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Spring 2025

Course: Mondays, 13:15-15

Exercises: Mondays, 15:15-16

Summary

In this course we will study the cell (minimum unit of life) and its components. We will study several key cellular features: Membranes, genomes, channels and receptors. We will apply physics-based models to make quantitative and predictive statements.

Content

Introduction to cell biophysics

Topics (lectures):

1. Introduction to concepts and biological systems (1-3)
2. Biological membranes: Hydrophobic effect, 2D elasticity (4-5)
3. Proteins: Ligand binding, ion channel function (6-7)
4. Dynamics: Diffusive, directed, crowded (8-9)
5. Genomes: 1D elasticity, regulation, transcription, synthetic biology (10-12)

Elements:

1. Introduction of biological systems and concepts
2. Description of observations and measurements
3. Estimates of relevant numbers / development of quantitative models
4. Analysis of research articles

Learning Outcomes

- Synthesize information from textbook and scientific articles
- Elaborate a model of a biophysical phenomenon
- Justify simplifications to the model
- Develop mathematical expressions corresponding to the model
- Interpret the results of the model

Assessment methods

The course assessment will be the final exam.

PHYS-301 Course Requirements

Your grade will be entirely based on a written exam during the exam period (June). On the exam, approximately 75% of the points will be attributed to exercise-based questions, and 25% will be attributed to journal article-based questions (subject to adjustment at the discretion of the instructor).

How to succeed in the course:

- Prepare for class by reading the assigned chapters in advance.
- Prepare for the exercise sessions by:
 - Attempting the exercises
 - Reading the journal article and filling in the related worksheets
- Volunteer to present an article during the exercises.
- Ask questions throughout the semester.

Exam rules:

Allowed:

- One page of formulae/notes, size A4 (front and back) handwritten

Not allowed:

- Any form of electronic device including a calculator

PHYS-301 Course Calendar

Date	Topic	To do
17.2	C1: Introduction	Review course content, ask questions Support: PBoC Ch. 1
17.2	E: Tips on reading the textbook	Read PBoC Ch. 1, ask questions
24.2	C2: Introduction - Construction plans for cells	Read PBoC Ch. 2.1, 2.2
24.2	E: Exercise Set 1	Exercise Set 1
3.3	C3: Mechanical and chemical equilibrium in the living cell	Read PBoC Ch. 5.2, 5.5.1
3.3	E: Exercise Set 2	Exercise Set 2
*10.3	C4: Biological membranes - Elasticity models	Read PBoC Ch. 11.1, 11.2
10.3	E: Tips on reading an article	Look over worksheet, ask questions
17.3	C5: Biological membranes – Shape	Read PBoC Ch. 11.3, 11.4
17.3	E: Article 1	Read Article 1, complete worksheet
*24.3	C6: Proteins - Stat mech models	Read PBoC Ch. 6.1.1, 6.4 (except 6.4.4)
24.3	E: Exercise Set 3	Exercise Set 3
31.3	Spring break	
7.4	C7: Proteins – Ion channels	Read PBoC Ch. 7.1.2, 11.5
7.4	E: Article 2	Read Article 2, complete worksheet
14.4	C8: Proteins - Dynamics, diffusion	Read PBoC Ch. 13.1, 13.2.1-13.2.3
14.4	E: Exercise Set 4	Exercise Set 4
28.4	C9: Proteins - Dynamics, directed transport	Read PBoC Ch. 16.1.1, 16.3.3
28.4	E: Article 3	Read Article 3, complete worksheet
5.5	C10: Genomes - Central dogma of molecular biology	Read PBoC Ch. 3.2.1, 6.1.2, 19.2 (except 19.2.5)
5.5	E: Exercise Set 5	Exercise Set 5
12.5	C11: Genomes – Networks	Read PBoC Ch. 19.3.2, 19.3.3
12.5	E: Article 4	Read Article 4, complete worksheet
19.5	C12: Genomes – Regulatory dynamics	Read .pdf
19.5	E: Exercise Set 6	Exercise Set 6
26.5	C14: Overview of the course	Bring questions
26.5	E: Q&A	Bring questions

This schedule is subject to change at the discretion of the instructor.
