MDSC 408
Research Design in Molecular Biology and Bioinformatics

Instructors:

Dr. Guido van Marle, M.Sc., Ph.D. **(Course Coordinator)**
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Office Hours/Policy on Answering Student Emails
Office hours are by appointment only. The instructors will respond to emails received during working hours by the next working day.

Teaching Assistants:
Laboratory TAs:

Jacey Kenny	Kaylan Burns
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Bioinformatics TAs:

Chantelle Lin	Daniel Castaneda Mogollon
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Time and Location:

TERM: Fall 2022 and Winter 2023	TIME: Tuesdays and Thursdays, 9:00-11:50 AM
LECTURES/Tutorials : O1500 and O1501	LABS: HSC 2525A, 2525B, 2526A & 2526B

Please carefully consult course schedule to confirm the location of individual sessions.

NOTE: We will NOT post any recording of the lectures or tutorials. Lecture slides and documents will be posted on Brightspace (by D2L).

Prerequisite/Co-Requisite:
Medical Science 308, with a minimum grade of "B-", and Medical Science 341 and admission to the BHSc Honours program.

Course Description:
An introduction to the research methods utilized in the Health Sciences. Students will begin to develop the knowledge and skills necessary to conduct research in their respective fields. The importance of research design, qualitative, quantitative and mixed methods and the theoretical constructs that inform these approaches will be emphasized.

Overarching Theme
After completion of the course, a student should have fundamental understanding of the basic molecular biology of prokaryotic and eukaryotic systems. In addition to an appreciation of the underlying mechanisms and processes, the student is expected to understand the experimental approaches that are used to generate data in the field. A measure of this understanding will be the ability to use the acquired knowledge to explain and interpret experimental observations, and to design appropriately controlled experiments to test hypotheses.

MDSC 408 Fall semester: In the Fall semester, you will gain exposure to and experience with the approaches and tools for probing biological phenomena at the molecular level. You will work individually and in pairs on a project using a variety of genetic, biochemical and molecular biological approaches. You will also be assigned a structural bioinformatics assignment that is related to the laboratory work so that you can integrate those concepts with practical lab experience.

The biological system we will be working with, in both the bioinformatics part and the laboratory part, is a fluorescent protein (for example, green fluorescent protein (GFP)). Not only are these proteins interesting in the way organisms use them in nature, they are also widely used as laboratory tools. The system allows us to use many different methodologies and approaches within the time and resource constraints of the course. It has features that include: 1) detailed structural information to facilitate the development of rational site-directed mutagenesis strategies, through which we can easily alter the properties of the protein; 2) an extensive array of well characterized homologues (for the bioinformatics projects); 3) a simple method for production and isolation of recombinant protein, so that we can analyze the altered properties of the proteins. You will need some familiarity with this system to understand the approaches taken, but they will help you develop a fundamental understanding of various concepts and approaches that can be applied to virtually any biological system under study.

MDSC 408 Winter semester: The Winter term is an extension of the laboratory work and theory covered in the Fall. While the Fall semester focuses mainly on molecular biology techniques utilized in prokaryotic systems, the Winter term is designed to extend this knowledge to eukaryotic systems. However, similar principles and techniques are applied to both eukaryotic and prokaryotic systems.

The laboratory part of the Winter term will include the discussion of eukaryotic cell culture techniques, types of eukaryotic cell lines, uses for cultured cells, and eukaryotic transfection systems. You will get hands-on experience in maintaining eukaryotic cell lines. You will transfect cells, isolate RNA from cells, synthesize cDNA, and examine changes in the gene expression using reverse transcription PCR (RT-PCR)

and quantitative real-time PCR (qrt-PCR). The bioinformatics components will consist of lectures/tutorials and assignments focusing on various sequence analyses and gene expression tools and approaches.

For the final assignment in the Winter semester, you will have to write a proposal that describes a number of experiments to study the effects of a protein (or gene) of your choice in eukaryotic cells. To design these experiments, you will have to use experimental evidence found in the current scientific literature. The purpose of the "letter of intent" is to give a one-page summary highlighting the proposed research you will be addressing with the experiments you are planning. This "letter of intent" will precede your research proposal and help you prepare for the final assignment. It will also help us ensure that you are on the right track with this assignment. The goal of these two assignments and the course is to teach you to integrate new knowledge with the existing knowledge and to design experiments. You will not only be required to explain the concepts covered in the lectures and readings, but to integrate the newly learned concepts into material that you have already learned in other courses or that you have encountered by reading the scientific literature.

