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Finding physics in the study of DNA

Books
by University Staff

BY DALE BARBOUR
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Physics is no longer the odd man out.

Traditionally the study of DNA has been the terrain of people from the chemistry and biology departments. But over the last ten years researchers have been finding that physics might just offer a new insight into both the function and possibilities of DNA.

Canada Research Chair in Nanoscale Physics Tapash Chakraborty brings together the three sciences in a new book entitled *Charge Migration in DNA: Perspectives from Physics, Chemistry, and Biology*, part of the Nanoscience and Technology series by Springer.

"We're hoping that by bringing together people from three different fields we can provide researchers with some new ways to think about DNA," Chakraborty said. "If you read the biology papers they'll talk about the charge going from one end to another, but they don't care about the mechanism that makes that work. As physicists, we do. And maybe by bringing our techniques to the research we'll be able to benefit biology in the end."

The book is drawn from a series of talks given at the *Charge Migration in DNA* symposium held at the University of Manitoba last year. Chakraborty is editor and contributes to the chapter "Physics Aspects of Charge Migration Through DNA."

As the title suggests, the concept behind the book is that DNA molecules can carry charges, not unlike a copper wire carrying an electrical charge. Although the process isn't nearly as simple.

The ramifications, however, are significant and some of them are already well known to the general public.

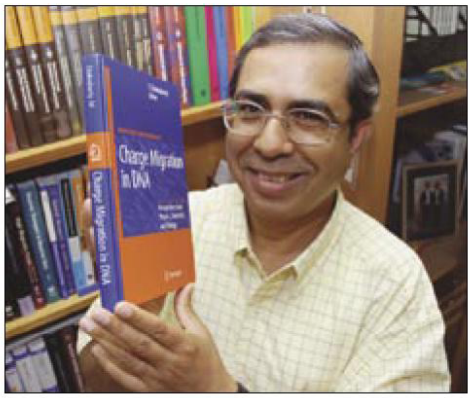

Photo by Dale Barbour

Canada Research Chair in Nanoscale Physics Tapash Chakraborty is expanding the study of DNA with *Charge Migration in DNA: Perspectives from Physics, Chemistry, and Biology.*

"People understand that anti-oxidants are healthy and that they should be eating fruit," Chakraborty said. The science behind that health tip has everything to do with the ability of DNA to carry a charge. When DNA molecules become oxidized, it means an ion has been knocked off the base of the DNA, changing its charge. As that charge transfers through the DNA, it has the ability to pass on the damage to other areas of DNA, eventually creating a DNA mutation. The results can range from cancer to Parkinson's disease to arthritis as well as aging.

"That's where the physics part becomes interesting. We're used to dealing with electronic circuits. The idea that charges can move through DNA is what has brought us together with the other sciences," Chakraborty said. "Maybe if we are able to understand how this oxidation damage propagates through the DNA, we'll be better able to explain how these diseases operate."

While one section of the book is dedicated to the health implications of DNA carrying charges, other chapters deal with the potential technology ramifications. Chakraborty's own research is dedicated to the idea of creating nanodevices – essentially using biological material such as DNA as circuits.

"Nanotechnology is based on the idea that things are shrinking. In computers, miniaturization has been taking place at an incredible rate," Chakraborty said. "What has been happening is that chips are being packed with more and more transistors."

The process has taken computers from the size of rooms to the palm of your hand in a generation. But the process can't go on forever.

"Eventually we'll reach a point where you can't make them smaller through conventional means," Chakraborty said. But DNA is the ultimate nano-circuit, due to its molecular recognition and self-assembling capabilities. "DNA is an important element for nanotechnology. We need to understand its electronic properties. It has not even been clear until now that DNA can conduct charges," Chakraborty said. How the process works and under what circumstance is still a matter of debate. Chakraborty's own lab is working on theoretical models for how the process might work.

It's the sort of approach that might one day lead to computers that are designed at the cellular level.

Charge Migration in DNA: Perspectives from Physics, Chemistry, and Biology is written with upper level graduate students and researchers in mind. Ultimately, Chakraborty said the goal is to draw together the research strength from all the disciplines.