

# Bioinformatics Applications (PLPTH813)

**Semester:** Spring 2023

**Instructor:** Sanzhen Liu, Plant Pathology, Kansas State University

**Contact information:** [liu3zhen@ksu.edu](mailto:liu3zhen@ksu.edu)

**ZOOM:** <https://ksu.zoom.us/j/93540130452> (just in case)

**Time:** Tuesday, Thursday 10:30am-11:20pm (lectures); Thursday 12:30-2:00pm (lab)

**Office:** <https://ksu.zoom.us/j/8468443307> (appointment is required)

**Office hours:** Tuesday 12:30-1:30pm

**Exams:** midterm from 10:30am on 3/9/2023 Thursday 10:30am; final is in the final week

## Goal of the course

PLPTH813 will cover the basic principle of regular bioinformatics applications and emphasize the practice of bioinformatics in biological research. The course will introduce some useful computation skills, such as Unix commands and R programming, in data analysis at the beginning of the semester, and then will apply these skills throughout the course. This course will be focused on the application of bioinformatics in next-generation sequencing (NGS) data analysis, including genetic mapping, genome assembly, variant discovery, genotyping, RNA-Seq, and so on. The ultimate goal of this course is to help students to be prepared for the next-generation biological research that often generates large data and requires computational skills in data management and data translation.

## Tentative course content

(The course content will be adjusted according to the advance of computational tools and the interests of course audience.)

### **PART 1.** Useful Unix tools and R programming

1. Unix/Linux system and useful tools
2. R introduction and useful R packages

### **PART 2.** Basic tools for DNA sequence analyses

1. Introduction of NGS technologies
2. Standard data formats
3. Tools for NGS data process and visualization

### **PART 3. Application of NGS in Genomics**

1. Genomic variant discovery
2. Phylogeny
3. Genetic mapping (QTL, bulked segregant analysis, genome-wide association)
4. Genome assembly (assembly tools and evaluation)
5. Comparative genomics
6. RNA-seq (technology, experimental design and differential expression)
7. scRNA-seq
8. Applications of machine learning in genomics

### **PART 4. Student project presentations**

## **Grading**

Participation 10%, Homework 30%, Midterm Exam 20%, Student project 15%, final Exam 25%

### **1. Participation**

Students are anticipated to be present in each Zoom session. Absence needs to be informed prior to the class. Without notifications, the score for the participation will be compromised.

### **2. Midterm and final exam**

The midterm exam will cover Part 1 and 2. The final exam will cover all teaching materials through the semester. Students are allowed to use books and laptops. Two hours will be given to students to return their answers. Communication is NOT allowed among students during the exam course.

### **3. Student project**

Students are expected to start to design their projects after February. The project can be related to students' own research projects or utilize public data for a meaningful analysis. Ideas will be proposed in a 5-minute presentation during the class. The presentation should include the goal, the rationale, the data source, and the expected result. In the week before the final week, students will present their projects. Each presentation will take ~15 minutes.

## **Other notes**

We will use the software R throughout the course. Students in the class are required to have the Beocat account that allows you to access the Beocat server and use R-studio through Beocat.

## **Acknowledgements**

The development and improvement of this course was contributed by Hairong Wei, Ying Hu, Lei Li, Zhiwu Zhang, Sonny Lee, Cheng He as well as students taking this course in the past.

## **Academic Honesty and Integrity Statement**

Kansas State University has an Honor & Integrity System based on personal integrity, which is presumed to be sufficient assurance in academic matters one's work is performed honestly and without unauthorized assistance. Undergraduate and graduate students, by registration, acknowledge the jurisdiction of the Honor & Integrity System. The policies and procedures of the Honor System apply to all full and part-time students enrolled in undergraduate and graduate courses on-campus, off-campus, and via distance learning. A component vital to the Honor & Integrity System is the inclusion of the Honor Pledge which applies to all assignments, examinations, or other course work undertaken by students. The Honor Pledge is implied, whether or not it is stated: "On my honor, as a student, I have neither given nor received unauthorized aid on this academic work." The default in this class is that ALL work will be accomplished individually, UNLESS my permission is given in advance of an assignment/quiz/exam/take-home exam/final. A grade of XF can result from a breach of academic honesty. The F indicates failure in the course; the X indicates the reason is an Honor Pledge violation. For more information, visit the Honor & Integrity System home web page at: <http://www.k-state.edu/honor/>

## **Statements for Academic Accommodations for Students with Disabilities**

Students with disabilities who need classroom accommodations, access to technology, or information about emergency building/campus evacuation processes should contact the Student Access Center and/or their instructor. Services are available to students with a wide range of disabilities including, but not limited to, physical disabilities, medical conditions, learning disabilities, attention deficit disorder, depression, and anxiety. If you

are a student enrolled in campus/online courses through the Manhattan or Olathe campuses, contact the Student Access Center at [accesscenter@k-state.edu](mailto:accesscenter@k-state.edu), 785-532-6441; for Salina campus, contact the Academic and Career Advising Center at [acac@k-state.edu](mailto:acac@k-state.edu) or call 785-826-2649.

## **Statement Defining Expectations for Classroom Conduct**

All student activities in the University, including this course, are governed by the Student Judicial Conduct Code as outlined in the Student Governing Association By Laws, Article VI, Section 3, number 2. Students who engage in behavior that disrupts the learning environment may be asked to leave the class.

## **Statement for Copyright Notification**

Copyright 2020 Sanzhen Liu as to this syllabus and all lectures. During this course students are prohibited from selling notes to or being paid for taking notes by any person or commercial firm without the express written permission of the professor teaching this course.