January 7, 2016

University of Guelph
College of Biological Science
Dept. Molecular and Cellular Biology
COURSE OUTLINE

Microbial Ecology MICR*4280
W16

Course description: (3-0) [0.50]
This course is a study of natural microbial communities: their structure, function and the factors that impact them. The topics include standard and new techniques that are being developed for analyzing microbial communities, current research on microbial ecology of the ocean, the terrestrial and the human ecosystems, Gaia theory, astrobiology and the role of microbes in the evolution of life on Earth. This course covers the metagenomic approach and how it impacts the current view of the diversity of uncultured microbes in the biosphere, and the biochemical basis for extremophile survival and the application of this knowledge on protein structure-function relationships and biotechnology. Department of Molecular and Cellular Biology.
Prerequisite(s): (MBG*2020 or MBG*2040), (MICR*2030 or MICR*2430). MBG*3350 is strongly recommended.

Teaching Team:
Course Instructor: *Dr. Wendy J. Keenleyside*
SCIE 3506, Department of Molecular and Cellular Biology, College of Biological Sciences. (519) 824-4120 Ext. 53813.
Office hours: tba or by appointment
Online: using open chat on Courselink, prior to the 2 quizzes and final exam.
Guest lecturers: 1. *Dr. Josh Neufeld, University of Waterloo – date & topic TBA*
https://uwaterloo.ca/neufeld-research-group/
2. *Christian Carlucci, Ph.D. candidate in Allen-Vercoe lab - early March*
"Characterizing the effects of microbial ecosystem therapeutics (MET) on Clostridium difficile virulence"
http://www.uoguelph.ca/mcb/people/faculty/faculty_allen-vercoe.shtml
3. *Kaitlyn Oliphant, Ph.D. candidate in Allen-Vercoe lab – early March*
4. *1 other possible – date & topic TBA*

Course Schedule:
Lectures: M/W/F 10:30-11:20 AM; **SSC3317**
- **Wed. Jan. 20 lecture tentatively scheduled in CBS computer lab**

Learning Outcomes:
The learning outcomes for this course are those concepts and abilities that will be assessed through the various graded components of the course. They are subject to modification (deletion and addition, the latter arising from the incorporation of guest lectures or newly published and relevant papers) and will be updated and posted accordingly. These are broken down by major course topics however course readings, class discussions and term

project will also further develop the broader MCB Program Learning Outcomes (MCB Learning Outcomes) and the University of Guelph learning outcomes (UofG Learning Outcomes).

A. The field of microbial ecology, its evolution, Gaia, Daisyworld and microbial community ecology.

By the end of this course, successful students should be able to:

1. a) Describe the major contribution(s) to microbial ecology made by Carl Woese, Kary Mullis, Martinus Beijerinck, Sergei Winogradsky and Rachel Carsen. b) Explain the reason for the large time lapses in the periods between the various contributions of these researchers.
2. a) Describe the connection between "biogeochemistry" and environmental microbiology; b) explain the driving forces for research in the discipline of biogeochemistry and how the *Anthropocene* relates to microbial ecology studies.
3. a) Explain, with examples, the critical roles of the bacteria and archaea, in biogeochemical cycling specifically, and in general, as the biological infrastructure of the planet. b) Using thermodynamic terms, describe the specific biogeochemical transformations catalyzed by the heterotrophs, autotrophs, lithotrophs, methanogens and other anaerobes; c) Distinguish *dissimilatory reduction* and *asymmilatory reduction,* giving examples of each (these concepts are all largely review from MICR2030/MICR2430)
4. a) Compare and contrast the basic *distinguishing features* of the lithotrophs, the oxygenic and anoxygenic phototrophs, heterotrophs and the bacteria and archaea that perform anaerobic respiration (also a review of MICR2030/2430); b) Explain, using thermodynamic principles, the hierarchy of utilization of electron donors and acceptors by the bacteria and archaea.
5. Describe the importance and roles of viruses, **and of horizontal gene transfer**, to microbial ecology and ecosystem structure/function.
6. a) Describe the processes or phenomena that help determine microbial community structure; b) discuss the characteristics of a "complex" community, and using specific examples, why complex communities are generally healthier than simpler communities.
7. Compare and contrast the (microbial) ecology concepts of a) "population" vs. "ecosystem" and b) "community" vs "ecosystem"
8. Discuss, with specific reference to the literature, a) the value of SSU rDNA in bacterial and archaeal phylogeny, b) the controversy about whether bacteria and archaea can actually be identified to the "species" level.
9. a) Provide the historical context in which Lovelock first came to propose the Gaia hypothesis; b) explain the connections between the second law of thermodynamics, the Martian and terran atmospheres with the Gaia hypothesis.
10. a) Discuss the controversies over the Gaia hypothesis, and how the revised "Gaia Theory" addresses at least some of these; b) Explain Lynn Margulis' contribution to Gaia theory; c) Describe Gaia Theory and being relatively un-falsifiable, provide an argument for or against, the value of Gaia Theory.
11. a) Describe how and why Lovelock came to propose the "DaisyWorld" model, and how the work by Wood and Coe (2007) validated a modified Daisyworld model; c) Discuss the connection between Gaian homeostasis, the modern synthesis

