

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2015	
Course Name	Bioinformatics	
Course Code	BIOTECH 4BI3	
Date(s) and Time(s) of lectures	Lecture: Thursday 5:30 – 8:30 Lab: Tuesday and Wednesday 5:30 - 8:30	
Program Name	Biotechnology	
Calendar Description	The course will familiarize students with the tools and principles of bioinformatics. Various software programs will be used to study and access genomic data formats and analysis techniques.	
Instructor(s)	Travis Banks	E-Mail: bankstr@mcmaster.ca Office Hours & Location: by appointment

2. COURSE SPECIFICS

Course Description	<p>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 and the databases and software tools that are typically encountered. Fundamentals of two programming languages common to bioinformatics, Python and R, will be taught. 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, 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.</p>		
Instruction Type	Code	Type	Hours per term
	C	Classroom instruction	39
	L	Laboratory, workshop or fieldwork	39
	T	Tutorial	0
	DE	Distance education	0
	Total Hours		78
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	ISBN:	No textbook required. Links to online readings will be provided in class	
	Other Supplies	http://avenue.mcmaster.ca	
Prerequisite(s)	BIOTECH 4GP3, ENG TECH 1CP3, 3ES3		
Corequisite(s)	None		
Antirequisite(s)	None		

<p>Course Specific Policies</p>	<p>Lectures Students are strongly encouraged to attend 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 three-hour lab is associated with this course and students are expected to attend. Laboratory experiments are designed to be completed within the allotted time. All lab assignments or reports must be submitted to the instructor in the manner requested (online or in person) on the stated due-date. Late assignments, without a suitable explanation, will not be accepted and marked as 0.</p> <p>Quizzes Several unannounced quizzes will be given through the semester. Quizzes will be designed to test students on their knowledge of recently covered topics in the lecture or reading. Quizzes missed without a suitable explanation will be marked as 0.</p> <p>Assignments All assignments must be submitted to the instructor in the manner requested (online or in person) on the stated due-date. Late assignments will not be accepted and marked as 0.</p> <p>Midterm Exam The midterm exam will cover all material presented in lectures, supplementary readings, and labs up to the week prior to the exam. If the midterm is missed and the student has a documented and approved report for their absence (see MSAF information below) then the final exam will account for 55% of their final grade. A missed midterm without a suitable reason will result in a mark of 0 being assigned to the midterm.</p> <p>Final Exam The final exam will cover all materials presented in lectures, textbook readings, supplementary readings and labs. The exam will be three hours in length.</p> <p>NOTE: Students must pass both components of the course –labs and lectures - to pass the course.</p>
<p>Departmental Policies</p>	<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</p>

	communicated to all students including those individuals that are not in class. Instructor has the right to submit work to software to identify plagiarism.	
3. SUB TOPIC(S)		
Week 1	Introduction and Basics of Python Core language concepts of the Python programming language will be discussed	Supplementary Reading
Week 2	Python Continue learning the Python language with a focus on program structure and regular expressions	
Week 3	BioPython This lecture will introduce the Python bioinformatics API, BioPython	Supplementary Reading
Week 4	Biological Databases Commonly used databases (DNA, protein, ontology, literature) will be discussed along with a number of web-based data visualization tools.	
Week 5	DNA Sequencing Technologies and Applications An in-depth discussion of past and present DNA sequencing technologies and how they are used in bioinformatics research.	Supplementary Reading
<i>Mid-term recess (Monday, October 12 to Saturday, October 17)</i>		
Week 6	DNA Sequence Quality Control and Read Mapping Techniques to assess the quality of DNA sequence information and strategies to enhance existing data. Theory behind sequence read mapping/re-sequencing and its application will also be discussed	Supplementary Reading
Week 7	DNA Assembly and Similarity Searches A discussion on algorithms and strategies associated with DNA assembly. Approaches for comparing DNA and protein sequences will be covered at length.	Supplementary Reading
Week 8	R and Bioconductor An introduction to the statistical programming language, R, and analysing high-throughput biological data with it.	
Week 9	Gene Expression and Network Analysis Discussions on current methods to analyse gene expression and the construction of regulatory networks from expression data.	Supplementary Reading
Week 10	DNA Annotation, Gene Prediction, Ontology Theory behind identifying genic regions in DNA and predicting their function	
Week 11	Phylogenetics and Comparative Genomics How comparing the evolutionary relatedness between genomes is accomplished and how it informs further genomics research.	
Week 12	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.	Supplementary Reading
Week 13	Review A comprehensive review of the class material in preparation for the final exam.	

