CBSC 5110: Special Topics: High-throughput Comparative Genomics (spring 2026)

Credit Hours: 3
Time: Mondays and Wednesdays, 9:00 a.m. - 10:20 a.m.
Location: McElroy Hall, room 101

This syllabus is intended as a guide for this course. Dates, assignments, and evaluation are subject to revision by the instructor and will be announced in advance when possible.

Course Faculty

Instructor of Record:

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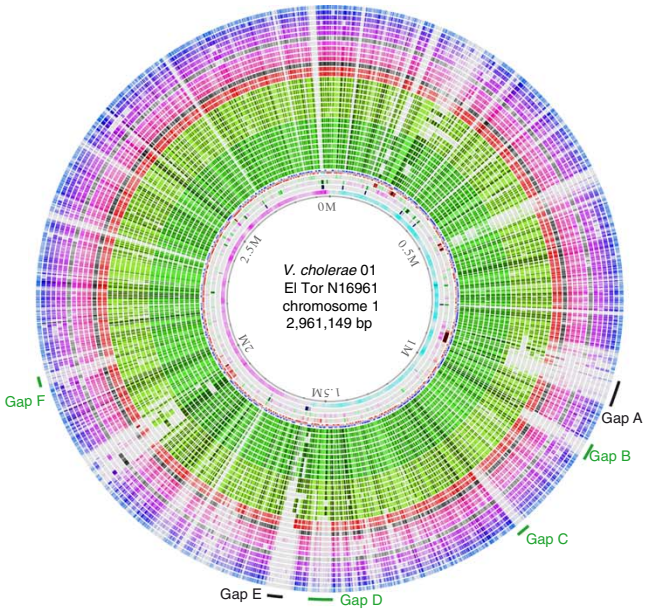
Office: McElroy-RJP 269
Office Hours: Mon. & Wed. 1-3 pm, and by request



PREREQUISITES:

- None.
- Basic knowledge of the programming language R is recommended, but not required.
- A basic understanding of molecular biology and genetics is helpful but not required.

Course Description

Course Catalog Description:

Special research problems in the various fields of veterinary biomedical sciences. Previously offered as VIDP 5110 and VBSC 5110. Offered for variable credit, 1-6 credit hours, maximum of 20 credit hours.

ABOUT THIS COURSE
This course provides an introduction to the field of genomics, focusing on the sequences as biological information, and the flow of information in biology. The curriculum will begin with the foundational principles of genomics and then explore computational methods and analytical pipelines required to manage and interpret the explosion of sequencing data.

Students will explore how disruptive innovations, such as third generation, single-molecule, long-read sequencing, have made large-scale genomic projects accessible and cost-effective. *The course will cover methods for comparing genomes across various scales, from dozens to hundreds to millions of genomes, with an emphasis on the stunning diversity and lack of sequence conservation and the importance of protein structural domains.*

The course is project-based, and students will utilize a specialized software suite, R-BioTools, to conduct their own comparative genomics analysis on a set of microbial genomes. Through hands-on application, students will gain practical experience in genomic data analysis and interpretation, preparing them for careers in research, medicine, and biotechnology.

REQUIRED MATERIALS

There is **no** required textbook for this course. I will provide a PDF version of my textbook: **Computing for Comparative Microbial Genomics: Bioinformatics for Microbiologists**, by David Wayne Ussery, Trudy M. Wassenaar, Stefano Borini, (ISBN 978-1-84800-254-8; Springer, 2009), as well as PDFs of recent articles published in the scientific literature; all materials you need will be provided through Canvas, and links to open-access articles will be provided in updated version of the course syllabus.

COMMUNICATION AND OFFICE HOURS

It is expected that you may need to contact me, or that you might want additional support when learning new material. Email is the best way to reach me, and I do my best to respond within 24 hours during weekdays. Please know that because I spend weekends with my family, I am away from email during those times. Responses to weekend emails may not arrive before Monday morning.

I hold office hours on **Mondays and Wednesdays** from **1:00-3:00**. These are student-centered times when I am available to answer questions outside class times. During office hours, you are welcome to simply stop by my office (room 269, McElroy Hall). I am also happy to arrange meetings beyond those times, either in person or on Zoom. Just send an email to schedule a time. Please do not hesitate to contact me; I am here to help you succeed!

