

Molecular Mechanisms of Heart Development in the Tunicate *Ciona*

In the gastrulating tunicate embryo, only two pairs of mesodermal cells near the vegetal pole represent the heart lineage. Each side of the embryo contains a pair of B8.9 and B8.10 blastomeres that express the *Mesp* transcription factor, just like the cardiac precursor cells of vertebrates (see Figure 20.12; Davidson et al. 2006). During neurulation, each of these four cardiac founder cells divides asymmetrically to produce a small cell that generates the cardiac precursors and a larger cell that generates anterior pharyngeal muscle precursors. The anterior tail cells do not migrate, but they express retinaldehyde dehydrogenase and initiate a retinoic acid gradient that specifies the heart cells as in vertebrate embryos.

Moreover, as in the vertebrate cardiac precursors, it appears that FGF signaling is critical for the production of heart cells, with FGF signals combining with *Mesp* to induce the expression of the *Nkx2-5*, *Gata*, and *Hand*-family transcription factors (Davidson and Levine 2003; Simões-Costa et al. 2005). When the cardiopharyngeal precursor cell divides, the cell that remains bound to the extracellular matrix of the epidermis retains the FGF receptors, while the cell that does not adhere to the epidermis internalizes and degrades such receptors. As a result, the cell attached to the epidermis can respond to FGF and become the heart precursor cell, while the cell without FGF receptors cannot respond to the paracrine factor and produces pharyngeal muscle instead (Cota and Davidson 2015).

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