Global Objectives

MDSC 408 is designed to give biomedical sciences and bioinformatics students the basic conceptual framework, knowledge and skill set to work and think independently in a medical science or life science research environment. By the end of MDSC 408, students will be able to successfully utilize a number of bioinformatics tools and perform a number of molecular biology techniques, interpret results and troubleshoot when problems arise.

The global objectives MDSC 408 are to enhance the student's:
1) understanding and use of scientific methodology and thought process
2) ability to understand and approach problems at the molecular level
3) ability to design experiments in a creative manner

Course Learning Outcomes

By the end of this course, students will be able to:
1. Demonstrate knowledge and understanding of the basic molecular biology techniques and will be able to successfully perform these techniques in a laboratory setting.
2. Apply the gained knowledge to troubleshoot and ultimately correct technically-based problems that arise in the laboratory.
3. Understand experimental design and be able to think through an experiment from beginning to end.
4. Critically evaluate the appropriateness and limitations of using various molecular biology techniques and research designs.
5. Describe why the particular technique/s or research method/s was/were chosen to answer the research question, list the advantages and disadvantages of the chosen method/s and suggest alternative approaches.

Specific Learning Objectives of the Bioinformatics assignments:
1. Perform basic bioinformatics searches and use Swiss-PDB tools to analyze the structure of the proteins.
2. Interpret the results generated by the bioinformatics searches and protein structure modeling and formulate a focused and well-defined hypothesis.
3. Propose methods to test the hypothesis in a framework of several specific aims.

4. Plan cloning and site-directed mutagenesis experiments in silico using various online and open source software tools.
5. Analyse and interpret next generation sequencing data using R and R -studio

Specific Learning Objectives of the Research
Transferable Skill Development:
Many of the skills and abilities that you are developing in your coursework are transferable to the workforce, graduate and professional studies and other facets of life. Employers seek applicants with transferable skills because they can be an asset in the workplace, regardless of industry or sector. Transferable skills are core skills for your success in building your future career.

The work that you will do in MDSC408 will help you build the following transferable skills:

- **Creativity and Innovation**: Find different and better ways to do things, being curious, thinking imaginatively.
- **Critical Thinking**: Actively and skillfully conceptualize, apply, analyze, synthesize, and/or evaluate information (data, facts, observable phenomena, and research findings) to make a reasoned judgement or draw a reasonable conclusion.
- **Information Literacy**: Find, understand, and use information presented through words, symbols, and images
- **Numeracy**: Use mathematical information such as numbers, symbols, words, and graphics to do tasks.
- **Problem solving**: Identify an issue, find and implement a solution, and assess whether the situation has improved.
- **Project Management:** Conceptualize, initiate, plan and execute a plan to achieve a predetermined goal (project) by effectively prioritizing activities and meeting deadlines.
- **Written Communication**: Share ideas and information by using words, images, and symbols.

Learning Resources

Recommended Textbooks/Readings
You do not need to buy any text book for this course

A Note regarding readings
A list of required readings will be outlined on D2L and links and documents will be made available, where possible. Required readings have been chosen carefully to inform you and enhance the lecture material**. Students are REQUIRED to complete assigned readings BEFORE each lecture.** Instructors will proceed in class on the assumption that students have read completely the assigned readings. Students should be aware that many of the readings they will be assigned may be of an unfamiliar nature and style. Students should allot sufficient time to allow for several reads of the assigned material.

Learning Technology Requirements
Brightspace (by D2L) 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 they receive all posted communications and documents and that they receive 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.

Evaluation

The University policy on grading and related matters is described in section F of the 2022-2023 Calendar.

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

Assignments:		
Description	**Due**	**Proportion of Final Grade**
Bioinformatics Assignments (Fall Semester): This is a series of assignments/exercises that will help you to understand and gain practical experience in working with the bioinformatics tools introduced in class.	**Various smaller independent assignments throughout both semesters. Adding up to a total of 30%**	**30%**
Letter of Intent for the (Winter Semester): One-page summary highlighting the proposed research, you will address with your research pro outline.	**Feb. 27, 2023**	**5%**
Research Proposal (Winter Semester): For the written final assignment of this course, you will be expected to write a proposal" outlining the experimental approach for the research proposed in the LOI, 5 pages single-spaced not including references or figures. This "proposal" describes the experiments to study the effects of a protein of your choice of eukaryotic cells.	**Apr. 3, 2023**	**15%**
Exams:		
Exam/Quizzes: Examination on all material presented in lectures of both the bioinformatics and the lab sections up to the date. ***These quizzes and exams consist of open ended questions and will be given online through Brightspace (D2L) during in person class time and have a time limit of 2 hrs.*** 2 quizzes in the Fall (10% each) • 1 Exam in the Winter (10%)	**Oct. 11, 2022** **Dec. 6, 2022** **March 14, 2023**	**10%** **10%** **10%**
Lab Notebooks:		
Lab notebooks will be in an electronic online format. Mark includes flow charts due at the beginning of every lab and the notebook that is collected/marked after each lab session sections. Covers pre-lab preparation, participation and lab work documentation. Also submitted in its entirety at the end of each term.	**Dec. 9, 2022** **and** **Apr. 14, 2023**	**10%** **10%**

