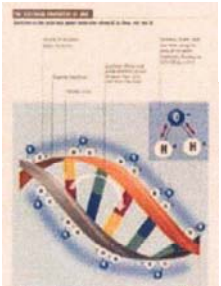
DNA - Celebrating 50 years of the double helix

Electrifying claims for DNA are dashed

By Celeste Biever

Can DNA conduct electricity? Some physicists claim it is a superconductor. Others believe it does not conduct electricity at all. And biologists have agonised about how conductivity might affect its function.

A consensus is emerging. Although the much-hyped molecule can transport electrons over a length of a few base pairs, allowing it to deflect oxidative damage away from important sections (New Scientist print edition, 15 March), it fails to conduct over longer distances. That will dash long-held hopes that the self-replicating molecule could be harnessed to make self-assembling nanowires.



The electrical properties of DNA

Researchers from the University of California, Los Angeles, have hammered the final nail in the coffin with an exhaustive paper submitted to Phvsical Review Letters. Thev show that conduction in a strand of DNA varies directly with humidity, implying that it is the layer of polarised water molecules sheathina the DNA. rather than the DNA itself, that is conducting overlong distances (see graphic).

'DNA has a water layer under practically any conditions. We have systematically changed the number of water layers and shown that the conductivity arises from water molecules, not the electrons on the DNA," says principal investigator George Grunar.

AC/DC

Before now, DNA has been shown to conduct an alternating current, but not direct currents. The UCLA researchers point

out that this is exactly what you would expect if water is responsible for the conductivity.

Water is a polar molecule, across which electrons can shift to produce an alternatina current. But they cannot travel freely from molecule to molecule to produce direct current. The most natural explanation is that the DNA is not conducting at all, says co-author Peter Armitage.

Other research published earlier in March by Phuan Ong, of Princeton University in New Jersey, supports the idea that DNA is an insulator. He removed the water and salt that clings to DNA, then tethered these "clean" strands to gold electrodes. The molecule did not conduct electricity.

Most of the claims for DNA conductivity put forward over the past decade have since been retracted, often after the original researchers realised that water, salts, or even electrodes placed too close to the helix could produce the observed effect. DNA's supposed superconducting properties, reported in Science in 2001, are now thought to have been caused by a layer of rhenium atoms coating the molecule.

Quantum tunnelling

So how can DNA conduct over short distances, but fail over longer ones? The Molecule's short-range conductivity depends on electrons moving between base pairs that run down the centre of the double helix.

To do this, they overcome the associated energy barriers through a quantum mechanical effect known as tunnelling. And according to theory, tunnelling becomes increasingly unlikely as the distances involved grow longer.

All the same. some researchers cling to the idea that DNA could be manipulated to carry a charge. Solid-state physicist Helene Bouchiat of Paris-Sud University and chemist Bernd Giese of the University of Basel say DNA may be a semi-

conductor -a substance like silicon that becomes conductive if doped with atoms containing extra electrons. If so, DNA could still be harnessed to make a conducting wire, they say.

But the UCLA group has given up hope. "Is it also a good candidate for a molecular wire? Our answer is an emphatic no," says Armitage.

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