(Darwinian evolution) and the maximum entropy principle.

12. Compare the perspective of Rachel Carson's view with respect to the environment and Lovelock's perspective, as expressed by his Gaia Theory

B. Technologies and strategies used in the study of microbial communities and microbial diversity

By the end of this course, successful students should be able to:

1. a) Describe the major questions addressed by microbial ecology studies, and why the answers to those questions are so important; b) Propose culture dependent and culture-independent methods of addressing those questions.
2. Explain why microbial ecology studies require multidisciplinary approaches and a combination of "top-down" (starting from the environment) and "bottom-up" (starting with the cell) approaches to provide real understanding.
3. a) Explain some of the underlying causes for our inability to culture the majority of Earth's microbes, including the recently proposed "Scout Hypothesis" and for this hypothesis, the evidence in support of the underlying phenomenon. b) provide some reasons for continuing efforts in axenic cultivation; c) define axenic culture and describe the classical microbiological approach of obtaining an axenic culture from an environmental sample and d) compare this to *in situ* cultivation (including describing what that involves) and the iChip.
4. Describe the limitations of metagenomic SSU rDNA analyses to characterize microbial communities.
5. Compare and contrast microcosms and mesocosms and describe, using a specific example, how a chemostat can be used as a microcosm.
6. a) Discuss the problems associated with using gene libraries and Sanger sequencing to determine a genome sequence, and how the 3 next generation approaches (454, Illumina & Ion Torrent/Ion Proton) overcome these problems; b) Discuss the advantages and disadvantages of these 3 next-gen sequencing systems.
7. Describe how DNA sequence data is analyzed and the bioinformatics challenges created by metagenomic surveys.
8. a) For each of the following, identify which would NOT be required if determining an organism's genome sequence using 454 Technologies instead of the traditional Sanger sequencing approach: i) restriction digestion, ii) cloning, iii) fluorescently-labeled nucleotides, iv) primer walking, v) assembly of contigs, vi) identification of potential *orfs*, vii) BLAST analyses, viii) generation of doubled-stranded sequence. b) For those that are NOT required, explain why.
9. Describe bacterial artificial chromosomes (BACs) and, provide a hypothetical or specific example of how BAC or large insert cloning of metagenomic DNA provides/provided valuable insights in some aspect of microbial ecology.
10. a) Define genetic streamlining/genome reduction; b) Discuss, with specific examples, how oligotrophy might give rise to selective pressure for genetic streamlining/genome reduction; c) Explain how genetic streamlining relates to "ecotypes/ecological phylotypes" and further complicates the "species concept" for bacteria and archaea.
11. a) Compare and contrast bacteriorhodopsin and proteorhodopsin and b) describe, with specific reference to current literature, the theories for their apparent

cosmopolitan distribution and physiological role in the marine environment.

