HORT 522: Transcriptomics: Data Analysis and Applications

Course Overview

In this course, you'll learn how to turn raw RNA-seq data into meaningful biological insights. We will walk through the complete transcriptomics workflow — from designing experiments and finding public datasets, to quality control, read alignment, quantification, and interpreting results through differential expression, network analysis, and pathway enrichment. You don't need to be a coding expert—you'll work with provided scripts and focus on understanding what the code does, how to run it, and how to interpret the results. Along the way, you will practice real-world skills using high-performance computing, UNIX, and R, and apply them to a semester-long project based on your own research interests.

Course Number	HORT 522
Semester	Fall 2025
Credits	3
Meeting Hours	TTh 9:10-1-:25 AM
Location	Pullman. CUE 114 Remote campus via Zoom link (see Canvas)
Recommend Preparation	Introductory coursework covering topics of general statistics and biology specifically covering DNA.
Requirement	A laptop with a minimal operating system. A laptop is required for connections to remote computational machines and for word processing.
Instructors	**Stephen Ficklin, Ph.D.** Associate Professor of Computational Biology, Dept. of Horticulture Email: stephen.ficklin@wsu.edu Phone: 509-335-4295 Office: 403A Plant Science Building, Pullman **Huiting Zhang, Ph.D.** Assistant Research Professor Dept of Horticulture. Email: huiting.zhang@wsu.edu Phone: 814-441-5765 Office: 403 Plant Science Building, Pullman
Office Hours	Tuesday 3-5pm. In-person or Zoom (See Canvas for Zoom link)

Student Learning Outcomes

By the end of this course, students will be able to:

1. Formulate biologically relevant research questions that can be addressed with RNA-seq data, identify, obtain, and evaluate RNA-seq datasets from public repositories.
2. Conduct quality control, read alignment, and quantification using standard RNA-seq analysis tools.
3. Know how to perform the most common applications with RNA-seq (de novo transcriptome construction, differential analysis, regulatory network construction, co-expression network construction, functional analysis) and interpret results.
4. Perform essential computational tasks for RNA-seq analysis using high-performance computing, UNIX, and R.

Learning Resources

Required Text: Course material will be provided by the instructor. No external texts are required.

Canvas: WSU's Canvas portal will be used to provide assignments, access to course grading, and periodic announcements. A Slack workspace will be set up for students to communicate in real-time.

Class Communication: Class communication will occur using email or Canvas.

Course Work

This course will consist of:

- (P) Semester-long project assignments
- (R) Reading assignments
- (W) Writing assignments
- (A) Out-of-class practice assignments
- (G) A group lecture.

In-class activities. In-class activities will vary depending on the subject. Sometimes preparatory learning in this class will occur prior to class via out-of-class assignments followed by in-class reinforcement from discussions, exercises and practice. Other times the class will be a full lecture. At times preparatory learning will be in class followed by out-of-class reinforcement practice. Please bring laptops for in-class exercises, but silence cell phones and turn off social media during class (e.g., Skype, Facebook, Twitter, etc.).

Assignments. Each week, one or more assignments will be provided for each student to complete individually. These assignments will consist of outside reading, semester long project activities, writing assignments and practice exercises. Assignments will be turned in using Canvas.

Group Lecture. A portion of this class will contain lectures by the student groups. Students will be organized into groups and assigned a topic regarding emerging technologies to learn about and provide instruction to other students in the class.

Exams. This course will not have an exam. In lieu of an exam, each student must 1) complete their assigned project; 2) deliver a presentation for other students in the class showing their research objectives, methods, results and interpretation of results; and 3) complete a short write-up (similar to a journal article) with background, methods, results and discussion of their project results.

Expectations

Out-of-class Work**:** For each hour of lecture equivalent, students should expect to have a minimum of two hours of work outside class. This includes reading, studying, or working on projects (6-9 hours per week). ***Please see the instructor if your efforts require more or less than this***. It is important that the course meet learning expectations for the topic but also not be over burdensome.

