BIOT*6550 Biodiversity and biotechnology [0.5]

Biodiversity spans a variety of hierarchical levels (e.g. genes, populations, species, communities) and spatial scales of organization. Biotechnology both enhances our understanding of this diversity and uses it as a substrate for a variety of wide-ranging biotechnological applications. Notably, DNA sequencing has revealed entire new domains of life and is routinely used to identify species, while next-generation sequencing can probe whole genomes and even community assemblages. Understanding species diversity and community interactions can help support crop health and agricultural productivity, while knowledge of microbial communities has applications in human health and industrial fermentation processes (e.g. beer and wine industries). In this course we will explore the DNA-based approaches used to characterize and analyse biodiversity followed by discussions of the biological concepts that define diversity within biological communities to investigate its impact on biotechnological applications.

BIOT*6550 consists of three modules. Lecture-based content will provide theoretical information on the biodiversity and interactions within biological systems with a focus on biotechnological application. Secondly, critical readings will be assigned for in-depth class discussions culminating in written assignments and student presentations of specific concepts. Finally, one practical project will be used to evaluate the theoretical knowledge discussed in class in the context of a specific biotechnological application.

Lectures: 2x 80-minute lectures per week (Tue/Thu 1:00-2:20 pm)

Location: SSC 3317 (*Except for January 25th – SSC 3513*)

Instructors: Drs. Robert Hanner and George van der Merwe

I. Specific learning objectives:

Successful students will undertake an advanced critical analysis of current research literature in molecular biology and biodiversity to identify the best approaches for a specific applied research goal, gaining foundational knowledge of biotechnology and biodiversity. They will understand the context in which biodiversity contributes to biotechnological applications that are globally competitive, and demonstrate a high degree of professional literacy in the process. By the end of the course successful students will have addressed six key learning objectives:

1. Depth and Breadth of Knowledge: achieved through traditional lectures and self-directed enquiry culminating in a literature review pertaining to a focal area of student interest.
2. Scientific Methodology: achieved through critical readings of the literature.
3. Specific Methodology: achieved through learner-centered discussions involving case studies presented in class.
4. Communication: achieved through oral presentations (of proposed project topic, literature review, journal article presentation and final project presentation) and written assignments (literature review, peer reviews, final project summary).

5. Professionalism: achieved through feedback from faculty and fellow students on both oral and written presentations.
6. Advancement of Science: achieved through participation in the peer review process, where students will provide written critiques on the work of their peers.

II. Course Structure:

A schedule of dates will be discussed in class and provided on CourseLink

Module 1 (3 weeks): Molecular Biodiversity

In-class lectures on DNA-based approaches for characterizing biodiversity (prokaryotes, eukaryotes and tools of the trade), considering the targeted development of biological diversity with a focus on application and innovation. Key reading assignments are drawn from the primary literature.

Topics

1) Biodiversity: genes to ecosystems
    a. From biochemical systematics to DNA taxonomy and molecular phylogenetics
    b. Biodiversity thru a genomic "macroscope"
    Key concepts: micro vs macro evolution (e.g. genes/populations evolve, species evolve); tools for analyses
2) Population Genomics and the morphology of the genome
    Our first real view of species?
    Key concepts: mutation, gene flow/migration, natural selection and random genetic drift; tools for analyses
3) What is the basic unit of Life?
    How many genomes does it take to make an organism
    Key concepts: community organization/structure (e.g. niches, symbiosis); tools for analyses

Students will select a specific topic of interest with a biotechnological application to investigate during the course of the semester.

Assignment 1: Select a topic and submit a written abstract on this this topic. This topic will be presented to the class in a short presentation (5 minutes) to the class. Both will be posted on CourseLink.

Peer evaluation 1: Each abstract and presentation will be assigned two students and one faculty member for evaluation. Peer reviews will also be evaluated.

Module 2 (3 weeks): Functional Organization

In-class lectures on gene evolution & genetic adaptation within biological niches. Genetic engineering vs. selection and genomic adaptation (domestication) will also be discussed. Key reading assignments are drawn from the primary literature.

