New York City College of Technology

School of Arts and Sciences

Department of Biological Sciences

COMPUTATIONAL GENOMICS HYBRID (BIO 3354) SYLLABUS

Course Information

Course Title: Computational Genomics
Course Code: BIO3354
Credits Hours: 3 credit hours; 3 hours combined laboratory and lecture per week; 15 weeks total.
Prerequisite: BIO3352

Required Lecture Text:
Next-Generation Sequencing Informatics, Second Edition, 2015, by Cold Spring Harbor Press
(http://cshlpress.com/default.tpl?cart=14538031342016704&action=full&--eqskudatarq=1041)
The course will use various published articles and reviews, as well as internet-based sources as reference text.

Official Course Description (from the College Catalog):
Covers selected advanced topics in computational genomics. Modern DNA microchips enable measurement of the activity state of tens of thousands of genes in a cell, and related techniques are being developed for measuring the protein contents. In this course students will utilize modern statistical and computational methods to understand biological processes. This course emphasizes studies of

gene and cell function made possible by recent advances in measurement technology, statistical and computational methods.

Course Mechanics

The class will meet once every week. Parts of this course will also be conducted online via *Blackboard* on a weekly basis. Attendance is absolutely required. Aside from serving as the venue to introduce new topics, the face-to-face meeting will also provide an opportunity for students to discuss any difficulty they are having regarding the online component of the course.

BIO3354 consists of five components:

1. In class-participation (5%)
2. Online participation (10%)
3. Online and in-class quizzes (15%)
4. Homework assignments (20%)
5. Research project (20%)
6. Exams (30%)

These components are described in the next section.

Course Objectives and Student Expectation

Students are expected to be able to work both independently and regularly, as well as collaborate with fellow students on group projects. This upper-level course is fast paced, and covers a diverse set of topics.

Students must access their *Blackboard* accounts at least 2 times per week and show active participation in Discussion Boards. The Discussion Board Rubric in the following section will be used to assess participation and contribution to the learning community in the *Blackboard* Discussion Boards.

Course Objectives	In addition to learning about recent topics in computational genomics, this course will also give the students an opportunity to practice important research skills: • To employ scientific reasoning and logical thinking. • To practice communicating complex technical material. • To employ both quantitative and qualitative analysis to describe and solve problems, both independently and cooperatively. • To complete a small-scale original research project. • To value knowledge and learning.
Topics	• Basics of Next Generation Sequencing • Next Generation Sequencing Experiments and their Computational Tools • ChIP-seq/RNA-seq/DNA methylation Analysis Platforms • Tophat/Cufflinks/Cuffdiff • Differential Expression Analysis Methods for RNA-seq • Galaxy • BedTools/Samtools/UCSC Genome Browser • Variant Calling for Next Generation Sequencing Data • Metagenomics

Quizzes	Quizzes, online and/or in-class, will be given periodically.
Final Project	A major component of this course is a research project. For this project, the students will choose a research topic in the area of computational genomics, and explore it in detail. Projects can range from quite theoretical to heavy implementation, and should include some component of original work. Students are encouraged to work in groups (2-3 students). Topics will be discussed in the first weeks of the course to allow plenty of time for preparation and research. The instructor will guide the groups with discussions in class and in office hours.
College Policy on Absence- Lateness	A student may be absent without penalty for 10% of the number of scheduled class meetings during the semester as follows: Class Meets Allowable Absence **1 meeting/week - 2 classes** Students are responsible for making up any missed work on days that they are absent. If a student's class absences exceed this limit the instructor will alert the student that a grade of WU may be assigned.

	Unless otherwise indicated by the instructor, **two times late is treated as one absence**.

Learning Outcomes for Gen Ed, CUNY Common Core, CUNY Flexible Core

Gen Ed Outcomes Learning	Students in this course will: 1. expand and deepen their knowledge by: ○ learning to value knowledge and learning; ○ understanding and appreciating the range of academic disciplines that constitute the interdisciplinary field of computational genomics/biology, and comprehending their relationships in this field of study; ○ using this course as a forum for the study of values and ethical principles that are at play in the rapid development of the field of bioinformatics, as well as for the study of basic and applied sciences that inform the physical world. ○ engaging in an in-depth, focused, and sustained program of study of computational genomics;

	○ pursuing disciplined, inquiry-based learning through online activities and lab exercises; ○ acquiring tools for lifelong learning, such as the proper and efficient ways to utilize existing scientific data and information to gain knowledge. 1. acquire and use tools needed for communication, inquiry, analysis, and productive work by: ○ communicating effectively using written, oral, and visual means;
	• understanding and employing quantitative analysis to describe and solve problems, both independently and cooperatively; • employing scientific reasoning and logical thinking; • using creativity to solve scientific problems. 1. work productively within the diverse discipline of computational genomics and related fields by: ○ gathering, interpreting, evaluating, and applying information from a variety of sources, as displayed in their final research projects; ○ understanding and navigating complex systems that support research and practice in computational genomics; ○ resolving complex issues creatively by employing multiple sources of information, systems, and tools. 2. understand and apply values and ethics in personal and professional domains by: ○ demonstrating intellectual honesty and personal responsibility; ○ demonstrating intellectual agility; ○ working in teams effectively;

