课程大纲
COURSE SYLLABUS

1.	**课程代码/名称** **Course Code/Title**	**空间基因组学 Spatial Genomics**
2.	**课程性质** **Compulsory/Elective**	专业选修课/Elective
3.	**开课单位** **Offering Dept.**	生物系/ Department of Biology
4.	**课程学分/学时** **Course Credit/Hours**	3/48
5.	**授课语言** **Teaching Language**	中英文 Chinese/English
6.	**授课教师** **Instructor(s)**	郑梅珍/Zheng Meizhen
7.	**开课学期** **Semester**	秋季/Autumn
8.	**是否面向本科生开放** **Open to undergraduates or not**	否/Not
9.	**先修要求** **Pre-requisites**	（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

10. 教学目标
Course Objectives

（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

基因组在空间结构上，并不是在染色体上呈线性地一字依次排开，而是随着 DNA 形成复杂高级结构的同时，具备了三维组织形式。空间基因组学（即三维基因组学）是一门研究基因组三维空间结构与功能的新兴学科，主要研究基因组序列在细胞核内的三维空间构象，及其对 DNA 复制、DNA 重组、基因表达调控等生物过程的生物学效应。本课程的目标是通过介绍空间（三维）基因组学的相关技术及其应用，帮助学生了解基因组在细胞核内的组装、空间结构、及其对基因的调控。通过该课程的学习，学生能够熟练掌握应用空间基因组学技术和手段研究染色质空间构象和基因的远程调控机制。本课程采用“讲授教学”和“科学案例分析”相结合的教学方式，促进学生对课程内容的理解，锻炼他们的科研思维能力，为培养空间基因组领域高层次创新人才奠定基础。

The genome is folded into a hierarchical structure but not arranged in a linear sequence on the chromosomes within the nucleus. Spatial Genomics, i.e., Three-dimensional (3D) genomics is an emerging discipline for studying the three-dimensional structure of the genome, and its effects on the biological processes such as DNA replication and recombination, and gene expression regulation. The goal of this course is to help students understand the genome organization in three-dimensional, by introducing the relevant techniques of Spatial (3D) genomics and their applications. Through the study of this course, students will be able to master the application of three-dimensional genomics techniques and methods to study the gene long-range regulation mechanisms of chromatin conformation. This course adopts the teaching method of combining "theory teaching" and "scientific case analysis" to help students understand the course content, exercise their scientific research thinking ability, and pave a road for cultivating high-level innovative talents in the field of Spatial (3D) genomics.

11. 教学方法
Teaching Methods

（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

本课程以中英文双语进行教学，采用课堂讲授空间三维基因组学相关技术的基本原理、实验设计、实验流程、及其在科学研究中的应用与发现，学生分组对科学研究案例进行分析讨论，全面培养学生对空间基因组学的研究内容、研究方法、前沿科学问题等方面的认识。

Teaching in both Chinese and English. The basic concepts of Spatial (3D) genomics, the experimental design and workflow, the application and findings are delivered via teaching. Students are organized into groups for Scientific Reports discussion.

12. 教学内容
Course Contents
（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.）

Section 1	**The history for the development of Spatial (3D) genomics (2hrs) 空间三维基因组学发展史** **Lecture 1**. Introduction to the course; and the history of Spatial (3D) genomics; (2hrs) 课程简介 • Syllabus: form of examination, grading policy and course introduction (1hrs) 课程和教学大纲 • Introduction of the history for the development of Spatial (3D) genomics (1hrs) 空间三维基因组学发展史介绍
Section 2	**The development and application of traditional Spatial (3D) genome mapping technologies (20hrs) 传统空间三维基因组学技术的开发与应用** **Lecture 2**. 3C（chromosome conformation capture ）(2hrs) 染色体构象捕获 • The principle for 3C method (1hrs) 3C 基本原理 • The application for 3C method (1hrs) 3C 的应用 **Lecture 3**. 4C（circular chromosome conformation capture）(2hrs) 环状染色质构象捕获 • The principle for 4C method (1hrs) 4C 的基本原理 • The application for 4C method (1hrs) 4C 的应用 **Lecture 4**. 5C（Carbon-Copy Chromatin Conformation Capture）(2hrs) 碳拷贝染色质构象捕获 • The principle for 5C method (1hrs) 5C 的基本原理 • The application for 5C method (1hrs) 5C 的应用 **Lecture 5**. Hi-C（High-throughput chromosome conformation capture）(2hrs) 高通量染色体构象捕获技术 • The principle for Hi-C method (1hrs) Hi-C 的基本原理 • The application for Hi-C method (1hrs) Hi-C 的应用 **Lecture 6**. Visualize HI-C data via Juicebox (2hrs) 使用 Juicebox 对 HI-C 数据可视化分析 • The introduction for Juicebox (1hrs) Juicebox 可视化工具介绍 • The practice for Juicebox (1hrs) Juicebox 可视化工具实操 **Lecture 7**. ChIA-PET（chromatin interaction analysis by paired-end tag sequencing）(2hrs) 特异因子介导的染色质远程交互技术 • The principle for ChIA-PET method (1hrs) ChIA-PET 的基本原理 • The application for ChIA-PET method (1hrs) ChIA-PET 的应用 **Lecture 8**. ChIA-PET derived technologies (2hrs) ChIA-PET 衍生技术 • The introduction for ChIA-PET derived method (1hrs) ChIA-PET 衍生技术介绍

