

**Course Outline (W2021)**

**BME808: Computations in Genetic Engineering**

<b>Instructor(s)</b>	Prathap Siddavaatam [Coordinator] Office: ENG 433 Phone: TBA Email: prathap.siddavaatam@ryerson.ca Office Hours: via zoom on Fri 6-7pm (email the Professor prior to meeting)
<b>Calendar Description</b>	Discusses the theory and practice of molecular database searching and sequence alignment in genetic engineering. Covers databases and Internet access, sequence homology searching, and multiple alignment and sequence motif analysis, and protein structure and function.
<b>Prerequisites</b>	BME 501 and BME 532 and MTH 410
<b>Antirequisites</b>	None
<b>Corerequisites</b>	None
<b>Compulsory Text(s):</b>	1. "Exploring Bioinformatics, A Project-Based Approach", Second Edition by Caroline St. Clair & Jonathan E. Visick Jones & Bartlett Learning 2015.
<b>Reference Text(s):</b>	1. "Sequence and Genome Analysis", D.W. Mount, Cold Spring Harbor Laboratory Press, 2004, ISBN 978-087969712-9 "Data Mining", I..H. Witten, E. Frank, M.A. Hall, Morgan Kaufmann, 2011. 2. Reproducible Bioinformatics with Python, Ken Youens-Clark, Released July 2021, Publisher(s): O'Reilly Media, Inc. ISBN: 9781098100889 3. Bioinformatics with Python Cookbook, 2nd Edition Paperback – November 2018
<b>Learning Objectives (Indicators)</b>	<p>At the end of this course, the successful student will be able to:</p> <ol style="list-style-type: none"> <li>1. Appraise the validity/reliability of bioinformatics sequence data relative to the degrees of error and limitations of sequence analysis theory and measurement. <b>(3a)</b></li> <li>2. Apply selection/decision-making techniques to determine the relative value of feasible alternatives or proposed solutions in a complex sequence analysis problem. <b>(4c)</b></li> <li>3. Design and develop simple software to perform given tasks as required by the problem, evaluate skills and tools to identify their limitations with respect to the project needs, and evaluate results using several skills and tools to determine the one that best explains 'reality'. <b>(5a)</b></li> <li>4. Gain a working knowledge of the literature of sequence analysis in the field of bioinformatics and how sequences are produced, annotated and analyzed. <b>(12b)</b></li> </ol> <p><b>NOTE:</b> Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).</p>
<b>Course</b>	3.0 hours of lecture per week for 13 weeks

<b>Organization</b>	2.0 hours of lab per week for 12 weeks 0.0 hours of tutorial per week for 12 weeks																
<b>Teaching Assistants</b>	Mr. Binh Nguyen [binh.nguyen at ryerson.ca ] Mr. Amirreza Rezvantlab [arezvant at ryerson.ca ]																
<b>Course Evaluation</b>	<table border="1"> <thead> <tr> <th colspan="2"><b>Theory</b></th> </tr> </thead> <tbody> <tr> <td>Midterm</td> <td>25 %</td> </tr> <tr> <td>Final</td> <td>45 %</td> </tr> <tr> <th colspan="2"><b>Laboratory</b></th> </tr> <tr> <td>Research Project</td> <td>10 %</td> </tr> <tr> <td>Labs</td> <td>10 %</td> </tr> <tr> <td>Tutorials</td> <td>10 %</td> </tr> <tr> <td><b>TOTAL:</b></td> <td><b>100 %</b></td> </tr> </tbody> </table> <p><b>Note:</b> 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 "<b>Theory and Laboratory</b>" 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 "<b>Course Evaluation</b>" section above for details on the Theory and Laboratory components (if applicable).</p>	<b>Theory</b>		Midterm	25 %	Final	45 %	<b>Laboratory</b>		Research Project	10 %	Labs	10 %	Tutorials	10 %	<b>TOTAL:</b>	<b>100 %</b>
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<b>Examinations</b>	Midterm exam in Week 8, 2.0 hours, closed book (covers Weeks 1-6 of lecture, assignment and laboratory material). Final exam, during exam period, 3.0 hours, closed book (covers all the course material). Exams Exams will be conducted via d2l both as assignment and quiz format.																
<b>Other Evaluation Information</b>	<p>Labs/Tutorials: From Week 2 onward.</p> <p>Participation: Based on in-class exercises and in-class presentations of recent advances in biotechnology.</p> <p>Research Project: Review and presentation of a scientific paper. The research project combines two separate components: a written component and an oral presentation component. The objective of this project is to study a specific topic in bioinformatics literature and to become familiar with the research community and history of bioinformatics. You must select a publication that presents either a specialized bioinformatics algorithm or its application. A 12 minute presentation and a two page technical report will be used to evaluate your project, as well as the technical merit and the skill with which the student communicates his or her message. Papers in (peer-reviewed) journals and conference proceedings are the main resources for this project. The last Lab/Tutorial sessions will be dedicated to the presentation of student projects.</p>																
<b>Other Information</b>	Tutorials always accompany experiment component in addition to tutoring done by TA.																

