UNIVERSITY OF SASKATCHEWAN

COURSE SYLLABUS

COURSE TITLE:	Biology 421.3 – Functional Genomics		
COURSE CODE:	30579	TERM:	T2 2015/16
COURSE CREDITS:	3.0	DELIVERY:	Practicum (Lab)
CLASS SECTION:	01	START DATE:	January 7th 2016
CLASS LOCATION:	Biology 227	LAB LOCATION:	
CLASS TIME:	1:30 to 4:30 Thursday and Friday		
WEBSITE:	via Blackboard		

Course Description

A practical course that will provide students with the background, experience and understanding of modern molecular biology as it pertains to the biological sciences. Emphasis will be placed on utilizing large, publically available datasets to generate and test hypotheses about how organisms function at the molecular level. A single research theme will be used in the lab for investigation of biological processes in model organisms, extending into non-model species.

Prerequisite: BIOL 316 or BIOC 311 or MCIM 391 and permission of the instructor; BIOL 301 is recommended

Learning Outcomes

By the completion of this course, students will be expected to:

1. access and interpret publically available genomic datasets
2. conduct basic molecular experiments in a laboratory setting, maintain accurate records, interpret and communicate the results.
3. integrate and correctly attribute ideas from published scientific sources in their work.
4. design, carry out, and interpret one or more experiments of their own based on a hypothesis generated from public datasets in collaboration with the instructor.
5. demonstrate and convey these principles in a format and style appropriate for the field.

Note: The University of Saskatchewan Learning Charter is intended to define aspirations about the learning experience that the University aims to provide, and the roles to be played in realizing these aspirations by students, instructors and the institution. A copy of the Learning Charter can be found at: http://www.usask.ca/university_secretary/LearningCharter.pdf

More information on the Academic Courses Policy on course delivery, examinations and assessment of student learning can be found at: http://www.usask.ca/university_secretary/council/academiccourses.php

Course Overview

Virtually all aspects of biology are being impacted by the availability and increased sophistication of genomic advances. Various –omics technologies generate large data sets that allow researchers to investigate global changes in metabolites, proteins, gene expression and genome structure. This has provided a wealth of data that can be correlated at the systems level, providing biological insight, but that also can be used to generate and test models and hypotheses about the molecular mechanisms behind biological processes. Functional genomics is complimentary to systems biology, focusing on post-sequencing genomic data and describing interactions and other active regulatory processes governing nucleic acid and protein functions. This course aims to open students to these experimental possibilities through practical experiments around a central theme. In this offering, we will be using Arabidopsis thaliana as our model species and learning how to form and test hypotheses about how this organism functions at the molecular level. We will be undertaking experiments to characterize two Arabidopsis mutants, looking at ways to integrate web resources with wet-lab verification.

Suggested order of topics

Tentative Schedule of Topics – since this course follows an ongoing research theme, many of the proposed topics are subject to the successful completion of previous weeks' experiments. As such, students should expect the following schedule to vary based on experimental results and the availability of research material and availability of outside resources. Since all experiments do not fit neatly into two, three-hour lab periods, students should expect some time to be spent in the lab outside of scheduled class times.

Week	Proposed Topics
Week 1	Introduction and overview, Lab Safety, importance of lab notebooks, course objectives and evaluation
Week 2	Using large datasets to address biological problems Overview of –omics and relationship to functional genomics. Accuracy & sensitivity in molecular biology applications. Using genomic resources for prediction vs. verification Access public graphic interface of microarray data (i.e. Biological Array Resource, Genevestigator) and identify Arabidopsis genes highly expressed under specific experimental treatment (e.g. light-, cold-, or phytohormone-induced genes) . Access organismal database (TAIR) to research gene(s) of interest, identify T-DNA insertion mutants.

