

## 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 <b>Course Title</b>	生化分离技术 <b>Bioseparations</b>
2.	授课院系 <b>Originating Department</b>	生物系 Department of Biology
3.	课程编号 <b>Course Code</b>	BIO346
4.	课程学分 <b>Credit Value</b>	3 (1)
5.	课程类别 <b>Course Type</b>	专业核心课 (生物技术专业) Major Core Courses (Biotechnology Major) 专业选修课 (生物科学专业) Major Elective Courses (Biological Sciences Major)
6.	授课学期 <b>Semester</b>	秋季 Fall
7.	授课语言 <b>Teaching Language</b>	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) <b>Instructor(s), Affiliation &amp; Contact</b> (For team teaching, please list all instructors)	龚欣 (理论部分负责人), 生物系, B 栋 206, gongx@sustech.edu.cn Xin GONG, Department of Biology, Rm.206 Building B 吕沫 (实验部分负责人), 生物系, lv.m3@sustc.edu.cn Mo LV, Department of Biology
9.	实验员/助教、所属学系、联系方式 <b>Tutor/TA(s), Contact</b>	吕沫, 生物系, lv.m3@sustc.edu.cn Mo LV, Department of Biology 助教(理论+实验部分): 待公布 To be announced
10.	选课人数限额(可不填) <b>Maximum Enrolment (Optional)</b>	

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	32		32		64

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	生物化学 II (新陈代谢) Biochemistry II (Metabolism) 分子生物学 Molecular Biology
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	无
14. 其它要求修读本课程的学系 Cross-listing Dept.	None

### 教学大纲及教学日历 SYLLABUS

#### 15. 教学目标 Course Objectives

生化分离技术是一门生物学专业核心课程。本课程的目标是为学生传授生化分离的基本知识和实验方法。通过本课程的学习, 让学生能够理解并掌握生化分离的原理、研究方法和研究思路, 熟悉常用的生化分离技术, 并最终学会应用这些知识和技巧来解决生物学中的研究问题。

生化分离技术实验是这门课程中重要的教学实践环节。本课程的实验设计是一门综合设计的实验项目, 以目前科研前沿的膜蛋白分离纯化技术和膜蛋白的相互作用为主线, 学生动手实验操作为主, 讲授为辅, 通过实验课教学巩固和补充课堂上讲授的理论知识, 锻炼学生的科学思维能力, 比如膜蛋白分离纯化技术的学习, 蛋白质与蛋白质之间的相互作用等都是科研上非常先进的科研技术。生化分离技术实验是一门非常有价值的课程, 它会让学生学习前沿的实验技术和方法, 参与实验设计, 总结和分析实验结果, 最终以科研论文的形式撰写实验报告。在生物实验过程中重视学生科学素质的培养, 通过本门课程的引导和培养, 激发学生对生物科学的兴趣, 培养学生的科研创新意识, 为拓展学生的生物科研思维打下坚实基础。

Bioseparations is a major core course in biology. Our aim is to teach the basic knowledge and techniques of bioseparations. With this course, we present the principles, methods and theories of bioseparations, and teach students to apply these knowledge and skills to solve problems in biological research.

Bioseparations laboratory is an important teaching practice in this course. Experimental design of this course is a comprehensive design experimental project. With the current cutting-edge membrane protein separation and purification technology and membrane protein interaction as the main line. Students hands-on experimental operation, teaching as a supplement. Through the experimental class teaching to consolidate and supplement the theoretical knowledge taught in class, exercise the scientific thinking ability of students, such as membrane protein separation and purification technology of learning, the interaction between protein and protein is a very advanced scientific research technology in scientific research. Bioseparations laboratory is a very valuable course, which will allow students to learn cutting-edge experimental techniques and methods, participate in experimental design, summarize and analyze experimental results, and finally write experimental reports in the form of scientific research papers. In the process of biological experiments, we attach importance to the cultivation of students' scientific quality. Through the guidance and cultivation of this course, we want to stimulate students' interest in biological science, cultivate students' consciousness of scientific research innovation, and lay a solid foundation for expanding students' thinking of biological research.

#### 16. 预达学习成果 Learning Outcomes

通过本课程的学习, 学生可以

1. 掌握生物制品的特性及生化分离的基本原理;
2. 了解评估生物制品的生物活性和纯度的各种分析方法;
3. 了解常用的生化分离技术;
4. 进行生化分离实验设计。

At the end of the course, students should be able to

1. List the basic properties of various types of bioproducts and basic principles of bioseparations;
2. Understand the analytical methods for the assessment of the biological activity and purity of bioproducts;
3. Understand various approaches for typical bioseparation processes;
4. Perform design and scale-up calculations for specific bioseparations.

