Individualized medical approach to genetic diseases.
Why Synthetic Nanopores?

• Compared to Biological Pores Synthetic Nanopores have:

  – Higher Stability
  – Better resistance to chemicals
  – Ruggedness to environmental conditions
  – Superior engineering capabilities
  – Wide selection of material possibilities
How do Nanopores Work?

“Thread a Needle”
Research Goals for Summer 2012
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One of the problems with current configuration:
Rate of Translocation.

• Slow down DNA strand passage through nanopore by chemical and electrical manipulation.
• Expected result is the capacity to achieve a translocation rate with lower bandwidth.
Drilling a Nanopore
Metalizing the Nanopore
Membrane Set up
Drilling a Nanopore

Norcada Silicon Nitride Chip

Norcada Chip at 56x
How TEM creates the pore

Transmission Electron Microscope (TEM)
Finalized Pore

Nanopore at 690 kx
Drilling a Nanopore
Metalizing the Nanopore Membrane Set up
Metalizing the Nanopore

Electron Beam Evaporator
Drilling a Nanopore
Metalizing the Nanopore
Membrane Set up
Membrane Set up

Teflon Structure

Top View

Bottom View
Membrane Set up

Current Measuring System
Negative Voltage

Positive Voltage

Silicon Nitrite Layer

Silver Layer

Gold Layer

Positive Voltage

Negative Voltage
Results
Silicon Nitride Membrane

- E. coli 5700 base pair DNA
- A 4.6 nm pore total translocation took 8 ms.
- Blockage levels 30% of open pore current value.
- Single base pair translocation time 1.75 μs
Future of Research

• Many common diseases such as diabetes, hypertension, deafness, and cancers have more complex causes that may be a combination of sequence variations in several genes on different chromosomes, in addition to environmental factors.

• Some disorders, such as cystic fibrosis (chr. 7) and sickle cell anemia (chr. 11), are caused by base sequence changes in a single gene.
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