GENOMICS Lecture and Lab (BIOL-340)
Fall 2020

Dr. Crista B. Wadsworth
Office Location: Gosnell Hall (08) Room 1272
Office Phone: 585-475-7961
Email: cbwsbi@rit.edu
Narayan Wong, M.S. (nhwsbi@rit.edu) (08-1260)

Description: The overall goal of this course is to provide students with an in-depth knowledge of the structure, organization, and expression of the genome. We will survey these topics in a diverse selection of organisms, ranging from microbes to humans. Students will also become familiar with the analysis of 'omics-type datasets through a series of guided computer labs, and the sequencing of microbial genomes will be emphasized in a hands-on laboratory component. At the end of the class students will be able to:

- describe the overall structure and organization of the genome in microorganisms, plants, and animals
- differentiate between genomic and other large-scale analyse, including genomics, transcriptomics, proteomics, metabolomics, and metagenomics
- describe and explain a broad spectrum of genomics methods, as well as current technical developments within the field
- handle and analyze large-scale experimental datasets, and present results and interpretations
- critically examine publications dealing with genomics, and be able to suggest alternative interpretations and follow-up experiments

Lecture meeting times: Monday, Wednesday, and Friday 9:05-9:55am

Lecture meeting location: https://rit.zoom.us/j/8062721762

Lab meeting time: Wednesday **Section 1** 2:30-3:50 pm and **Section 2** 4:00-5:20 pm

Lab meeting location: Gosnell 1232 (genomics room)

Office hours: Wednesday 10:00-12pm or by appointment via zoom:
https://rit.zoom.us/j/8062721762

Text: Readings will be a combination of review and research articles, and book chapters. All readings will be provided as .pdfs on the MyCourses website, **please check the course contents section regularly for up to date readings!**

Course expectations: Genomics is designed to be a rigorous course, and it requires a significant amount of work outside of class. **Reading the assigned materials is not optional.** I fully expect you to read and comprehend the assigned literature. There is also a lab component which is designed to make you think, troubleshoot, design experiments and communicate in a collaborative manner. This course does **not** emphasize simply memorization of facts. Our understanding of genomics, as with most scientific fields, is very dynamic. Therefore, in addition to the topics covered in lecture, we stress the importance of interpreting and analyzing new information and applying your knowledge to new situations. Attendance is required. Please contact me ahead of class if you have a conflict. Late work is accepted with permission, penalty may be incurred if unduly late as determined by instructor.

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Evaluation: Your final grade will be calculated based on the below table. **Final grades will not be curved**.

Grading Scale: 93.3 – 100 = A, 90 – 93.3 = A-, 86.7 – 89 = B+, 83.3 – 86.6 = B, 80 – 83.3 = B-, 76.7 – 79 = C+, 73.3 – 76.6 = C, 70 – 73.3 = C-, 60 – 69 = D, Below 60 = F

Assignment	Description	Percentage
Exams	There will be two in class exams (open book, open note) and one cumulative take home final exam (open book, open note). Each exam will be weighted equally and **the lowest exam grade will be dropped**. There will be no make-up exams, missed exams will be scored as a "0" and dropped from your final grade.	30%
Digital lab notebook	Your laboratory notebook will be collected and graded at the end of the semester for completeness, accuracy, neatness and content. This semester it will be a **digital** record of your work.	15%
Manuscript draft	This manuscript is a description of the laboratory exercises and experiments we complete over the course of the semester. The draft will be written in the style of a scientific paper with your lab partner(s).	15%
Manuscript final	See above.	25%
Problem sets	There will be a series of in-class problem sets designed to help you learn how to analyze 'omics-type datasets. **These will be due the Thursday following their assignment at midnight (12am)**. Please submit these on the MyCourses site.	15%

Tentative lecture schedule

Wed	Aug 19	Course introduction and mechanics
Fri	Aug 21	Introduction to genomics and "big data"
Mon	Aug 24	Genome structure and organization: Prokaryotes
Wed	Aug 26	Genome structure and organization: Eukaryotes
Fri	Aug 28	*Computer lab #1: Introduction to the dataset*
Mon	Aug 31	The Human Genome Project and computer set up
Wed	Sep 2	Genomic variation I
Fri	Sep 4	*Computer lab #2: Practice with the command line*
Mon	Sep 7	Genomic variation II
Wed	Sep 9	Evolution and genomic change
Fri	Sep 11	*Computer lab #3: Working with genomic sized datasets*
Mon	Sep 14	Next generation sequencing I
Wed	Sep 16	Next generation sequencing II
Fri	Sep 18	***Exam #1***