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.)**

### 理论课部分（Lecture Part）(32 hours)

第1章 生物技术产品和生化分离技术绪论（学时：3小时）

Chapter 1 Introduction to Bioproducts and Bioseparations (3 hours)

1.1 生物制品的分类及特性

1.1 Classification and Characteristics of Bioproducts

1.2 生化分离的一般过程及单元操作

1.2 General Process and Unit Operation of Bioseparations

第2章 生化分离的分析方法（学时：4小时）

Chapter 2 Analytical Methods for Bioseparations (4 hours)

2.1 分析属性

2.1 Assay Attributes

2.2 生物活性的分析

2.2 Analysis of Biological Activity

2.3 纯度的分析

2.3 Analysis of Purity

2.4 微生物学分析

2.4 Microbiology Assays

第3章 细胞破碎（学时：3小时）

Chapter 3 Cell Lysis (3 hours)

3.1 细胞结构的一些要素

3.1 Some Elements of Cell Structure

3.2 化学法细胞破碎

3.2 Chemical Methods for Cell Lysis

3.3 机械法细胞破碎

3.3 Mechanical Methods for Cell Lysis

3.4 膜蛋白的提取

3.4 Extraction of Membrane Proteins

第4章 过滤 (学时: 2小时)

Chapter 4 Filtration (2 hours)

4.1 过滤的原理

4.1 Filtration Principles

4.2 过滤介质及设备

4.2 Filter Media and Equipment

4.3 膜污染

4.3 Membrane Fouling

第5章 离心与沉降 (学时: 2小时)

Chapter 5 Centrifugation and Sedimentation (2 hours)

5.1 沉降的原理

5.1 Sedimentation Principles

5.2 沉降的分析方法

5.2 Methods for Analysis of Sedimentation

5.3 超速离心

5.3 Ultracentrifugation

5.4 絮凝与沉降

5.4 Flocculation and Sedimentation

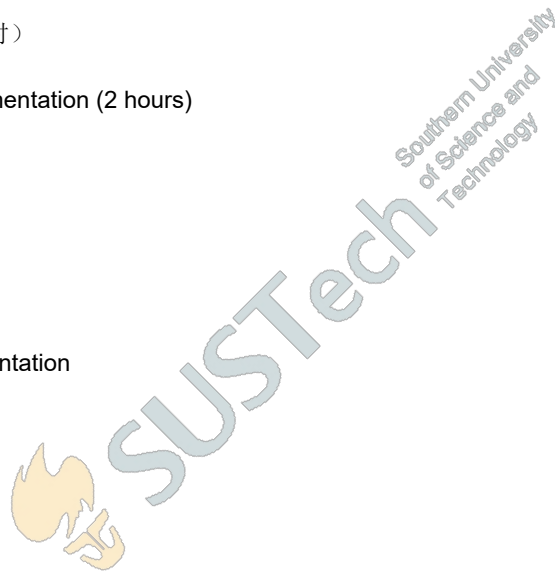
第6章 萃取 (学时: 2小时)

Chapter 6 Extraction (2 hours)

6.1 萃取的原理

6.1 Extraction Principles

6.2 双水相萃取系统



## 6.2 Aqueous Two-Phase Extraction Systems

第7章 沉析 (学时: 2小时)

### Chapter 7 Precipitation (2 hours)

7.1 蛋白质的溶解度

7.1 Protein Solubility

7.2 沉析的方法

7.2 Methods of Precipitation

第8章 吸附 (学时: 6小时)

### Chapter 8 Adsorption (6 hours)

8.1 吸附类型

8.1 Adsorption Type

8.2 亲和吸附

8.2 Affinity Adsorption

8.3 离子交换

8.3 Ion Exchange

8.4 反相

8.4 Reverse Phase

8.5 疏水相互作用

8.5 Hydrophobic Interaction

8.6 等温吸附线

8.6 Adsorption Isotherms

8.7 批量吸附

8.7 Batch Adsorption

8.8 固定床吸附

8.8 Packed Bed Adsorption

第9章 色谱分离技术 (学时: 4小时)

### Chapter 9 Chromatography (4 hours)

9.1 色谱系统



9.1 Chromatography System

9.2 色谱柱的类型

9.2 Types of Chromatographic Columns

9.3 色谱理论

9.3 Theory of Chromatography

9.4 色谱峰

9.4 Chromatographic Peak

9.5 二元色谱

9.5 Binary Chromatography

第10章 膜分离技术 （学时：2小时）

Chapter 10 Membrane-based Bioseparation (2 hours)

10.1 膜分离的分类

10.1 Classification of Membrane-based Bioseparation

10.2 超滤

10.2 Ultrafiltration

10.3 微滤

10.3 Microfiltration

10.4 透析

10.4 Dialysis

10.5 液膜分离技术

10.5 Liquid Membrane Processes

10.6 膜色谱

10.6 Membrane Chromatography

第11章 生物技术产品的精制 （学时：2小时）

Chapter 11 Bioproducts Polishing (2 hours)

