

MDSC 401

Introduction to Bioinformatics

Instructors:

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Office Hours/Policy on Answering Student Emails

Office Hours: Immediately after end of class; meet Dr. Bieda at end of class. Please arrange in advance to meet.

Emails: answered within 3 business days

Teaching Assistants:

TBA

Time and Location:

Wednesday, 12-3 pm O'Brien 1501

Please consult course schedule to confirm location of individual sessions.

Prerequisite/Co-Requisite:

6 units (1.0 full-course equivalent) in Computer Science at the 300 level or [Medical Science 341](#) and [351](#) or 6 units (1.0 full-course equivalent) in Biological Sciences at the 300 level or consent of the instructor.

Course Description:

This introductory course will familiarize students with algorithms and computational techniques for bioinformatics applications. Topics to be covered include algorithm and search engines for the analysis of nucleic acid and protein sequences and structures; machine learning techniques for biological data analysis; systems biology approaches for computational modelling.

Overarching Theme

This is an introductory course in bioinformatics, suitable as a first course on this topic. This course is designed to allow students from a wide variety of backgrounds to understand the basic foundations of bioinformatics. Hence, this course only requires basic knowledge of biology (DNA, RNA, protein) as a prerequisite.

Each class is a combination of a lecture focusing on theory and methods followed by a linked

computer exercise performed in class with faculty supervision. Sequence alignment is the focus of most of the course, with students introduced to the mathematics and algorithms underlying current approaches, along with computer exercises focusing on uses of major resources (e.g. NCBI BLAST). Differences in classical sequence alignment issues and new issues presented by "next-generation" sequencing are discussed and next-generation sequencing algorithms are presented. Multiple sequence alignment and phylogenetic/gene tree construction are the next topic, followed by full introduction to hidden Markov models and their use in sequence analysis. In the last section of the course, gene expression array analysis and chromatin immunoprecipitation array analysis are introduced, with a view toward emerging questions in bioinformatics. In all cases, bioinformatics analyses are presented in context of fundamental biological questions.

The emphasis is on development of student facility with mathematical and algorithmic approaches that are widely used across bioinformatics, along with practical experience using major online bioinformatics resources (e.g. Genbank, UCSC genome browser, ensembl, NCBI BLAST, NCBI GEO).

Global Objectives

By the end of this course, students will have:

1. Developed an understanding of the fundamental logic of bioinformatics investigation and research.
2. Developed an understanding of the current state and prospects for bioinformatics in relation to other areas of biomedical research.
3. Developed an in-depth understanding of the central algorithms used in sequence alignment.
4. Gained a basic understanding of some of the key mathematical concepts used in bioinformatics research.

Learning Objectives

By the end of this course, students will have:

1. Developed an understanding of issues surrounding of sequence analysis of DNA, RNA, and proteins ("sequence analysis").
2. Developed an introductory understanding of the conceptual, mathematical, and algorithmic foundations of paired and multiple sequence alignment and their importance in biomedical research and actually performed sequence alignments.
3. Developed an understanding of the next-generation sequencing revolution in biomedical science and an understanding of the bioinformatics issues.
4. Developed an understanding of two of the most widely used and generally applicable computational approaches (dynamic programming and hidden Markov models) in bioinformatics.
5. Actually performed dynamic programming; actual use of hidden Markov model formulations.

6. Developed an understanding of the importance and role of phylogenetic and gene trees in biomedical research and actually performed tree construction.
7. Developed an understanding of use and importance of gene expression arrays.
8. Developed an understanding of bioinformatics as a discipline and current and potential future questions.

Recommended Textbooks/Readings

All material will be presented in lectures, so there are no required readings for this course.

Evaluation

The University policy on grading and related matters is described in section F.2 of the 2017-2018 Calendar.

In determining the overall grade in the course the following weights will be used:

50% Assignment 1

50% Assignment 2

A Note regarding Written Portions of Above Assignments:

Writing skills are important to academic study in all disciplines. In keeping with the University of Calgary's emphasis on the importance of academic writing in student assignments (section E.2 of 2017-18 Calendar), writing is emphasized, and the grading thereof in determining a student's mark in this course. The Bachelor of Health Sciences values excellence in writing. Competence in writing entails skills in crafting logical, clear, coherent, non-redundant sentences, paragraphs and broader arguments, as well as skills with the mechanics of writing (grammar, spelling, punctuation). The University of Calgary offers a number of instructional services through the Students' Success Centre's Writing Support Services (<http://www.ucalgary.ca/writingsupport/>) for students seeking feedback on assignments or seeking to improve their general writing skills. Students are **strongly encouraged** to take advantage of these programs.

Grading Scheme:

| | | | |
|------------|-----------|-----------|-----------|
| A+ 97-100% | B+ 80-84% | C+ 65-69% | D+ 54-56% |
| A 90-96% | B 75-79% | C 60-64% | D 50-53% |
| A- 85-89% | B- 70-74% | C- 57-59% | F 0-49% |

Missed Components of Term Work:

Students will lose 25% per day (or portion thereof) past the deadline for all assignments. In this case, assignments will NOT be accepted more than 72 hours after the posted deadline and students failing to submit any assignment within this time frame will receive a mark of zero. Students who miss a quiz will receive a mark of zero unless the instructor has been previously notified. There will be NO exceptions to this policy.

