Calcium helps build strong cells

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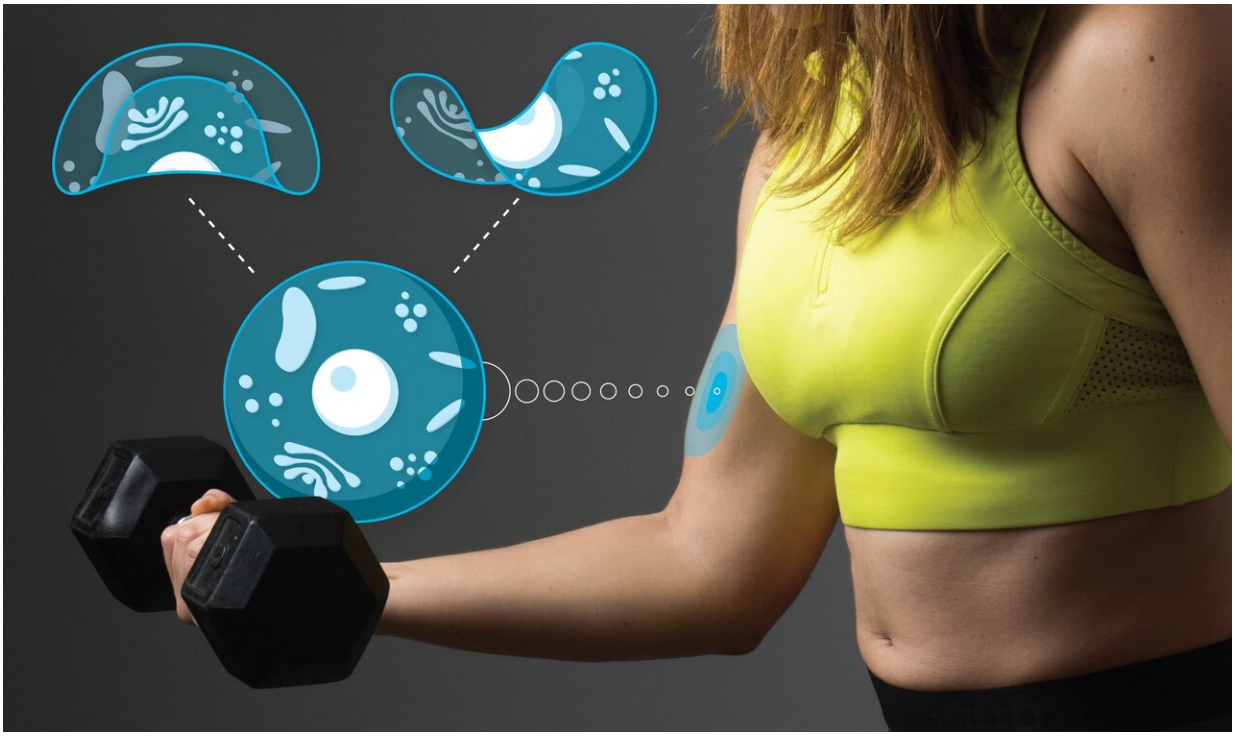

Credit: Carnegie Mellon University, Department of Chemical Engineering

Every time you flex your bicep or stretch your calf muscle, you put your cells under stress. Every move we make throughout the day causes our cells to stretch and deform. But this cellular deformation can be dangerous, and could potentially lead to permanent damage to the DNA in our cells, and even cancer. So how is it that we're able to keep our bodies moving without constantly destroying our cells? Thanks to a new

study by Carnegie Mellon University Chemical Engineering (ChemE) Professor Kris Noel Dahl, and Associate Professor Sara Wickström of the University of Helsinki, we now know that the answer lies in a humble mineral we consume every day.

"Basically, every time we flex a muscle, we're risking DNA damage that could lead to cancer," says Dahl. "Or we would be, that is, if it weren't for the calcium in our cells."

Their recent paper published in *Cell* marks the first time that researchers have definitively shown how cells maintain their structural integrity despite the strain of mechanical forces.

"As cells stretch and compress through the course of our daily activities," says Dahl, "they have to rearrange their internal structures to compensate. Our study found that they are able to do this through the use of calcium. It's kind of like when you're tying a bow in a ribbon. When you have to shift your hands, you ask someone to put their finger on the knot to hold it in place and make sure it doesn't come apart. For our cells, that 'finger' is calcium."

In particular, calcium is essential in protecting the nucleus of the cell and the DNA it contains. When mechanical stretch acts on the cell, it deforms the nucleus, putting the DNA inside at risk. Healthy cells are able to counteract this deformation using a calcium-dependent nuclear softening, which allows the nucleus to stretch without breaking. But failure to mount this response can result in DNA damage, which can lead to cell death, loss of proper cell function, or in extreme cases, cancer.

"Our colleagues who research materials science are often trying to find materials that are force-responsive," says Dahl. "But here we've found actively responding materials inside of living cells. Not only is there the quick response using calcium, but there's also the longer-term response

that cells use to withstand persistent, high-amplitude stretch, by changing the epigenetics of the cell. This has exciting implications for how cells respond genetically, as well as how tissues respond mechanically."

"This entire research project is truly a testament to the collaborative spirit here at Carnegie Mellon," says Dahl. "The project was conceived during a conference in Singapore, where Professor Wickström and I met. We gathered the data using a microscope in Finland, and analyzed it here at Carnegie Mellon using algorithms we developed in Pittsburgh. This is a truly global collaboration, the kind that the culture of CMU really encourages."

Next, the researchers will use this new understanding of how cells respond to stretch to consider what happens to cells during the aging process. As we age, our cells and tissues don't deform as well as they used to, and the consequences of this reduced deformation can lead to an increased risk of cell damage. The question is, do cells not deform as well because they are stiffer, resulting in cellular dysfunction? Or does cell dysfunction lead to reduced deformation? The next step will involve studying cellular deformation at different points throughout the aging process, to determine if it's possible to interrupt this cellular stiffening, and improve cell function during as we age.

More information: Michele M. Nava et al. Heterochromatin-Driven Nuclear Softening Protects the Genome against Mechanical Stress-Induced Damage, *Cell* (2020). DOI: 10.1016/j.cell.2020.03.052

Provided by Carnegie Mellon University, Department of Chemical Engineering

https://phys.org/news/2020-06-calcium-strong-cells.html