Late Work: Late assignments are not penalized so long as they are completed satisfactorily within a month of the due date or the last day of class (whichever comes first). Students who communicate ahead of time if they cannot complete an assignment within the month will be provided with a additional time.

Attendance**:** Attendance of this class is highly encouraged for student success. Absences because of illness, personal and/or family crises, mandated court appearances, university-approved events, or similar reasons will be accommodated if such absences are not excessive, and notification is provided to the instructor in advance. Excused absences should be arranged prior to any known or planned event. Required University activities will be excused absences if an official Class Absence Request form signed by the sponsoring faculty or organization is given to the instructor before the event.

Make-up: Students who are unable to complete reading, assignments, exercises, or projects during the allotted period have up to one month to submit assignments without penalty. After 1 month no credit will be received unless prior arrangements have been made to extend the grace period. If a student cannot participate in group work in a timely manner, they may be assigned to a different group to make up for a lost grade if communication ahead-of-time is made. The policy for allowed absences is described in the "Attendance" subsection above.

Class Schedule

This course is meant to be flexible and will adjust to the learning needs of students. Changes to the following schedule may occur. If changes do occur an updated course schedule will be provided. In the table below SLO indicates student learning outcomes from the daily topics and activities as numbered in the "Student Learning Outcomes" section above.

Date	Class Day	Weekday	Week	Topic
Module 0: Course Introduction and Setup				
19-Aug	1	Tu	1	Framing Biological Questions with Transcriptomics - practice choose a research question.
21-Aug	2	Th	1	Finding Public Data - What is a good genome, what is a gene model, what is functional annotations, where to find them. Find public transcriptome data
Module 1: Biocomputing				

26-Aug	3	Tu	2	Jupyter Notebooks, UNIX Command Line, and HPC
28-Aug	4	Th	2	Practice Day
2-Sep	5	Tu	3	Introduction to R: Data Structures and Basic Syntax
4-Sep	6	Th	3	Practice Day
Module 2: De novo Transcriptome Assembly and Annotation				
9-Sep	16	Th	4	Introduction to De Novo Assembly: Trinity Workflow
11-Sep	17	Tu	4	Evaluating Assembly Quality: BUSCO and N50 Metrics
16-Sep	18	Th	5	Functional Annotation: KEGG, InterProScan, BLAST
18-Sep	19	Tu	5	Discovery Reflection: What Did You Learn from Assembly?
Module 3: RNA-Seq Preprocessing				
23-Sep	7	Tu	6	Good Experimental Design for RNA-seq
25-Sep	8	Th	6	RNA-seq Quality Control and alignment
30-Sep	9	Tu	7	Discovery Reflection: Review of good experiment design
Module 4: DEG Analysis				
2-Oct	10	Th	7	Differential Expression: Concepts and Tools, Batch Effects and Normalization
7-Oct	11	Tu	8	Visualizing DEG Results: PCA and Volcano Plots
9-Oct	12	Th	8	Functional Enrichment Analysis
14-Oct	13	Tu	9	Discovery Reflection: What Did the Data Reveal?
Module 5: Co-expression Network Construction and Analysis				
21-Oct	15	Tu	10	Identifying Key Modules and Hub Genes in WGCNA
23-Oct	20	Th	10	Discovery Reflection: What Biological Patterns Emerged?
Module 6: Regulatory Network Construction and Analysis				
30-Oct	22	Th	11	Finding Key Regulators: Network Centrality and Influence
4-Nov	23	Tu	12	Validating Predicted Regulatory Interactions
6-Nov	24	Th	12	Discovery Reflection: Which Regulators Stood Out?
Module 7: Emerging and Developing technologies and analysis (spatial, single-cell, full-length RNA-seq) - group lectures				
11-Nov		Tu	13	*No Class -- Veterans Day Holiday*
13-Nov	25	Th	13	Single-cell RNA-seq
18-Nov	26	Tu	14	Dimensionality Reduction and Clustering
20-Nov	27	Th	14	Full-length RNA-seq
25-Nov		Tu		*No Class -- Thanksgiving Break*
27-Nov		Th		*No Class -- Thanksgiving Break*
Module 8: Presentations and Exam				
2-Dec	28	Tu	15	Final Project Presentations: Communicating Your Discoveries (Part 1)
4-Dec	29	Th	15	Final Project Presentations: Communicating Your Discoveries (Part 2)
9-Dec		Tu		*No Class -- Exam Week*
11-Dec		Th		*No Class -- Exam Week*

