LIVE WIRE

Do cells use electricity to repair DNA? Jacqueline Barton aims to find out

By Robert F. Service

I t’s a crazy idea, right?” says Jacqueline Barton. Sitting composedly in her bookshelf-lined office at the California Institute of Technology (Caltech) in Pasadena, she looks the picture of the establishment scientist. But for decades, she has fought a battle with many of her biochemist colleagues over the properties of DNA and, more recently, her unorthodox proposal about how the body repairs damage to this vital molecule.

Up to a million times a day, photons in sunlight, mutagens in food, water, and air, and other assaults damage the DNA molecules coiled inside the nucleus of each cell. A broad family of protein sentinels, acting as repair proteins, manages to find the damage and repair it. A broad family of protein sentinels, acting as repair proteins, manages to find the damage and repair it.

THE NOTION that DNA could conduct electricity actually dates back to shortly after Watson and Crick solved the structure of the molecule in 1953. Chemists noted that the double helix was only part of what made DNA interesting. The sugar and phosphate groups that make up DNA’s “backbone” actually more resemble an exoskeleton, spiraling around a core of nucleotide bases. These base pairs, as binding to Ts and Gs to Cs. Each base contains a ring of atoms, known as an aromatic group, with doughnut-shaped electron clouds above and below each ring. The aromatic groups and their electron clouds overlap, creating what looks like a continuous path for electrons—a molecular wire, if you will. But in the 1950s and 1960s, when chemists looked for signs that DNA conducts electrons, most found nothing.

Barton knew nothing of this history in 1983, when she moved from Hunter College to Columbia University as a young professor. At the time, she was studying the transfer of charges between metal compounds capable of binding DNA at specific sites. In 1985, one of her postdocs, Vijay Kumar (now at the University of Connecticut, Storrs), added some DNA and saw conductivity shoot up, suggesting that, like a wire, the DNA was helping charges move between distant metals. Looking back through the literature, Barton and Kumar spotted the earlier studies. In most of them, researchers were testing DNA that had been isolated, dried, and frozen for easier analysis. “People weren’t looking at DNA under physiological conditions,” Barton says. So she and her colleagues measured DNA’s conductivity at room temperature and in solution and saw unmistakable signs that DNA was in fact ferrying charges over long distances.

In other words, DNA’s ability to transport electricity is not a property of isolated DNA, but rather a property of intact DNA. But when DNA gets damaged, its conductivity drops—a property cells may harness to home in on problems.

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Barton has grown accustomed to critics uncomfortable with her ideas.