Course Learning Outcomes

1. Genomics Foundations. By **January 23rd** (**week 3)**, students will be able to explain the concept of genomes as biological information and describe the flow from DNA to proteins, demonstrated by scoring at least 80% (Mastery Level) on weekly quizzes covering introductory genomics and bioinformatics.

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2. Phylogenetic Analysis with R-BioTools. By **February 11 (week 6)**, students will construct and compare at least three 16S rRNA phylogenetic trees (species-only, diverse, combined datasets) using R-BioTools, and submit figures and a short written interpretation.

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3. Comparative Genome Analysis. By **March 11 (week 10)**, students will calculate and visualize core- and pan-genomes for their dataset and provide a 1–2 paragraph analysis of biological implications. Graduate students will additionally compare results with one published pan-genome study.

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4. Genome Atlas Construction and Interpretation. By **April 15 (week 15)**, students will generate at least three genome atlases (including AF074613 and AP018692) and predict the location of replication origins, supported by at least one reference to published work.

Attendance & Absenses

Absences:

Life happens — people get sick, things come up. Absences for illness or personal reasons are fine, but please let me know ahead of time (or as soon as you can) so I'm aware and can help you stay caught up. Consistent communication is key.

Attendance:

Attending and participating in class results in deeper learning and better prepares you for success on assignments and assessments. Because I want you to be successful, I think it is important that I see you in class.

Professionalism

Please refer to the CBSC Student Handbook for further information on expectations and professionalism.

Conduct of the course

Weekly Project Assignments: Each student is expected to maintain their own personal set of genomes and set of figures, created by R-BioTools, and these can be shared with the class.

- **Due 11 February**. Use R-BioTools to build a 16S rRNA tree for the set of genomes chosen for the project. Compare three different trees: genomes from the same species; genomes from diverse organisms; all of the genomes combined.

- **Due 25 February.** Use R-BioTools to construct a BLAST Matrix for the set of chosen genomes for the project. Compare three different matrices: genomes from the same species; genomes from diverse organisms; all of the genomes combined.

- **Due 11 March.** Use R-BioTools to calculate the pan- and core-genomes for the set of chosen genomes for the project. Make three plots for the same sets of genomes as before. (species only, diverse, all)

- **Due 1 April.** Use R-BioTools to generate codon usage plots for the chosen set of genomes.

- **Due 15 April.** Use R-BioTools to generate at least one genome atlas, from the set of genomes chosen for the project. Describe in a sentence or two what the atlas represents for this particular genome. Based on the atlas, predict the location of the origin of replication for that genome. Make an additional two atlases, for GenBank accessions AF074613 and AP018692. How do these compare with each other? Which one was used in Carston's paper? (PMID 11145420).

- **Due 27 April.** Five page project report, including figures made from R-BioTools, and final presentation due.

Grading Scale, Policy and Expectations, and Rubrics:

The tables below show the points possible for assignments/assessments along with the grading scale for this course. Your grades will be recorded in the Canvas gradebook so that you can easily track your progress. Weekly quizzes will be posted on Canvas, and are due BEFORE the start of class on Monday (that is, no later than 9:30 a.m. on Monday). I recommend taking the quiz more than once - multiple attempts are allowed, and after the first try, the answers are given, so it should be pretty easy to get a perfect score on the exam. The idea is to prime you for what the lecture will be about. Quizes are every week, and I will take the grades from the 10 highest scores. (Note there are more than 10 weeks in the semester!). Because course grades are based on demonstrated mastery of learning outcomes, there are no opportunities for extra credit. Rather than focusing on "extra" work, I prefer that you devote your efforts toward the actual assignments. Grades in this course will not be rounded up. This means an 89.9% earns a B, not an A. To earn an A, you must receive between 90-100% of the total possible points.

