CDB SEMINAR

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15:00 – 16:00 Auditorium C1F

Modeling stratified epithelium: cell lineage and linearized hydrodynamics

Summary

Although it has been known that cell differentiation plays an important role in tissue development and regulation, the biological details of cell differentiation are still poorly understood. Several kinds of cell differentiation models have been presented for different tissues, and it is interesting to study the basic differences between these models. In this work, we consider stratified epithelium, a multilayered self-renewal tissue, and build up a minimal model which includes the spatial information and cell lineage dynamics. We numerically and analytically solve the homeostasis state and discuss how different differentiation models can lead to different tissue functionality and stratification. Thus, we provide a possible way to deduce the unknown cell differentiation mechanism by fitting the observed degree of stratification with our model.

The minimal model also shows other properties. For example, we find that there is no stratified homeostasis state if there is only short-range interaction between the cells. That is, long-range coupling such as morphogen needs to be included to avoid the trivial homogeneous state. Interestingly, our model in general permits the existence of multiple homeostasis states if both long and short-range interactions between the cells are present, and the degree of stratification is different for different homeostasis states. Furthermore, since cell proliferation/apoptosis fluidize a tissue, we construct a hydrodynamic model to study the linearized dynamics of stratified epithelium close to its homeostasis state. We show that an epithelium with thick stem cell niche could be less stable due to strong shear strain accumulated outside the stem cell niche. The most unstable wavelength is comparable to the thickness of the tissue.

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