12. a) Discuss the differences between transcriptomics and proteomics and their "meta-" equivalents; b) Propose a strategy for assessing the transcriptome or proteome and discuss the limitations of doing this in a culture-independent way, using environmental samples.
13. Explain how DGE works and identify its advantages and disadvantages over cloning and sequencing SSU rDNA.
14. a) Describe how community structure and function can be determined using a combination of molecular/(meta)genomic and analytical approaches; b) Explain, using specific examples, why microbial communities are best understood using a combination of culture-dependent and culture-independent techniques.
15. a) Explain how DGE works and identify its advantages and disadvantages over cloning and sequencing SSU rDNA; b) Explain why statistical analyses are so critical to doing DGE.
16. Compare and contrast DGE with microarray (i.e. the phylochip) analyses, and FISH.
17. a) Compare and contrast the three types of quantitative PCR: taqman PCR, Sybr Green and digital droplet PCR (ddPCR); b) explain the advantages of these approaches over traditional PCR for quantification; c) identify some specific uses in microbial ecology studies; d) Describe RT-PCR and explain how it differs from "real time" PCR (which some…not YOU…would abbreviate to RT-PCR).
18. a) Describe DNA, RNA and PLFA -stable isotope probing (SIP) techniques and explain why the data they generate needs to be confirmed with alternative techniques; b) At a very basic level, explain how Raman-FISH might provide confirmation of the results of a SIP experiment; c) Propose a DNA-SIP experiment to answer a hypothetical microbial ecology question.
19. Propose a hypothetical situation where any one of the above techniques would be used to answer a microbial ecology question.

C. Microbial ecology and evolution: theories for the origin of life, mapping the tree of life, astrobiology and the extremophiles

By the end of this course, successful students should be able to:

1. a) Provide the connection(s) between exobiology, James Lovelock, astrobiology and microbial ecology; b) Describe the theory of panspermia and identify the relevance of meteorite ALH84001 to this theory.
2. a) Describe the techniques for tracing the very early events in the history of life on Earth. b) Explain why it is easier to trace the more recent events and life forms.
3. a) Describe the various theories for the appearance of the first organics on prebiotic Earth; b) Explain the connection between the Hadean geological era and one or more of these sources of organics; c) Describe the theory of chemical evolution, who proposed the theory and how Urey and Miller's experiments provide experimental evidence for the theory; d) Describe how the theory of "backward evolution" might provide an explanation for the evolution of metabolic diversity in Earth's life forms.
4. a) Explain the connection between the proposed "RNA World" and the evolution of the first life forms, including the prevailing conditions at that time, and the chemical stability/lability of RNA vs DNA; b) Discuss how a modern day ribozyme provides evidence in support of an RNA World.
5. a) Compare the conditions on primordial Earth (~3.8Ga) with those of present day and explain how those primordial conditions were essential to abiogenesis (the

spontaneous evolution of life from non-life); b) Describe the "great oxygenation event", its connection to ancient and modern stromatolites, and the chain of events arising from the event, leading to life on Earth in its present form; c) Explain the scientific evidence of the great oxygenation event and the explanation for the billion year lag between production of oxygen and the event.

