

# Theoretical Biophysics

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- 1 Outline of the lectures
- 2 Prerequisites
- 3 Organizational Matters
- 4 Literature
- 5 Lecture 1

- The Statistical Mechanics of Biopolymers

- Models for Biopolymers

- Freely-jointed chain

**Important Concepts:** end-to-end distance, radius of gyration, Kuhn length, persistence length, scaling

- The Gaussian Chain Model

**Important Concepts:** fluctuating bond, Hamiltonian for the Gaussian Chain Model

- Self-Avoiding Chains

**Important Concepts:** self-avoidance, scaling exponent, Flory argument, lattice chains

- Conformations and Energy Landscapes

**Important Concepts:** energy landscape, random heteropolymer, REM model, glass transition temperature

- Macromolecules in solution

**Important Concepts:** Flory-Huggins theory,  $\theta$ -temperature, phase transitions, morphology, nucleation, spinodal decomposition

- The Statistical Mechanics of Biopolymers (continued)
  - **Macromolecules at surfaces**  
**Important Concepts:** mushroom conformation
- The Physics of Proteins
  - **Folding as a spin glass problem**  
**Important Concepts:** hierarchy of free energy barriers
  - **Lattice Models**  
**Important Concepts:** HP model, Go model
- The Physics of Chromosomes
  - **Force-Extension Relation**
  - **Chromatin**
  - **Loop Models**  
**Important Concepts:** Ensemble average, averaging over disorder

- Transport
  - Diffusion and Diffusion in a Crowded Environment  
**Important Concepts:** Disorder, anomalous diffusion fractional motion
  - Diffusion-Reaction Systems  
**Important Concepts:** chemotaxis
  - Polymer dynamics  
**Important Concepts:** Rouse model, reptation
- (The Physics of Membranes)

- Dynamical Systems
  - Population Dynamics
    - Important Concepts:** Bifurcation
  - Cellular Automata
  - Polymer dynamics
- The Physics of Networks
  - Random Graphs: Erdős-Renyi-Model
  - Small World-Networks: Watts-Strogatz-Model
  - Scale Free Networks: Barabasi-Albert-Model
  - Neural Networks
  - Genetic Networks: Random Boolean Networks

# Prerequisites

- Mainly Statistical Physics
- Biological background knowledge will be provided on a case by case basis

# Organizational Matters

- Time: Mondays and Wednesdays 09:15 to 11:00
- Venue: Kirchhoff-Institute INF 227 / HS 2
- Lecture material can be found at:  
<http://wwwcp.tphys.uni-heidelberg.de/biophysics/index.php>
- Exercises on Theoretical Biophysics:
  - A number of projects will handed out to interested parties.
  - The projects will commence starting November, once we have made some inroads into the topics.



# Literature

- Beside the lecture materials that will be made available for every lecture there is a script that is the basis for this course. The script can be downloaded from the course website. Individual portions will be made available.
- Books
  - Theoretical Molecular Biophysics Series: Biological and Medical Physics, Biomedical Engineering Scherer, Philipp, Fischer, Sighart F. 1st Edition., 2010, XIII, 371 p. 250 illus., 3 in color., Hardcover ISBN: 978-3-540-85609-2