There is no final exam for this course.

A student's final grade for the course is the sum of the separate assignments. It is not necessary to pass each assignment separately in order to pass the course.

A Note regarding Writing 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 2022-23 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). Sources used in research papers must be properly documented. The University of Calgary offers 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:

Letter Grade	Description	Percentage
A+	Outstanding performance	96-100
A	Excellent performance	90-95.99
A-	Approaching excellent performance	85-89
B+	Exceeding good performance	80-84
B	Good performance	75-79
B-	Approaching good performance	70-74
C+	Exceeding satisfactory performance	65-69
C	Satisfactory performance	60-64
C-	Approaching satisfactory performance	57-59
D+	Marginal pass	54-56
D	Minimal pass	50-53
F	Does not meet course requirements	0-49

Missed Components of Term Work:

All assignments:
Students will incur a 5% per day late deduction for submission past the deadline. 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.

Quizzes/Exams:
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.

NOTE: There will be no make-up exams/quizzes. If you miss an exam for a legit reason the weighting of the exam/quiz will be combined with the next exam/quiz or assignment.

Extensions will NOT be granted on any assignment or quizzes in MDSC 408. The only exceptions to this are those in keeping with the University Calendar (debilitating illness, religious conviction, or severe domestic affliction) that are received in writing and with supporting documentation. Traffic jams and late or full buses are common events in Calgary and are NOT acceptable reasons for late arrivals to class,

meetings and examinations. Please note that while absences are permitted for religious reasons, students are responsible for providing advance notice and adhering to other guidelines on this matter, as outlined in the University Calendar (https://www.ucalgary.ca/pubs/calendar/current/e-4.html).

Course Evaluations and Student Feedback
Student feedback will be sought at the end of the course through the Universal Student Rating of Instruction (USRI) and a qualitative student evaluation. Students are welcome to discuss the process and content of the course at any time with the instructor. Students may also address any concerns they may have with Dr. Ebba Kurz, Associate Dean (Undergraduate Health and Science Education) in the Cumming School of Medicine (kurz@ucalgary.ca).

Attendance
Attendance to the laboratories is mandatory and will form part of the lab notebook grade.

Conduct During Lectures
The classroom should be respected as a safe place to share ideas without judgement - a community in which we can all learn from one another. Students are expected to frame their comments and questions to lecturers in respectful and appropriate language, always maintaining sensitivity towards the topic. Students, employees, and academic staff are also expected to demonstrate behaviour in class that promotes and maintains a positive and productive learning environment.

As members of the University community, students, employees and academic staff are expected to demonstrate conduct that is consistent with the University of Calgary Calendar, the Code of Conduct and Non-Academic Misconduct policy and procedures, which can be found at https://www.ucalgary.ca/legal-services/university-policies-procedures.

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

Use of Internet and Electronic Communication Devices in Class
The Bachelor of Health Sciences program aims to create a supportive and respectful learning environment for all students. The use of laptop and mobile devices is acceptable when used in a manner appropriate to the course and classroom activities. However, research studies have found that inappropriate/off-topic use of electronic devices in the classroom negatively affects the learning of others during class time.

Students are responsible for being aware of the University's Internet and email use policy, which can be found at https://www.ucalgary.ca/policies/files/policies/electronic-communications-policy.pdf .

UNIVERSITY OF CALGARY POLICIES AND SUPPORTS

Copyright
All students are required to reach the University of Calgary policy on Acceptable Use of Material Protected by Copyright (https://www.ucalgary.ca/policies/files/policies/acceptable-use-of-material-protected-by-copyright-policy.pdf) and requirements of the Copyright Act (https://laws-lois.justice.gc.ca/eng/acts/C-42/index.html) to ensure they are aware of the consequences of unauthorized sharing of course materials (including instructor notes, electronic versions of textbooks,

etc.). Students who use material protected by copyright in violation of this policy may be disciplined under the Non-Academic Misconduct Policy https://www.ucalgary.ca/pubs/calendar/current/k.html.