Mon	Sep 21	Databases
Wed	Sep 23	Databases
Fri	Sep 25	*Computer lab #4: Annotation files*
Mon	Sep 28	Handling and processing 'omics-type data I
Wed	Sep 30	Handling and processing 'omics-type data II
Fri	Oct 2	*Computer lab #5: Variant call files*
Mon	Oct 5	Functional annotation I
Wed	Oct 7	Functional annotation II
Fri	Oct 9	*Computer lab #6: Connecting genotype to phenotype*
Mon	Oct 12	Comparative genomics: Reconstructing evolutionary history I
Wed	Oct 14	Comparative genomics: Reconstructing evolutionary history II
Fri	Oct 16	***Exam #2***
Mon	Oct 19	Comparative genomics: Specialized applications I
Wed	Oct 21	Comparative genomics: Specialized applications II
Fri	Oct 23	*Computer lab #7: Introduction to R*
Mon	Oct 26	Comparative genomics: Wrap up
Wed	Oct 28	Transcriptomics I
Fri	Oct 30	*Computer lab #8: Visualization of data*
Mon	Nov 2	Transcriptomics II
Wed	Nov 4	Transcriptomics III
Fri	Nov 6	*Computer lab #9: RNA-seq*
Mon	Nov 9	Proteomics and metabolomics
Wed	Nov 11	What's next?
Fri	Nov 13	*Computer lab #10: KEGG Enrichment analysis*
Mon	Nov 16	Final exam review
Wed	Nov 18	Final exam review
Fri	Nov 20	Wrap up
Mon	Nov 23	No class-study for finals

Finals Week Dec 1-4th,7-8th. You will have a take home final exam during this week.

Tentative lab schedule

Wed	Aug 19	Introduction and experimental planning	
Wed	Aug 26	Experimental evolution #1	
Wed	Sep 2	Experimental evolution #2	
Wed	Sep 9	DNA isolation	
Wed	Sep 16	DNA quantification	
Wed	Sep 23	MIC testing	
Wed	Sep 30	Fitness costs	
Wed	Oct 7	Compiling results and write up #1	
Wed	Oct 14	Library QC and *de novo* assembly	**Draft of MS due!**
Wed	Oct 21	SNP calling #1	
Wed	Oct 28	SNP calling #2	
Wed	Nov 4	Compiling results and write up #2	
Wed	Nov 11	Flex week	
Wed	Nov 18	Wrap up	**Final MS due!**

Tips on writing your manuscript

Title: A catchy, yet descriptive and concise, description of the study. What was your main finding? What is the most novel aspect of what you found? This is what ultimately catches the reader's attention!

Abstract: This will be a summary of why the work was conducted (what was the gap of knowledge in your field), your main findings, and a brief conclusion on what your work adds to your field.

1. Use past tense.
2. Never give information that is not stated in the paper. Always present the specific results.
3. Write it last and re-examine it word by word several times over.

Introduction: Your introduction should include a narrative on the scope and nature of the problem being investigated, as well as an in-depth review of the literature previously published on the topic. Here you are again trying to hook your reader's attention, and draw them into your narrative.

1. Identify your audience. What level of explanation is needed?
2. Clearly state the scope and nature of the study throughout. Every sentence should support and justify the importance of what you have done.
3. Include relevant literature to support your narrative.
4. Use the "triangle essay approach". Start off broad, and get more specific throughout, leading towards your hypothesis.
5. Present a biological hypothesis at the end of your introduction.

Methods: This section should include the specifics of what you have done. These need to be specific enough that someone else can exactly reproduce your work! Include details like DNA concentrations, brands of reagents, published names of cell lines used. Volumes and concentrations are important. However, don't include details like: "I used a p1000 to pipette." Use the past tense.

Results: The results section should include the majority of your figures and tables. What did you find? Here, describe clearly all of your experimental results. This section should not include any interpretation of your results, but is simply an objective set of statements describing what you have found. Use past tense.

Discussion:

1. Present the principles, relationships and generalizations shown by your results. Do not restate them.
2. Point out exceptions or lack or correlation to expected findings. Define the unsettled points.
3. Show how your findings fit in with previous findings in your field of study. Do they agree? Do they not? Why?
4. State your conclusions as clearly as possible.
5. Summarize your evidence for each conclusion.
6. This is the hardest section to write. It requires the most thought. It helps to outline this section and think about it, rearrange it etc. before you start to write it.

<u>Tips on formatting your lab notebook</u>

This semester we will compile a digital lab notebook documenting your experiments. Use a Word document, or similar word processor.

- Number all pages.
- Include a Table of Contents at the beginning.
- Date all entries.
- Use TITLE—PURPOSE—PROCEDURE—RESULTS—DISCUSSION format.

Title: Give the experiment an informative title. The reader should be able to decipher the purpose of the experiment using only this! For example "PCR of the 23s rRNA gene in 16 commensal *Neisseria*".

Purpose: This should be a short yet descriptive statement of what the goal of the experiment is. For example, you may include information about what type of data or molecular construct the experiment is expected to produce.