6. a) Describe the "faint young sun problem" of primordial earth and how atmospheric CH_4 and CO_2 levels helped protect against the problem; b) Discuss the relevance of these gases to the "great oxygenation event", the current Anthropocene era and, as Lovelock described it, our current "interglacial".
7. a) Beginning with accretion, trace the major events or changes in the evolution of life on Earth, giving approximate time frames; b) For each of the events or changes identified, explain the nature of the evidence.
8. a) Identify the approximate time period during the evolution of the biosphere, that the prokaryotes were believed to be the only life forms and describe what was thought to be happening to them during this time; b) Describe the controversy surrounding the use of the term "prokaryote"; c) Provide the prevailing theory for the vastly greater diversity and distribution of the bacteria and archaea, relative to the eukaryotes.
9. a) Compare and contrast the two major theories for eukaryogenesis (traditional vs "hydrogen hypothesis"), including supporting evidence or in and identify those for which there is relatively strong or convincing evidence; b) Describe the endosymbiont theory, who championed the theory, and the evidence that subsequently proved the Theory; c) Define HGT and EGT and discuss their roles in the evolution of life on Earth.
10. a) Discuss the concept of a Last universal Common Ancestor (LUCA), the reason(s) for its incorporation into the traditional view of the evolution of life on earth and explain how Carl Woese's view of LUCA changed over the course of his career; b) Describe Woese's "pre-Darwinian era" and how that can still explain those processes common to all life; c) Explain what Woese theorized would cause a primordial life form to cross its Darwinian Threshold, what the result would have been for that organism and its incorporation into a phylogenetic tree, why life as we know it did not necessarily arise from a single cell crossing this threshold.
11. a) Discuss the challenges to deriving an accurate Tree of Life (ToL) and Pace's arguments relating to the structure of the ToL, in particular, to the deep branches of the tree; b) What makes SSU RNA the current "gold standard" for tracing the ToL, despite its limitations? c) Describe an alternative to SSU RNA sequencing that might be used to obtain more accurate information about the deep branches of the ToL; d) Explain the statement that ideally, "molecular fossils" would generate a molecular tree that is identical to an organismal tree.
12. a) ***Assuming an accurate ToL***, discuss how deep branches could provide information on the prevailing conditions on primordial Earth; b) Describe the phylogeny of the archaeal domain and how bootstrapping has provided data that the *Euryarchaeota* are **polyphyletic**; c) Describe the various metabolic types found in the *Euryarchaeota* vs the *Crenarchaeota* and explain why the archaeal domain in particular, is populated with **microbial dark matter**; d) Explain the controversy, as Woese describes it, about the term "prokaryote".

13. Draw a ToL that incorporates a preDarwinian era, star radiations for the three domains and the hydrogen hypothesis for eukaryogenesis.
14. Identify the criteria and adaptations for being a psychrophiles, thermophile, and hyperthermophile and provide example organisms; b) Provide example environments in which each would be found; c) describe how studies of the psychrophiles and (hyper)thermophiles relate to the field of astrobiology; d) Describe the lethal effects of failure to adapt to temperature extremes and explain the difference between tolerance to an extreme environmental condition and being an extremophile; e) Discuss potential biotechnological applications arising from the study of adaptation to temperature extremes.
15. Explain why some psychrophiles also halophiles; b) Explain why there no hyperthermophilic phototrophs.
16. Compare and contrast the *Thermotogales* bacteria with *Pyrolobus.* b) Explain why these organisms would be ideal for PLFA-SIP.
17. a) Describe some of the experimental strategies for characterizing the structural basis for heat- and cold-adaptation in orthologous enzymes; b) Discuss the different structural characteristics of thermophilic and psychrophilic enzymes and how these differences provide better stability and/or activity at the T_{opt} for each type of enzyme.
18. Describe how Bae and Phillips studied temperature adaptation in adenylate cyclase, and how their data supported their hypotheses.
19. Define the term "semirational design" as it applies to structural biology and the extremophiles. b) Explain how semirational design was used to change the pH optima of orthologous L-arabinose isomerase enzymes.

D. Microbial communities:

Human gut microbial communities: (this will likely be revised based on content of guest lectures)

By the end of this course, successful students should be able to:

1. a) Explain why can the human GI tract be thought of as another organ. b) Summarize some of what we know about the microbial ecology of the human gut and describe the major challenges to characterizing the microbial ecology of the human gut.
2. a) Explain the concept of "dysbiosis" and how gut dysbiosis can result in disease. b) With a focus on ecological theory re. the importance of biodiversity, explain how antibiotic use can have long-term consequences for the gut microflora and the health of the individual. b) Explain how antibiotic therapy relates to CDI (and define CDI).
3. a) Describe the use of "microbial ecosystem therapeutics" to cure *Clostridium difficile* infections; b) Describe the other methods for treating these infections and why MET represents a possible improvement over those approaches.
4. a) Describe "roboguts", and discuss how it simultaneously represents a microcosm and a chemostat. (b) Explain how would a metagenomic approach could be used to assess roboguts diversity and homeostasis.

