Gateway Science and Math Course Redesign Program – Proposal 2015-2016
Due: March 16, 2015.

Important Dates

March 16, 2015: Gateway Science and Math Course Redesign proposals due. Submit to Gary Smith (gsmith@unm.edu).

April 10, 2015: Selection of three course-redesign teams announced.

May 14, 15, 18, 2015: Course-redesign teams *must attend* STEM Gateway Redesign Institute (2.5 days).

June 1-August 15, 2015: Course-redesign teams develop proposed curriculum and pedagogical redesign elements; informal meetings between teams and with STEM Gateway facilitators.

August 17, 2015: Revised syllabus for fall-semester implementation provided to STEM Gateway by course- redesign teams (with designated sections for Fall 2015 and Spring 2016 implementation).

2015-2016 Academic Year: Implementation of redesign with collection of assessment data. STEM Gateway will advise throughout the process and arrange for ongoing monthly teaching professional development activity sessions with the combined teams as a faculty learning community.

Compensation Schedule

Summer 2015 compensation for faculty and graduate assistant members of the course reform teams begins on June 1.

Fall 2015-Spring 2016 graduate assistantship (August 15-May 15) contract will be finalized upon receipt of syllabus illustrating changes proposed following the course-design institute.

Summer 2016 compensation for faculty and graduate assistant commences June 1 providing that course- redesign implementation occurred as planned and assessment data were collected.

Continue to complete proposal form

A. Foundational Information

Course number, or numbers (including department/program prefix): __Biol203, Biol203L______________

Course name(s): ________Ecology and Evolution Lecture and Lab_______________

If the redesign will affect companion laboratory or recitation/problem solving sessions that have a separate course number/title, then please list these course numbers and titles in this space:

Both are included in the course re-design proposal.

Typical number of sections and students taught during fall, spring, and summer semesters (listing lab and recitation/problem solving sessions separately from the lecture) for each course involved in the redesign proposal:

Fall: 180 – 240 students

Fall Labs: 24 students per section

Spring: 180 -240

Spring Labs: 24 students per section

Summer: 48

Summer Labs: 24 students per section

Purpose. What are the specific, measurable objectives of your proposed redesign project?

Our objectives:

(1) Create a new laboratory that complements lecture with laboratory exercises that focus on the application and analysis of lecture topics. The prior lab was entirely independent of the lecture (focused on diversity of life).
(2) Make the laboratory inquiry-based.
(3) Design lectures and laboratories that include active learning exercises and student-collaborative learning.
(4) Develop laboratory exercises that focus on quantitative skills and correspondingly increase the lecture material devoted to analysis and models.
(5) Feature research by UNM biology faculty in both lecture and laboratories.

A recent **syllabus** of Bio203 lecture is provided as an attachment.

Significance: Why are the objectives provided above important to the recruitment, retention, and graduation of students at UNM?

How our objectives will improve recruitment, retention, and graduation:

(1) Biol 203/203L are typically taken by second year undergraduates; thus, this serves as an early gateway course for retaining students. A complementary lab gives students deeper exposure to the lecture material, improving retention and building skills that are critical for upper division coursework. Historically, BIOL 203L has been an impediment to retention and graduation because students achieving a passing grade in the lecture course do not pass the lab.

(2) Inquiry-based labs teach students the process of science, creating more competent researchers and deepening critical thinking skills. Inquiry-based labs increase recruitment and retention because students recognize their ability to contribute to science, rather than studying a body of facts.

(3) Collaborative learning promotes learning and retention of underrepresented students. Social, collaborative learning is more closely aligned with cultural learning experiences (Sanchez, 2000) that are common among Hispanic and Native American students. Sanchez, I.M., 2000, Motivating and maximizing learning in minority classrooms. New Directions for Community Colleges 112:35 - 44.

(4) The development of quantitative skills and toolsets builds bridges between biology and other disciplines (e.g., mathematics, physics, chemistry) that can increase student performance across STEM fields.

(5) Students who interact with meaningful data from local, ongoing research will be more engaged in the learning process and more likely to remain in STEM fields. A subset of students will be able to target their area of interest more quickly than in a traditional classroom, and become involved with current research earlier in their careers. Key benefits that R1 institutions provide to undergraduates include exposure to and engagement in the most cutting-edge research. Our course reform leverages these benefits by creating synergies between UNM teaching and UNM research.

B. Preliminary Redesign Plan

STEM Gateway anticipates that your redesign plan will mature and change as a consequence of subsequent participation in the course-redesign institute and during the first-summer planning effort. However, a well-developed proposal should show that the redesign team has a foundational understanding of key concepts of course design in university-level science and the assessment of student learning.

The *preliminary* plan, presented as responses to the prompts found below, should show consideration of and a commitment to implement the five elements for a scientific approach to optimization of science education (modified from the Carl Wieman Science Education Initiative, University of British Columbia and the Top 25 Project, Miami University):

1. Specification of measurable learning outcomes

2. Rigorous objective assessment of student achievement of these outcomes

3. Implementation of teaching methods aimed at maximizing achievement with respect to the specified outcomes, that are consistent with empirically established results and principles

   Use methods to actively engage students in their learning and with other learners and, wherever appropriate, employ inquiry-driven approaches to learning

   Reduce the amount of class time spent on low-level memory or descriptive material by incorporating approaches to facilitate students learning this material outside of class

   Methods are built on specific student learning outcomes tied to assessment that continuously monitors student learning and modifies the course as necessary

4. Means for easy dissemination and duplication of materials, methods, and technology to other course instructors

5. Sustainable and continued optimization based on results of assessment

1. List the measureable learning outcomes for the redesigned (these may be current student learning outcomes for the course or potential revisions to those outcomes).

