

Outline of the course on “Fluctuations and Scaling in Biology”

(this is less than a syllabus, I just list here the main topics only)

- I. Introduction (concepts, basic notions, relevance)
- II. Fractals
 - Definitions (self-similarity, fractal dimension)
 - Useful rules
 - Self-affine fractals
 - Simple models of fractal growth
 - Examples
- III. Self-organized criticality (sand piles, evolution, lung)
- IV. Bacterial colonies
 - bacteria in general
 - morphological diagram
 - models of fractal colony growth (static, dynamic)
- V. Synchronization
 - fireflies, cicada, pacemaker cells, walking humans, etc, synchronize
 - continuous coupling of rotators (Kuramoto model, quenched and shot noise)
 - integrate and fire coupling
- VI. Fluctuations driven transport: molecular motors
 - examples: kinesin, actin/myosin (muscle)
 - simplest models
 - a model for the stepping motion of kinesin
- VII. Networks in life
 - basic models (random, small world [Watts and Strogatz], growing scale-free [Barabasi-Albert])
 - social networks (citations)
 - flow on networks
- VIII. Collective motion
 - flocking everywhere
 - basic models
 - modeling crowds (lane formation, panic)