The origin and evolution of animal morphogenesis: insights from our closest relatives

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All animals are characterized by a recognizable, species-specific adult shape, which results from a controlled process of morphogenesis during embryonic development. Morphogenesis relies on a small core set of cellular mechanisms: cell adhesion, migration, division, deformation, and apoptosis. The mechanisms that shape animal embryos did not always exist, but gradually evolved as their single-celled ancestors successively acquired multicellularity, development, and cell differentiation more than 600 million years ago. While the origin of animals has only left few fossil traces, insights can be gained by the study of modern groups. In recent years, important concepts have emerged from the study of choanoflagellates, the closest living relatives of animals.

Choanoflagellates are free-living aquatic protists that possess multiple features informative on the origin of animal development: they display a polarized cell architecture (with apical flagellum and microvilli) reminiscent of that of epithelial cells; their genome encodes an animal-like developmental molecular toolkit (including cadherins, integrins, collagens, actomyosin and its regulators); and they can facultatively develop into multicellular colonies that resemble early animal embryos. Our work combines functional genetics and high-resolution imaging to understand how choanoflagellate cell shape is generated, how shapes of individual cells underlie emerging multicellular shapes and behaviors, and how these findings inform our understanding of the origin of animal morphogenesis.