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Tiny computing machine fueled by DNA

The device was awarded the Guinness World Record for "smallest biological computing device"

Fifty years after the discovery of the structure of DNA, a new use has been found for this celebrated molecule: fuel for molecular computation systems. The research, conducted by scientists at the Weizmann Institute of Science, will appear in this week's issue of Proceedings of the National Academy of Sciences USA (PNAS).

Whether plugged in or battery powered, computers need energy. Around a year ago, Prof. Ehud Shapiro of the Weizmann Institute made international headlines for devising a programmable molecular computing machine composed of enzymes and DNA molecules. Now his team has made the device uniquely frugal: the single DNA molecule that provides the computer with the input data also provides all the necessary fuel.

The source of fuel of the earlier device was a molecule called ATP, the standard energy currency of all life forms. The redesigned device processes its DNA input molecule using only spontaneous, energy releasing operations. It breaks two bonds in the DNA input molecule, releasing the energy stored in these bonds as heat. This process generates sufficient energy to carry out computations to completion without any external source of energy.

A spoonful (5 milliliters) of "computer soup" can contain 15,000 trillion such computers, together performing 330 trillion operations per second with 99.9% accuracy per step. These computers need very little energy (all supplied, as mentioned, by the input molecule) and together release less than 25 millionths of a watt as heat.

The device was recently awarded the Guinness World Record for "smallest biological computing device."

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The study was carried out by Yaakov Benenson, Dr. Rivka Adar, Dr. Tamar Paz-Elizur, Prof. Zvi Livneh and Prof. Ehud Shapiro of the Institute's Biological Chemistry Department and the Computer Science and Applied Mathematics Department.

Prof. Ehud Shapiro's research is supported by the Dolfi and Lola Ebner Center for Biomedical Research, Yad Hanadiv, the Robert Rees Fund for Applied Research and the Samuel R. Dweck Foundation.

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