Scientists observe bacteria tumble their way out of surface traps

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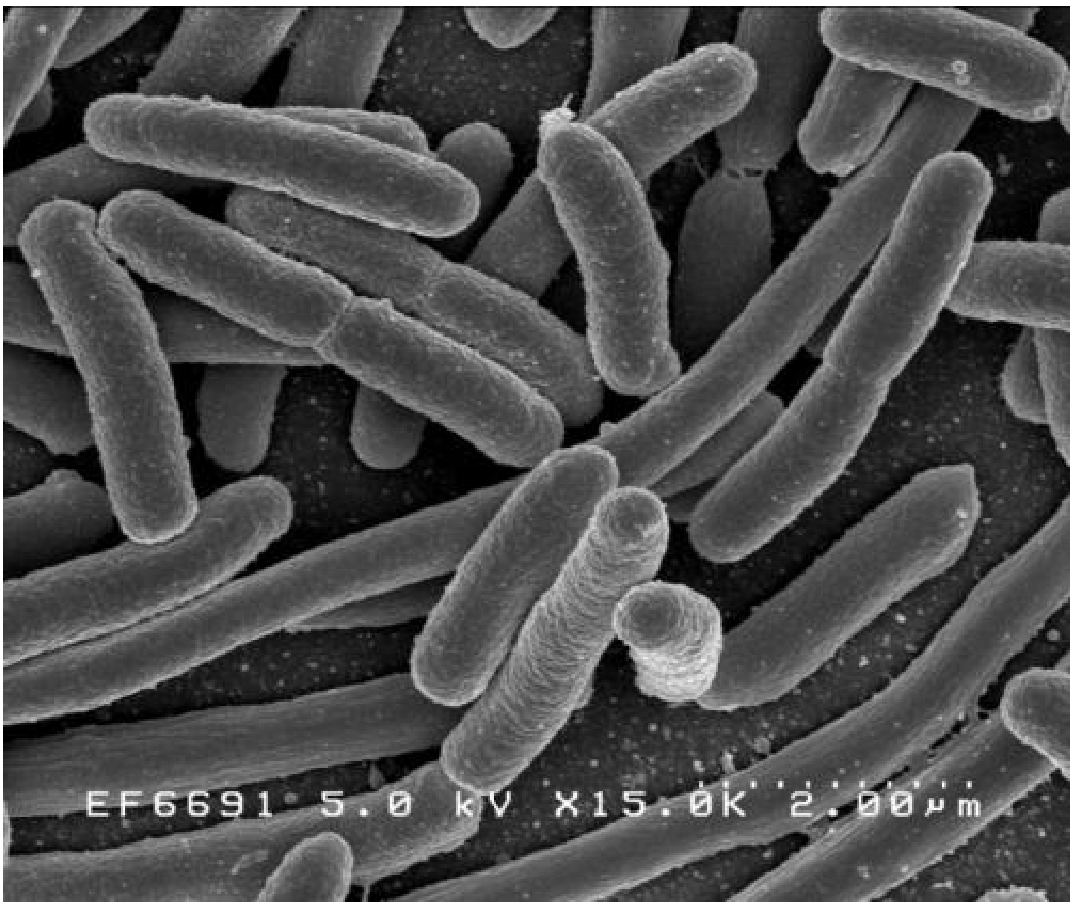

Escherichia coli. Credit: Rocky Mountain Laboratories, NIAID, NIH

While tracing the movement of *Escherichia coli*, a team of French researchers noticed that near solid surfaces, the bacteria run in circles. Loop after loop, the tracing almost looks like an Olympic figure skating rink before the Zamboni irons the sheet of ice smooth. Breaking down *E. coli*'s routine step by step, the scientists identified a signature move—surface tumbling. The work appears May 5 in the *Biophysical Journal*.

Bacteria can live as individuals, swimming freely around the environment, but eventually, they settle down on surfaces to form colonies and biofilms. To do so, bacteria randomly tumble to slow down and re-orientate themselves three-dimensionally, to explore and find the ideal environment.

"Tumbles are very interesting. The bacteria itself does not know where the environment is preferential for them," says first author Laurence Lemelle, a biophysicist at École Normale Supérieure de Lyon (Normal School of Lyon). "It doesn't know where to go, how to feel things. But it knows if the past environment was better or worse than the present." Bacteria use the gathered information to stop tumbling or lower the frequency of tumbling. "This means you swim more towards a direction. At the end, the population statistically swims towards the preferential conditions," she says.

Some studies claim that bacteria don't tumble and only swim when they're near a surface. But Lemelle and her colleagues say that claim sounds unlikely. Physics predicts that bacteria would get trapped, running in infinite circles on the surface if they only swam.

However, it's not easy to track these tiny creatures. Propelling forward with their several tails known as flagella, bacteria swim 20 times the length of their body in one second, and tumble happens even quicker, at one-tenth of a second. In fact, you're likely to miss the tumble even if your camera is high-res enough to film bacteria. To take a close look at how bacteria escaped from the surface, the team built a high-magnification, high-sensitivity, high-speed camera equipped with night vision.

The recording showed that when the bacteria swim near the surface, the water friction on the body near the surface causes the trajectory to bend. To prevent being trapped running in circles on the surface, the bacteria tumbles. It decelerates, and one of the flagella jiggles out of place, reorienting where it was heading. In some cases, like swimmers pushing off a pool wall, the jiggling flagella kicks on the surface, resulting in a sharper turn. The wild flagellum then returns to the bundle, accelerates the bacteria, and goes back to swimming.

"We now know that bacteria can tumble on surfaces, and these tumbles are very specific," said Lemelle. "Elucidating the strategy of surface exploration that is underlined by these tumbles is an important future step."

To the bacteria, tumbling allows them to escape from the surface, enabling them to colonize other places and optimize the exploration of the surface itself. Bacteria can swim on cell surfaces until they get in contact with a specific receptor to optimize infections. They can also swim to settle down on surfaces that are difficult to clean to form bacterial biofilms, which can be antibiotic-resistant.

"Before the pandemia, the COVID pandemic, it was difficult to convince people that we need to anticipate and develop alternative approaches to reduce the surface biocontamination," said Lemelle. "People were like, 'We have plenty of antibiotics. There's resistance, but we have time.' From a medical standpoint, understanding the near-surface tumbling events of bacteria can help limit the biocontamination of surfaces and develop antibacterial methods."

More information: *Biophysical Journal*, Lemell et al.: "Tumble Kinematics of Escherichia coli Near a Solid Surface" www.cell.com/biophysj/fulltext … 0006-3495(20)30274-5 , DOI: 10.1016/j.bpj.2020.03.024

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