

Department of Biology Course Outline

SC/BIOL 3095 3.00 Introduction to Bioinformatics Fall 2024

Course Description

Bioinformatics is the field of study focused on the analysis and interpretation of biological data using computer software tools, as well as the development of new approaches, methods, and software used to analyze that data. This course introduces the different types of biological data that can be analyzed using a bioinformatics approach, and current methods and tools that can be used in those analyses. This will include the basic theoretical and practical background needed to select, understand, and implement computational approaches to tackle specific biological and medical problems, particularly with respect to biological sequence data (DNA, RNA, and protein). Skills in Linux computing and scripting in Bash, R, and Python will be acquired. Case studies will be used to illustrate the applications of bioinformatics to biological and medical research.

Two lecture hours per week. Eleven 3-hour computer lab sessions. One term. Three credits.

Course Format, Hardware and Software Requirements

Lectures and computer labs will be held in person on campus. Lecture slides will be posted on eClass prior to each lecture. Most lectures will be recorded and made available on eClass. **Quizzes** will be conducted in person during the lecture period.

Computer labs (tutorials) will not be recorded. Students may only attend the section in which they are registered. Attendance is required.

A **laptop computer with internet access is required** (PC or Mac). Free software for bioinformatics analyses will need to be installed (e.g., R, R studio, Python). Installation instructions will be provided.

The **lab exam** will take place during the final tutorial period the week of Dec. 2.

The **final exam** will be conducted in person during the exam period, De. 8–20. Exact date and time TBD by the Registrar's Office.

Prerequisites

SC/BIOL 2040 3.00 Genetics and one of: SC/BIOL 2060 3.00 Statistics for Biologists, MATH2030 3.0 Elementary Probability, MATH 2131 3.0 Introduction to Statistics II.

Course Instructor and Contact Information

Instructor: Prof. Ryan Schott

- Email: schott@yorku.ca. Please include BIOL 3095 in the subject line.
- Office Hours: Mondays after class or by appointment (Zoom or in-person).
- Office Location: Farquharson 211C.

Copyright Protection of Course Material

All material associated with this course is the intellectual property of the instructor and/or protected under Canadian Copyright Law. All course material, including lecture recordings, activities, tests/exams, problem sets and assignments, are to be used for personal study purposes only.

Unauthorized distribution in any form can lead to a violation under Canadian Copyright Law and/or Academic Misconduct charges under York University Senate Policy. Unauthorized distribution includes sharing and/or uploading of material anywhere and with anyone.

Penalties under Academic Misconduct can include failure in the course, a transcript notation, and/or suspension.

Schedule

Lectures: Mondays 10:30 am – 12:30 pm in ACW 106. Lectures may be delivered in an online format due to illness or other extenuating circumstances or emergencies.

Computer Labs (tutorials): Eleven computer lab (tutorial) sessions (including the lab exam) of 3 hours each week excluding the first. Day and time determined by your tutorial section.

Evaluation

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| 1. Lab Assignments – 40% | 10 assignments worth 5%, lowest dropped. |
| 2. Journal Reflections – 15% | 6 reflections (biweekly) worth 3% each, lowest dropped. |
| 3. Quizzes – 15% | 6 quizzes (biweekly) worth 3% each, lowest dropped. |
| 4. Lab Exam – 10% | Cumulative (covering the whole course). In-person during final tutorial period. Exact date and time determined by your section. |
| 5. Final exam – 15% | Cumulative (covering the whole course). In-person during the exam period, Dec. 5–20. Exact date and time TBA by the registrar. |

Important Dates

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| First Class: | Mon. Sept. 9 |
| Reflections: | Biweekly starting Sept. 9 |
| Quizzes: | Biweekly starting Sept. 16 |
| Reading Week: | Oct. 14–18 (no class or labs) |
| Lab Assignments: | Weekly starting Sept. 16 |
| Last Class: | Mon. Dec. 2 |

Lab Exam: Week of Dec. 2 (final tutorial period)
Final Exam: Exam period, Dec. 5–20 (day and time tbd)

Last date to drop course without receiving a withdrawal note on your transcript: Nov. 8.

NOTE: for additional important dates such as holidays, refer to the “Important Dates” section of the Registrar’s Website at <https://registrar.yorku.ca/enrol/dates>

Resources

Website: The course will be managed through an eClass site. Please log in at <https://eclass.yorku.ca>

Optional eBooks/Web Resources

The Biostar Handbook: 2nd Edition

<https://www.biostarhandbook.com/>

Rosalind

<https://rosalind.info>

Optional Textbooks

Introduction to Bioinformatics 5/e

Arthur Lesk

ISBN-13: 9780198794141

Concepts in Bioinformatics and Genomics

Jamil Momand and Alison McCurdy

ISBN-13: 9780199936991

Additional web research and journal articles will be provided in class and on eClass.

