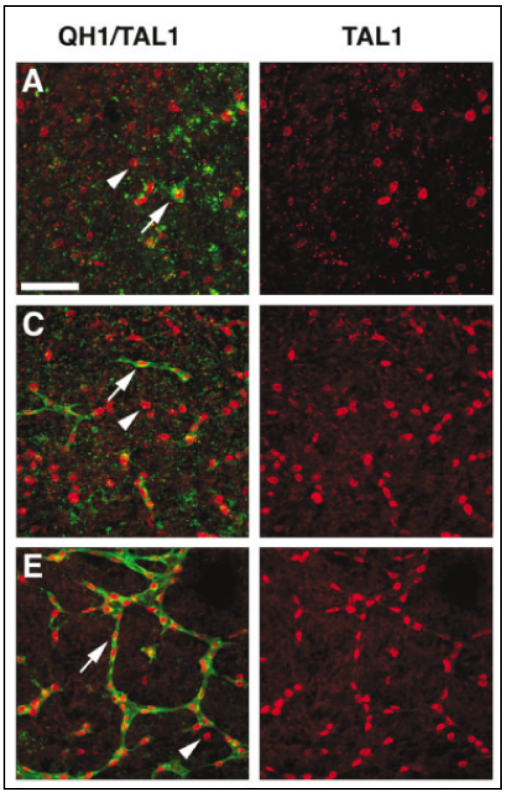
Assignment: Vascular Patterning

Vasculogenesis

Vasculogenesis is the *de novo* formation of blood vessels during embryogenesis.

When angioblasts (endothelial cell precursors) differentiate from the mesoderm, they appear as isolated cells or small clusters.

Rapidly afterwards, they coalesce to form a network of endothelial cells (see figure).



Vascular endothelial growth factor (VEGF) is known to be a critical factor in this process, both during differentiation and network morphogenesis. For example, it has been shown that VEGF acts as a potent chemoattractant to guide cell motility. However, the mechanisms by which VEGF regulates the coalescence of angioblasts are still debated.

Mathematical models

Two competing models (here called model A and model B) have been proposed that can both explain the formation of networks from isolated cells. Both have been formulated in terms of a cellular Potts model (representing cells) coupled to a reaction-diffusion model (representing molecules).

Assignment

Describe the biological mechanisms that underlie both models.

- Explore the difference between the Morpheus models.
- Write down the PDEs for both models.
- Interpret the PDEs in terms of biological processes.
- Describe the differences between the two models.

Describe methods to validate/falsify the two mechanism.

- Describe 2 or 3 (wet-lab) experiments that could establish which mechanism is a more plausible explanation.

- Perform sensitivity analyses for 3 key parameters of the mathematical models.
  For this, use the ParamSweep function in Morpheus:
  - Right-click on a parameter
  - Open ParamSweep pane
  - Enter range of values for parameter
  - Start parameter sweep (press start while in ParamSweep pane)

- How do the two models differ in terms of the predictions they generate? And how can these be tested experimentally?