	• The application for ChIA-PET derived method (1hrs) ChIA-PET 衍生技术应用 **Lecture 9**. ChIA-PIPE：(2hrs) ChIA-PET 数据分析工具包 • The introduction for ChIA-PIPE (1hrs) ChIA-PIPE 数据处理工具包的介绍 • The application for ChIA-PIPE (1hrs) ChIA-PET 数据处理工具包的应用 **Lecture 10**. Basic Browser：(2hrs) ChIA-PET 数据可视化工具 • The introduction for Basic Browser (1hrs) Basic Browser 可视化工具包的介绍 • The practice for Basic Browser (1hrs) Basic Browser 可视化工具包的实践 **Lecture 11**. 3C-derived technologies (2hrs) 3C 衍生技术 • The principle for 3C-derived technologies (1hrs) 3C 衍生技术的基本原理 • The application for 3C-derived technologies (1hrs) 3C 衍生技术的应用
Section 3	**RNA-chromatin DNA interactions (10hrs) RNA-染色质 DNA 的交互技术与应用** **Lecture 12**. The world of RNA：(2hrs) RNA 的世界与功能 • The different types of RNA (1hrs) RNA 的类型 • The functions of RNA (1hrs) RNA 的功能 **Lecture 13**. Chart/ChIRP (RNA targets) ：(2hrs) RNA 结合的染色质靶点 • The principle for Chart/ChIRP method (1hrs) Chart/ChIRP 的基本原理 • The application for Chart/ChIRP method (1hrs) Chart/ChIRP 的应用 **Lecture 14**. CLIP-seq (RNA binding proteins) ：(2hrs) RNA 结合的目标蛋白 • The principle for CLIP-seq method (1hrs) CLIP-seq 的基本原理 • The application for CLIP-seq method (1hrs) CLIP-seq 的应用 **Lecture 15**. RNA-DNA ：(2hrs) 全基因组 RNA-染色质交互网络 • The principle for RNA-DNA interaction method (1hrs) RNA-DNA 交互技术的基本原理 • The application for RNA-DNA interaction method (1hrs) RNA-DNA 交互技术的应用 **Lecture 16**. RNA-RNA：(2hrs) 全基因组 RNA-RNA 交互网络 • The principle for RNA-RNA interaction method (1hrs) RNA-RNA 交互技术的基本原理 • The application for RNA-RNA interaction method (1hrs) RNA-RNA 交互技术的应用
Section 4	**The development and application of new-Gen 3D genome mapping technologies (14hrs)** 新一代三维基因组学技术的发展与应用 **Lecture 17**. The contribution and limitation of traditional 3D genomics：(2hrs)传统三维基因组学的贡献和局限 • The contribution for traditional 3D genome mapping technologies (1hrs) 传统三维基因组学的贡献 • The limitation for traditional 3D genome mapping technologies (1hrs) 传统三维基因组学技术的局限 **Lecture 18**. The 4D nucleome project：(2hrs) 4DN 四维核计划 • The background introduction for the 4D nucleome project (1hrs) 四维核计划背景介绍

		• The organization and achievement for the 4D nucleome project (1hrs) 四维核计划的组织与成就 **Lecture 19**. 4DN portal：(2hrs)四维核计划网站介绍和资源使用 • The introduction for 4DN portal (1hrs) 四维核计划网络资源介绍 • The practice for the 4DN portal (1hrs) 四维核计划网站实操 **Lecture 20**. GAM：(2hrs)基于显微切割的染色质构象捕获技术 • The principle for GAM method (1hrs) GAM 技术的基本原理 • The application for GAM method (1hrs) GAM 技术的应用 **Lecture 21**. SPRITE：(2hrs)基于染色质复合物末端标记的新一代三维基因组技术 • The principle for SPRITE method (1hrs) SPRITE 技术的基本原理 • The application for SPRITE method (1hrs) SPRITE 技术的应用 **Lecture 22**. ChIA-Drop：(2hrs)基于微流控系统对染色质复合物进行标记的新一代三维基因组技术 • The principle for ChIA-Drop method (1hrs) ChIA-Drop 技术的基本原理 • The application for ChIA-Drop method (1hrs) ChIA-Drop 技术的应用 **Lecture 23**. ChIA-DropBox：(2hrs)单分子染色质复合物分析和可视化工具包 • The introduction for ChIA-DropBox (1hrs) ChIA-DropBox 工具包的介绍 • The uses for ChIA-DropBox (1hrs) ChIA-DropBox 工具包的使用
	Section 5	**Lecture 24**. Write a review about the application and development of Spatial 3D Genomics 综述空间三维基因组学的应用和发展

13. 课程考核
Course Assessment

（①考核形式 Form of examination；②.分数构成 grading policy；③如面向本科生开放，请注明区分内容。If the course is open to undergraduates, please indicate the difference.）

出勤 Attendance 10%；课堂表现 Class Performance 25%；平时作业 Assignments 25%；期末综述 Review 40%

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

教师指定的空间基因组学相关科研文献和最新进展。

The assigned literature and the advances in Spatial (3D) genomics.