Marine microbial communities

By the end of this course, successful students should be able to:

1. a) Explain the pressing need for studying the microbial ecology of the world's oceans and the inherent challenges in doing so; b) Describe the roles of the aerobic and anaerobic heterotrophs, photosynthetic bacteria, lithotrophs and mixotrophs to the marine environment as well as the biosphere.
2. a) Describe the basic conversions in the carbon cycle. b) Describe the relationships between the "biological carbon pump", the "Great acceleration" and the anthropocene; c) Identify the major microbial contributors to the biological carbon pump and identify how they relate to the practice of "ocean iron fertilization" and "artificial ocean upwelling"; d) Explain why it is ironic that i – the Earth System is described in anatomical terms (e.g. by the International Geosphere-Biosphere Programme), and ii) James Lovelock was one of the first proponents of artificial ocean upwelling.
3. a) Describe the connection(s) between heterotrophic respiration, fermentation, methanogenesis and methanotrophy; b) Define syntrophy and explain its connection to methanogenesis; c) Propose a FISH experiment for demonstrating the intimate relationship between syntrophic partners; d) Explain the connection between the phenomena of syntrophy and the "Great Plate Count Anomaly".
4. a) Explain why it is so imperative that the environmental controls on methanogenesis and methanotrophy be determined; b) Discuss the concern regarding methane hydrates and global climate change; c) What are some of the anthropogenic practices that contribute to production of methane?
5. Why is the deep subsea biosphere potentially an important, and vastly unexplored factor in global biogeochemical cycling?
6. a) Discuss, with examples, how next generation sequencing made possible the discovery of the phenomena of i – genome streamlining, ii – the rare biosphere, and iii – mixotrophy, in the world's oceans; b) What are the theories for how or why these phenomena occur, or are relevant?
7. a) Describe the connection between the Sargasso Sea and proteorhodopsin (PR); b) Discuss how recent data on the distribution of PR may call into question modeling of carbon and energy flux in the marine euphotic zones, and how this would relate to Earth System studies.
8. a) Describe the Global Ocean Survey and how and why data from the GOS represents "the tip of the iceberg"; b) Compare and contrast the GOS studies of the JCVI ("J. Craig Venter Institute") with those of Sogin et al.
9. a) Compare and contrast the terms ecotypes, species and operational taxonomic unit; b) Why might one argue that the concept of "species" is problematic with bacteria and archaea?

10. a) Compare and contrast *Pelagibacter ubique* and *Dokdonia* sp. MED134. b) Discuss how the ecophysiological role of PR was examined in the latter, and why the data arising from those studies is not universally applicable to other PR- containing microbes.
11. On what types of observations would it be proposed that HGT was the explanation for the cosmopolitan distribution of PR in marine bacteria?
12. a) Describe some of the factors that would determine microbial community structure in the marine environment; b) Why, in particular, are viruses such key players in marine microbial ecology?
13. a) Explain the term "anthropocene" and how it relates to the microbes. b) Explain the connection between the anthropocene, microbial ecology and some proposed "climate engineering" strategies. c) Describe the potential impact of climate change on the ecology of the Canadian Arctic, bioprospecting, the stability of methane clathrates and the relationship between all of these aspects and the microbes.

E. Scientific method, scientific literacy and core values:

Working in groups, by the end of this course, successful students will:

1. Be able to critically analyse the primary literature, design, justify and communicate through oral and written proposals, a novel and scientifically valid bioremediation project for a known ecological problem.
2. Through open and regular communication between project group members, learn to become an effective research team, and come to understand the difference between group work and teamwork, and the skills inherent in developing an effective team.
3. Demonstrate a good work ethic by setting goals, meeting deadlines and working cooperatively and responsibly with project team members.
4. Reflect upon, develop and articulate, personal values and ethics related to the environment and microbial ecology.

