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**	**免疫与微生物学综合实验和科研实践** **Integrated Laboratory Research Training - Immunology and Microbiology**
2.	**授课院系** **Originating Department**	基础免疫与微生物学系 Department of Immunology & Microbiology, School of Life Sciences
3.	**课程编号** **Course Code**	BIO482
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**	春季 Spring / 夏季 Summer / 秋季 Fall
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：温子龙，讲席教授，wenzl@sustech.edu.cn 团队成员： 温子龙，讲席教授，wenzl@sustech.edu.cn 董涛，　教授，dongt@sustech.edu.cn 欧西军，　副教授，ouxj@sustech.edu.cn 刘忠民，助理教授，liuzm@sustech.edu.cn 何思聪，助理教授，hesc@sustech.edu.cn 周稳，　副教授，zhouw@sustech.edu.cn 余化鹏，　副教授，yuhp@sustech.edu.cn 张丽，　助理教授，zhangl3@sustech.edu.cn Course Coordinator: Wen Zilong, Chair Professor, wenzl@sustech.edu.cn Group Members: WEN Zilong, Chair Professor, wenzl@sustech.edu.cn DONG Tao, Professor, dongt@sustech.edu.cn OU Xijun, Associate Professor, ouxj@sustech.edu.cn LIU Zhongmin, Assistant Professor, liuzm@sustech.edu.cn

		HE Sicong, Assistant Professor, hesc@sustech.edu.cn ZHOU Wen, Associate Professor, zhouw@sustech.edu.cn YU Huapeng, Associate Professor, yuhp@sustech.edu.cn ZHANG Li, Assistant Professor, zhangl3@sustech.edu.cn
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 / 学时数 Credit Hours

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
		156	实验室研讨会以及口头报告：36 Lab meeting and presentation: 36	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

本课程致力于给学生提供融入生物科研活动的机会和平台，通过进入实验室开展和免疫与微生物学研究项目相关的实践活动，并参与课题组内的学术讨论，来促进学生掌握基本实验技术和体会现代生物学的科研思路。

This course aims to provide a platform and opportunity for the students to be part of biological research activity, allowing them to enter the laboratories, perform work in immunology and microbiology related projects, and join group discussions. This course will help the students to master basic experimental techniques and understand the strategies of modern biological research.

16. 预达学习成果 Learning Outcomes

在完成本课程后，学生将会

1. 得到在生物实验室实践的经验；
2. 熟悉并掌握免疫与微生物学研究相关的基本方法；
3. 提高学术交流的能力；

4. 更好地理解如何开展现代生物学科研。

Upon completion of this course, the students will

1. Gain experience of doing research work in a biological research laboratory;
2. Master some basic experimental techniques related to immunology and microbiology;
3. Improve abilities in scientific communications;
4. Understand better how to perform modern biological research.

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.)

模块一：干细胞、免疫细胞以及生物成像

本模块利用模式动物（果蝇，斑马鱼，小鼠），通过单细胞转录组分析、分子生物学、细胞生物学、遗传学和基因编辑技术，追踪免疫细胞的发育过程和动态分布，阐述免疫细胞的生成以及免疫应答的基本原理。同时，利用高时空分辨率活体成像与生物影像定量分析等技术手段，分析活体细胞动态，并利用深度学习等算法，实现对细胞类型的自动识别与分类以及动态过程进行多时空维度的观测。通过该课程的实践训练，学生将熟悉并掌握发育生物学，细胞免疫学，遗传学和分子生物学的基本方法，让学生了解人体免疫细胞如何建立自身防御系统。

Module 1: Stem Cells, Immune Cells, and Biological Imaging

This module uses model organisms (fruit flies, zebrafish, mice) to track the developmental process and dynamic distribution of immune cells, and elucidate the basic principles of immune cell generation and immune response through single-cell transcriptome analysis, molecular biology, cell biology, genetics, and gene editing techniques. At the same time, high spatiotemporal resolution in vivo imaging and quantitative analysis of biological imaging are used to analyze the dynamic behavior of living cells. Deep learning algorithms are used to automatically identify and classify cell types and observe dynamic processes in multiple spatiotemporal dimensions. Through practical training in this course, students will become familiar with and master the basic methods of Developmental Biology, Cell Immunology, Genetics, and Molecular Biology and understand how human immune cells establish their own defense system.

