[Frontiers in Synthetic Biology]

Term: [Fall]
Credits: [3]
Class Hours: [48] (Teaching Hours: [48], Lab Hours: [],
Practice Hours: []

Course Coordinator

Name	Zibo Chen	**Contact Info**	zibochen@westlake.edu.cn
Office Address	E9-204	**Office Hours**	By appointment

Course Instructor(s) [List all other instructors here. Add more blanks if needed.]

Name #1	Fangzhou Xiao	**Name #2**	
Contact Info	xiaofangzhou@westlake.edu.cn	**Contact Info**	
Name #3		**Name #4**	
Contact Info		**Contact Info**	

Course Description [Shall include course introduction, prerequisites, etc.]

Synthetic biology is an innovative and rapidly evolving field that merges principles from biology, engineering, physics, chemistry, and computer sciences to design and construct new biological systems or redesign existing ones for purposeful applications. This course offers a comprehensive exploration of synthetic biology, tracing its conceptual foundations and cutting-edge advancements. Beginning with an introduction to the three major schools of thought in synthetic biology, the course journeys through the molecular biology revolution of the 1970s, the development of biocircuits, and the emergence of genetic engineering tools. Students will delve into key concepts such as bistability, oscillations, stochasticity, metabolic engineering, molecular programming, and population-level dynamics. The course also tackles advanced concepts like kinetic proofreading, combinatorial complexity, neural networks, and proteome partitioning, while addressing real-world implications through discussions on ethics and biosafety.

The course includes a midterm presentation (Week 9) and a final presentation (Week 16) to deepen understanding and encourage critical thinking. No strict prerequisites are required, though familiarity with basic molecular biology, biochemistry, and cell biology is recommended. This course is ideal for students eager to explore how synthetic biology redefines life at molecular, cellular, and population scales. We strongly recommend that you take the course “Computation and Control in Biological Systems” simultaneously, since the content strongly complements each other.

Learning Objectives

By the end of the course, you will:

- Be able to tinker with biological problems from several new perspectives with drastically different fundamental principles.
- Be comfortable with basic program packages frequently used in synthetic biology.
- Be familiar with quantitative approaches in modern synthetic biology.

Learning Resources

An introduction to systems biology by Uri Alon

For general background on modeling of biological circuits, a nice (and free!) reference is Richard Murray's book "Biomolecular Feedback Systems" (most relevant are the first 3 chapters):
http://www.cds.caltech.edu/~murray/BFSwiki/index.php/Main_Page

Assessments and Grading [Each criterion can be weighted freely totaling 100%.]

Assessment Criteria	Percentage
Attendance	15
Participation	15
Assignment	40
Course Paper	30
Exam (open-book/closed-book)	
Other	

Grade	Assessment Standard
Pass	≧60 points
Fail	<60 points

Course Policies

Course Schedule

Week	Theme/Topic	Instructor(s)	Assignments
1	Three schools of thought	Zibo Chen	
2	A brief survey of synbio since 2000	Zibo Chen	
3	Biocircuits 1 (bistability, positive/negative feedback, adaptation, chemotaxis)	Zibo Chen	
4	Demand theory, metabolic engineering	Fangzhou Xiao	
5	Biocircuits 2 (ultrasensitivity, oscillations, multistability)	Zibo Chen	
6	Biocircuits 3 (stochasticity, noise, Gillespie)	Zibo Chen	1
7	Kinetic proofreading	Zibo Chen	
8	Genetic engineering	Zibo Chen	
9	Midterm presentation	Zibo Chen	
10	Theory of computation	Zibo Chen	
11	Molecular programming I	Zibo Chen	
12	Protein design	Zibo Chen	
13	Molecular programming II	Zibo Chen	
14	Promiscuous interactions, combinatorial complexity, and neural networks	Zibo Chen	2
15	Artificial cells	Zibo Chen	

16	Final presentation	Zibo Chen	