DNA MEMORY CHIPS

The average human writes 40 million Terabytes of data every day! How? DNA, or Deoxyribonucleic Acid. Through enzymatic reactions, DNA is read, written, and erased, and can store massive amounts of data. Researchers are now using the electrical properties of DNA to develop memory technologies for computational data.

HOW DOES IT WORK?

DNA is the memory storage molecule of all living things. It is two chains of nucleotides that coil around each other to form a double helix. The interactions between the nucleotides of each chain are so strong that scientists can fold DNA in very specific ways at a nanoscale. To do this, short pieces of complimentary DNA “staple” a longer DNA molecule into a new shape. This DNA origami is used as a scaffold to create other molecules or materials.

DNA, IT’S ELECTRIC

DNA nucleotides within the double helix allow electricity to flow. In its natural state, DNA has a high electrical resistance, meaning that electrical current does not flow easily. However, by using DNA origami techniques, researchers can fold DNA molecules into complex molecular structures, or breadboards (see page 2), to improve the conductance so that electricity flows more easily.

This can be harnessed for Read Only Memory (ROM) storage, thus creating a DNA-ROM (see figure above).

WIRING DNA FOR MEMORY

Scientists are taking this one step further by developing nanoscale wires that can send an electrical current through DNA molecules and read the amount of information the molecules hold. They found that different DNA sequences have different conductances and could be used to encode and store computational data. For example, one sequence’s conductance value represents a “1” and another sequence with a different conductance value could be a “0”.

THE BOTTOM LINE

Nanoscale wires harness the power of DNA memory!

THE DNA ELECTRICIANS

Josh Hihath and Yonggang Ke are part of a collaborative, multidisciplinary team to create electrically conductive DNA wires. Josh is an electrical and computer engineer at UC Davis, and Yonggang is a biomedical engineer at Georgia Tech. Together, their work aims to assemble DNA-based memory devices and circuits and develop tools for programming these systems. They are training a new generation of scientists that work at the interface of biology and nano/electrical engineering.

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WORDS TO KNOW

DNA
Double helix of two nucleotide chains that stores genetic information

Nanoscale
Measurement scale where one nanometer is a billionth of a meter

Conductance
The ability of an electrical current to pass through an object

ROM: Read-only Memory
Built-in computer memory that can be read at high speeds but cannot be changed

WHAT'S A BREADBOARD?

Breadboards are fundamental to building a circuit. Originally, people used actual wooden boards for slicing bread to build their circuits. Now you can build your own using online simulators!

Check out this tutorial to build an old school breadboard using materials from your house!

DNA MASTERPIERCES

DNA origami technology is becoming cheaper and faster, allowing scientists to create bigger and bigger nanostructures. One research group even created a nanoscale version of the Mona Lisa! This technology can be used in a range of applications from molecular computation to drug delivery.

TRY IT OUT

Fold your own DNA origami using this tutorial to see the molecule’s unique double helix structure!