F. Definitions (this list is not inclusive):

By the end of this course, successful students should be able to define:

- Rare biosphere
- Tag sequencing
- PLFA-SIP
- Methanotrophs
- Syntrophy
- Endergonic vs exergonic
- thermodynamic disequilibrium
- maximum entropy principle
- Primary production vs respiration vs fermentation
- The Anthropocene
- The "Great Acceleration"
- Biological carbon pump
- Ocean iron fertilization

- Artificial ocean upwelling
- Climate engineering
- The Earth System
- Gaia *Theory*
- Emergent
- taxonomic (biological) diversity
- functional diversity
- ecosystem stability
- Population vs guild vs community vs ecosystem
- Greenhouse gases
- Methane hydrates
- Earth's faint young sun days
- Bootstrapping
- Nitrification
- Denitrification
- Evolutionary randomization (re. SSU RNA)
- Prokaryote
- OTU/operational taxonomic unit
- Extremozymes
- "Divide and swap" method of generating genetic chimeras
- Semi-rational design
- Deep subseafloor biosphere
- Ocean snow
- Microenvironments
- Oligotrophic vs copiotrophic
- Euphotic zone
- Tag sequencing
- Comparative genomics and genome streamlining
- Ecotypes
- Proteorhodopsin and mixotrophy
- Tetraether lipids
- Global ocean survey
- Agents of mortality
- Axenic culture and extant organism
- horizontal gene transfer
- community metagenome
- *in situ* cultivation & iChip
- Scout hypothesis

G. *Microorganisms (this list is not inclusive):*
By the end of the semester, the student should be able to describe the relevance of the following to microbial ecology:
- *Bacillus psychrophilus*
- *Thermotogales bacteria*

- *Psychromonas bacterial spp.*
- *Pyrolobus spp.*
- Cyanobacteria
- *Crenarchaeota*
- *Euryarchaeota*
- Methanogens
- *Synechococcus*
- *Prochlorococcus*
- *Pelagibacter ubique*
- *Dokdonia sp.* MED134

Course Resources:
The course *website* is available through Courselink.
There is no textbook for this course; *readings* come from the primary and secondary literature. Links for these readings, either to the abstract, or to the open access article, will be posted on Courselink.
Other resources on the website: lecture slides; links related to the bioremediation project and description of the project, including due dates; course outline; class discussion board; midterm answers

Course Content:
Lectures: The course material will largely be presented using an interactive lecture format with PowerPoint slides (uploaded prior to class). Assigned readings will be from the primary and secondary literature and will complement what is taught in class. For the more complex readings, questions will be provided along with the paper, to guide and focus your reading.
Work outside of class: in some instances, 1 or more readings and relevant questions will be assigned and read *in advance of lecture*, and class time will be used for discussion/debate on the impact of the findings and the moral or ethical issues related to those studies.
Team work: the bioremediation project will run the duration of the semester and will, with one exception, be worked on outside of class time. To facilitate electronic communication among team members, each team will have a dedicated discussion board and locker.

Week[a]	Lecture Topics	Readings[b]
1	The evolution of microbial ecology and microbial community ecology	1. Madsen, 2011. 2. Heidelberg et al., 2010 3. Goldenfeld and Woese. 2007 4. Konopka, 2009 5. Gilbert, J.A. & Neufeld, J.D. 2014.
2	Gaia theory and the Daisyworld model	6. Lovelock, 2003 7. Wood and Coe, 2007

Week[a]	Lecture Topics	Readings[b]
3-5	Technologies and strategies used in the study of microbial communities and microbial diversity	8. Epstein, S.S. 2013. 9. Pedrós-Alió, 2006 10. Fromin, N. et al. 2002 11. Gafan, G. P. et al. 2005 12. Coll-Lladó et al., 2011 13. Chen and Murrell, 2010
5-8	Microbial ecology and evolution: theories for the origin of life, mapping the tree of life, astrobiology and the extremophiles	14. Atlas and Barta, 1998[c] 15. Woese, C.R. 2004 16. Pace, 2009 17. Morris, 2010 18. Rothschild and Mancinelli, 2001 19. Bae and Phillips, 2006
8-11	Ecology of microbial communities ➢ *Marine* ➢ *Human gut in health and disease*	20. Madsen, 2011 21. Heidelberg et al., 2010 22. Goldenfeld and Woese, 2007 23. Pedrós-Alió, 2006 24. Delong, E.F. 2007 25. Nealson, K.H. and Venter, J.C. 2007 26. Kimura et al., 2011 27. Sogin et al., 2006
12	Microbial ecology & the anthropocene era: Gaia revisited	28. Lovelock, 2003 29. Goldenfeld and Woese, 2007 30. Lovelock, 2008