Procedure: The procedure section is a step by step description of what you have done. This should be in outline format (bullet points may be helpful). The purpose of this section is to record key experimental details so you (or someone else) could return to this page and repeat the experiment exactly the same way. Include details here like incubation times, running voltages, DNA concentrations etc. This section should include any deviations from established protocols. It is important to *keep up to date* with your notebook, as it is very easy to forget what you have done and any modification that you may have made to protocols!

Results: This section should include all data gathered in the experiment. You may include tables, figures (photographs or diagrams), gel images, and the like here.

Discussion: In this section you will interpret your results. For example, what does it mean when you have a smear on your gel? Or what does seeing higher absorbance in one cell culture vs. another mean? You should present your conclusions as related to the purpose of the experiment, and the results obtained. Offer possible explanations for any deviation from predicted results including any supposed experimental error.

LAB NOTEBOOK GRADING RUBRIC

CATEGORY	Proficient (4-5)	Developing (2-3)	Basic (0-1)
Organization	• All pages are numbered and dated. • Each experiment contains title, purpose, brief procedure or reference to lab manual. • Observations, recorded data and calculations are present. • All information recorded in pen not pencil. • Experiment listed in table of content.	• Most pages are numbered and dated. • Some of the experiments are missing one or two of the following: title, purpose, brief procedure or reference to lab manual. • Recorded data and observations are incomplete in some areas. • Some of the information is recorded in pencil. • Some experiments are not recorded in table of content.	• Most pages are not numbered and dated. • Most of the experiments are missing several of the following: title, purpose, brief procedure or reference to lab manual. • Recorded data and observations are incomplete in most areas or not present. • All information is recorded in pencil. • Most experiments are not recorded in table of content.
Content	• All observations are recorded completely. • All data is recorded and neatly presented with units to the correct number of significant figures. • All calculations are included and neatly presented with details including units and significant figures.	• Observations are not complete and missing important details. • Data is recorded, but is not presented neatly or some are missing units or the correct number of significant figures. • Calculations are included, but are not presented neatly or missing details including units and significant figures.	• Observations are mostly missing. • All data is not recorded and not neatly presented with missing units and have incorrect number of significant figures. • Calculations are not included or are very sparse with no units and incorrect significant figures.
Analysis	• Data is explicitly analyzed, methods of analysis are described with appropriate detail. • Calculations are presented neatly. • Graphs, if appropriate, are included with analysis of slope and related information. • Sources of error are explored and considered when evaluating data.	• Data analysis is implied, but not explicit, and methods of analysis are not described or properly used. • Calculations are not complete. • Graphs, if appropriate, are included, but they are done incomplete or incorrect. • Sources of error are explored, but they are inadequate or incomplete.	• Data analysis is not included. • Calculations are missing. • Graphs, if appropriate, are missing or grossly incorrect. • Sources of error are not explored.
Conclusion	• Results are explicitly interpreted and compared with literature data and/or concepts discussed in lecture. • Conclusion is written in coherent manner with proper English syntax.	• Superficial and immediate conclusions are recorded. • Results are interpreted but interpretation is not explicit. • Conclusions are not written coherently and contain some spelling or grammatical errors.	• Conclusions are not logical and/or do not agree with data presented. • Conclusions are written in non-coherent manner with many spelling and grammatical errors.

Academic Honesty: Plagiarism, fabrication of data, and cheating will not be tolerated in any form. If sufficient evidence is found of academic dishonesty, students will be notified and will either be assigned a “F” for the assignment or a “F” for the course, depending on the severity of the offense. Please refer to the full RIT academic honesty policy for more information (http://www.rit.edu/studentaffairs/studentconduct/rracademicdishonesty.php).

Respect for Diversity: It is my intent that students from all diverse backgrounds and perspectives be wellserved by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, religion, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

COVID-19 SYLLABUS ADDENDUM.
We are all aware of the unique circumstances of this fall semester resulting from the worldwide COVID-19 SARS-2 pandemic. RIT has consulted federal, state, and local guidelines and policies to implement a safe, yet educational environment for students, faculty and staff. These guidelines, located at https://www.rit.edu/ready/ are routinely updated as conditions change.

What do these mean for this class? When we meet in person everyone will wear a mask that covers their mouth and nose at all times and have freshly washed or sanitized hands. In class, students will sit in assigned seats in the locations designated by faculty. We will not congregate in hallways, bathrooms or classrooms prior to or after class. Any presence of fever or other COVID-19 symptoms will be reported on the RIT Daily Health Screen Monitoring https://www.rit.edu/news/rit-launches-daily-health-screen-monitoring-covid-19-symptoms; please notify Dr. Wadsworth so that the best way to accommodate your learning can be planned.

We will talk in class about these expectations to ensure that we all are comfortable with what is happening during class. I encourage your communication about any special needs or concerns. Together we will learn about genomics in a safe and productive format!