Course Content

LECTURES (Tentative topics. Material may be updated/change)

Introduction: Informatics and Biological Data

- What is informatics and how can it be applied to biological data?
- What types of biological data can be studied using informatics approaches?
- How do we store and retrieve biological data?

Sequence Alignment

- Pairwise sequence alignment
- Dot plots
- Measures of sequence similarity
- Basic local alignment
- Multiple sequence alignment

DNA and Genome Sequencing

- DNA sequencing
- Next generation sequencing methods
- Quality control
- Genome assembly
- Gene prediction and genome annotation

Genomics

- Genome analysis
- Sequence and structural variation
- Variant calling
- Comparative and evolutionary genomics

RNA and Transcriptome Sequencing

- RNA and cDNA sequencing
- Real time and quantitative PCR
- Microarrays
- RNA-Seq
- Single cell and spatial RNA-Seq
- Transcriptome assembly

Transcriptomics

- Transcriptome analysis
- Transcripts vs genes
- Transcript and gene quantitation
- Experimental design
- Differential Expression analysis
- Gene ontology

Molecular Phylogenetics and Evolution

- Methods of inferring phylogenetic trees
- Nucleotide, codon, and protein substitution models
- Molecular clocks and dating
- Applications of phylogenetics (e.g., tree of life, COVID-19, human origins)
- Molecular evolution and selection analyses

Proteins and Proteomics

- Isolating and sequencing proteins
- Identification of proteins
- Methods of protein structure determination
- Protein folding
- Protein structure prediction

Applications and Emerging Approaches

- Evolutionary medicine
- Drug discovery
- Newest bioinformatics approaches and techniques (review of recent literature)

GUEST LECTURES

Up to three guest lectures will take place during the semester. Guest lectures will introduce students to people and careers in different fields and applications of bioinformatics (e.g., academia, industry, government; ecology, evolution, biomedicine). Details will be provided during class.

LABS

Each weekly lab will introduce a different set of tools used in bioinformatics building off the concepts learned during that week's lecture. Labs will consist of an interactive walkthrough in the use of those tools and how they can be applied to retrieve or analyze biological data followed by an individual or small group assignment that requires application of knowledge to produce or analyze a biological dataset while answering a series of questions on the material.

Experiential Education and E-Learning

This course uses different tools and software for the retrieval and analysis of biological data. Links and installation instruction will be provided during class. The guest lectures will provide students with real world exposure to bioinformaticians employed in different sectors and different career paths that are available to pursue in bioinformatics.

Course Policies

Missed Quiz & Reflection Policy

- There are no makeup quizzes or reflections.
- Only your top 5 quizzes and reflections count towards your grade; therefore, you can miss one quiz and one reflection without penalty.
- If you miss two quizzes/reflections, the grade for the second missed quiz/reflection will normally be zero unless there are exceptional mitigating circumstances. If that is the case, email schott@yorku.ca within 48 hours of the second missed quiz (ideally before, but as soon as you are able to do so) and attach any supporting documentation you wish to provide.

Missed Exam Policy

- If you miss the lab exam or final examination please complete and submit a Deferred Standing Agreement (DSA) form available from the Registrar's website to schott@yorku.ca together with a letter outlining the reason for missing the exam, within **one week** of the missed exam.
- If you are approved to write a deferred exam, an in-person final/lab exam will be arranged on campus as soon as possible.

Lab/Tutorial Attendance & Missed Lab/Tutorial Policy

- **Students may only attend the tutorial section in which they are registered.** Please ensure you are registered in a section that does not conflict with your other courses.
- **There are no makeup tutorial sessions.**
- Complete or partial **Lab assignments** are due at the end of the tutorial period. Some lab assignments may also have components due by the following session.
- Your top 9 lab assignments count towards your grade; therefore, you can miss one lab without penalty.
- If you miss a lab inform your TA as soon as possible.

Penalty for late submission of assignments: 5% per calendar day.

Email etiquette

Subject line: please begin with “BIOL 3095” followed by a brief, but reasonably detailed, indication of the subject of your email (e.g., “question about lecture 3”, etc.)

Body of the email: remember to include your name and student number at the end of every email.

Response time: please allow 2 working days. Do **not** send a second email before 2 working days have passed, but **do** send a second email if more than 2 working days have passed.

