Chemotactic cell movement during Dictyostelium development and chick gastrulation

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Development is critically dependent on a number of distinct cellular behaviours such as cell division and cell death, cell differentiation and cell movement, which all have to be precisely controlled in space and time. We investigate the molecular mechanisms by which cells signal each other during development and furthermore how cells detect these signals and translate this information in directed coordinated movement. We study these questions in two different experimental systems, the social amoebae *Dictyostelium discoideum,* a simple genetically tractable micro-organism showing a relatively simple starvation induced multicellular development.

In Dictyostelium starvation for food induces the aggregation of thousands of individual amoebae into a multi-cellular aggregate. During aggregation the cells differentiate into a number of distinct celltypes, which form a migrating slug that transforms into a fruiting body consisting of a stalk supporting a mass of spores. The chemotactic aggregation of the cells is controlled by propagating waves of cyclic-AMP emanating periodically form aggregation centres. Experiments show that also in the multicellular stages the migration of the cells is controlled by propagating waves of cAMP. We use continuous and discrete models to investigate the relationship between signalling and movement to understand the dynamical interactions that result in the morphogenesis of this organism.

We also investigate the role of chemotaxis in the control of gastrulation movements in the chick embryo. During gastrulation the mesoderm and endoderm cells move into the embryo to take up their correct topological positions. We have tracked the migration of mesoderm cells, expressing fluorescent proteins, during gastrulation in the chick embryo and show that their movement is controlled by a combined action of chemo-attractants and repellents, controlled by members of the Fibroblast Growth Factor (FGF) family of growth factors. We have also visualised extensive cell flows occurring in the epiblast during the formation of the primitive streak, the site of invagination of the mesoderm and endoderm cells. Our current hypothesis is that formation of the primitive streak also involves a combination of chemo-attractants and repellents. We have started to use different modelling approaches to analyse the control of cell movement during the formation of the primitive streak.

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