# ASU researchers discover DNA-based electronic storage system

By Rithwik Kalale, ASU News
November 7, 2025

At Arizona State University’s Biodesign Institute, researchers are pushing the boundaries of what DNA can do — not just in terms of biological applications, but as a building block for next-generation electronics.

In a new study, Josh Hihath, director of the Biodesign Center for Bioelectronics and Biosensors, along with his team, demonstrated that DNA can function as a fully electronic, chip-integrated memory system.

By precisely controlling how metal ions bind within a DNA molecule, the team was able to create, view and delete digital data on a nanochip they created themselves.

“DNA has long been referred to as a ‘genetic memory,’” Hihath said. “We wanted to create a system that took advantage of DNA’s unique storage capabilities, but in a way that was directly compatible with electronic systems.”

Traditional DNA data storage relies on sequencing, which is a slow, labor-intensive process that isn’t compatible with today’s electronic devices. To overcome this, Hihath’s team developed a new approach that uses DNA’s chemical flexibility to store information electronically.

The system works by inserting metal ions (specifically silver and mercury) between bases in the DNA strand. Depending on the pH and the applied electrical voltage, different ions bind to the molecule, changing its electrical resistance and effectively toggling between three distinct states: +1, 0 and –1.

These reversible changes create a memory system capable of the same functions as a typical electronic storage device, a major step toward integrating biological molecules into solid-state electronics.

“The information in our DNA is stored as metal ions that coordinate with specific bases,” Hihath said. “Changing the gate voltage allows us to shift the pH near the DNA and control which ions bind — letting us write, read and erase data."

Achieving a stable and reusable DNA-based device took years of work. The team used carbon nanotubes as ultra-small electrodes to hold individual DNA molecules in place, allowing them to operate for hours or even days without degradation. In testing, the memory device was cycled 48 times, remaining readable throughout.

"The biggest challenge was developing stable DNA-based devices," he said. "Our carbon nanotube architecture has made that possible."

While the concept of DNA-based memory might sound futuristic, Hihath sees immediate potential in other areas, especially sensing and molecular control.

"DNA could be used as a sensor where the presence of certain analytes triggers a chemical reaction that modifies its electronic properties," he said. "It opens up possibilities in organic chemistry, drug discovery, catalysis and beyond."

Being able to electronically control chemical reactions at the single-molecule level could transform how researchers design nanoscale materials and smart systems.

The project was funded by the National Science Foundation's Growing Convergence Research program, which brings together scientists from different disciplines to tackle complex problems. In this case, chemists, nanotechnologists and electronic engineers joined forces to create something no single field could achieve alone.

"Working with this diverse group has opened us up to new ways of solving problems and thinking about them," he said. "It's been a very rewarding experience."

For Hihath and his team, this research isn't just about creating a new kind of memory, it's about reimagining what's possible when biology and electronics meet.

"It shows we can make stable electronic devices out of DNA, do controlled single-molecule chemistry and read it out electronically," he said. "That's a foundation for real-world DNA-based technologies — and sensing systems may be the first to emerge."

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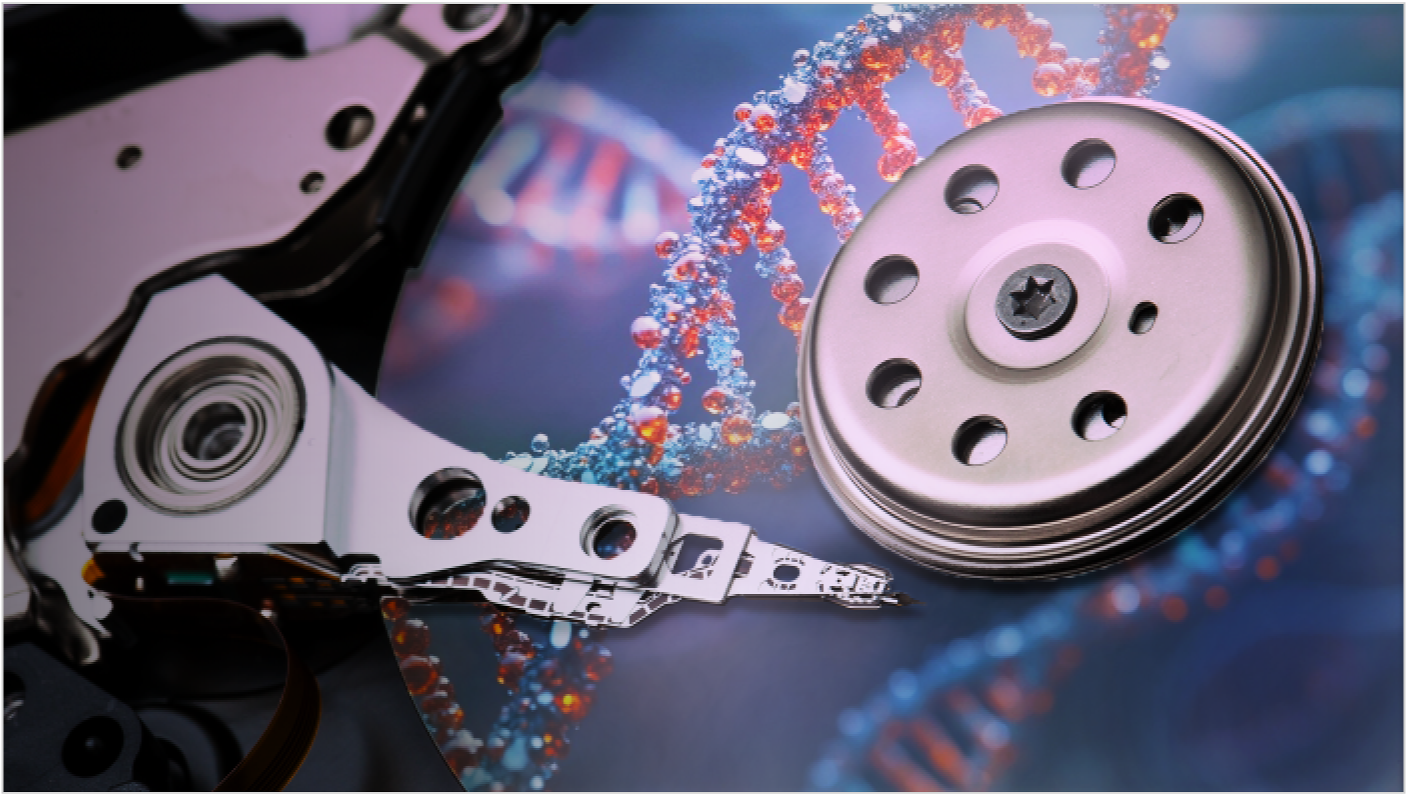
*This story originally appeared on ASU News.*

# Main image



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## Text image(s)

Josh Hihath