Instructor Intellectual Property
Course materials created by instructors (including course outlines, presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the instructor. 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
It is the student's responsibility to request academic accommodations according to the University policies and procedures listed below. The Student Accommodations policy is available at https://ucalgary.ca/student-services/access/prospective-students/academic-accommodations. Students needing an accommodation based on disability or medical concerns should contact Student Accessibility Services (SAS) 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.pdf). SAS will process the request and issue letters of accommodations to instructors. For additional information on support services and accommodations for students with disabilities, visit www.ucalgary.ca/access/ .

Students who require an accommodation in relation to their coursework based on a protected ground other than disability should communicate this need in writing to Dr. Ebba Kurz (kurz@ucalgary.ca), Associate Dean (Undergraduate Health and Science Education).

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.

Academic Misconduct refers to student behaviour that compromises proper assessment of a student's academic activities and includes (but is not limited to): cheating, fabrication, falsification, plagiarism, unauthorized assistance, failure to comply with an instructor's expectations regarding conduct required of students completing academic assessments in their courses, and failure to comply with exam regulations applied by the Registrar. **It also includes using of third party websites/services to access past/current course material, essay/assignment writing services, or real-time assistance in completing assessments, seeking answers to assessment questions and similar, whether paid, bartered or unpaid.**

For information of the Student Academic Misconduct Policy and Procedures, please visit;
https://ucalgary.ca/policies/files/policies/student-academic-misconduct-policy.pdf
https://ucalgary.ca/policies/files/policies/student-academic-misconduct-procedure.pdf

Additional information is available on the Academic Integrity website at: https://ucalgary.ca/student-services/student-success/learning/academic-integrity.

Recording of Lectures
Audio or video recording of lectures (or similar) is prohibited except where explicit permission has been received from the instructor.

Freedom of Information and Protection of Privacy Act
Student information will be collected in accordance with typical (or usual) classroom practice. Students' assignments will be accessible only by the authorized course faculty. Private information related to the individual student is treated with the utmost regard by the faculty at the University of Calgary

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 10 business days** of first being notified of the grade. https://www.ucalgary.ca/pubs/calendar/current/i-2.html

Sexual and Gender-Based Violence Policy
The University recognizes that all members of the University Community should be able to learn, work, teach and live in an environment where they are free from harassment, discrimination, and violence. The University of Calgary's sexual violence policy guides us in how we respond to incidents of sexual violence, including supports available to those who have experienced or witnessed sexual violence, or those who are alleged to have committed sexual violence. It provides clear response procedures and timelines, defines complex concepts, and addresses incidents that occur off-campus in certain circumstances. Please see the policy available at https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf

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/
Student Advocacy and Wellness Hub (CSM)
          https://cumming.ucalgary.ca/student-advocacy-wellness-hub/home
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 (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

BHSc Student Faculty Liaison Committee (SFLC)
The BHSc SFLC, with elected representatives from all majors, serves to raise issues of interest to BHSc students to the program administration, including items pertaining to curriculum, scheduling and events. A list of current representatives can be found on the BHSc website.

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 medrep1@su.ucalgary.ca or medrep2@su.ucalgary.ca.

Student Success Centre
The Student Success Centre provides services and programs to ensure students can make the most of their time at the University of Calgary. Our advisors, learning support staff, and writing support staff assist students in enhancing their skills and achieving their academic goals. They provide tailored learning support and advising programs, as well as one-on-one services, free of charge to all undergraduate and graduate students. For more information visit: https://www.ucalgary.ca/student-services/student-success

Emergency Evacuation/Assembly Points
As part of the University of Calgary Emergency Evacuation plan, students, faculty, and staff should locate the closest Assembly Point in case of Fire Alarm. Safety signage is posted throughout the campus showing the locations and the possible route to these locations. All students, faculty, and staff are expected to promptly make their way to the nearest Assembly Point if the Fire Alarm is activated. No one is to return into campus facilities until an all clear is given to the warden in charge of the Assembly Area. For more information, see https://www.ucalgary.ca/emergencyplan/building-evacuation/assembly-points

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, associated readings, and exam 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 Brightspace(D2L) announcements. The exam dates are firm and will not be altered.