Religious observance days

Should the dates for a quiz, lab, or exam pose a conflict with a religious observance day for your particular religion, you must notify the instructor **at least 3 weeks before the date of the activity**. In the event of a religious observance conflict with the final exam, students must complete an

Examination Accommodation Agreement Form, available at:

<https://secure.students.yorku.ca/pdf/religious-accommodation-agreement-final-examinations.pdf>

and submit it to the instructor **at least 3 weeks before the date of the exam**.

Community Guidelines

The following values are fundamental to academic integrity and are adapted from the International Center for Academic Integrity*. In our course, we will seek to behave with these values in mind.

| As students, we will... | As a teaching team, we will... |
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| <ul style="list-style-type: none">• Honestly demonstrate our knowledge and abilities on assignments and exams• Communicate openly without using deception, including citing appropriate sources | <ul style="list-style-type: none">• Provide honest feedback on your demonstration of knowledge and abilities on assignments and exams• Communicate openly and honestly about the expectations and standards of the course via the syllabus, and with respect to assignments and exams |
| <ul style="list-style-type: none">• Complete assignments on time and in full preparation for class• Show up to class on time, and be mentally/physically present• Participate fully and contribute to team learning and activities | <ul style="list-style-type: none">• Provide timely feedback on your assignments and exams• Show up to class on time, and be mentally and physically present• Create relevant assessments and class activities |
| <ul style="list-style-type: none">• Speak openly with one another, while respecting diverse viewpoints and perspectives• Provide sufficient space for others to voice their ideas | <ul style="list-style-type: none">• Respect your perspectives even while we challenge you to think more deeply and critically• Help facilitate respectful exchange of ideas |
| <ul style="list-style-type: none">• Contribute fully and equally to collaborative work, so that we are not freeloading off others• Not seek unfair advantage over fellow students in the course | <ul style="list-style-type: none">• Create fair assignments and exams, and grade them in a fair, and timely manner• Treat all students equitably |

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| <ul style="list-style-type: none"> • Not engage in personal affairs while on class time • Be open and transparent about what we are doing in class • Not distribute course materials to others without authorization | <ul style="list-style-type: none"> • Be available to all students when we say we will be • Follow through on our promises • Not modify the expectations or standards without communicating with everyone in the course |
| <ul style="list-style-type: none"> • Say or do something when we see actions that undermine any of the above values • Accept a lower or failing grade or other consequences of upholding and protecting the above values | <ul style="list-style-type: none"> • Say or do something when we see actions that undermine any of the above values • Accept the consequences (e.g., lower teaching evaluations) of upholding and protecting the above values |

*This class statement of values is adapted from Tricia Bertram Gallant, Ph.D.

University Policies

Academic Honesty and Integrity

Academic misconduct undermines the values of honesty, trust, respect, fairness, and responsibility that we expect in this class. York University provides supports such as academic integrity workshops to ensure that all students understand the norms and standards of academic integrity that we expect you to uphold.

York students are required to maintain the highest standards of academic honesty and they are subject to the Senate Policy on Academic Honesty (<http://secretariat-policies.info.yorku.ca/policies/academic-honesty-senate-policy-on/>). The Policy affirms the responsibility of faculty members to foster acceptable standards of academic conduct and of the student to abide by such standards. Please review and familiarize yourself with the policy.

There is also an academic integrity website with comprehensive information about academic honesty and how to find resources at York to help improve your research and writing skills, and cope with university life. Students are expected to review the materials on the Academic Integrity website:

Examples of actions that do not adhere to York's Academic Integrity Policy include:

- Plagiarism (passing off someone else's work as your own)
- Accessing unauthorized sites for assignments or tests
- Unauthorized collaboration on assignment and exams
- Uploading work to third party repository sites (e.g., Course Hero, One Class, etc.)
- Scanning, sharing, uploading, or publishing exams, tests, or scholarly work

For more information on what academic integrity is and why it is important see:

<https://spark.library.yorku.ca/academic-integrity-what-is-academic-integrity/>. Information on the process of investigations into breaches of academic honesty:

<https://spark.library.yorku.ca/academic-integrity-breach-of-policy-on-academic-honesty/>

Academic Standards: Third Party Repository Sites

Numerous students in Faculty of Science courses have been charged with academic misconduct when materials they uploaded to third party repository sites (e.g. Course Hero, One Class, etc.) were taken and used by unknown students in later offerings of the course. The Faculty's Committee on

