南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	**系统生物学综合实验和科研实践** **Integrated Laboratory Research Training-Systems Biology**
2.	**授课院系** **Originating Department**	生命科学学院系统生物系 Department of Systems Biology, School of Life Sciences
3.	**课程编号** **Course Code**	BIO483
4.	**课程学分 Credit Value**	6
5.	**课程类别** **Course Type**	专业选修课 Major Elective Courses
6.	**授课学期** **Semester**	秋季 Fall 春季 Spring 夏季 Summer
7.	**授课语言** **Teaching Language**	中英双语 English & Chinese
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	课程负责人： 陈炜，讲席教授，chenw@sustech.edu.cn 团队成员： 陈曦，助理教授，chenx9@sustech.edu.cn 戴紫薇，助理教授，daizw@sustech.edu.cn Andrew Hutchins，副教授，andrewh@sustech.edu.cn 靳文菲，副教授，jinwf@sustech.edu.cn 李妍，助理教授，liy33@sustech.edu.cn 孙颖，副教授，suny@sustech.edu.cn 曾福星，助理教授，zengfx@sustech.edu.cn 郑梅珍，助理教授，zhengmz@sustech.edu.cn 梁征宇，助理教授，liangzy@sustech.edu.cn 梁超，副教授，liangc@sustech.edu.cn Course Coordinator: CHEN Wei, Chair Professor Group Members: CHEN Xi, Assistant Professor DAI Ziwei, Assistant Professor

		Andrew Hutchins, Associate Professor JIN Wenfei, Associate Professor LI Yan, Assistant Professor SUN Ying, Associate Professor ZENG Fuxing, Assistant Professor ZHENG Meizhen, Assistant Professor LIANG Zhengyu, Assistant Professor LIANG Chao, Associate Professor
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	待公布 To be announced
10.	选课人数限额(可不填) Maximum Enrolment（Optional）	每学年开设 1-2 个教学班级，每班级限额 5 人. 1-2 classes per school year with a maximum of 5 students per class.

11. 授课方式 Delivery Method

讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours				
		192		192

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	生物学原理，普通生物学实验 Principles of Biology, General Biology Laboratory
13.	后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 none
14.	其它要求修读本课程的学系 Cross-listing Dept.	无 none

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程为生命科学学院为大二或大三年级本科生开设的六学分、三学期制的专业限选课，课程致力于将理论教学与实践教学相结合、基础教育与专业教育相结合、科研与教学相结合。从而调动学生自主学习、激发学生求知欲和创造性，训练学生提出和发现生物学问题并运用系统生物学的技术与方法解决实际问题的能力。同时，利用系统生物学系独特的跨学科科研优势，以科研促教学，发挥科学研究在人才培养中的平台作用，并且使之制度化。

课程内容包括分子生物学、生物化学、细胞生物学和计算生物学等四个教学模块，通过科研项目将教学模块有机结合。这些科研项目主要来源于：

1. 在研的科研课题

2. 通过“大学生创新创业训练计划项目”、“攀登项目”、大学生生命科学竞赛等获得正式立项的课题。

学生在科研实验室参与本课程的学习、实践，是开放式、综合性的，旨在强化学生“探究式”学习习惯及培养科学思维能力，在创新精神、科研能力、团队合作、科研道德等方面获得全面提高。

Integrated Laboratory Research Training-Systems Biology is a six-credit, three-semester course for sophomore or junior undergraduates in the School of Life Sciences. The course is dedicated to combining theoretical and practical teaching,

fundamental and professional education, and research and learning. The course aims to motivate students to learn independently, stimulate their curiosity and creativity, and cultivate their abilities to discover biological problems and apply the techniques and methods of systems biology to solve those practical problems. Meanwhile, the Department of Systems Biology takes advantage of its unique interdisciplinary scientific research to promote teaching through scientific research and institutionalize scientific research's role as a platform for personnel training.

The course content includes four teaching modules: Molecular Biology, Biochemistry, Cell Biology, and Computational Biology, which are comprehensively integrated through research projects. These scientific projects are mainly from:

1. Research projects in progress

2. Projects that have been formally established through the "Student Innovation and Entrepreneurship Training Program", "Climbing Project" and Life Science Competition for Students.

Students will participate in the study and practice of this course in the research laboratory, which is open and comprehensive, aiming to strengthen students' "inquiry" learning habits and cultivate scientific thinking skills, and obtain comprehensive improvement in the spirit of innovation, research ability, teamwork, and research ethics.

16. 预达学习成果 Learning Outcomes

通过本课程的学习，学生将：

1. 系统掌握每个模块的实验科学原理和实验操作步骤；
2. 掌握基因调控网络动力学的基本理论；
3. 掌握基因表达控制系统的重构与定量分析相关理论和实验设计；
4. 掌握计算生物学/生物信息学的核心算法，并具备一定的编程技能；
5. 了解学科各个领域最新的发展动向，对学科的发展趋势有所认识。

By taking this course, students will:

1. Master the scientific principles and experimental procedures of each module;
2. Master the basic theory of Gene Regulatory Network Dynamics;
3. Master the theories and experimental designs related to the reconstruction and quantitative analysis of gene regulatory systems;
4. Mater the core algorithms in Computational biology / Bioinformatics and have advanced programming skills;
5. Understand the latest trends of progresses in various fields of systems biology and have an awareness of the trends of the discipline.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

以科研项目为支撑的模块式教学，根据项目的具体研究内容、技术考核指标、拟解决的关键问题等指标衔接不同模块中合适的科研方法和教学内容，各个模块的教学顺序不固定。

Research projects support modular teaching, and the appropriate research methods and teaching contents in different modules are articulated according to the specific research contents, criteria for technical assessment, critical problems to be solved, and other indicators of the projects. The order of modules is not fixed.

