

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2020	
Course Name	Bioinformatics	
Course Code	BIOTECH 4BI3/BIOTECH 6BI3	
Date(s) and Time(s) of lectures	Lecture: Tuesday 5:30 – 8:20 Lab: Monday and Thursday 5:30 – 8:20	
Program Name	Biotechnology	
Calendar Description	The course will familiarize students with the tools and principles of bioinformatics. Various software programs and languages will be used to access and analyze genomic data	
Instructor(s)	Travis Banks	E-Mail: bankstr@mcmaster.ca Office Hours & Location: by appointment

2. COURSE SPECIFICS

Course Description	In this course students will be introduced to bioinformatics and the role that this discipline plays in genomics-based research. Topics will be approached from the perspective of the bioinformatician with an emphasis on sequence analysis, algorithms, and software tools that are typically encountered. The Python programming language will be used for data processing and analysis. The students will gain an understanding of next-generation sequencing technologies, their applications and limitations. DNA assembly/read mapping algorithms and genome sequencing strategies will be discussed followed by genome annotation and public resources for gene and protein sequence information. State-of-the-art techniques to measure gene expression and network analysis will be discussed. The identification of DNA polymorphisms and their uses in marker-trait associations will be a topic of discussion. The laboratory portion of this class will give students the opportunity to explore commonly used online biological databases, carry out DNA sequence quality control, perform DNA assembly, DNA annotation, gene expression analysis and use software involved in phylogenetic analysis and comparative genomics. With the completion of the course students will have a thorough understanding of bioinformatics and will be capable of performing many of tasks commonly asked of a bioinformatician.		
Instruction Type	Code	Type	Hours per term
	C	Classroom instruction	39 (virtual)
	L	Laboratory, workshop or fieldwork	36 (virtual)
	T	Tutorial	0
	DE	Distance education	0
	Total Hours		
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	ISBN:	No textbook required. Links to online readings will be provided in lectures.	

	Other Supplies	Source
	Access to a computer running Ubuntu Linux 16.04 or better and a computer running Python 3	Students can install Python 3 on their personal computers or use Google’s ‘Colaboratory’ to write and run Python programs. Students can use their own Ubuntu Linux machine or use Google Cloud to rent a cloud-based system. Getting this setup will be covered in the first lab. Note: There may be a small cost for those using a cloud-based Ubuntu instance.
Prerequisite(s)	BIOTECH 4GP3, ENG TECH 1CP3, 3ES3	
Corequisite(s)	<i>None</i>	
Antirequisite(s)	<i>None</i>	
Course Specific Policies	<p>Lectures Students are strongly encouraged to watch each lecture as significant material will be presented that is not in the online readings. Students will be responsible for the content of lectures and supplementary reading material.</p> <p>Laboratory A weekly three-hour lab is associated with this course. Laboratory experiments are designed to be completed within the allotted time. All lab assignments or reports must be submitted to the instructor through Avenue-to-Learn by the stated due-date. Late labs, without a suitable explanation, will not be accepted and marked as 0.</p> <p>Assignments All assignments must be submitted to the instructor through Avenue-to-Learn by the stated due-date. Late assignments will not be accepted and marked as 0.</p> <p>Final Exam In lieu of a written final exam, students will prepare a written presentation that reviews a bioinformatics publication. The instructor and student will agree on the publication 1 month before the end of term.</p>	
Departmental Policies	<p>Students must maintain a GPA of 3.5/12 to continue in the program.</p> <p>In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests and examinations.</p> <p>Where group work is indicated in the course outline, such collaborative work is mandatory.</p> <p>The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.</p> <p>Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class.</p>	

	Instructor has the right to submit work to software to identify plagiarism.	
3. SUB TOPIC(S)		
Week 1	Python review and introduction to BioPython This lecture will review core Python language concepts and introduce the Python bioinformatics API, BioPython.	
Week 2	DNA Sequencing Technology and Applications An in-depth discussion of past and present DNA sequencing technologies and how they are used in bioinformatics. Techniques to assess the quality of DNA sequence information will be discussed	
Week 3	DNA Quality Control and K-mer Analysis Approaches to quality control of sequencing data will be discussed.	
Week 4	DNA Assembly A discussion on algorithms and strategies associated with DNA assembly.	
Week 5	DNA Similarity Searchers and File Formats Theory and approaches to comparing DNA or protein sequences will be discussed. An overview of important file formats for data exchange will be presented.	
Week 6	Mid-term recess	
Week 7	DNA Annotation, Gene Prediction, Ontology Theory behind identifying genic regions in DNA and predicting their function.	
Week 8	Gene Expression Analysis Theory behind DNA read mapping and its application will be presented along with a discussion on current methods to analyse gene expression data.	
Week 9	Phylogenetics and Comparative Genomics How comparing the evolutionary relatedness between genomes is accomplished and how it informs further genomics research.	
Week 10	DNA Polymorphism and Trait Association Topics include identifying DNA polymorphisms among individuals and how genetic markers and bioinformatics are used to diagnose disease, fight crime, and feed the planet.	
Week 11	Deep Learning in Bioinformatics An examination of emerging approaches to applying deep neural networks in bioinformatics such as SNP prediction, epigenetic analysis, and protein function prediction	
Week 12	Class Project Presentations	
Week 13	Class Project Presentations	

Week 14	Wrap up	
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Midterm Recess: Monday, October 12 to Sunday, October 18
 Classes end: Wednesday, December 9
 Final examination period: Thursday, December 10 to Wednesday, December 23
 All examinations MUST be written during the scheduled examination period.

List of experiments

Lab 1	Getting Started - Python Notebooks and Ubuntu
Lab 2	Python
Lab 3	Regular Expressions and File Parsing
Lab 4	BioPython – Biological File Parsing
Lab 5	Quality Assessment of NGS Data
Lab 6	Read Mapping
Lab 7	Small Genome Assembly
Lab 8	SNP Analysis – Applied Python
Lab 9	SNP Finding with GATK
Lab 10	RNA-Seq Analysis
Lab 11	Phylogenetic Analysis
Lab 12	Primer Design

Note that this structure represents a plan and is subject to adjustment term by term.
 The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING *including dates*	Weight
Assignments	35%
Project	20%
Labs	35%
Final Presentation	10%
TOTAL	100%

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

1. Explain the role of bioinformatics in multi-disciplinary research teams
2. Demonstrate proficiency in Python with the ability to apply it to real-world problem solving
3. Explain state-of-the-art DNA sequencing technologies and the challenges associated with analysis of the corresponding data
4. Demonstrate how to identify differentially expressed genes from RNA-Seq data
5. Summarize the theory behind DNA assembly and perform an assembly
6. Outline how DNA polymorphisms are discovered, detected and used in the prediction of phenotypes
7. Experiment with commonly used bioinformatics software such as BLAST, bowtie, SAMTOOLS, GATK, and PHYLIP

6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS

ANTI-DISCRIMINATION

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty: The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COMMUNICATIONS

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests. <http://www.mcmaster.ca/policy/Students-AcademicStudies/Studentcode.pdf>

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.