Week 3	Practical applications of PCR
	Tools for primer design
	Genomic DNA preps of mutant and wild-type Arabidopsis seedlings, agarose gel electrophoresis
	Identify homozygous insertion mutants using 2- and 3-primer PCR of genomic DNA isolated in Week 2
Week 4	RNA and cDNA: generating cDNA, from cDNA libraries and ESTs to modern transcriptome analysis and verification of large data sets
	RNA isolation and quantification from mutant seedlings, cDNA synthesis & RT-PCR
Week 5	Cloning. Brief history of cloning methods, library design & screening, PCR-based cloning in organisms with and without sequenced genomes
	Ligation of amplified cDNA and Transformation of E. coli from week 4
	Fast Minipreps & Restriction analysis (alternatively, colony PCR)
Weeks 6 & 7	Sequence analysis, expression vectors, shuttle vectors, transformation vectors and other applications
	Using sequence analysis software. Alignment vs. assembly
	Design strategy for (one or more of) promoter::reporter construct, protein-GFP fusion, His-tagged protein (or other epitope tag), heterologous expression in other organisms
	Subcloning open reading frame into yeast expression vector and yeast transformation using PCR-based approach (homologous recombination)
	Generating C-terminal His-tagged constructs using restriction enzyme-based cloning, transformation into E. coli

Week 8	Expressing genes in heterologous hosts, functional complementation, generating transgenic organisms
	Preparation of media for functional complementation of a yeast mutant with a plant protein in *S. cerevisiae*; set up to monitor growth in wild-type and mutant yeast strains over the week
	Plasmid minipreps and digests of His-tagged constructs
	Transformation of yeast and/or Agrobacterium
Weeks 9 & 10	Recombinant Protein Expression – techniques and applications
	Measuring Proteins: Abundance, Activity, Interactions (When and why to use western blotting, ELISA, Immunoprecipitation, EMSA)
	Induction and purification of His-tagged proteins by immobilized metal affinity chromatography
	Separation of proteins by SDS-PAGE
Weeks 9 & 10	Protein extraction from plant tissue, quantification of crude extract (Lowry/Bradford/BCA assay)
	Western transfer and immunodetection
Week 11 -	Absolute or relative abundance in measuring gene expression. Hybridization vs. amplification in detecting transcript abundance
	RNA isolation and cDNA synthesis
	qRT-PCR, gene amplification from 'non-model' species
Week 12	Where and when is my gene expressed? Where are the products? (OPTIONAL based on term scheduling; transgenic material provided to students and completed with the assistance of the Biology microscope technician in the Biology Microscope Suite)
	Analysis of Promoter::GUS, Promoter::GFP or GFP fusion proteins to address timing of expression, comparing to the online eFP browser
	Predicted protein localization using prediction programs (Psort, Mitopred, predotar) and confirmation in transgenic Arabidopsis

Weeks 12 & 13	Wrap up & Testing Student Hypotheses. During the term students will be encouraged to use online resources to come up with a simple hypothesis, based on publically available data, and easily testable using one of these techniques (a western blot, or RT-PCR for example). Over the course of the term they will interact with the instructor and TA to refine the experimental design and set up the experiment so that the analysis can be completed in the last week or two of class.

Last day to withdraw from course without academic penalty is Tuesday March 15th 2016.

Instructors

Contact Information:

Dr. Christopher Todd Instructor	Room 143 Biology Building	chris.todd@usask.ca
Maryam Nourimand Teaching Assistant		m.nourimand@usask.ca

Resource Material

All course materials and standard operating procedures will be posted to the course Blackboard site

Grading Scheme

Maintaining Lab Notebooks	10%
In-lab quizzes and assignments	15%
Laboratory Performance	20%
Individual Experiments	20%
Term Paper	35%
Total	100%

Evaluation Components

Maintaining Lab Notebooks:

Value: 10% of final course grade
Date: TBD
Length: N/A
Format: N/A
Description: Lab notebooks will be collected and evaluated twice during the term. Students will be provided feedback.

Quizzes and assignments:

Value: 15% of final course grade
Date: Varying throughout the term
Length: varies
Format: short answer written questions, short take-home assignments
Description: Short in lab quizzes and take-home assignments geared towards evaluating students' understanding of core concepts and lab techniques.

Laboratory performance

Value: 20% of final course grade, 10% each six-week period
Date: After week six and at end of term
Format: direct feedback on perceived in-class performance from the instructor(s)
Description: Lab performance will not be based on getting the "correct" results, but on ability to follow protocols, work independently/in teams, initiative, and group discussion. Perceived performance and suggestions for improvement will be documented and communicated to students after week six.