第一部分：分子生物学， 48 学时

二代测序的基本原理

1. 合成测序的历史、基本原理

2. 二代测序的发展、工作原理

3. 单细胞测序介绍

分子克隆，基因编辑，遗传筛选

1. 哺乳动物细胞基因表达载体的构建

2. 基于 CRISPR/Cas 技术的基因编辑

3. 基于 CRISPR/Cas 技术的基因筛选

Part I: Molecular Biology, 48h

Basic principles of second-generation sequencing

1. History and basic principles of DNA sequencing

2. Development and working principles of second-generation (DNA/RNA/epigenomics) sequencing

3. Introduction to the single cell sequencing

Molecular Cloning, Gene Editing, Genetic Screening

1. Construction of gene expression vectors in mammalian cells

2. Gene editing based on CRISPR/Cas techniques

3. Gene screening based on CRISPR/Cas techniques

第二部分：生物化学，48 学时

三维基因组学——染色质构象与基因调控

1. 三维基因组学简介

2. 三维基因组高通量建库

3. 三维基因组高通量数据处理

4. 三维基因组数据可视化展示

蛋白质翻译机器——复合物结构与调控机制

1. Ribo-seq 的原理及数据分析

2. 翻译调控验证

3. 调控复合物的结构分析

Part II: Biochemistry, 48h

3D Genomics - Chromatin Conformation and Gene Regulation

1. Introduction to 3D genomics

2. High-throughput library construction for 3D genomics

3. Processing of 3D genomics high-throughput data

4. 3D genomics data visualization and presentation

Protein Translation Machine - Complex Structure and Regulatory Mechanism

1. Principles and data analysis of Ribo-seq

2. Validation of translational regulation

3. Structural analysis of regulatory complexes

第三部分：细胞生物学，48 学时

细胞类型的基因组学和表观遗传控制

1. 小鼠胚胎干细胞的操作模块

2. 细胞类型的表观遗传控制模块

3. 干细胞转录组学

癌症生物学——基因功能及表型鉴定

1. 肿瘤细胞生长，增殖，侵袭，转移能力测定

2. 肿瘤细胞周期，凋亡，代谢，压力应激检测

3. 小鼠原位肿瘤模型，转移模型鉴定目标基因体内功能、表型

Part III: Cell Biology, 48h

Genomics and Epigenetic Control in different Cell Types

1. Manipulation of mouse embryonic stem cells

2. Epigenetic control in different cell types

3. Stem cell transcriptomics

Cancer Biology - Gene Function and Phenotype Identification

1. Determination of tumor cell growth, proliferation, invasion, and metastatic capacity

2. Tumor cell cycle, apoptosis, metabolism, and stress assay.

3.In situ tumor model and metastasis model in mice to identify target gene function and phenotype in vivo

第四部分：计算生物学，48 学时

数学生物学

1.酶促反应动力学模型

2.基因调控动力学模型

3.全基因组代谢网络模型和流平衡分析

4.生物网络拓扑结构分析

5.微分方程组的动态和稳态分析

6.生物网络参数估计

7.生物网络的参数敏感性和鲁棒性分析

8.生物网络和多组学数据的整合

9.多组学数据分析算法

单细胞组学数据

1. 单细胞组学数据分析和细胞图谱构建

2. 单细胞组学数据降维和可视化计算方法开发

3. 肿瘤免疫微环境的单细胞组学解析

4. 单细胞多组学数据整合和数据挖掘

Part IV: Computational Biology, 48h

Mathematical Biology

1.Enzymatic reaction kinetic models

2. Gene regulation kinetic models

3. Genome-scale metabolic network model and flux balance analysis

4. Biological network topology analysis

5. Dynamic and steady-state analysis of differential equations

6. Parameter estimation of biological networks

7. Parameter sensitivity and robustness analysis of biological networks

8. Integration of biological networks and multi-omics data

9. Algorithms for multi-omics data analysis

Single-cell omics data analysis

1. single cell omics data analysis and cell atlas construction

2. development of computational methods for dimensionality reduction and visualization of single-cell omics data

3. single-cell omics analysis of tumor immune microenvironment

4. Single-cell multi-omics data integration and data mining

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

无 none

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance		30		春季/秋季学期，4 学时/周 夏季学期（6 周），8 学时/天 实验室会议: 2 次/月 Spring/Fall semester, 4 hours/week Summer semester (6 weeks), 8 hours/day Lab meetings: 2 times/month
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments				
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation		40		完成所有模块的学习后，以小组为单位进行项目答辩 After completing all modules, conduct project defense in groups
其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary)		30		(每个模块独立撰写实验报告和做口头报告) Experiment report and oral presentation for each independent module.

20. 记分方式 **GRADING SYSTEM**

☐ A. 十三级等级制 **Letter Grading** ☑ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority

本课程经生命科学学院教学工作委员会审议通过 This course is approved by the Teaching Affairs Committee, School of Life Sciences.