1. 利用模式生物，研究造血干细胞和免疫细胞的发育与功能

(a). 单细胞转录组分析：通过单细胞转录组分析，实现对免疫细胞亚群的分类和发育轨迹的预测

(b). 分子探针的构建及应用：构建 RNA 分子探针， 通过原位杂交技术追踪免疫细胞的发育过程和动态分布

(c). 基因编辑技术：利用基因编辑技术，构建免疫细胞缺陷和免疫应答异常的动物模型 (动物实验由指导老师/助教操作)

(d). 体液免疫检测：通过流式细胞和酶联免疫分析，揭示疫苗诱导抗体应答的动态变化规律

1. Using model organisms to study the development and function of hematopoietic stem cells and immune cells

(a) Single-cell transcriptome analysis: Using single-cell transcriptome analysis to classify immune cell subtypes and predict their developmental trajectories

(b) Construction and application of molecular probes: Constructing RNA molecular probes to track the developmental process and dynamic distribution of immune cells through in situ hybridization techniques

(c) Gene editing technology: Using gene editing technology to construct animal models with immune cell defects and abnormal immune responses (Animal experiments are performed by instructors)

(d) Humoral immune detection: Revealing the dynamic changes in vaccine-induced antibody responses through flow cytometry and enzyme-linked immunosorbent assay (ELISA).

2. 高时空分辨率活体成像与生物影像定量分析

(a). 高分辨荧光显微成像技术：利用果蝇和斑马鱼早期胚胎为模型，采用荧光显微镜、转盘共聚焦显微镜、双光子显微镜等光学显微成像技术，构建细胞形态和行为的高时空分辨率图像数据库。

(b). 数字图像处理技术：利用 Fiji, MATLAB, Prism 等图像处理和数据分析软件，自动提取荧光图像中细胞膜、骨架、胞核等细胞结构，并定量分析细胞形状参数和迁移特征，在亚细胞层面对胚胎发育的动态过程进行多时空维度的观测和分析。

(c). 机器学习技术：基于高分辨荧光图像和细胞特征参数信息，利用深度学习等算法，实现对细胞类型的自动识别与分类，并挖掘胚胎发育过程中细胞行为的规律特征。

2. High spatiotemporal resolution in vivo imaging and quantitative analysis of biological imaging

(a) High-resolution fluorescence microscopy technology: Using fruit flies and zebrafish early embryos as models, optical microscopy imaging technologies such as fluorescence microscopy, spinning disk confocal microscopy, and two-photon microscopy are used to construct a high spatiotemporal resolution image database of cell morphology and behavior.

(b) Digital image processing technology: Using image processing and data analysis software such as Fiji, MATLAB, and Prism to automatically extract cell structures such as cell membranes, cytoskeletons, and nuclei from fluorescence images, and quantitatively analyze cell shape parameters and migration characteristics. The dynamic process of embryonic development is observed and analyzed in multiple spatiotemporal dimensions at the subcellular level.

(c) Machine learning technology: Based on high-resolution fluorescence images and cell feature parameter information, deep learning algorithms are used to automatically identify and classify cell types, and to explore the regular features of cell behavior during embryonic development.