[a] these are approximate dates and are subject to minor alteration, including by the addition of 2-4 guest lectures

[b] these are subject to minor change

[b] Chapter 2 – textbook is on 2h reserve in library (see below)

Methods of Assessment

Assessment		Due Date or Date of Assessment	Course Content /Activity	Learning Outcomes Addressed
Form of Assessment	% final grade			
Quiz[a] 1	15%	Fri. Feb. 5, 2016	Lectures and assigned readings weeks 1 -4	A1-12; B1-?; some of F
Quiz[a] 2	15%	Fri. Mar. 11, 2016	Lectures and assigned readings weeks 5 -8	B; C1- 19; some of F and G

Final exam	35%	8:30-10:30am, Fri. Apr. 22	Cumulative	A-D; F-G
Team charter - signed	0.5	Fri. Jan. 22 @ beginning of class	Group project[c]	E2-4
Extended abstract for bioremediation project[b]	4.5	Fri. Feb. 12	Group project	E, plus some aspects of A, B, C and D (these will vary with the project)
Team effectiveness feedback	1.5	1. Fri. Feb. 12 2. Mon. Mar. 14	Group project[c]	E2-4
Oral presentation of bioremediation project	12%	Mon. Apr. 4, Wed. Apr. 6	Group project	E, plus some aspects of A, B, C and D (these will vary with the project)
Peer review of oral presentations	2.5%	Mon. Apr. 4, Wed. Apr. 6	Group project	E, plus some aspects of A, B, C and D (these will vary with the project)
Written proposal for bioremediation project	14%	Apr. 8, 2016	Group project[c]	E, plus some aspects of A, B, C and D (these will vary with the project)
Assessment of Team distribution of effort	Ungraded	Apr. 8, 2016	Group project[c]	E2-4

[a] 30 min., in class. No alternate dates.

[b] A detailed description of this assignment will be provided separately

[c] Teams will negotiate and sign the terms of a team charter (template on Courselink) and will discuss and be asked to provide feedback twice before the oral presentations and final paper ("Team Effectiveness Feedback" template on Courselink) and final anonymous distribution of effort evaluations of their team members. The team as a whole will use the individual results of the early effectiveness evaluation to identify and report their agreed-upon steps for improving performance. The final evaluation is done individually using the UofG PearTool, and will be used to assess individual grades based on the team mark. The individual grade may go UP or DOWN, relative to the group grade, within limits. As with work-place/research teams (which are generally the norm), the development of an effective team requires effort, communication and skill but results in a synergy allowing superior performance than through individual efforts. The signed charter is handed in at the beginning of class, the effectiveness feedback summaries to the Courselink dropbox; all 3 are all or none grading for meeting the deadline and evidence of good faith effort.

Important Dates

- these are also identified in the Courselink calendar

	DATE	DESCRIPTION
1	Mon. Jan 18	Deadline for selecting project group members (groups of 3-4[a])
2	Wed. Jan 20	Initial project team meeting → class mtg in CBS computer lab
3	Fri. Jan. 22	Signed team charters due @ beginning of class
4	Mon. Feb. 5	Quiz 1 • *in class, 1st 30 minutes* • lecture follows
5	Fri. Feb. 12	➢ 1st Team effectiveness feedback summary due ➢ Extended abstract due (.docx) ➢ upload to dropbox *by 11:59pm*
6	**Feb. 15-19**	**Break week – no classes**
7	Fri. Mar. 11 **40th class day**	Quiz 2 • *in class, 1st 30 minutes* • lecture follows
8	Mon. Mar. 14	➢ 2nd Team effectiveness feedback summary due to dropbox
9	Fri. Mar. 25	Holiday – no classes
10	Mon. Apr. 4, Wed. Apr. 6	Project oral presentations (+ peer eval of seminars) • *in class*
11	Fri. April 8 **Last class day**	➢ Written research proposal due. Submission as .doc or.docx file, to D2L dropbox *by 11:59pm* ➢ PEAR evaluations of group distribution of effort due
12	Fri. Apr. 22	Final exam: cumulative • 8:30-10:30am, location TBA