Individual Experiments:

Value: 20% of final course grade. (10% documented experimental design and activity; 10% short interpretation and write-up)
Date: Continuing throughout the term
Description: Students will design and carry out individual experiments using one or more lab techniques learned during the term. Students will submit an initial hypothesis and design and will be provided feedback and opportunity to address any potential problems before carrying out the experiment. A short (1-2 page) write up will be submitted for feedback from the instructor prior to inclusion of the final draft in the Term Paper.

Term Paper:

Value: 35% of final course grade,
Date: TBD; after the end of classes, but before the end of the exam period
Description: Summative research paper addressing the entire lab component of the course written as a short research paper

Note: There is no final exam in BIOL 421

University of Saskatchewan Grading System

Students are reminded that the University has established a grading system to be used in all of its courses. Information on literal descriptors for grading at the University of Saskatchewan (reproduced below) can be found at: http://students.usask.ca/current/academics/grades/grading-system.php

Scheduling of Exams

Students must bring their current University of Saskatchewan student card to all exams and be prepared to present it for verification purposes. Entry into certain campus buildings where exams may be held, also requires a valid student card.

It is forbidden for students to utilize in any way during an exam, any electronic device (e.g., cell phone, dictionary, palm pilot, translator, etc.). This includes calculators because these are not required for any exam.

Midterm and final examinations, and the lab exam, must be written on the date scheduled. Final examinations may be scheduled at any time during the examination period in December 2013; students should therefore avoid making prior travel, employment, or other commitments for this period.

In the event that a student is absent from the **midterm exam** through no fault of his/her own due to a medical emergency, death in the family, or other valid reasons, documentation must be provided explaining the absence, to assist in the determination of whether permission will be granted for the student to write a deferred mid-term exam. Students absent for the Mid-Term Lecture Exam **must advise their Instructor in person or by telephone (not by email) and initiate arrangements for writing a Deferred Mid-Term Exam, within 3 working days of the missed exam**, in order to avoid being assigned a grade of zero for the exam.

If a student is absent from the **final exam** through no fault of his or her own for medical or any other valid reason, **he/she must apply to the Dean's Office of the College in which he/she is registered for an opportunity to write a Deferred Final Exam**, **within 3 working days of the missed exam**. Documentation must also be provided to explain the absence from the final exam. Deferred exams may utilize a different format than the regular exam, at the sole discretion of the instructors.

Students are encouraged to review all examination policies and procedures:
http://www.usask.ca/calendar/exams&grades/examregs/

Student Feedback

Lab report feedback will usually be available within one week. Midterm and final exam grades will be communicated via the course Blackboard site and exams will be available for student review by appointment. Grades for oral reports will be generated through a combination of instructor and peer evaluation of performance

Attendance Expectations for Laboratory Classes

Since this is a practical class, attendance every week is required for students to meet the course objectives. If you are unable to attend due to illness or emergency we will make a reasonable effort to allow students to complete the week's experiment or to provide you with data and materials to continue working the following week. Attendance and participation will be reflected in the "Laboratory Performance" portion of your final grade.

Integrity Defined (from the Office of the University Secretary)

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behavior that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct (http://www.usask.ca/university_secretary/honesty/StudentAcademicMisconduct.pdf) as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals (http://www.usask.ca/university_secretary/honesty/StudentNon-AcademicMisconduct2012.pdf)

For more information on what academic integrity means for students see the Student Conduct & Appeals section of the University Secretary Website at: http://www.usask.ca/university_secretary/pdf/dishonesty_info_sheet.pdf

Examinations with Disability Services for Students (DSS)

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Disability Services for Students (DSS) if they have not already done so. Students who suspect they may have disabilities should contact DSS for advice and referrals. In order to access DSS programs and supports, students must follow DSS policy and procedures. For more information, check http://www.students.usask.ca/disability/, or contact DSS at 966-7273 or dss@usask.ca.

Students registered with DSS may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through DSS by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by DSS.

Prepared by Christopher Todd