模块二：病原菌与宿主相互作用以及免疫应答的分子机制（学生病原菌）

通过微生物学、细胞生物学、生物化学、分子生物学和结构生物学的手段，研究病原菌与宿主的相互作用机制。该课程教学的内容主要包括：讲述病原菌的主要致病机制，讲解宿主如何应对病原菌感染以及病原菌如何调控宿主的免疫机制。通过该课程的实践训练，学生将熟悉并掌握微生物遗传学和生物化学的基本方法，让学生了解病原菌和宿主的协同进化，以及针对该病原菌可能的防治策略。

Module 2: Molecular Mechanisms of Pathogen-Host Interactions and Immune Responses

Using Microbiology, Cell Biology, Biochemistry, Molecular Biology, and Structural Biology, the course studies the mechanisms of pathogen-host interactions. The content of this course mainly includes the main pathogenic mechanisms of pathogens, how hosts respond to pathogen infections, and how pathogens regulate host immune mechanisms. Through practical training in this course, students will become familiar with and master the basic methods of microbial genetics and biochemistry, understand the co-evolution of pathogens and hosts, and develop prevention and treatment strategies against the pathogen.

1. 微生物遗传学和细胞生物学方法挖掘关键基因功能

(a). 细菌遗传学技术：利用大肠杆菌为模型，通过转座子随机突变筛选控制细菌形态、色素产生、蛋白分泌等关键基因，利用分子生物学手段对基因功能进行鉴定，并且在细菌体内通过精准基因编辑技术构建突变体。通过该训练，学生将熟悉并掌握微生物遗传学和生物化学的基本方法，能够独立完成功能基因鉴定、蛋白纯化、酶学反应设计等。

(b). 细胞生物学技术：利用动物细胞，以结核分枝杆菌疫苗卡介苗株为模型，研究病原菌与宿主的相互作用机制。具体包括克隆目的基因，构建各类型的表达载体，转染哺乳动物细胞系，通过 SDS-PAGE, Western blot, 细胞活力测定，免疫荧光染色，免疫共沉淀等实验方法来研究其功能，利用基因编辑技术构建敲除细胞系，并通过酵母双杂交来筛选与靶标蛋白相互作用的蛋白。(病原菌实验由指导老师/助教操作)

1. Using Microbial Genetics and Cell Biology methods to explore key gene functions

(a) Bacterial genetics technology: Using E. coli as a model, key genes controlling bacterial morphology, pigment production, protein secretion, etc. are screened through transposon random mutagenesis. Gene function is identified using Molecular Biology techniques, and mutant strains are constructed using Precise Gene Editing technology in bacteria. Through this training, students will become familiar with and master the basic methods of microbial genetics and biochemistry, and be able to independently complete functional gene identification, protein purification, enzyme reaction design, etc.

(b) Cell Biology technology: Using animal cells and the Mycobacterium bovis BCG vaccine strain as a model, the course studies the mechanisms of pathogen-host interactions. This includes cloning target genes, constructing various types of expression vectors, transfecting mammalian cell lines, and studying their functions through experimental methods such as SDS-PAGE, Western blot, cell viability assays, immunofluorescence staining, and immunoprecipitation. Knockout cell lines are constructed using gene editing technology, and proteins that interact with target proteins are screened using yeast two-hybrid. (Pathogen experiments are performed by instructors)

2. 利用生物化学和结构生物学等技术方法探索天然免疫关键信号的激活与调控

(a). 生物化学重构：利用原核体系表达纯化人类天然免疫关键受体和调控蛋白，利用体外生物化学方法重构天然免疫反应。

(b). 荧光显微镜和电镜技术：通过荧光标记的方法，在显微镜下观察免疫信号关键复合体的激活。通过负染透射电镜的方法，观察天然免疫关键信号分子活化后形成纤维状激活小体的形态，探究其激活下游信号的机制。

2. Using Biochemical and Structural Biology techniques to explore the activation and regulation of key signals in innate immunity

(a) Biochemical reconstruction: Using prokaryotic systems to express and purify human innate immune receptors and regulatory proteins, and using in vitro biochemical methods to reconstruct innate immune responses.

(b) Fluorescence microscopy and electron microscopy techniques: Using fluorescence labeling methods to observe the activation of key immune signal complexes under the microscope. Using negative staining transmission electron microscopy to observe the formation of fibrous activation bodies after activation of key innate immune signal molecules, and explore the downstream signaling mechanisms of their activation.

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		40		
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		30		
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.