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DNA computer sets Guinness record

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REHOVAT, Israel, Feb. 24 (UPI) -- The latest entry in the Guinness Book of World Records for smallest biological computing device is a microscopic gadget composed of DNA and enzymes that not only reads DNA for data but uses it as fuel.

Israeli scientists reported Monday that just two spoonfuls could hold up to 30 million billion of such molecular computers, which could perform about 660 trillion operations per second -- nearly 20 times as many as Japan's Earth Simulator, the most powerful supercomputer now active.

"The long-term goal is to eventually create autonomous, programmable molecular computing devices that can operate in vivo, eventually inside the human body, and function as 'doctors in a cell,'" researcher Ehud Shapiro, a computer scientist at the Weizmann Institute of Science, told United Press International.

By detecting biochemical anomalies, the micro-computers could consult "their programmed medical knowledge to direct the synthesis and delivery of biomolecules that serve as drugs," Shapiro explained.

DNA stores both information -- in the form of the genetic code in humans -- and energy. "Nature uses DNA for information storage, but does not exploit it as an energy supply," Shapiro said.

The new device is an advance on a computer made of DNA previously announced by Shapiro and colleagues about a year ago. The device's input, output and "software" are composed of DNA molecules, while the hardware is made of naturally occurring enzymes that can manipulate DNA. When mixed together in a solution, the hardware and software work together, with the enzyme regulating the input according to rules encoded on the software molecule.

All computers need energy, and the research team's previous DNA computer used a molecule called adenosine triphosphate, or ATP, the biochemical whose high-energy phosphate bonds are used by all cells as their standard fuel. In findings appearing online Feb. 24 in the Proceedings of the National Academy of Sciences, the scientists said the enzymes regulating the input molecules can use the energy released to drive calculations.

"Our experiments demonstrate for the first time that we may use a DNA molecule as an input for computation, and at the same time fuel this computation by the energy stored in the very same molecule," Shapiro said. "Such combination, although theoretically conceivable, is practically impossible with conventional electronic computers."

The computer requires very little energy, the scientists said. For example, even the hypothetical spoonful releases less than 25 millionths of a watt as heat. Moreover, the new computer is 50 times faster than before.



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"I would say this is a proof of concept," said IBM researcher Charles Bennett in Yorktown Heights, N.Y. "I think there's a long way to go from doing a particular computation like they propose here to making a general purpose molecular computer that's fast enough and reliable enough and energetically cheap enough to be useful."

Shapiro admitted that the work remains at a very basic stage, but added the researchers hope to create even more powerful devices and perhaps create DNA computers that can work in living cells.

"The main hurdle, which will take a decade or so to overcome, is science's inability to synthesize 'designer enzymes,'" Shapiro said. "Science does not know how to create enzymes that meet our needs."

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(Reported by Charles Choi, UPI Science News, in New York)

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