

Course Outline (F2023)

BME501: Bioinformatics

Instructor(s)	Eric Harley [Coordinator] Office: VIC 741 Phone: TBA Email: eharley@torontomu.ca Office Hours: Wednesdays, 12-2 pm
Calendar Description	Introduction to analysis, management, and visualization of cellular information at the molecular level. The course includes an overview of mathematical modeling and simulation, pattern matching, methods for phylogenetics, gene recognition, distributed and parallel biological computing, designing and managing biological databases (both relational and object-oriented), linking disparate databases and data, data mining, reasoning by analogy, hypothesis formation and testing by machine.
Prerequisites	BLG 601 and CEN 199 and MTH 312
Antirequisites	CPS 501
Corerequisites	None
Compulsory Text(s):	1. Bioinformatics I: Sequence Analysis and Phylogenetics, by Sepp Hochreitter, Lecture Notes, Institute of Bioinformatics, Johannes Kepler University Linz; online: http://www.master-bioinformatik.at/curriculum/BioInf_I_Notes.pdf
Reference Text(s):	1. Exploring Bioinformatics, A Project-Based Approach, Second Edition by Caroline St. Clair & Jonathan E. Visick Jones & Bartlett Learning 2015. Available as an ebook from https://campusstore.ryerson.ca/t-accesscodes.aspx 2. Data Mining, Practical Machine Learning Tools and Techniques, Third Edition, I.H. Witten, E. Frank, M.A. Hall, Elsevier, Morgan Kaufmann Publishersl, 2011.
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: <ul style="list-style-type: none"> 1. Develop further knowledge of science in support of application to engineering problems. (1a) 2. Apply mathematical principles, skills, and tools to solve engineering problems, highlighting limitations or a range of applications; use algorithms and available software to solve mathematical models. (1b) 3. Evaluate sources of information, check the feasibility of design based on obtained results, and assess the reliability of conclusions. (2a) 4. Develop further knowledge of uses of modern instrumentation, data collection techniques, and equipment to conduct experiments and obtain valid data. (5a) 5. Apply statistical procedures, investigate possible artefacts, verify experimental results, consider possible extensions of results to other areas, interpret results with regards to given assumptions, and assess accuracy of results. (5b) 6. Discuss the responsibility of the engineer to protect the public interest when working with genes and genetic data. (8b)

	<p>7. Discuss ethical protocols and risks when collecting, analyzing and sharing genetic data or modifying genes. (10a)</p> <p>NOTE: Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).</p>										
Course Organization	<p>3.0 hours of lecture per week for 13 weeks 0.0 hours of tutorial per week for 12 weeks</p>										
Teaching Assistants	<p>Irene Miah (irene.miah@torontomu.ca) Michael Nigro (michael.nigro@torontomu.ca)</p>										
Course Evaluation	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Midterm Exam</td> <td style="text-align: right;">30 %</td> </tr> <tr> <td>Quizzes</td> <td style="text-align: right;">5 %</td> </tr> <tr> <td>Assignments</td> <td style="text-align: right;">20 %</td> </tr> <tr> <td>Final Exam</td> <td style="text-align: right;">45 %</td> </tr> <tr> <td>TOTAL:</td> <td style="text-align: right;">100 %</td> </tr> </table> <p>Note: In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both "Theory and Laboratory" components, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the "Course Evaluation" section above for details on the Theory and Laboratory components (if applicable).</p>	Midterm Exam	30 %	Quizzes	5 %	Assignments	20 %	Final Exam	45 %	TOTAL:	100 %
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Examinations	<p>Midterm exam in Week 8, two hours, multiple-choice, short-answer and programming, closed book (covers Weeks 1-5).</p> <p>Final exam, during exam period, three hours, closed-book, comprehensive, in a computer lab on a computer.</p>										
Other Evaluation Information	<p>None</p>										
Teaching Methods	<p>Mondays: in-person lecture, 11am-12pm, TRS2166 Thursdays: in-person lecture, 8-10 am, TRS2166</p> <p>(Teaching methods: lectures with slides, problem-based learning using laptop to teach Python, implement algorithms and run data mining algorithms, internet to do database searches. Student presentations of project results.)</p>										
Other Information	<p>None</p>										

