Cells Show "Personality" When They Move

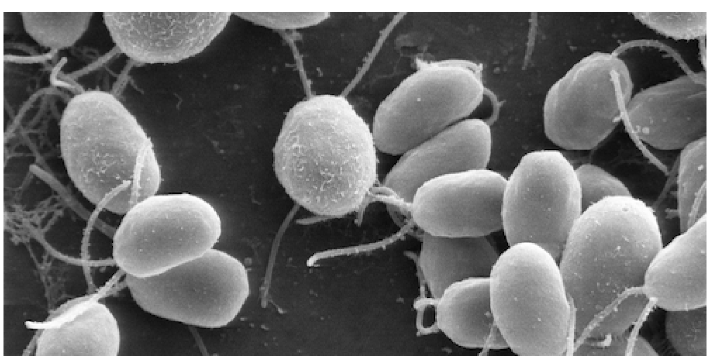
A study of cellular motion demonstrates a method for isolating individual cellular behavior from environmentally induced random motion.

By Michael Schirber

Certain cells—such as bacteria and tumor cells—can move on their own, but their net motion is a mix of internal action and environmental noise. Roland Netz from the Free University of Berlin and his colleagues have now shown that these factors can be separated in motion-tracking data for swimming algae cells and crawling cancer cells [1]. Surprisingly, the genetically identical cancer cells exhibited a diverse range of self-driving behavior, suggesting that DNA does not preordain all their activity.

The motion of a tiny bead in a glass of water is a random walk. The water molecules bump into the bead, pushing it this way and that. This so-called Brownian motion can be described mathematically with the Langevin equation, which expresses the acceleration of the bead as the sum of a velocity-dependent friction term and a random noise term.

But what happens when the object drives itself? Netz and his colleagues have been working on this type of active-matter problem using the generalized Langevin equation, in which the friction term is replaced with a more complicated function called the memory kernel [2]. This kernel encapsulates the different factors that influence the object—both at present and in the past.



Credit: Dartmouth Electron Microscope Facility, Dartmouth College

The team first measured the motion of three sets of objects: unicellular algae, breast-cancer cells, and plastic beads. Using methods that Netz's group had previously developed, they extracted from the data a memory kernel for each individual object. Among the active cells, the spread in the kernels was large. "Initially, we don't know if this spread is from the cells being different from each other, or if it's just from randomness," says Netz's Free University colleague, Anton Klimek.

The researchers ran simulations based on the extracted kernels and showed that they could isolate the spread attributable to cell-to-cell variations. Even though the cancer cells all came from the same cell line, they exhibited a similar amount of variation as the genetically diverse algae cells did. The finding agrees with biological studies that have shown that the gene sequence is not alone in determining behavior. "A cell goes through different stages and experiences a different microenvironment as it develops," Netz explains. The researchers speculate that their data-analysis methods could form the basis of a noninvasive way to study cell response to drugs or other environmental factors.

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REFERENCES

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