Grading

All students begin the course with 100 points (an A grade). Students can maintain this A by completing all assignments on Canvas. Each assignment will be given a set number of points. If an assignment is not turned in the student is docked the prescribed points. If portions of the assignment are incorrect, then all or a portion of the points will be docked. Students can repeat assignments as many times as necessary to within a month of the original assigned date and regain all lost points.

Scale:

Grade	Points	Grade	Points
A	93+	C	70-73.9
A-	90-92.9	C-	66-69.9
B+	86-89.9	D+	62-65.9
B	82-85.9	D	58-61.9
B-	78-81.9	F	0-57.9
C+	74-77.9		

Mid-Term Grade**:** The mid-term grade will be the number of points the student has at the time midterm grades are due.

Incomplete Grade Policy (Academic Rule 90h): Incompletes are granted only with permission of the instructor and are subject to the following guidelines:

1. Students must request an incomplete in writing or by e-mail from the instructor before the end of the semester.
2. The request must be signed and dated by the student (or identified by the student's e-mail address) and must explain the reasons behind the request for the incomplete.
3. To be considered for an incomplete, there are two main conditions:
    a. A student must complete a minimum amount of the assigned course work. Specifically, a student must complete 75 percent of the course work.
    b. A student must have a mathematical possibility of passing the class. A passing grade is 60 percent or above for the entire course.
4. If extraordinary circumstances (e.g., family emergency, serious illness) are involved and are documented to the instructor's satisfaction, the professor/ instructor retains the discretion to grant an incomplete even if the minimum conditions outlined in item 3 above are not met. If an incomplete is granted, the standard WSU policy applies (i.e., ALL work must be completed within one full year from the end of the enrollment semester at issue, unless a shorter time is specified by the instructor. Otherwise, an automatic grade of "F," or failing, will be entered on the student's transcript).

Rounding of Grades: Grades will be rounded to the nearest whole number grade (e.g., 89.2 becomes 89 and 89.5 becomes 90).

University Syllabus Statement

Students are responsible for reading and understanding all university-wide policies and resources pertaining to all courses (for instance: accommodations, care resources, policies on discrimination or harassment), which can be found in the university syllabus.

Academic Integrity Statement

You are responsible for reading WSU's Academic Integrity Policy, which is based on Washington State law. If you cheat in your work in this class you will:

- Fail the assignment/ course.
- Be reported to the Center for Community Standards.
- Have the right to appeal my decision.
- Not be able to drop the course or withdraw from the course until the **appeals** process is finished.

If you have any questions about what you can and cannot do in this course, ask me.

If you want to ask for a change in my decision about academic integrity, use the form at the Center for Community Standards website. You must submit this request within 21 calendar days of the decision.

Please consult Graduate Student Rights and Responsibilities for more information.

Students in Crisis – Pullman Resources

- If you or someone you know is in immediate danger, DIAL 911 FIRST!
- Student Care Network: https://studentcare.wsu.edu/
- Cougar Transit: 978 267-7233
- WSU Counseling and Psychological Services (CAPS): 509 335-2159
- Suicide Prevention Hotline: 800 273-8255
- Crisis Text Line: Text HOME to 741741
- WSU Police: 509 335-8548
- Pullman Police (Non-Emergency): 509 332-2521
- WSU Office of Civil Rights Compliance & Investigation: 509 335-8288
- Alternatives to Violence on the Palouse: 877 334-2887
- Pullman 24-Hour Crisis Line: 509 334-1133