Course Content

Week	Hours	Chapters / Section	Topic, description
1-2	6	1	<p>Introduction</p> <ul style="list-style-type: none"> - Introduction to BME 501 <p>NCBI databases</p> <ul style="list-style-type: none"> - Parkinson's Disease primary databases and metadatabases genome-wide association studies <p>Data mining (Ch 1, 2) -- class attribute instance</p> <p>Chapter 1 and 2 of Bioinformatics 1; Chapter 1 of Exploring Bioinformatics</p>
3	3	2	<p>Computational Manipulation of DNA</p> <ul style="list-style-type: none"> - Introduction to Python genetic - screening for cystic fibrosis - computational algorithms string manipulation - Data mining (Ch 4.1) -- OR 1R rules <p>Chapter 2 of Exploring Bioinformatics</p>
4-5	6	3	<p>Sequence Alignment</p> <ul style="list-style-type: none"> - Origin of new influenza virus strains optimal global and local alignments of DNA alignment parameters <p>Needleman-Wunsch algorithm EMBOSS implementation</p> <p>two dimensional arrays dynamic programming</p> <p>Data Mining (Ch 4.2) -- Naive Bayes</p> <p>Chapter 3 of Bioinformatics 1; Chapter 3 of Exploring Bioinformatics</p>
6	3	D2L notes	<p>(Reading week for CPS501 cohort)</p> <p>Ethics</p> <ul style="list-style-type: none"> - protect the public interest - privacy issues when collecting and analyzing data - risks and responsibilities when modifying genes - CRISPR-CAS9 potential
7	3	4	<p>Database Searching and Multiple Sequence Alignment</p> <ul style="list-style-type: none"> - searching sequence databases for matches (BLAST) - multiple sequence alignment using ClustalW alignment algorithms and heuristics - overuse of agricultural antibiotics - antibiotic resistance - dynamic programming - Data mining (Ch 5) -- credibility accuracy <p>Chapter 4 of Bioinformatics 1; Chapter 4 of Exploring Bioinformatics</p>
8	3		<p>Midterm (Thursday, Oct 26, 2h) (covering Weeks 1-5)</p> <p>Monday lecture: Data mining (Ch 4.3) Decision trees</p>

9	3	5	Substitution Matrices and Protein Alignments - scoring matrices for protein alignment - deriving substitution matrices nested hash tables. Chapter 3 of Bioinformatics 1; Chapter 5 of Exploring Bioinformatics
10	3	6	Distance Measurement in Molecular Phylogenetics - Evolutionary relationships - distance metrics (Jukes-Cantor, Kimura Tamura) - introduction to phylogenetic trees phylogeny.fr - Data Mining (Ch 4.8) -- clustering Chapter 5 of Bioinformatics 1; Chapter 6 of Exploring Bioinformatics
11	3	7	Tree-building in Molecular Phylogenetics - How to use distance measurements - agglomerative clustering - single linkage UPGMA neighbor joining - probabilistic methods in phylogenetics Chapter 5 of Bioinformatics 1; Chapter 7 of Exploring Bioinformatics
12-13	6	9	Sequence-Based Gene Prediction - Prediction of genes in a resistance plasmid - ORF finding and promoter prediction - NCBI ORF Finder NEBcutter EasyGene - pattern matching algorithms Chapter 9 of Exploring Bioinformatics

University Policies

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on [the Senate website](#)

Important Resources Available at Toronto Metropolitan University

- [The Library](#) provides research [workshops](#) and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the [Library's virtual research help service](#) to speak with a librarian.
- [Student Life and Learning Support](#) offers group-based and individual help with writing, math, study skills, and transition support, as well as [resources and checklists to support students as online learners](#).
- You can submit an [Academic Consideration Request](#) when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the [Senate website](#) and select the blue radio button on the top right hand side entitled: Academic Consideration Request (ACR) to submit this request.

For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences

more than 3 days in duration and those that involve a final exam/final assessment, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate [Policy 167: Academic Consideration](#).

- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The [Remote Learning Guide](#) for students includes guides to completing quizzes or exams in D2L Brightspace, with or without [Respondus LockDown Browser and Monitor, using D2L Brightspace](#), joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for [Faculty](#) and [students](#).

Accessibility

- Similar to an [accessibility statement](#), use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).
- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about [Academic Accommodation Support](#).
- Learn [how to register with AAS](#).

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about [Academic Accommodations versus Academic Consideration and how to access each](#).

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:** 24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:** 24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via [My SSP app](#) or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca
- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the [Toronto Metropolitan University Mental Health and Wellbeing](#) website.