Examinations and Academic Standards (CEAS) found in these cases that the burden of proof in a charge of aiding and abetting had been met, since the uploading students had been found in all cases to be willfully blind to the reasonable likelihood of supporting plagiarism in this manner. Accordingly, to avoid this risk, students are urged not to upload their work to these sites. Whenever a student submits work obtained through Course Hero or One Class, the **submitting student will be charged with plagiarism and the uploading student will be charged with aiding and abetting.**

Note also that exams, tests, and other assignments are the copyrighted works of the professor assigning them, whether copyright is overtly claimed or not (i.e. whether the © is used or not). Scanning these documents constitutes copying, which is a breach of Canadian copyright law, and the breach is aggravated when scans are shared or uploaded to third party repository sites.

Accessibility

York University is committed to principles of respect, inclusion and equality of all persons with accessibility needs across campus. The University provides services for students with accessibility needs (including physical, medical, learning, and psychiatric needs) needing accommodation related to teaching and evaluation methods/materials. These services are made available to students in all Faculties and programs at York University.

Students in need of these services are asked to register with accessibility services as early as possible to ensure that appropriate academic accommodation can be provided with advance notice. You are encouraged to schedule a time early in the term to meet with each professor to discuss your accommodation needs. Please note that registering with accessibility services and discussing your needs with your professors is necessary to avoid any impediment to receiving the necessary academic accommodations to meet your needs.

Additional information is available at the following websites:

Counselling & Development Services - <https://counselling.students.yorku.ca>

Counselling & Disability Services at Glendon – <https://www.glendon.yorku.ca/counselling/>

York Accessibility Hub - <https://accessibilityhub.info.yorku.ca>

Religious Observance Accommodation

York University is committed to respecting the religious beliefs and practices of all members of the community and making accommodations for observances of special significance to adherents. Should any of the dates specified in this syllabus for an in-class test or examination pose such a conflict for you, contact the Course Director within the first three weeks of class. Similarly, should an assignment to be completed in a lab, practicum placement, workshop, etc., scheduled later in the term pose such a conflict, contact the Course Director immediately. To arrange an alternative date or time for an examination scheduled in the formal examination periods (December and April/May), students must complete and submit an accommodation request form **at least 3 weeks before the exam period begins**: <https://secure.students.yorku.ca/pdf/religious-accommodation-agreement-final-examinations.pdf>

Student and Instructor Conduct in Academic Situations

Students and instructors are expected to maintain a professional relationship characterized by courtesy and mutual respect. Moreover, it is the responsibility of the instructor to maintain an appropriate academic atmosphere in the classroom and other academic settings, and the responsibility of the student to cooperate in that endeavour. Further, the instructor is the best person to decide, in the first instance, whether such an atmosphere is present in the class. The policy and procedures governing disruptive and/or harassing behaviour by students in academic situations is available at <http://secretariat-policies.info.yorku.ca/policies/disruptive-and-or-harassing-behaviour-in-academic-situations-senate-policy/>.

Academic accommodation refers to educational practices, systems and support mechanisms designed

to accommodate diversity and difference. The purpose of accommodation is to enable students to perform the essential requirements of their academic programs. At no time does academic accommodation undermine or compromise the learning objectives that are established by the academic authorities of the University.

University rules regarding registration, withdrawal, appealing marks, and most anything else you might need to know can be found on the university's website, here:

<https://calendars.students.yorku.ca/policies-and-regulations>

Assistance for Students (Academic and Well-Being)

Academic Advising: <https://www.yorku.ca/science/academic-advising/>. Departments also offer program-specific advising. Check with your Department's Undergraduate Office.

Centre for Human Rights, Equity, and Inclusion: <https://rights.info.yorku.ca>

Centre for Indigenous Students Services: <https://aboriginal.info.yorku.ca/>

Food Access, Funding, & Supports/Resources: <https://students.yorku.ca/food>

Good2Talk 24-hour Ontario Student Helpline: 1-866-925-5454 /Text: GOOD2TALKON to 686868

Keep.meSAFE: <https://myssp.app/keepmesafe/ca/home>

Learning Commons (general academic learning supports including library research, time management, study skills, career planning, etc.): <https://learningcommons.yorku.ca/>

Peer Assisted Study Sessions (PASS): <https://www.yorku.ca/colleges/bethune/get-help/pass/>

Peer Tutoring: <https://www.yorku.ca/colleges/bethune/get-help/peer-tutoring/>

Sexual Violence Response and Support: <https://thecentre.yorku.ca>

Student Counselling, Health & Well-being: <https://counselling.students.yorku.ca/>