It is the agreement of all Faculty and Staff involved in MDSC401 that extensions will NOT be granted on any assignment or quizzes. The only exceptions to this are those in keeping with the University Calendar (illness, religious conviction, or domestic affliction) that are received in writing and with supporting documentation. Please be advised that students should notify the instructor before the assignment deadline to discuss.

Desire2Learn (D2L)

Desire 2 Learn is located on the University of Calgary server and will be used extensively for communication with students. **It is the student's responsibility to ensure that s/he gets all posted communications and documents and that s/he receives emails sent by instructors or fellow students through D2L.** Only your @ucalgary.ca email address may be linked to D2L. Please ensure that you are regularly checking your @ucalgary.ca account.

If you need help accessing or using D2L, please visit the Desire2Learn resource page for students: <http://elearn.ucalgary.ca/d2l-student/>.

Policies Governing the Course:

Attendance

Attendance is strongly recommended for successful completion of assignments.

Conduct During Lectures

Students are expected to conduct themselves in a mature and courteous manner during ALL lectures. Students are expected to frame their comments and questions to lecturers in respectful and appropriate language, always maintaining sensitivity towards the topic.

Students are expected to take notes during each session and should not rely solely on handout material supplied by the instructors.

Electronic Devices

The Bachelor of Health Sciences program aims to create a supportive and respectful learning environment for all students. Research studies have found that student use of electronic devices (laptops, tablets, etc) in the classroom negatively affects the learning of both the user and those sitting nearby. Inappropriate use of laptops is also disruptive to your fellow classmates and disrespectful to the lecturer. The use of laptops and other electronic note-taking devices is permitted; however, their use in the classroom should be for course-related work/note-taking only. Please do **NOT surf the web, check email or do other unrelated work.**

Students who use their laptops inappropriately or are otherwise disruptive during lectures will be asked to leave.

Cell phones (or similar devices) should **be turned off** (not merely silent) upon entering the classroom. Sending/receiving text messages or leaving the class to take calls is disruptive to the entire class and will not be tolerated unless absolutely necessary. Students who disregard this rule during lectures or tutorials will be asked to leave. These items are not permitted under any circumstance during exams/quizzes, etc.

Copyright

It is the responsibility of students and professors to ensure that materials they post or distribute to others comply with the Copyright Act and the University's Fair Dealing Guidance for Students (library.ucalgary.ca/files/library/guidance_for_students.pdf). Further information for students is available on the Copyright Office web page (<http://library.ucalgary.ca/copyright>)

A Note Regarding Instructor Intellectual Property

Generally speaking, course materials created by professor(s) (including course outlines, presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the professor(s). These materials may **NOT** be reproduced, redistributed or copied without the explicit consent of the professor. **The posting of course materials to third party websites such as note-sharing sites without permission is prohibited.** Sharing of extracts of these course materials with other students enrolled in the course **at the same time** may be allowed under fair dealing.

Academic Accommodations Based on Disability or Medical Condition

It is the student's responsibility to register with Student Accessibility Services to be eligible for formal academic accommodation in accordance with the Procedure for Accommodations for Students with Disabilities (https://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf). If you are a student who may require academic accommodation and have not registered with Student Accessibility Services, please contact their office at (403) 220-8237; <http://www.ucalgary.ca/access/>. Students will be provided with all necessary accommodations to ensure equal opportunity to succeed in this course. Please provide the instructor your accommodation letter from Student Accessibility Services within 14 days after the start of this course so that all needed arrangements for exams and assignments can be made.

Accommodations on Protected Grounds other than Disability

Students who require an accommodation in relation to their coursework based on a protected ground other than disability, should communicate this need, preferably in writing, to the designated BHSc program contact, Mrs. Jennifer Logan (jljlogan@ucalgary), or to Dr. Ebba Kurz, Associate Dean, Undergraduate Health and Science Education, Cumming School of Medicine. Students who require an accommodation unrelated to their coursework or the requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Vice-Provost (Student Experience). For additional information on support services and accommodations for students with disabilities,

visit www.ucalgary.ca/access/.

Academic Misconduct

The University of Calgary is committed to the highest standards of academic integrity and honesty. The University of Calgary has created rules to govern all its members regarding the creation of knowledge and the demonstration of knowledge having been learned. These rules are contained principally in Sections J to L of the *University of Calgary Calendar*. Students are expected to be familiar with these standards and to uphold the policies of the University in this respect. The Calendar also stipulates the penalties for violating these rules. Please know that the University and the Cumming School of Medicine take these rules seriously. **All incidences of academic dishonesty in this course, such as cheating and plagiarism, will be reported to the Associate Dean for investigation;** infractions will be noted on the record of a student found to be guilty.

Recording of Lectures

Audio or video recording of lectures is prohibited except where explicit permission has been received from the instructor.