Topics

1) Gene duplication as a force in evolution
   Flexibility for natural selection and gene function adaptation (several examples: plants and yeast; *S. cerevisiae* whole genome duplication; functional development and diversification of genes
2) Genetic adaptation
   a. Gain- and loss of function alleles
   b. Adaptation to environmental impacts – Domestication
      Context – beer/fermentation industry
   c. Identification of alleles responsible for evolved traits
      Single gene vs. polygenic traits; Methods of identification

Assignment 2: Summary presentation of a key paper from the primary literature pertaining to their selected project topic. Submission of a literature review that underpin their proposed final report.

Peer review 2: 2 students + 1 faculty/presentation.

Module 3 (6 weeks): Gene Evolution and Targeted Development

In-class lectures on the impact of biological communities and interactions within biotechnological application(s). Group discussions on evaluating the benefits and limitations of microbial systems in different biotechnological settings. Examples include, but are not limited to microbial diversity in the production of alcoholic beverages, probiotics and the human microbiome.

1) Identification & Characterization of population diversity
   a. Isolation, identification and and characterization of organisms
      i. Physical isolation (enrichment [or selection] for specific microbial species – growth enrichment)
      ii. Genomic-based strategies
      iii. Applications: examples in food production (spoilage/safety – detection of organisms; sensitive detection methods)
2) Product development and innovation through diversity
   a. Multiple species involved in product development
      i. Crop development (symbiosis)
      ii. Mixed cultures in fermentation process [wine and beer]
3) Process evaluation and analysis

Assignment 3: Final paper presentation

Peer review 3: 2 students + 1 faculty/presentation

Practicum report due

III. <u>Course evaluation:</u>

	Final weight	Learning outcomes
Written assignment	50%	1-4
Topic proposal 10%		
Lit review 15%		
Final report 25%		
Presentations	30%	4-5
Topic proposal 10%		
Journal article 10%		
Final presentation 10%		
Peer review & Practicum (10% each)	20%	1-6

The schedule of due dates for the assignments, presentations and peer review outline below, will be discussed in class and provided on CourseLink.

Written assignment(s): Students will be required to write a literature review on a selected topic of interest to the student and relevant to the course. It will be submitted and graded in stages (to promote early feedback from faculty), beginning with the topic proposal, followed by the literature review and culminating with the final report. The review should provide an overview of the specific scientific concept(s) covered in the assigned reading, area(s) of development needed, and a critical assessment of the (potential) biotechnological application(s) of this technology. The final written assignments should be no longer than 10 pages (1.5 line spacing; 12 point font), not including any figures, and supported by a minimum of 20-30 references. Assignments will be uploaded to CourseLink and the final report will be subjected to anonymous peer review by two classmates prior to its submission for instructor evaluation at the end of the course.

Presentations: Students will prepare and deliver three presentations relating to their written assignment. The objective is to provide a topic overview and discuss a key paper in the field, and finally, to summarize the impact on or relationship to biotechnology. They will be followed by a short (e.g. 3-5 minute) discussion/question period. Presentations will follow typical conference guidelines and will be uploaded to CourseLink.

Peer Review: Students will engage in the peer review process to evaluate the oral and written submissions of two other students in the class. The course instructors will evaluate the peer review comments of the *students-as-reviewers*, which will contribute 10% to their final grade.

Practicum: Students will undertake group work and prepare a group report on their attempts to characterize the impacts of yeast diversity of product development and innovation during beer production.

IV. Course Policies:

Deferrals policy:
Only medical or compassionate accommodations will be granted a deferred examination. Documentation is required within 1 week following the exam.

E-mail Communication
As per university regulations, all students are required to check their <mail.uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

When You Cannot Meet a Course Requirement
When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the undergraduate calendar for information on regulations and procedures for Academic Consideration: Academic Consideration

Drop Date
The last date to drop one-semester courses, without academic penalty, is the 40th class day. To confirm the actual date please see the schedule of dates in the Undergraduate Calendar. For regulations and procedures for Dropping Courses, see the Graduate Calendar.

Copies of out-of-class assignments
Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Accessibility
The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Centre for Students with Disabilities as soon as possible.
For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: Centre for Students with Disabilities

Academic Misconduct
The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor. The Academic Misconduct Policy is detailed in the Academic Calendar: Academic Misconduct

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: **Academic Calendars**