A MATHEMATICAL APPROACH TO NEURULATION

MONIQUE CHYBA, FREDERIC MERCIER, AARON TAMURA-SATO

All vertebrate animals, including humans, produce new neurons and glia (the two primary specialized cell types of the brain) throughout life. Neurons and glia derive from neural stem cells, which reside, proliferate, and differentiate in specialized zones termed niches. Neural stem cells proliferate extensively during development and progressively generate the brain, a phenomenon named neurulation, or brain morphogenesis. What are the mechanisms that control neural stem cell proliferation and differentiation? F. Mercier and colleagues have characterized extracellular matrix structures, named fractones, in the neural stem cell niches of the adult and developing brain. In these niches, fractones directly contact neural stem cells and their immediate progeny. Inspired by these biological discoveries, we are developing a mathematical model predicting cellular proliferation from the spatial distribution of fractones. We model this biological process as a control system, the control depicting the spatial distribution of the active fractones. This is a novel approach with respect to the most commonly reaction-diffusion (R-D) models seen in the literature on morphogenesis.