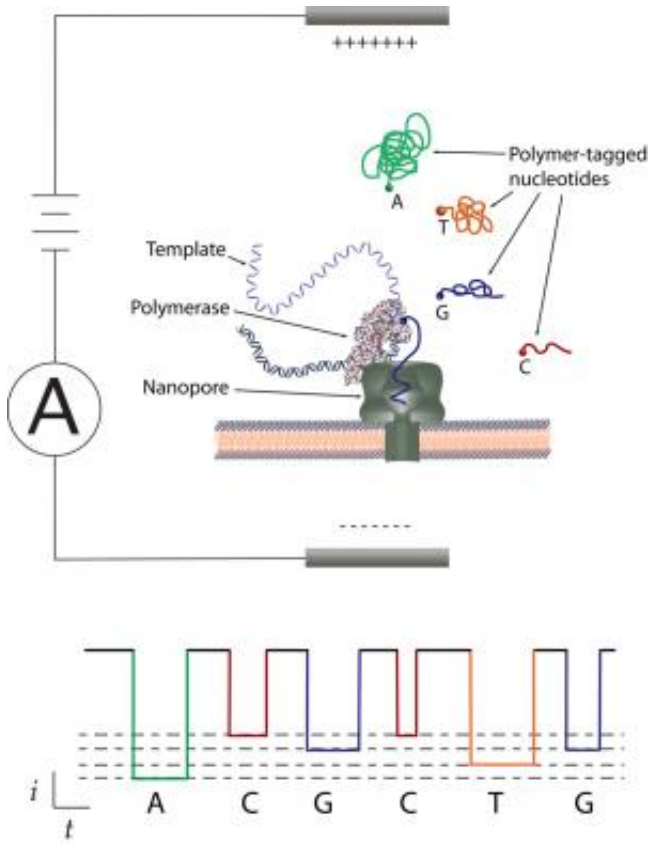
Engineers collaborate on inexpensive DNA sequencing method

October 3 2012



Schematic of an artificial membrane, across which a voltage forces an ionized fluid through the nanopore. Nucleotides on a strand of DNA are first tagged with different-sized polymers, and then the strand is passed near the nanopore opening, where a polymerase cleaves the polymers and passes them one by one through the nanopore. As they pass, the pore produces a unique ionic current blockade signature due to the tag's distinct chemical structure, thereby determining DNA sequence. Credit: NIST

(Phys.org)—Rapid, accurate genetic sequencing soon may be within reach of every doctor's office if recent research from the National Institute of Standards and Technology (NIST) and Columbia University's School of Engineering and Applied Science can be commercialized effectively. The team has demonstrated a potentially low-cost, reliable way to obtain the complete DNA sequences of any individual using a sort of molecular ticker-tape reader, potentially enabling easy detection of disease markers in a patient's DNA.

While sequencing the genome of an animal species for the first time is so common that it hardly makes news anymore, it is less well known that sequencing any single individual's DNA is an expensive affair, costing many thousands of dollars using today's technology. An individual's genome carries markers that can provide advance warning of the risk of disease, but you need a fast, reliable and economical way of sequencing each patient's genes to take full advantage of them. Equally important is the need to continually sequence an individual's DNA over his or her lifetime, because the genetic code can be modified by many factors.

The new method determines DNA sequences by attaching distinct molecular "tags" to each of the four chemical building blocks, or "bases," that comprise the genetic information in a strand of DNA—abbreviated as A, G, C and T. Each of these polymer tags can then be cut from the strand and passed, one by one, through a nanometer-size hole in a membrane. A steady stream of fluid and ions flows through this "nanopore," which is large enough to contain only one tag at a time. As the polymer tags are different sizes, the change in electrical current caused by altered fluid flow shows which of the four bases sits at each point on the DNA strand.

Nanopores and their interaction with polymer molecules have been a longtime research focus of NIST scientist John Kasianowicz. His group collaborated with a team led by Jingyue Ju, director of Columbia's

Center for Genome Technology and Biomolecular Engineering, which came up with the idea for tagging DNA building blocks for single molecule sequencing by nanopore detection. The ability to discriminate between the polymer tags was demonstrated by Kasianowicz, his NIST colleague Joseph Robertson, and others. Columbia University has applied for patents for the commercialization of the technology.

Kasianowicz estimates that the technique could identify a DNA building block with extremely high accuracy at an error rate of less than one in 500 million, and the necessary equipment would be within the reach of any medical provider. "The heart of the sequencer would be an operational amplifier that would cost much less than $1,000 for a one-time purchase," he says, "and the cost of materials and software should be trivial."

Kasianowicz adds that a private company might create a large array of nanopores that can analyze a single individual's genome cut up into many short strands of DNA, each of which could be sequenced quickly. Such an array potentially could provide the low-cost sequencing needed for routine medical use.

More information: S. Kumar, C. Tao, M. Chien, B. Hellner, A. Balijepalli, J.W.F. Robertson, Z. Li, J.J. Russo, J.E. Reiner, J.J. Kasianowicz and J. Ju. PEG-labeled nucleotides and nanopore detection for single molecule DNA sequencing by synthesis. *Scientific Reports* (Nature Publication group). Sept. 21, 2012. doi:10.1038/srep00684

Provided by National Institute of Standards and Technology

Citation: Engineers collaborate on inexpensive DNA sequencing method (2012, October 3) retrieved 18 July 2024 from https://phys.org/news/2012-10-collaborate-inexpensive-dna-

sequencing-method.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.