Modeling lung branching morphogenesis

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October 8, 2012

Abstract: Our lung forms tree-like structure during development. This structure is useful in maximizing the surface area of gas exchange. During development, the lung consists of two components, the epithelium and mesenchyme, and molecular interactions of these two tissues are supposed to be important to form branched structure. Various molecules are known to be involved in this process, but how their interactions results in branched structure remain to be elucidated.

At first we consider simple experimental situation where isolated epithelial tip is embedded in Matrigel (biological material which is similar to extracellular matrix in vivo). By adding extracellular signaling molecule called fibroblast growth factor (FGF) in the culture medium we can reproduce the branching morphogenesis in vitro. This situation can be modeled with two-species reaction-diffusion model with nonlinear growth. Next, we simplified the epithelial-mesenchymal molecular interactions and formulated a model that consists of interface equation coupled with convolution kernel of FGF10 production. The models can reproduce the branching morphogenesis in vivo. We are now planning to extend the the model to reproduce three-dimensional branch pattern.

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