Other Important Information

Freedom of Information and Protection of Privacy Act

This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIP); students should identify themselves on written assignments (exams and term work) by their name and ID number on the front page and ID on each subsequent page. Work assigned to you by your course instructor will remain confidential unless otherwise stated before submission. The assignment cannot be returned to anyone else without your expressed permission to the instructor. Grades will be made available on an individual basis and students will not have access to other students' grades without expressed consent. Similarly, any information about yourself that you share with your course instructor will not be given to anyone else without your permission. See <http://www.ucalgary.ca/policies/files/policies/privacy-policy-2011.pdf> for more information.

Appeals

If there is a concern with the course, academic matter or a grade, first communicate with the instructor. If these concerns cannot be resolved, students can proceed with an academic appeal, as per Section I of the University Calendar. Students must follow the official reappraisal/appeal process and may contact the Student Ombuds' Office (<http://www.ucalgary.ca/ombuds>) for assistance with this and with any other academic concerns, including academic and non-academic misconduct. Students should be aware that concerns about graded term work may only be initiated **within 15 days** of first being notified of the grade.

Resources for Support of Student Learning, Success, Safety and Wellness

Student Success Centre <http://www.ucalgary.ca/ssc/>
Student Wellness Centre <http://www.ucalgary.ca/wellnesscentre/>

Distress Centre <http://www.distresscentre.com/>
Library Resources <http://library.ucalgary.ca>

Wellness and Mental Health Resources

The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the excellent mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU Wellness Centre (Room 370 MacEwan Student Centre, <https://www.ucalgary.ca/wellnesscentre/services/mental-health-services>) and the Campus Mental Health Strategy (<http://www.ucalgary.ca/mentalhealth/>).

Student Ombuds' Office

The Student Ombuds' Office supports and provides a safe, neutral space for students. For more information, please visit www.ucalgary.ca/ombuds/ or email ombuds@ucalgary.ca

Student Union (SU) Information

The SU Vice-President Academic can be reached at (403) 220-3911 or suvpaca@ucalgary.ca; the SU representatives for the Cumming School of Medicine can be reached at medrep2@su.ucalgary.ca.

Emergency Evacuation/Assembly Points

Assembly points for emergencies have been identified across campus. Assembly points are designed to establish a location for information updates from the emergency responders to the evacuees; and from the evacuated population to the emergency responders. The primary assembly point for the Health Sciences Centre is the Health Research Innovation Centre Atrium. For more information, see the University of Calgary's Emergency Management website: <http://www.ucalgary.ca/emergencyplan/assemblypoints>.

Safewalk

Campus security will escort individuals, day or night, anywhere on campus (including McMahon Stadium, Health Sciences Centre, Student Family Housing, the Alberta Children's Hospital and the University LRT station). Call 403-220-5333 or visit <http://www.ucalgary.ca/security/safewalk>. Use any campus phone, emergency phone or the yellow phone located at most parking lot pay booths. Please ensure your personal safety by taking advantage of this service.

Class Schedule

The following is a list of topics for class and assignment / exam due dates. Please note that unforeseen circumstances may cause changes to the schedule with respect to the timing of topics and readings. Students will be notified of all changes in a timely manner by way of email and D2L announcements.

| <u>Lecture</u> | <u>Date</u> | <u>Topic</u> | <u>Lecturer</u> |
|----------------|-------------|---|-----------------|
| 1 | Jan 10 | Bioinformatics <i>Introduction to Bioinformatics and Genomics</i> | Bieda |
| 2 | Jan 17 | Bioinformatics <i>Probability 1</i> | Bieda |
| 3 | Jan 24 | Bioinformatics <i>Probability 2</i> | Bieda |
| 4 | Jan 31 | Bioinformatics <i>Optimal Sequence Alignment</i> | Bieda |
| 5 | Feb 7 | Bioinformatics <i>Statistical Significance of Alignment Scores</i> | Bieda |
| 6 | Feb 14 | Bioinformatics <i>Multiple Sequence Alignment and Trees</i> <i>First Assignment is Made Available by end of day</i> | Bieda |
| 7 | Feb 21 | No Class – Reading Week | |
| 8 | Feb 28 | Bioinformatics <i>Alignment of Next Generation Sequencing Datasets</i> <i>First Assignment is due on the Tuesday following this class by 12 noon (March 6, 2017)</i> | Bieda |
| 9 | Mar 7 | Bioinformatics <i>Introduction to Markov Models</i> | Bieda |
| 10 | Mar 14 | Bioinformatics <i>Hidden Markov Models I</i> | Bieda |
| 11 | Mar 21 | Bioinformatics <i>Hidden Markov Models II</i> | Bieda |
| 12 | Mar 28 | Bioinformatics <i>Analysis of Gene Expression Data</i> <i>Second Assignment is Made Available by end of day</i> | Bieda |
| 13 | Apr 4 | Bioinformatics <i>Motif Finding in Sequences</i> | Bieda |

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|----|--------|--|-------|
| 14 | Apr 11 | <i>Bioinformatics: Looking toward the future: rise of high throughput biology</i> <i>Second Assignment is due on the Tuesday <u>following</u> this class by 12 noon (i.e April 17, 2017)</i> | Bieda |
|----|--------|--|-------|