2012 PHYS 7654 Basic Training in Condensed Matter Theory
2012 PHYS 7683 Physics of Bio-locomotion
Module on Physics of Organisms
Jane Wang

Summary of the Lectures and Supplementary Materials

Lecture 1

Reading Chapter 1 of Schrodinger's What is Life?

Chapter 1 is free on Google books

Lecture 2 & 3

Physics of Chemoreception

Reference: Berg and Purcell, Biophysical Journal 1977
http://www.cell.com/biophysj/abstract/S0006-3495(77)85544-6

Key question: Can bacteria 'count' molecules?
The analysis is based on considerations of basic physical processes that dictate the movement of a bacterium and the diffusion and adsorption of nutrients subject to statistical fluctuations.

Part 1 Hydrodynamics and Diffusion to Capture

1. If a bacteria suddenly stops propelling itself, it will stop instantaneously due to viscous drag.

2. The rate at which cell-surface receptors adsorb molecules from the surrounding fluid is limited by diffusion, but the total rate is nearly maximal when only a small fraction of the cell surface is covered by receptors.

Part 2 Poisson Statistics and Signal-to-Noise ratio

1. A perfect instrument and noise from statistical fluctuations

2. Calculate the variance of measurements by a single receptor.

3. Estimate the time needed to have a sufficiently low error so that the bacterium can sense the gradient of the concentrations.

4. The time turns out to be on the order of 1s, which is comparable to the time between tumbles.

Lecture 4

Curious phenomena at Low Reynolds number Flows

G. I. Taylor's lecture on low Reynolds number flow is at http://web.mit.edu/hml/ncfmf.html

Time reversibility in Stokes flows
Scallop theorem
Different mechanisms to propel slender bodies (flexible filament, [sinusoidal or] helical waves)