Assignment or Assessment Task	Points Possible	% of total grade
R-BioTools figures & progress reports	500	30%
Weekly Quizzes (best 10 @ 100 points each)	1000	30%
Final project oral presentation	100	40%
Total Possible	-	100%

Percentage of Possible Points	Grade
90-100%	A
80-89%	B
70-79%	C
60-69%	D
0-59%	F

LATE AND MISSED WORK

Due dates are designed to keep you on track throughout the semester, and this course will be more manageable if you maintain the established schedule. Deep learning develops over time, and this schedule is designed so that feedback from one task will be received in time for you to apply it on later assignments. However, I know that life happens, so you will be able to extend the deadline of one assignment by up to two days. You do not need to share the reason why with me; just email to let me know that you are going to use this extension. If a larger issue arises, such as jury duty or a major medical emergency, please email me and we will create a plan together.

INCLUSIVITY AND ACCESSIBILTY

My goal is that you will have a positive learning experience and leave this course thinking about concepts in ways you may not have previously. There could be times when a discussion feels a bit uncomfortable, but considering others' points of view is an important aspect of college life. OSU has a diverse student population, and I believe each person should feel like a valued member of our learning community; however, it is up to all of us to create an environment that fosters respect for everyone. Although I consider this a personal responsibility as your instructor, I hope that you will join me in the effort.

I am committed to educational access and have attempted to structure the course in ways that will enable your success. Yet, if something seems amiss, please let me know right away. I am happy to visit with you during office hours regarding strategies that will help you be successful. Beyond my help, there are other mechanisms of support available to you. If you believe that you qualify for academic accommodations, please contact **Student Accessibility Services**. Their office is located at 1514 W. Hall of Fame Ave. #103 (in the Seretean Wellness Center behind the Colvin Recreation Center) and their phone number is (405) 744-7116. You may also qualify for **Student Support Services,** so it is worth checking. **The LASSO Center** can provide tutoring and academic support, and the **OSU Writing Center** can help with all aspects of writing. There are many more services available to you, including those pertaining to accessing basic needs, health and wellness resources, and mental health support. If you find yourself in need, please look at the OSU webpage, **Connecting Cowboys to Resources**.

ACADEMIC INTEGRITY POLICY

The official academic integrity policy is shown below, but this is what I really want you to know. In my experience, most academic integrity issues are the result of:

1. Students not realizing that something actually *is* an academic integrity violation.
2. Students thinking that they cannot successfully complete an assignment without support.
3. Students falling behind and feeling pressure to complete an assignment quickly.

Please do not let situations such as these result in an even larger issue. If you are unsure, ask. If you need additional support, reach out. If an assignment is taking longer than expected, use your two-day extension or come talk with me. I would much prefer that we work something out together than to see you suffer a consequence that could have been prevented.

At OSU, we value academic integrity. Violating academic integrity comes in many forms including cheating, copying others' work, or even reusing portions your own work. Maintaining integrity is an ethical ideal important during your time as a student, but it is also valued when you begin your career. If you're not sure whether something is a violation, please ask. You can also learn more by reading **OSU's Violations of Academic Integrity**. Essentially, even when it feels challenging, you should always submit your own original work.

Language from Academic Affairs:

OSU is committed to maintaining the highest standards of integrity and ethical conduct. All OSU courses will maintain this level of ethical behavior and integrity. Participating in behavior that violates academic integrity (e.g., unauthorized collaboration, plagiarism, multiple submissions, cheating on examinations, fabricating information, helping another person cheat, unauthorized advance access to examinations, altering or destroying the work of others, and altering academic records) will result in an official academic sanction. Assignments, quizzes, and exams (individual questions or in their entirety) should not be uploaded to websites offering note-sharing, tutoring, or other academic help (free or paid subscription). Violations may subject you to disciplinary action, including the following: receiving a failing grade on an assignment, failing a course, receiving a notation of a violation of academic integrity on your transcript, having the academic integrity violation become part of your educational record, and being suspended from the university. Students have the right to appeal the charge. Contact the Office of Academic Affairs at 101 Whitehurst, 405-744-5627, or academics@okstate.edu for more information. A copy of the university's policy is available at http://academicintegrity.okstate.edu.