	a. transforming biological information into knowledge.
CUNY Common Core Learning Outcomes	Students in this course student will: • identify and apply fundamental concepts and methods of biological and informatics sciences; • use computational genomics tools of to carry out collaborative laboratory investigations; • gather, analyze, interpret and present data in effective written reports; • identify and apply research ethics in gathering and reporting scientific data.
CUNY Flexible Core Learning Outcomes	Students in this course student will: • identify and apply fundamental concepts and methods of biological and informatics sciences to explore the scientific world; • demonstrate how tools of biological sciences and quantitative technologies to analyze problems and develop solutions; • articulate and evaluate the impact of genomic and computational technologies on the contemporary worlds, such as issues of personal privacy, security, and ethical responsibilities; • understand scientific principles underlying matters of policy or public concern in which science plays a role.

Course Coordinator

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Grading Policies

Please bear in mind that this course is an intensive 3-credit science course with a laboratory component. Class presentations of research projects and completion of assignments/quizzes are required. Optional assignments for extra credits (max 10%) will be offered during the semester. Only these assignments are optional and will be explicitly described in the class. Student performance on this course will be evaluated as follows:

Lab/Lecture

Assignment	**Description**	**Points**
In class participation	Weekly attendance	**5%**
Online participation	Active participation on online activities (based on Blackboard)	10%
Online/in-class quizzes	5 online and in-class quizzes	15%
Assignments	Homework assignments based on	**20%**

	computer lab	
Research Project	**(Breakdown below)** - 10-minute in class presentation (10%) - 5-page written report of the research project (10%)	**20%**
Exam 1	**Midterm Exam**	**15%**
Exam 2	**Final Exam**	**15%**
Total		**100%**

Note:

Letter grades will be determined using a standard percentage point evaluation as outlined below:

A	93-100
A-	90-92.9
B+	87-89.9
B	83-86.9
B-	80-82.9
C+	77-79.9

C	70-76.9
D	60-69.9
F	Below 60

Policy on Academic Integrity

Academic dishonesty includes any act that is designed to obtain fraudulently, either for oneself or for someone else, academic credit, grades, or any other form of recognition that was not properly earned. Academic dishonesty, which will not be tolerated in this course and at City Tech, encompasses the following:

Cheating	Defined as intentionally giving, receiving, using or attempting to use unauthorized materials, information, notes, study aids, including any form of unauthorized communication, in any academic exercise. It is the student's responsibility to consult with instructors to determine whether or not a study aid or device may be used.
Plagiarism	Plagiarism is intentionally and knowingly presenting the ideas or works of another as one's own original idea or works in any academic exercise without proper acknowledgement of the source. The purchase and submission of a term paper,

	essay, or other written assignment to fulfill the requirements of a course, and violates section 213-b of the *State Education Law*. This also applies to the submission of all or substantial portions of the same academic work previously submitted by the student or any other individual for credit at another institution, or in more than one course.
Course Policy on Academic Integrity	Cheating and plagiarism will not be tolerated in this course. Penalties are the following. Cheating in in-class exams or quizzes will merit an automatic zero for the exercise. Copying from classmates' lab worksheets and other take-home or online assignments will also merit an automatic zero for the exercise. Repeated violations will be reported to the Chair and the Dean, and may result in a final grade of "F" in the course, or even expulsion from the College. If you are unsure whether any of your actions constitute cheating or plagiarism, please consult the instructor for guidance.

Lecture and Laboratory Schedule

Week	**Lecture/Laboratory**	**Chapter**
1	**LECTURE:**	**1**

	Introduction to Next Generation Sequencing. **LAB:** Introduction to bioinformatics resources/programs (UCSC Genome Browser, R/Bioconductor).	
2	**LECTURE:** History of Sequencing informatics. **LAB:** Introduction to Galaxy	3
3	**LECTURE:** Visualization of Next Generation Sequencing Data. **LAB:** Data formats, Genome Browsers, Genomics Visualization Software	**5**
4	**LECTURE:** Genome Annotation. **LAB:**	**10**

	ENCODE, GTF, ENSEMBL, igenomes	
5	**LECTURE:** Public Sequence Databases **LAB:** NCBI, ENA, 1000 Genomes, TCGA, ICGC	**4**
6	**LECTURE:** Quality Control and Data Processing. LAB: Galaxy, FASTQC tools.	**2**
7	**Midterm Exam.**	
8	**LECTURE:** DNA Sequence Alignment. **LAB:** Galaxy, Alignment tools.	6
9	**LECTURE:** RNA-seq (I). **LAB:** Galaxy, RNA-seq pipeline.	**13**
10	**LECTURE:** RNA-seq (II). **LAB:**	**13**

	Galaxy, RNA-seq pipeline.	
11	**LECTURE:** ChIP-seq. **LAB:** Galaxy, ChIP-seq pipeline.	**12**
12	**LECTURE:** Variant Calling **LAB:** Galaxy, variant calling pipeline.	**11**
13	**LECTURE/LAB:** Invited Speaker or Online Lecture	
14	**In-class project presentations.**	
15	**Final Exam**	