DOCTORAL COURSES

« Introduction to the Physics of Biology »

Profs Karsten KRUSE and Renaud JOLIVET

Every Tuesday from 14.15 to 16.00 - In Sciences I, room 306

Outline:

Modern experimental techniques like various forms of fluorescence microscopy, atomic force microscopy, and the tools of molecular biology that allow to specifically change the molecular components of a cell have yielded an unprecedented detail view on cellular processes. Many of them are many-body effects that require physical analysis for a proper understanding. The aim of this course is to give an introduction to recent developments in the physics of biological systems. It will cover theoretical as well as experimental aspects. In the first part, the expression of genes will be treated as a stochastic process. Then the mechanical properties of DNA will be discussed, which will entail a discussion of entropic forces and the worm-like chain model. We will then turn to molecular motors, that is, protein machines that transduce chemical energy into mechanical work. We will discuss the general properties of theses motors and introduce a two-state model for their description. This part will close by discussing spontaneous oscillations of coupled molecular motors. We will then turn to the brain as a physical object. After discussing the energetics of the brain we will discuss the foundation of neuronal dynamics, notably in terms of simplified neuron models. The courses will continue with the application of information theory in neuroscience and with learning and plasticity. Finally, we will move towards neural networks and machine learning. The biological concepts necessary for following the course will be introduced as we proceed. Although some familiarity with biological concepts might clearly help, it is not a prerequisite for following the course.

Format:

Starts the week of 19 February 2018 until 1st June 2018.