## Course Content

Week	Hours	Chapters / Section	Topic, description
1	3	Exploring Bioinformatics Chapters 1 2 D. Mount: Chapter 12	<p>Introduction to Bioinformatics and Computational Genomics:            Structure of nucleic acids DNA RNA            Role of mRNA tRNA and ribosome            Gene transcription translation protein genetic code            Bioinformatics Databases structure type data quality            Introduction to Python (review of string analysis)</p> <p>Data mining:            Review of terminology OR 1R models evaluation</p>
2	3	Exploring Bioinformatics: Chapter 8	<p>DNASequencing:            Deep sequencing of clinical samples            Assembly and Mapping            Algorithm for determining largest overlap            Next generation sequencing            Methods: Sanger Shotgun 454 Illumina Solid</p> <p>Data Mining:            Review of Naive Bayes model</p>
3	3	Exploring Bioinformatics: Chapters 3 5 D Mount: Chapter 3 4	<p>Sequence Alignment:            Fundamentals of sequence Alignment            Scoring Alignments            Substitution matrices and scoring            Dynamic Programming Alignment algorithms            Sequence similarity databases            Alignment score significance: probability            Data mining: Decision trees</p>
4	3	Exploring Bioinformatics: Chapters 4 5 D. Mount: Chapter 5	<p>Multiple sequence alignment:            Global and local sequence alignments            Profile alignments            Hidden Markov Models (Forward and Viterbi algs.)</p> <p>Database Homology Searching:            Data mining: clustering methods</p>
5	3	Exploring Bioinformatics: Chapters 9 D.	<p>Gene Prediction:            Sequence-Based</p>

		Mount: Chapter 7	
6	3	Exploring Bioinformatics: Chapters 10 D. Mount: Chapter 7	Gene Prediction: Advanced
7	3		CRISPR/Cas system: Mechanism Applications
9	4	Exploring Bioinformatics: Chapter 11 D. Mount: Chapter 10 (pp 417-434)	Proteins: Primary secondary and Tertiary Structures Ramachandran plot Classes of protein structure Protein databases Motifs folds domains Accessing files of sequences from databases
10	3	Exploring Bioinformatics: Chapter 11 D. Mount: Chapter 10 (pp 435-467)	Protein Homology modeling: Secondary structure prediction Ab initio modeling homology modeling Tertiary structure prediction
11	3	Exploring Bioinformatics: Chapter 12 D. Mount: Chapter 8	Nucleic Acid Structure Prediction
12	3	D. Mount: Chapter 13	Microarrays: Introduction Analysis
13	3		Data Mining and Machine Learning: Perceptron Neural Nets Significance Applications in Bioinformatics

## Laboratory(L)/Tutorials(T)/Activity(A) Schedule

Week	L/T/A	Description
2	TUT 1: Exploring bioinformatics database on the internet	Students will be familiarized with key features of the bioinformatics databases.
3	LAB 1: Python tutorial	Students will familiarize themselves with this scripting language and use it to write simple bioinformatics applications.
4	TUT 2: Sequencing DNA	Gaining experience with DNA sequencing data and software that analyzes it. Example: the human gut metagenome in NCBI trace archives.
5	LAB 2: Dynamic programming algorithm Pairwise Sequence Alignment	Students will implement the dynamic programming algorithm and gain a better understanding of pairwise sequence alignment.
6	TUT 3: Assembly of DNA sequence data	Writing a simulator to generate synthetic DNA sequencing data (fragments)
7	LAB 3: Data Mining	Students practice with Weka Data Mining software
8	TUT 4: Multiple sequence alignment	Practice with online software (CLUSTAL) and with Hidden Markov Models on paper.
9	LAB 4: Gene annotation	Implementation of CpG approach to finding the promoter region.

10	TUT 5: RNA Secondary Structure	Using online software to predict RNA structure.
11	LAB 5: Classification of proteins	Students will experiment with support vector machines and attribute selection to classify protein according to structure (all alpha all beta or mixed).
12	TUT 6: Predicting protein secondary structure	Implementation and testing of Chou-Fasman alg.
13	Research project: Review and presentation of a scientific paper	Students will learn to present and research on papers from (peer-reviewed) journals and conference proceedings for communicating scientific information.