Date	Group A	Group B
Tuesday September 6	Course introduction GFP lecture PCR lecture Lab safety	Course introduction GFP lecture PCR lecture Lab safety
Thursday September 8	MB 1 PCR, SOE-PCR **HSC O1500** Lab 1: pipetting, plates, basic PCR	Lecture 1 BINF BLAST Sequence Databases BINF: Tutorial **HSC O1501**
Tuesday September 13	MB 2 Cloning I: Restriction enzymes **HSC O1500** Lab 2: gel and SOE PCR#1	Lecture 2 BINF Alignments PCR Primer design BINF: Tutorial **HSC O1501**
Thursday September 15	Lecture 1 BINF BLAST Sequence Databases **HSC O1501** BINF: Tutorial	MB 1 PCR, SOE-PCR **HSC O1500** Lab 1: pipetting, plates, basic PCR
Tuesday September 20	Lecture 2 BINF Alignments PCR Primer design **HSC O1501** BINF: Tutorial	MB 2 Cloning I: Restriction enzymes **HSC O1500** Lab 2: gel and SOE PCR#1
Thursday September 22	MB 3 Cloning II Plasmids **HSC O1500** Lab 3: gel, gel extraction and SOE PCR #2	Lecture 3 BINF Cloning and SOE PCR Assignment **HSC O1501** Tutorial
Tuesday September 27	MB 4 Cloning III TA cloning, Gibson Assembly **HSC O1500** Lab 4: gel, gel extraction, quantification	BINF Tutorial: Cloning and SOE PCR assignment
Thursday September 29	Lecture 3 BINF: **HSC O1501**	MB 3 Cloning II Plasmids **HSC O1500**

	Cloning and SOE PCR Assignment Tutorial	Lab 3: gel, gel extraction and SOE PCR #2
Friday September 30	**National Day for Truth and Reconciliation (No class)**	
Tuesday October 4	BINF Tutorial Cloning and SOE PCR assignment **Online**	MB 4 Cloning III TA cloning, Gibson Assembly **HSC O1500** Lab 4: gel, gel extraction, quantification
Thursday October 6	**QUIZ #1 Q&A**	**QUIZ #1 Q&A**
Tuesday October 11	**QUIZ #1 O1500/O1501/BHSc labs**	**QUIZ #1 O1500/O1501/BHSc labs**
Thursday October 13	MB 5 Transformation **HSC O1500** Lab 5: restriction digest and ligation	Lecture 4 BINF: Protein structure and modeling **HSC O1501** Tutorial
Tuesday October 18	(no lecture) Lab 6: transformation	BINF tutorial: Protein structure and Modeling
Thursday October 20	MB 6 Protein expression/purification **HSC O1500** Lab 7: Plasmid prep, digest and gel to check insert	BINF Tutorial: Protein structure and Modeling
Tuesday October 25	Lecture 4 BINF: Protein Structure and modeling **HSC O1501** Tutorial	MB 5 Transformation **HSC O1500** Lab 5: restriction digest and ligation
Thursday October 27	BINF tutorial: Protein structure and Modeling	(no lecture) Lab 6: transformation
Tuesday November 1	BINF Tutorial: Protein structure and Modeling	MB 6 Protein expression/purification **HSC O1500** Lab 7: Plasmid prep, digest and gel to check insert
Thursday November 3	(no lecture) Lab 8: Protein purification make SDS-PAGE gels	Lecture 5 BINF: Alignments and Phylogenetics and Modeling Tutorial

November 6-November 12	Term Break (No Class)	Term Break (No Class)
Tuesday November 15	MB 7 Protein analysis/gel electrophoresis methods **HSC O1500** Lab 9: SDS-PAGE gels, coomassie stain	BINF tutorial: Alignments and Phylogenetics and Modeling
Thursday November 17	MB 8 Reporters again & synthetic biology **HSC O1500** Lab 10: analyze gels.	BINF tutorial: Alignments and Phylogenetics and Modeling Exercise
Tuesday November 22	Lecture 5 BINF: Alignments and Phylogenetics **HSC O1501** Tutorial	(no lecture) Lab 8: Protein purification make SDS-PAGE gels
Thursday November 24	BINF Tutorial: Alignments and Phylogenetics and Modeling	MB 7 Protein analysis/gel electrophoresis methods **HSC O1500** Lab 9: SDS-PAGE gels, Coomassie stain
Tuesday November 29	BINF Tutorial: Alignments and Phylogenetics and Modeling	MB 8 Reporters again & synthetic biology **HSC O1500** Lab 10: analyze gels.
Thursday December 1	**QUIZ #2 Q&A**	**QUIZ #2 Q&A**
Tuesday December 6	**QUIZ #2 O1500/O1501/BHSc Labs**	**QUIZ #2 O1500/O1501/BHSc Labs**