Civil Engineering and Engineering Mechanics

Seminar Announcement
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Forces and movements in crowded environments: from tumor cells to penguin huddles

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Abstract

Emperor penguins in a huddle are packed so tightly that individual movements become impossible, reminiscent of a jamming transition in compacted colloids. It is crucial, however, that the huddle structure is continuously reorganized to give each penguin a chance to spend sufficient time inside the huddle, compared with time spent on the periphery. Emperor penguins solve this problem by moving collectively in a highly coordinated manner to ensure mobility while at the same time keeping the huddle packed. Our data show that the dynamics of penguin huddling is governed by intermittency and approach to kinetic arrest in striking analogy with cells migrating through a 3-dimensional (3-D) environment that imposes a high steric hindrance. 3-D environments that are frequently used to study tumor cell migration are biopolymer matrices such as self-assembled collagen, fibrin, or Matrigel networks and gels. The mechanical properties of such gels are characterized by strain stiffening under shear and strong lateral contraction under stretch. Time-lapse force microscopy reveals that cells migrate through the 3-D biopolymer network of a collagen gel in a gliding motion with alternating phases of simultaneously high or low contractility, elongation, migratory speed, and persistence. Furthermore, 3-D cell migration is enhanced by a higher network stiffness, opposite to cell behavior in 2-D, as long as the pore size does not fall below a critical value where it causes excessive steric hindrance. These findings reveal fundamental differences in the migration behavior of cells in a 2-D versus a 3-D environment, as well as large differences in the migration strategies between common tumor cell types.

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