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Life in a Tight Spot: How Bacteria Swim in Heterogeneous Media[1] SUJIT DATTA, TAPOMOY BHATTACHARJEE, DANIEL AMCHIN, JENNA OTT, FELIX KRATZ, Princeton University — Diverse processes in healthcare, agriculture, and the environment rely on bacterial motility in porous media; indeed, most bacterial habitats—e.g., biological gels, tissues, soils, and sediments—are heterogeneous porous media. However, while bacterial motility is well-studied in homogeneous environments, how confinement in a porous environment impacts bacterial transport remains poorly understood. To address this gap in knowledge, we combine microscopy, materials fabrication, and microbiology to investigate how *E. coli* moves in 3D porous media. By probing single cells, we demonstrate that the paradigm of run-and-tumble motility is dramatically altered by pore-scale confinement. Instead, we find a new mode of motility in which cells are intermittently and transiently trapped as they navigate the pore space; analysis of these dynamics enables prediction of bacterial transport over large length and time scales. Further, by developing a new 3D printing approach, we design multi-cellular communities with precise control over the spatial distribution of bacteria. Using this approach, we show that concentrated populations can collectively migrate through a porous medium—despite being strongly confined—and develop principles to predict and direct this behavior.

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