A particle dynamics model of cell-cell rotation and morphological behavior

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ABSTRACT

In this talk, I introduce and describe a particle-based biological model, incorporating ideas from dissipative particle dynamics, elastic mechanics and force-based heuristics, to explain the persistent rotation between adherent cell-cell pairs cultured on micropatterned substrates [1]. This biological observation is particularly interesting, because the rotation of such cell-cell pairs runs in the opposite reference frame from what is predicted from classical theories of single cell locomotion [2]. The reason for this exceptional behavior has not been addressed previously.

In the present model, I show how particle dynamics can apply known biophysical parameters, including actomyosin forcing, viscous dissipation and cortical tension, to physically explain this curious rotational behavior. Without any artificial cues, the model spontaneously and consistently reproduces the same rotational reference frame as observed experimentally. This result corroborates the hypothesis that both rotational and morphological phenomena are, in fact, physically coupled by an intracellular torque of a common origin. Subsequent analyses then characterize the physical conditions upon which such behavior can be expected. As a computational tool, this particle based approach utilizes efficient and physically consistent concepts to explain multicellular dynamics, and I advocate its use as a complement to classical biological modeling tools, such as the Cellular Potts method.

REFERENCES

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