Active Matter Model for Cell Patterns

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Abstract

In many tissues, such as skin or intestinal epithelium, stem cells lie in periodic local areas. In those areas, stem cells divide and differentiate without migration, whereas the differentiated cells migrate out of the local areas actively. Even though the previous model for stem cell patterns considered all the hydrodynamical couplings allowed by symmetry[1], it is still based on assumption that there was no spontaneous polarization in the homogeneous state. To extend the model, we derive a hydrodynamic model based on the generalized Onsager principle[2]. In this model, the spontaneous polarity states, birth and death of cells, self-propelled motion of differentiated cells and ATP hydrolysis are all accounted for. Linear stability analysis is conducted to reveal long-wave instability inherent in the neighborhood of the constant steady states. Multiple unstable modes are investigated and their dependence on various active factors in the system are studied.

References

[1] Edouard Hannezo, Alice Coucke, and Jean-François Joanny. Interplay of migratory and division forces as a generic mechanism for stem cell patterns. *Phys. Rev. E*, 93:022405, Feb 2016.

[2] X. Yang, J. Li, G. Forest, and Q. Wang. Hydrodynamic theories for flows of active liquid crystals and the generalized onsager principle. *Entropy*, 18(6):202, 2016.