11.1 结晶

11.1 Crystallization

11.2 干燥



## 11.2 Drying

### 实验课部分:

### 生化分离技术实验 (32 学时)

#### Bioseparations Laboratory (32 hours)

##### 模块 I (实验 1) 膜蛋白与可溶性蛋白分离纯化技术介绍和本实验课程项目的总体设计 (4 小时)

**Module I (Lab1)** . Lecture on separation and purification of membrane protein and soluble protein technology and the overall design of this experimental course (4 hours)

介绍实验室规则、安全、课程设置及实验安排; 实验记录本及实验报告要求; 实验课的考核及评分标准; 介绍膜蛋白与可溶性蛋白分离纯化和应用的相关技术。本实验课程项目的总体设计。

Introduce Bioseparations Laboratory safety, course requirement (notebook and report), course schedule (basic content of nucleic acid and protein) and evaluation. Introduce the separation and purification of membrane protein and soluble protein. The overall design of this experimental course.

##### 模块 II (实验 2-3) 构建哺乳动物细胞和大肠杆菌表达系统 (8 小时)

实验 2: 质粒的提取和哺乳动物细胞的培养 (4 小时)

**Module II (Lab2-3)** Construct the expression system of mammalian cells and *Escherichia coli*

Lab2: Plasmid extraction and mammalian cell culture (4 hours)

分离去内毒素的质粒 DNA, 培养真核细胞。

Plasmid DNA is isolated from endotoxin. Culture eukaryotic cells.

实验 3. 哺乳动物细胞的瞬时转染与构建大肠杆菌表达系统 (4 小时)

Lab3: Transient transfection of mammalian cells and construction of *Escherichia coli* expression system (4 hours)

利用瞬时转染方法将质粒转入哺乳动物细胞中。细胞转染后, 定期观察细胞。构建大肠杆菌表达外源蛋白的表达系统。

Plasmids are transferred into mammalian cells by transient transfection. After transfection, the cells were observed regularly. The expression system of exogenous proteins in *Escherichia coli* is constructed.

##### 模块 3 (实验 4-5) 重组整合膜蛋白的表达和纯化 (8 小时)

**Module III (Lab4-5) Expression and purification of recombinant integromembrane proteins (8 hours)**

细胞破碎, 去污剂处理细胞膜, 利用亲和层析的方法纯化膜蛋白, SDS-聚丙烯酰胺凝胶电泳检测纯化产物。纯化产物再通过 AKTA 分子筛层析纯化膜蛋白, SDS-聚丙烯酰胺凝胶电泳检测纯化产物。这一步为本实验的重点, 膜蛋白的纯度直接影响实验最终的结果。

The cell membrane is treated with a detergent, the membrane protein is purified by affinity chromatography, and the purified product is detected by SDS-PAGE. The purified products are purified by AKTA molecular sieve chromatography and detected by SDS-PAGE. This step is very important in this experiment, and the purity of membrane protein directly affects the final result of the experiment.

**模块 4 (实验 6-7) 可溶性蛋白的分离纯化 (8 小时)**

**Module IV (Lab6-7) Separation and purification of soluble proteins (8 hours)**

细胞破碎，利用亲和层析的方法纯化可溶性蛋白，SDS-聚丙烯酰胺凝胶电泳检测纯化产物。纯化产物再通过 AKTA 离子交换层析纯化可溶性蛋白，SDS-聚丙烯酰胺凝胶电泳检测纯化产物。对可溶性蛋白的纯度要求较高，其纯度影响蛋白之间的相互作用效果。

Cell disruption, the soluble protein is purified by affinity chromatography, and the purified product is detected by SDS-PAGE. The purified products are purified by AKTA ion exchange column chromatography and detected by SDS-PAGE. The purity of soluble protein is high quality, and its purity affects the effect of protein interaction.

**模块 5 (实验 8) 蛋白质与蛋白质之间的相互作用 (4 小时)**

**Module V (Lab8) Protein-protein interaction (4 hours)**

利用 pull-down 技术测膜蛋白与可溶性蛋白之间的相互作用，通过蛋白相互作用来研究细胞通路。pull-down 技术是检测已知的蛋白相互作用条件，筛选未知蛋白相互作用的常用方法。

Pull-down technique is used to measure the interactions between membrane proteins and soluble proteins, and to study the cellular pathways through protein interactions. Pull-down technique is a common method to detect known protein interaction conditions and screen unknown protein interactions.

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

教材/Textbook:

Bioseparations Science and Engineering, Second Edition, Roger G. Harrison et al., 2015.

参考书/Reference Book:

Principles of Bioseparations Engineering, Raja Ghosh, 2006.

**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		10		
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects		15		
平时作业 Assignments				
期中考试 Mid-Term Test		20		
期末考试 Final Exam		20		
期末报告 Final Presentation				



实验课（可根据需要改写以上评估方式）  
Others (The above may be modified as necessary)

	35		八次实验课的总分。 Total score for eight experimental classes.
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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

本课程经生物系本科教学指导委员会审议通过。  
This Course has been approved by Undergraduate Teaching Steering Committee of Department of Biology.