## Policies & Important Information:

Students must be reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on the following URL: <http://ryerson.ca/senate/course-outline-policies>

1. Students are required to obtain and maintain a Ryerson e-mail account for timely communications between the instructor and the students;
2. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented;
3. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO, unless otherwise stated. Marking information will be made available at the time when such course assessment components are announced.
4. Ryerson senate policy 157 requires that any electronic communication by students to Ryerson faculty or staff be sent from their official Ryerson email account.
5. Familiarize yourself with the tools you will need to use for remote learning. The [Continuity of Learning Guide](#) for students includes guides to completing quizzes or exams in D2L or Respondus, using D2L Brightspace, joining online meetings or lectures, and collaborating with the Google Suite.
6. The University has issued a minimum technology requirement for remote learning. Details can be found at: <https://www.ryerson.ca/covid-19/students/minimum-technology-requirements-remote-learning>. Please ensure you meet the minimum technology requirements as specified in the above link.
7. Ryerson COVID-19 Information and Updates (available <https://www.ryerson.ca/covid-19/students>) for Students summarizes the variety of resources available to students during the pandemic.
8. Refer to our **Departmental FAQ** page for information on common questions and issues at the following link: <https://www.ee.ryerson.ca/guides/Student.Academic.FAQ.html>.

## Missed Classes and/or Evaluations

When possible, students are required to inform their instructors of any situation which arises during the semester which may have an adverse effect upon their academic performance, and must request any consideration and accommodation according to the relevant policies as far in advance as possible. Failure to do so may jeopardize any academic appeals.

1. **Academic Consideration Requests for missed work** (e.g. missing tests, labs, etc) - According to [Ryerson Senate Policy 134](#), sections 1.2.3, if you miss any exams, quizzes, tests, labs, and/or assignments for health or compassionate reasons you need to inform your instructor(s) (via email whenever possible) in advance when you will be missing an exam, test or assignment deadline. When circumstances do not permit this, you must inform the instructor(s) as soon as reasonably possible "*In the case of illness, a [Ryerson Student Health Certificate](#), or a letter on letterhead from an appropriate regulated health professional with the student declaration portion of the Student Health Certificate attached. For reasons other than illness, proper documentation is also required (e.g. death certificate, police report, TTC report).* **ALL supporting documentation for illness or compassionate grounds MUST be submitted within three (3) working days of the missed work.**" **NOTE: You are required to submit all of your pertinent documentation through Ryerson's online Academic Consideration Request system at the following link: [prod.apps.ccs.ryerson.ca/senateapps/acadconsform](http://prod.apps.ccs.ryerson.ca/senateapps/acadconsform).**
2. **Religious, Aboriginal and Spiritual observance** - If a student needs accommodation because of religious, Aboriginal or spiritual observance, they must submit a Request for Accommodation of Student Religious, Aboriginal and Spiritual Observance AND an Academic Consideration Request form within the first 2 weeks of the class or, for a final examination, within 2 weeks of the posting of the examination schedule. If the requested absence occurs within the first 2 weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the absence. Both documents are available at [www.ryerson.ca/senate/forms/reobservforminstr.pdf](http://www.ryerson.ca/senate/forms/reobservforminstr.pdf). **If you are a full-time or part-time degree student, then you submit the forms to your own program department or school;**
3. **Academic Accommodation Support** - Before the first graded work is due, students registered with the [Academic Accommodation Support office](#) (AAS - [www.ryerson.ca/studentlearningsupport/academic-accommodation-support](http://www.ryerson.ca/studentlearningsupport/academic-accommodation-support)) should provide their instructors with an Academic Accommodation letter that describes their academic accommodation plan.

## Virtual Proctoring Information (if used in this course)

Online exam(s) within this course may use a virtual proctoring system. Please note that your completion of any such virtually proctored exam may be recorded via the virtual platform and subsequently reviewed by your instructor. The virtual proctoring system provides recording of flags where possible indications of suspicious behaviour are identified only. Recordings will be held for a limited period of time in order to ensure academic integrity is maintained and then will be deleted.

**Access to a computer that can support remote recording is your responsibility as a student.** The computer should have the latest operating system, at a minimum Windows (10, 8, 7) or Mac (OS X 10.10 or higher) and web browser Google Chrome or Mozilla Firefox. You will need to ensure that you can complete the exam using a reliable computer with a webcam and microphone available, as well as a typical high-speed internet connection. Please note that you will be required to show your Ryerson OneCard prior to beginning to write the exam. In cases where you do not have a Ryerson OneCard, government issued ID is permitted.

Information will be provided prior to the exam date by your instructor who may provide an opportunity to test your set-up or provide additional information about online proctoring. Since videos of you and your environment will be recorded while writing the exam, please consider preparing the background (room / walls) so that personal details are not visible, or move to a room that you are comfortable showing on camera.

## Turnitin (if used in this course)

Turnitin.com is a plagiarism prevention and detection service to which Ryerson subscribes. It is a tool to assist instructors in determining the similarity between students' work and the work of other students who have submitted papers to the site (at any university), internet sources, and a wide range of books, journals and other publications. While it does not contain all possible sources, it gives instructors some assurance that students' work is their own. No decisions are made by the service; it generates an "originality report," which instructors must evaluate to judge if something is plagiarized.