Classes end – Tuesday December 8, 2015
 Final examination period: Wednesday December, 9, 2015 to Tuesday, December 22, 2015
 All examinations MUST BE written during the scheduled examination period.

List of experiments

Lab 1	Introduction to the Command Line
Lab 2	Python
Lab 3	BioPython –Biological File Parsing
Lab 4	Application of NCBI online DBs and Tools
Lab 5	Quality Assessment of NGS Data
<i>Mid-term recess (Monday, October 12 to Saturday, October 17)</i>	
Lab 6	<i>Small Genome Assembly</i>
Lab 7	Kmer Analysis
Lab 8	Annotation of Genomic DNA Fragment
Lab 9	Introduction to Statistical Programming in R
Lab 10	RNA-Seq Analysis Using R
Lab 11	Phylogenetic Analysis
Lab 12	Identification and Application of SNPs from NGS Data

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
Quizzes	2%
Assignments	20%
Mid-term test	20%
Laboratory	23%
Final examination (tests cumulative knowledge)	35%
TOTAL	100%

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

5. LEARNING OUTCOMES

1. **Learn the role of bioinformatics in multi-disciplinary research teams**
2. To gain proficiency in Python with the ability to apply it to real-world problem solving
3. Understand state-of-the-art DNA sequencing technologies and the challenges associated with analysis of the corresponding data
4. Learn the theory behind DNA assembly and allow one to critically evaluate publicly available genome assemblies
5. Understand how DNA polymorphisms are discovered, detected and used in the prediction of phenotypes

6. POLICIES

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/Anti-Discrimination%20policy.pdf>

Academic Integrity

You are required to exhibit honestly and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

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.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, located at: <http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf>.

The following illustrates only three forms of academic dishonesty:

1. Plagiarism. E.g. the submission of work that is not own or for which other credit has been obtained
2. Improper collaboration in group work
3. Copying or using unauthorized aids in tests and examinations.

Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)

The McMaster Student Absence Form is a self-reporting tool for **Undergraduate Students** to report absences that last up to 3 days and provides the ability to request accommodation for any missed academic work. Please note, this tool cannot be used during any final examination period.

You may submit a maximum of 1 Academic Work Missed requests per term. It is YOUR responsibility to follow up with your Instructor immediately regarding the nature of the accommodation.

If you are absent more than 3 days or exceed 1 request per term you **MUST** visit your Associate Dean's Office (Faculty Office). You may be required to provide supporting documentation.

This form should be filled out immediately when you are about to return to class after your absence. <http://www.mcmaster.ca/msaf/>

E-Learning Policy

Consistent with the Bachelor of Technology's policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail account, and program affiliation may become apparent to all other students in the course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about this disclosure please discuss this with the course instructor. Avenue can be accessed via <http://avenue.mcmaster.ca>.

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.

Turnitin (Optional)

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students submit their assignment/work electronically to Turnitin.com where it is checked against the internet, published works and Turnitin's database for similar or identical work. If Turnitin finds similar or identical work that has not been properly cited, a report is sent to the instructor showing the student's work and the original source. The instructor reviews what Turnitin has found and then determines if he/she thinks there is a problem with the work. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the

instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to <http://www.mcmaster.ca/academicintegrity/turnitin/students/>

Protection of Privacy Act (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.

<http://www.mcmaster.ca/univsec/fippa/fippa.cfm>

Academic Accommodation of Students with Disabilities Policy

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information consult McMaster's policy for Academic Accommodation of Students with Disabilities

<http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf>

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. <http://sas.mcmaster.ca>

Student Code of Conduct

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.

<http://judicialaffairs.mcmaster.ca/pdf/SCC.pdf>