课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	BIO5011/**系统生物学 Systems Biology**
2.	**课程性质** **Compulsory/Elective**	Elective
3.	**课程学分/学时** **Course Credit/Hours**	3/48
4.	**授课语言** **Teaching Language**	English and Chinese
5.	**授课教师 Instructor(s)**	黄巍副教授 Prof. Wei Huang huangw@sustc.edu.cn
6.	**先修要求** **Pre-requisites**	Calculus I & II, General Biology, two out of three (Biochemistry I, Cell Biology, Developmental Biology) 高等数学 I&II、普通生物学、（生物化学 I，细胞生物学、发育生物学，三选二）

7. 教学目标 Course Objectives

Systems Biology is an elective course. It is designed to help students thoroughly understand the concepts and the ways of thinking in systems biology, cutting edge systems biology research projects, and the scientific background of systems biology research methods in various biological researches. It will expose them to the rigorous scientific research methods and multidisciplinary research approaches. It is also a general course to inspire their curiosity, improve knowledge in biological science.

系统生物学是一门专业必修课，旨在帮助学生深入理解生物研究中的系统化研究思维、研究课题及方法的科学背景，学习科学研究的严谨方法和多学科交叉的研究方式，激励其科学好奇心和勇气，并培养学生热爱自然、关爱社会、珍视生命的情操，提高生命科学知识素养而开设的综合性素质教育必修课程

8. 教学方法 Teaching Methods

Systems biology is a course that requires students with thorough knowledge in biology and logical reasoning, competence in mathematics and computational skills. This course normally designed to teach students with strong math and physics background. However, these students usually lack the biological sense to grasp the big questions in systems biology.

系统生物学是一个对学生的知识背景要求比较高的学科，涉及的生物问题非常广泛，对学生的理性思维、和数学、计算能力也有一定的要求。国外的系统生物学课程通常是针对有物理数学背景的学生而开设，这些学生对生物问题的认识又有所欠缺。

This course is designed to group studies for students with strong biology background with students with strong background in computer science or engineering. It will integrate the teachings of basic concepts with case studies, focused on the fundamental thinkings as well as the big pictures. The students, as small groups of 3-4, will present cutting edge research papers, working on systems biology course projects including imaging processing, data

analysis, mathematic modelling and computational simulations. The project report will be finished independently. In addition, they will also independently write a review paper to establish the possible connections between their research interests/directions with systems biology.
本课程将计算机和工程背景强的和生物背景强的同学组成小组，通过以基本概念和案例教学相结合的形式，教授系统生物学的整体概念和基本思路。并通过学生以小组的形式讲诉前沿论文，做系统生物学数据处理和建模的小课题，并在期末撰写评论文章的形式，建立对系统生物学的直接认识，并鼓励他们思考、探讨自己的研究方向与系统生物学相结合的可能性。
After finishing this course, the students are expected to:
(1) Establish the systematic thinking of biological problems
(2) Establish the understanding of scientific background, biological questions, and systems biology theoretical and experimental methods through student of classic systems biology studies.
(3) Obtain preliminary capability to perform systems biology mathematic simulation
(4) Establish their interests in biology and related disciplines, improve their capability to communicate with scientists from other disciplines.
本课程完成后，学生将能够：
（1）培养对生物问题的系统化认知的视角
（2）培养对系统生物学一些经典课题的科学背景，生物问题和系统生物学的理论和实验方法的了解。
（3）掌握一定的系统生物学数学模拟的能力。
（4）培养对生命科学及其交叉学科的兴趣，提高未来与其它学科的人士交流合作的能力。

9. 教学内容 Course Contents

Section 1	Part 1：Single reaction, Introduction，Michaelis-Menten kinetics 第一部分：单一反应 简介、米氏动力学
Section 2	MATLAB tutorial, equilibrium binding, cooperativity and ultrasensitivity MATLAB 介绍、平衡结合、协同性和超敏现象 Course Project #1：two out of three problems: simulation of Michaelis-Menten kinetics without MATLAB ODE solver; analysis of origins of degradation and dilution in gene expression; analysis the process and quantification of RNAi 课程课题#1，3 选 2：数值模拟米氏反应动力学，分析基因表达中的降解和稀释的来源；分析 RNAi 的过程与量化
Section 3	Part 2: Simple network, complex function Positive feedback and multistability, stability analysis, computer simulation session, 正反馈和多稳态，稳定性分析、计算机模拟
Section 4	Synthetic switches, more complex network with bistability 合成生物学开关，更加复杂的双稳态网络

	Section 5	Biological oscillators 生物振荡器
	Section 6	Simulation of biological oscillator, computer simulation session 计算机模拟生物振荡器
	Section 7	Journal Club on recent research of biological oscillations 生物振荡器的最新文献研讨
	Section 8	Course Project #2，modeling of gene regulatory circuits, gene expression noise, fitting experimental data 课程课题#2，基因调控线路的数学模型、基因表达噪声、实验数据拟合
	Section 9	Part 3: Small network high performance Bacteria chemotaxis, behaviour, components, network, performance 第三部分：小网络、高性能 细胞化学趋向性、行为、元件、网络和性能
	Section 10	Diffusion, Fick's law, image process of real bacteria chemotaxis images 扩散、胡克定律、细菌化学趋向性的实验图像
	Section 11	Course Project #3, modelling and simulation of cell random motion, chemotaxis, image processing and data analysis of experimental data, simulation of pattern formation 课程项目#3，数学建模和计算机模拟细胞的随机运动、化学趋向性运动、实验图像处理和数据处理、模拟图式形成
	Section 12	Part 4: Larger network, less details Research of gene regulation networks: painstaking experiment-based networks vs large scale data-based networks 第四部分：大网络和细节的缺失 基因调控网络的研究：基于精心设计实验的煞费苦力的网络确认 与基于大数据的网络推测
	Section 13	Network modeling and experimental design, differential equation-based studies 网络模型和实验设计：基于微分方程的网络研究
	Section 14	Network modeling and experimental design, infer network from large scale data 网络模型和实验设计：从大数据推测的网络研究
	Section 15	Part 5: Spatial interactions and pattern models Turing's pattern formation model, computer simulation session 第五部分：空间相互作用和图示形成的模型 图灵图式形成模型和计算机模拟
	Section 16	Recent experimental evidences of Turing's model

		关于图灵模型的最近实验验证
	Section 17	Theory and experimental evidences of morphogen gradient 基于形态发生因子梯度的图式形成模型：理论与实验证据
	Section 18	Part 6: Growth and differentiate, noise and robustness scRNA-seq, spatially resolved transcriptomics and characterization of embryo development 第六部分：生长与分化，噪声与鲁棒性 单细胞 RNA 测序，空间转录组学和胚胎发育的刻画
	Section 19	Proliferation dynamics and regulation of populations 生长动力学和细胞数量的调控

10. 课程考核 Course Assessment

Overall Scoring：Pass/Fail， 整体评分：二级制

Scoring on final literature review（thesis introduction style 40%），project presentation reports, journal club and project report (40%)， class attendance (20%)，final score at or higher than 60% will be pass， otherwise will be fail.
根据期末文献综述（40%）、课程项目的进展交流,总结报告、和文献研讨（40%）、课堂出勤（20%），打分，再按照总成绩计算，60 分及以上通过，60 分以下不通过。

11. 教材及其它参考资料 Textbook and Supplementary Readings

There is no textbook. Most recent scientific literatures will be provided to students as supplementary reading materials.
教材：无
参考资料：最新系统生物学科技文献.