tion in the metabolism of fats. To monitor the presence of these fatty acids in the insulin-sensitive organs (liver, muscles, adipose tissue), the researchers have either fed or injected the patients with chemically-labeled lipids. They will thus be able to determine whether these lipids are oxidized and used as an energy source, or stored in the adipose tissue. In parallel, the researchers will analyze the underlying genetic regulations. The whole experiment will make it possible to monitor the metabolic modifications that result from the lack of physical activity.

In other words, space medicine is not only targeted at a few cosmic adventurers—it could also do wonders for extending life on Earth.

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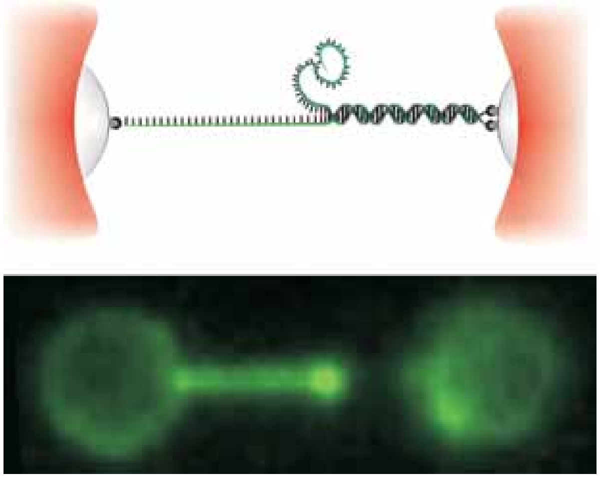
Genetics

DNA Elasticity Unzipped



→ Top: Visual rendition of the experiment. The laser beams of the optical tweezers (red) hold the plastic beads to which a piece of DNA is attached and partially unzipped (left). Bottom: Fluorescent image of the process showing the two beads and the partially unzipped DNA (left).

BY ELIAS AWAD

→ **By mimicking the mechanical constraints exerted on the DNA molecule,** researchers have succeeded in precisely measuring the molecule's response to force.

DNA looks pretty much like a long ladder twisted into a double helix. Present in the cells of all living organisms, the DNA molecule carries every individual's genetic information in the form of a sequence of base pairs that bind together the two strands of the double helix. These bases are of four kinds: adenine (A), thymine (T), cytosine (C), and guanine (G), with A always paired with T, and C with G. During many cellular processes, such as cell division or protein synthesis, the cell's machinery needs to "read" the genetic code. To do so, the double helix is peeled, i.e., "unzipped" into two separate strands. In the process, DNA is subject to stretching and bending, hence the importance of an in-depth description of its mechanical properties.

To investigate how double-stranded DNA responds to mechanical stress, an international team[1] including researchers from CNRS submitted a DNA molecule of known sequence to increasing stretching forces using "optical tweezers."[2]

"We stretched a double-stranded DNA molecule by forces up to 70 picoNewton (pN)," explains Ulrich Bockelmann, head of the Nanobiophysics lab (NBP). "Since both strands were clamped at one end and only one was clamped at the other, the unzipping could occur only at one end and in one direction. It was monitored by detecting the appearance of single-stranded DNA."

"We were surprised to observe that under a low stretching force, below 35 pN, the DNA first overwinds, which leads to tightening of the double helix," says Bockelmann. When the force exceeds 35pN, however, the DNA starts unwinding. Then, at about 65 pN, it suddenly overstretches, gaining 70 % in length for a tiny increase in force. "This is due to the separation of the two strands of the double helix," explains Bockelmann. "It occurs in a step-wise manner because the bonds between A-T bases "melt" more easily than the ones between C-G ones."

This in-depth quantitative study of the mechanical behavior of DNA has led the team to present a new mathematical model of DNA elasticity. It also highlights the importance of measuring mechanical forces to investigate the physics of DNA. This can contribute to a better understanding of how proteins act on DNA *in vivo*, within the cellular machinery.

01. From Amsterdam's VU University (Netherlands), Copenhagen's Niels Bohr Institute (Denmark), and the Laboratoire de nanobiophysique (NBP) (CNRS / ESPCI / Paris Tech).
02. P. Gross et al., "Quantifying how DNA stretches, melts and changes twist under tension," *Nature Physics*, 2011. 7: 731-6.

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