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Author: Rhee, Jerry
Mohammad Nejad, Talisa
Comets, Olivier
Flannery, Sean
Gulsoy, Emine Begum
Iannaccone, Philip
Foster, Craig

Title: Promoting convergence: the phi spiral in abduction of mouse corneal behaviors

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Abstract: Why do mouse corneal epithelial cells display spiraling patterns? We want to provide an explanation for this curious phenomenon by applying an idealized problem solving process. Specifically, we applied complementary line-fitting methods to measure transgenic epithelial reporter expression arrangements displayed on three mature, live enucleated globes to clarify the problem. Two prominent logarithmic curves were discovered, one of which displayed the ϕ ratio, an indicator of an optimal configuration in phyllotactic systems. We then utilized two different computational approaches to expose our current understanding of the behavior. In one procedure, which involved an isotropic mechanics-based finite element method, we successfully produced logarithmic spiral curves of maximum shear strain based pathlines but computed dimensions displayed pitch angles of 35° (ϕ spiral is ~17°), which was altered when we fitted the model with published measurements of coarse collagen orientations. We then used model-based reasoning in context of Peircean abduction to select a working hypothesis. Our work serves as a concise example of applying a scientific habit of mind and illustrates nuances of executing a common method to doing integrative science.

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