Students agree by taking this course that their written work will be subject to submission for textual similarity review to Turnitin.com. Instructors can opt to have student's papers included in the Turnitin.com database or not. Use of the Turnitin.com service is subject to the terms-of-use agreement posted on the Turnitin.com website. Students who do not want their work submitted to this plagiarism detection service must, by the end of the second week of class, consult with their instructor to make alternate arrangements.

Even when an instructor has not indicated that a plagiarism detection service will be used, or when a student has opted out of the plagiarism detection service, if the instructor has reason to suspect that an individual piece of work has been plagiarized, the instructor is permitted to submit that work in a non-identifying way to any plagiarism detection service.

## Academic Integrity

Ryerson's [Policy 60 \(the Academic Integrity policy\)](#) applies to all students at the University. Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism - a serious academic offence, with potentially severe penalties and other consequences. It is expected, therefore, that all examinations and work submitted for evaluation and course credit will be the product of each student's individual effort (or an authorized group of students). Submitting the same work for credit to more than one course, without instructor approval, can also be considered a form of plagiarism.

Suspensions of academic misconduct may be referred to the Academic Integrity Office (AIO). Students who are found to have committed academic misconduct will have a Disciplinary Notation (DN) placed on their academic record (not on their transcript) and will normally be assigned one or more of the following penalties:

1. A grade reduction for the work, ranging up to and including a zero on the work (minimum penalty for graduate work is a zero on the work);
2. A grade reduction in the course greater than a zero on the work. (Note that this penalty can only be applied to course components worth 10% or less, and any additional penalty cannot exceed 10% of the final course grade. Students must be given prior notice that such a penalty will be assigned (e.g. in the course outline or on the assignment handout);
3. An F in the course;
4. More serious penalties up to and including expulsion from the University.

The unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited, in accordance with Policy 60 (Sections 2.8 and 2.10). Intellectual property includes, but is not limited to:

1. Slides
2. Lecture notes
3. Presentation materials used in and outside of class
4. Lab manuals
5. Course packs
6. Exams

For more detailed information on these issues, please refer to the [Academic Integrity policy](#) (<https://www.ryerson.ca/senate/policies/pol60.pdf>) and to the Academic Integrity Office website (<https://www.ryerson.ca/academicintegrity/>).

## Academic Accommodation Support

Ryerson University acknowledges that students have diverse learning styles and a variety of academic needs. If you have a diagnosed disability that impacts your academic experience, connect with Academic Accommodation Support (AAS). Visit the [AAS website](#) or contact [aaadmin@ryerson.ca](mailto:aaadmin@ryerson.ca) for more information.

Note: All communication with AAS is voluntary and confidential, and will not appear on your transcript.

## Important Resources Available at Ryerson

1. The Library (<https://library.ryerson.ca/>) 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 go to <https://library.ryerson.ca/workshops>
2. Student Learning Support (<https://www.ryerson.ca/student-life-and-learning/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 (<https://www.ryerson.ca/student-life-and-learning/learning-support/>).
3. You can submit an Academic Consideration Request (<https://prod.apps.ccs.ryerson.ca/senateapps/acadconsform>) when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may



always visit the Senate website (<https://www.ryerson.ca/senate/>) and select the blue radial button on the top right hand side entitled: Academic Consideration Request (ACR) to submit the request.

*Policy 167: Academic Consideration due to COVID-19: Students that miss an assessment due to cold or flu-like symptoms, or due to self isolation, are currently not required to provide a health certificate. Other absences must follow [Policy 167: Academic Consideration](#).*

Also NOTE: Outside of COVID-19 symptoms, the new Policy 167: Academic Consideration does allow for a once per term academic consideration request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. In the absence is more than 3 days in duration and/or is for a final exam/final assessment, documentation is required. For more information please see Senate [Policy 167: Academic Consideration](#).

4. Ryerson COVID-19 Information and Updates for Students (<https://www.ryerson.ca/covid-19/students/>) summarizes the variety of resources available to students during the pandemic.
5. Familiarize yourself with the tools you will need to use for remote learning. The Continuity of Learning Guide (<https://www.ryerson.ca/centre-for-excellence-in-learning-and-teaching/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.
6. Information on Copyright for Faculty (<https://library.ryerson.ca/copyright/faculty/copyright-faqs/my-teaching-materials-have-been-posted-online/>) and students (<https://library.ryerson.ca/copyright/home/copyright-for-students-2/students-course-sharing-websites-and-file-sharing/>).
7. At Ryerson, 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. Below are resources we encourage all Ryerson community members to access to ensure support is reachable. <https://www.ryerson.ca/mental-health-wellbeing>.

**If support is needed immediately, you can 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)