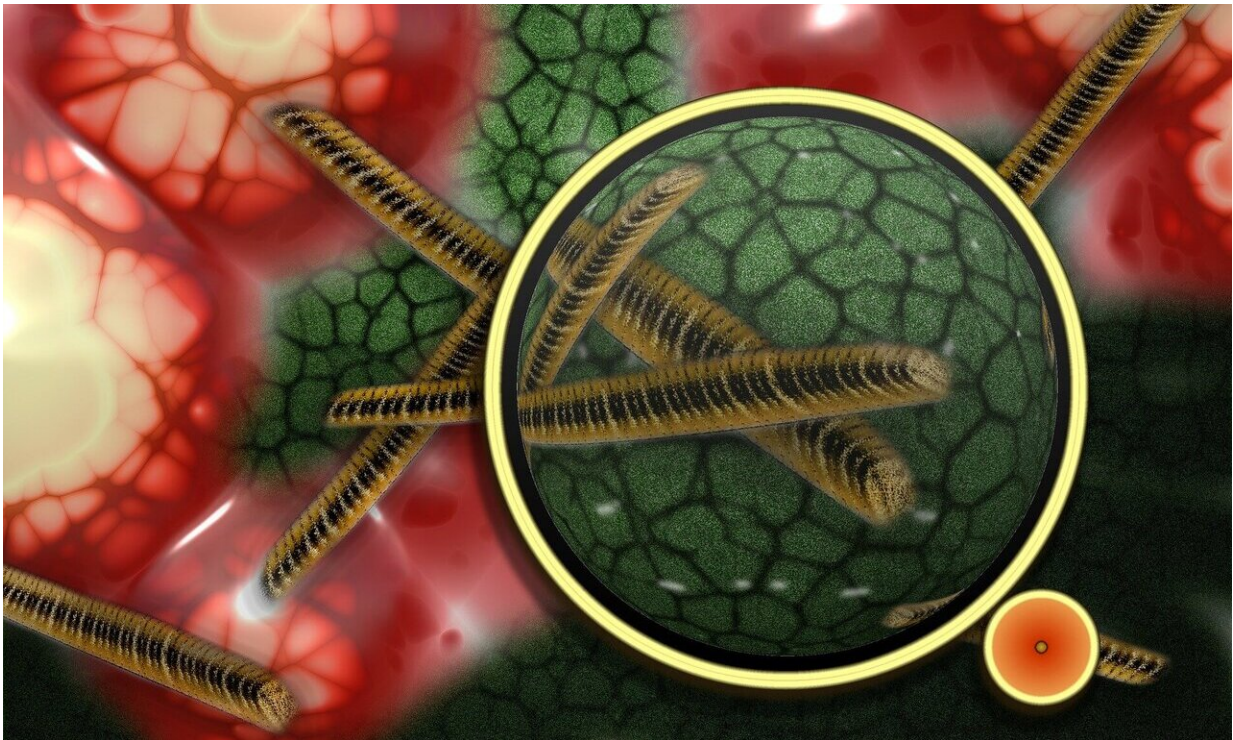


# Physical forces affect bacteria's toxin resistance, study finds

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A random conversation between two Cornell researchers at a child's birthday party led to a collaboration and new understanding of how bacteria resist toxins, which may lead to new tools in the fight against harmful infections.

Physical forces have been known to affect how cells in our body grow and survive, but little has been understood about the role these forces play in prokaryotes—single-cell organisms, including bacteria.

Christopher Hernandez, associate professor in the Sibley School of Mechanical and Aerospace Engineering, had an idea for a [microfluidic device](#) that would subject individual bacteria to known amounts of force and mechanical deformation. But he knew of few ways to measure the effects—until a chance encounter with Peng Chen, the Peter J.W. Debye Professor in the College of Arts and Sciences' Department of Chemistry and Chemical Biology.

Chen had developed a way to tag and observe a specific molecule that pumps toxins from the inner membrane of certain bacteria. By putting their ideas together, the researchers have shown conclusively that mechanical stresses can interrupt the ability of bacteria to survive exposure to toxins.

Their paper, "Mechanical Stress Compromises Multicomponent Efflux Complexes in Bacteria," published Nov. 26 in the *Proceedings of the National Academy of Sciences*.

Gram-negative bacteria are characterized by their dual-membrane cell envelope and have the ability to assemble molecular pumps to rid themselves of toxic substances that manage to migrate into the cell, including antibiotics.

Hernandez and Chen's research showed that when *E. coli* bacteria were placed into a microfluidic device and forced to flow into very tight spaces, the resulting [mechanical stresses](#) alone were enough to cause these pumps to break apart and stop working.

"This is one of the first studies to look at the mechanobiology of

bacteria," Hernandez said. "Our findings provide evidence that bacteria are similar to other types of [cells](#) in that they respond to mechanical forces through molecular complexes."

"Our work shows that you can disrupt the pump complex of [bacteria](#) with mechanical means," Chen said, "and this may give us a new tool to enhance treatments of bacterial diseases."

The methodology Hernandez and Chen created can be used to examine all sorts of prokaryotic cell structures, functions and behavior.

"This creative, collaborative research effort, which exploits capabilities in single molecule biology, will provide the Army with a better fundamental understanding of not only the cellular features that keep microbes alive, but how mechanical stress at the cellular level can control bacterial viability and thus provide a novel potential means of controlling bacterial infections," said Robert Kokoska, program manager for microbiology at Army Research Office, an element of U.S. Army Combat Capabilities Development Command's Army Research Laboratory that supported the research.

**More information:** Lauren A. Genova et al. Mechanical stress compromises multicomponent efflux complexes in bacteria, *Proceedings of the National Academy of Sciences* (2019). [DOI: 10.1073/pnas.1909562116](#)

Provided by Cornell University

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