[a] Dr. Keenleyside will help in assembling groups upon request, on a first come-first served basis

Course and University Policies

Grading:

1. *Quizzes* - students who miss either or both quizzes will have the grade weight(s) transferred to the final (cumulative) exam.

Student responsibilities:

1. *Working in teams*: Project teams of 3-4 will negotiate and sign the terms of a team charter and twice through the semester will individually fill out, then discuss as a

group, their "Team Effectiveness Feedback" assessments. The team as a whole will use the individual results of the individual evaluations and their discussions to identify and report agreed-upon steps for improving performance. Finally, each individual will provide, through the UofG PEARTool, distribution of effort evaluations of their team members. The average assessment of each team member will be used to assess individual grades based on the team mark. The individual grade may go UP or DOWN, relative to the group grade, within limits. As with work-place teams (which are generally the norm), the development of an effective team requires effort, communication and skill but results in a synergy that leads to performance, creativity and productivity that are superior to what a single member working alone can accomplish.

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 Dr. Keenleyside in writing, with your name, id#, and e-mail contact. See the undergraduate calendar for information on regulations and procedures for Academic Consideration

Missed quizzes: with appropriate documentation, the grade weight will be transferred to the final exam

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 Student Accessibility Services (formerly the Centre for Students with Disabilities) as soon as possible.

For more information, contact Student Accessibility Services at 519-824-4120 ext. 56208 or email mailto:csd@uoguelph.ca or see the Student Accessibility Services website

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 Undergraduate Calendar.

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

Dr. Keenleyside will NOT normally respond to e-mails after hours, and will not respond to e-mails with questions that can be easily answered by reading the course outline or through information posted on Courselink. Questions about grades will be dealt with by appointment only.

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 Undergraduate 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.

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.

Technology in the classroom

While in class, please do not use your laptop for anything other than activities related to this course. Turn your cell phones off, or put them on silent, and do not text-message during class.

Expectations of professional conduct among group members

You are expected to treat each other with courtesy, including through electronic communication, which must be done using ONLY e-mail, the group's dedicated discussion board and locker. Where there is concern about a group member's behaviour, document your concerns via e-mail, copying Dr. Keenleyside. If the concern is not appropriately addressed, you are to schedule a group meeting with Dr. Keenleyside to resolve the problem.

Grading

There will be no alternative dates for the two quizzes. Students who miss either or both, when accompanied by appropriate documentation, will have the grade weight transferred to the final exam.

For written components of the bioremediation project, submissions are due in *.docx* format, to the appropriate dropbox, by 11:59pm. Failure to meet the deadline will result in penalties of 10% per day.

Failure to adhere to the terms of the group contract will be determined by confidential PEAR evaluation of the group's distribution of effort. Dr. Keenleyside may use those evaluations to mark individuals up or down, relative to the group marks. In extreme circumstances, accompanied by failed early intervention mediated by Dr. Keenleyside, an individual may be removed from a group; *that student will be required to work on an independent bioremediation project.*

Campus Resources

If you are concerned about any aspect of your academic program:

- make an appointment with a Program Counsellor in your degree program. http://www.bsc.uoguelph.ca/index.shtml

If you are struggling to succeed academically:

- There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.
- Student Health Services is located on campus and is available to provide medical attention.
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations.

<u>If you have a documented disability or think you may have a disability:</u>

- <u>Student Accessibility Services</u> (SAS) formerly Centre for Students with Disabilities can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability.