BE 159 Spring 2014
Talking points: Howard, Grill, and Bois, "Turing's next steps: the mechanochemical basis of morphogenesis"

1. What is meant by the term "length scale" in the context of this paper?
2. The authors take a rather simplistic view on how length scales can arise. How do the authors construct the length scales? What are the merits of this approach? What criticisms do you have?
3. What are the time scales necessary to set up chemical patterns using diffusion-like mechanisms? Is diffusion fast enough? For long-ranged patterns, do we also need to think about the time it takes cells to read out the local concentration?
4. This notion of cellular read-out of morphogenetic cues is important. In the supplemental reading, Mammoto and Ingber refer to cytoskeletal tension as a fundamental regulator. Howard, Grill, and Bois mention that "stresses can also realign the cytoskeletal filaments, thereby altering the delivery of chemical signals by motor proteins." What are some other ways that stresses and tension may be a regulator of cellular activity?
5. In Box 1, the authors describe a "positive feedback loop" involving biochemistry and mechanics. What is meant by this?
6. The authors describe length scales using continuum parameters, such as diffusion coefficients, flow velocity, etc. Is this legit? When might we need to consider individual molecules or cellular structures.
7. As the authors mention, Turing did not know about the motor proteins dynein and kinesin. He did know about osmotic pressure, though, and explicitly described it in his landmark paper. What are some key differences between forces resulting from activity of motor proteins and by osmotic pressure?
8. The length scale for the case of a Turing pattern had a more complicated mathematical form than those of the other patters the authors describe. Why is this?
9. The authors say that "chemical reactions are inherently local phenomena." What does "local" mean in this context?
10. What is advection?
11. What is a Péclet number? How does it appear in an advection-diffusion equation?
12. Why might it be difficult to determine whether motion of small particles is driven by thermal diffusion or active transport? What is "active diffusion?"
13. Why is it so important to have good measurements of physical constants like the diffusion coefficient to understand how patterning works? How does the case of Bicoid underscore this notion?
14. The authors define stress as a "force per area." What are some examples of stresses experienced by moving cells and developing tissues?
15. How do we know that diffusion it too slow to coordinate beating of the flagella of a bull sperm?