

Regulation and interpretation of morphogen signaling in spinal cord development

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In the developing vertebrate neural tube, opposing morphogen gradients regulate dorsoventral patterning and tissue growth. We combine quantitative assays in embryos and organoids with biophysical modeling to investigate the control and interpretation of morphogen signaling dynamics in the neural tube. In recent work, we developed geometrically constrained two-dimensional organoids in which dorsal neural tube patterning self-organizes. Pattern formation depends on the emergence of BMP and Wnt signaling gradients with characteristic biphasic temporal dynamics. We show that these dynamics arise from coupled negative and positive feedback on ligand production. Cells interpret the resulting signaling trajectories to specify distinct cell fates at defined developmental times. Our results reveal regulatory principles governing morphogen-producing domains in the neural tube and demonstrate how temporally ordered pattern formation can emerge from dynamic signaling.