Embryonic Cleavage Modeling as a computational approach to Sphere Packing Problem.

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Embryonic cleavage depends on the distribution in the cytosol of molecular signals that influence mitotic spindle positioning. By implementing the New Kind of Science (NKS) theory in which a simple rule can evolve with a complex overall behavior, here we propose a new theoretical approach that is capable of modeling the mechanisms of early embryonic cleavage dynamics. The model shows that the same spindle pole orientation rule governs the first three embryonic cleavages, which progressively allow the transition from one to eight daughter cells. However, likely due to the establishment of an apical-basal cell polarity, the fourth cleavage that allows the transition from eight to sixteen cells needs a change of spindle pole orientation and position. Finally, we present evidence of a strong similarity between Kepler’s Sphere Packing Problem and embryonic cleavage, which thus represents a prominent example of natural computing.

References