AI USAGE

Daily use of AI tools, such as ChatGPT or Google Gemini, *is expected*, as these can help with homework assignments and potential coding problems. Appropriate uses of these tools should *enhance* your learning, not replace the effort required to learn something new. Ideas for using AI appropriately include helping you trouble-shoot problems getting R-BioTools properly installed, as well as for getting basic information about the various genomic subjects discussed in the course. AI can be helpful for brainstorm ideas for a writing assignment, generating practice questions to help you prepare for exams, or checking your written work for grammatical errors. It would not be appropriate to use AI to completely produce, reproduce, or manufacture written work and/or other assignments without devoting any personal effort to the learning process, as this would result in an academic integrity violation. We will discuss more about appropriate AI usage regarding specific assignments in class.

Whenever AI is utilized in any project, research, or clinical decision-making, it should be explicitly acknowledged. The usage, reliability, and limitations of the technology should be thoroughly communicated and understood.

College Policies, Procedures, and Services

Additional policies and information, including academic integrity, can be found in the Oklahoma State University Syllabus Attachment for Spring 2026 on Canvas.

CBSC 5110: Special Topics in High-throughput Genomics

Mondays & Wednesdays: room 101, McElroy Hall, 9:30 – 10:20 p.m., spring 2026

Weekly themes for main lectures (*Monday* class; one page version)

Week	Topic
1 12 Jan	Intro. to Computers / Informatics
2 19 Jan	**Installation of R-BioTools** (note: this is for Wednesday, 21 January; there is no class on Monday the 19th).
3 26 Jan	**Sequences as biological information: introduction to genomics & bioinformatics**
4 2 Feb	**Viruses, part 1: What is a viral species?**
5 9 Feb	**Viruses, part 2: Genomic epidemiology**
6 16 Feb	**Viruses, part 3: Comparison of ~20 *million* SARS CoV-2 Viruses**
7 23 Feb	**Bacteria, part 1: Introduction to Genome Atlases**
8 2 March	**Bacteria, part 2: Sequence Alignments and BLAST matrices**
9 9 March	**Bacteria, part 3: Codon Usage and Proteome comparisons**
10 16 March	**Spring Break - no class!**
11 23 March	**Bacteria, part 4: Core- and Pan-genomes**
12 30 March	**Bacteria, part 5: Comparison of 1.5 *million* *Salmonella* genomes**
13 6 Apr	**Microbiome, part 1: 16S rRNA analysis and metagenomics**
14 13 Apr	**Microbiome, part 2: Gut/brain axis**
15 20 Apr	**Eukaryotes, part 1: The Human Genome Project**
16 26 Apr	**Eukaryotes, part 2: The *Million* Genomes project**
18 4 May	Final Report and project presentations due - 4 May, 2026

VMED 7481: Special Topics in High-throughput Genomics

Mondays & Wednesdays: room 101, McElroy Hall, 9:30 – 10:20 p.m., spring 2026

Weekly themes for course project (*Wednesday* class; one page version)

Homework	Week #	R-BioTools topics
	Week 1 14 Jan	**Intro. - choose organisms**
	Week 2 21 Jan	**Installation of R-BioTools**
	Week 3 28 Jan	R-BioTools - more background
	Week 4 4 Feb	R-BioTools - preliminary list of genomes
	Week 5 11 Feb	**R-BioTools - final list** (~12 from same species & ~12 'diverse')
H1	**Week 6** 18 Feb	**R-BioTools - build 16S rRNA trees**
	Week 7 25 Feb	**R-BioTools - work on projects**
H2	**Week 8** 4 March	**R-BioTools - BLAST matrix**
	Week 9 11 March	**R-BioTools - work on projects**
	Week 10 18 March	**Spring Break - no class!**
H3	**Week 11** 25 March	**R-BioTools - calculating pan- and core-genomes**
	Week 12 1 Apr	**R-BioTools - work on projects**
H4	**Week 13** 8 Apr	**R-BioTools - codon usage plots**
	Week 14 15 Apr	**R-BioTools - work on projects**
H5	**Week 15** 22 Apr	**R-BioTools - genome atlases**
	Week 16 28 Apr	**R-BioTools - work on projects**
	Week 17 6 May	**Final Report and project presentations due - 4 May, 2026**