Current specific learning outcomes include:
A. Students will demonstrate an understanding of key principles in various biological sub-disciplines that span molecular to ecosystem levels of organization
B. Students will able to design, test, and evaluate scientific hypotheses
C. Students will be able to summarize and interpret key findings of research papers

Proposed specific learning outcomes *and* objectives are outlined in Table 1.

2. At this preliminary point in your planning, how do you plan to assess student achievement of the outcomes stated in #1?

We will develop a set of rotating exam questions to assess the student learning outcomes in the lecture course. Laboratories will be designed to produce products (quizzes, reports, graphs, models) that assess each learning outcome, with student scores on the product measuring their degree of proficiency. We anticipate that some student learning outcomes will be unique to lecture or lab, and others will overlap between lecture and lab, with potential to assess them twice.

3. Describe the teaching methods that your are currently considering for the redesign and link these proposed methods to a) the purpose of the project described on page 3, b) the learning outcomes stated above and c) to your current knowledge of research on teaching and learning processes.

For the lecture, we aim to

- increase active and collaborative learning (think-pair-share, small group discussion, peer-led small group problem-solving, iclicker questions)

Sanchez, I.M. (2000) Motivating and maximizing learning in minority classrooms. New Directions for Community Colleges 112:35 - 44.

Hoskinson, A. -M, Barger, N. M. and Martin, A. P. (2014) Keys to a Successful Student-Centered Classroom: Three Recommendations. Bulletin of the Ecological Society of America. Bulletin of the Ecological Society of America 95(3) : 281 - 292. DOI http://dx.doi.org/10.1890/0012 - 9623 - 95.3.281

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoraofor, N., Jordt, H., Wenderoth, M. O. (2014) Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences 111: 8410 – 8415.

- increase course structure (e.g., add weekly online pre-quizzes, in-class worksheets and peer instruction and/or online exercises to a course currently evaluated only on the basis of iclicker questions (participation, not accuracy) and 4 exams)

Moderate course structure caused greater improvements in student outcomes for first generation college students and underrepresented minorities than for other student sub-populations.

Eddy, S. L. and Hogan K. A. (2014) Getting Under the Hood: How and for Whom Does Increasing Course Structure Work? CBE—Life Sciences Education. Vol. 13, 453–468, Fall 2014

- integrate lecture information with the hands-on activities and discussions that occur in the lab

Reinforcement based on application of the material will increase learning and retention, especially when addressing common misconceptions in evolution and ecology.

Hoskinson, A. - M., M. D. Caballero, J. K. Knight. 2013 . How can we improve problem - solving in undergraduate biology? Applying lessons from 30 years of physics education research. CBE - Life Science Education 12: 153 - 161. DOI 10.1187/cbe .12 - 09 – 0149

http://www.binghamton.edu/ecomisconceptions/index.html

Also, there is evidence that "the greatest student gains were observed when "lecture" and laboratory were integrated into a single course."

Sundberg MD (2003) Strategies to help students change naïve alternative conceptions about evolution and natural selection. Reports of the National Center for Science Education 23 (Mar-Apr): 23-26

http://ncse.com/rncse/23/2/strategies-to-help-students-change-naive-alternative-concept

For the lab, **we are starting from scratch**. We are generally interested in collecting and analyzing datasets in ecology and evolution to teach the nature and process of science.

We have had our application to the **National Academies Special Topics Summer Institute on Course-based Undergraduate Research Experiences** (CURE Summer Institute) accepted (Rudgers and Dettweiler-Robinson – see pdf attachment). "This is a working meeting during which participants will learn about and use evidence-based teaching strategies to develop a CURE they will teach at their home institution during the 2015-2016 academic year. Working sessions will focus on the features of science research projects that lend themselves to CUREs, and on teaching CUREs using evidence-based teaching strategies, such as active learning, assessment, and mentoring. Each participant or participating team will have an experienced CURE instructor as an onsite facilitator and distant mentor as they teach their CUREs during the academic year."

We aim to focus lab course content on research that is based in New Mexico and/or conducted by UNM faculty.

We will solicit datasets, data 'nuggets,' and hands-on learning problems from UNM faculty. We aim to provide authentic problem-solving in the lab, rather than "cookie-cutter" exercises where the outcome is known. http://datanuggets.org/

When possible, we will also incorporate collections from the Museum of Southwestern Biology, using their recent undergraduate learning materials. (http://aimup.unm.edu/)

We posit that research-based activities that connect students to the local environment and to ongoing research at UNM will more deeply engage students in the learning process and bridge transitions into independent research projects with UNM faculty. Tracking student progress, retention, and learning as part of the course redevelopment will aid in evaluating this hypothesis.

4. Describe your preliminary plan for expanding the redesign to include all sections of the affected course or courses.

Because the laboratory component is entirely new and is taught by graduate student TAs, expansion will be global to all sections. Cara Lea Council-Garcia trains the graduate student TAs in weekly meetings.

The incorporation of changes to the lecture will likely be slower than changes to the laboratory. However, we have agreement from all faculty that currently teach the course that they are willing to participate (even if not members of the redesign team); there is general agreement that course redesign is necessary. Making all materials available, and having Rudgers and Dettweiler-Robinson focus a semester (fall 2015) of teaching effort on course redesign will facilitate the development of materials and their transfer. For example, efforts during fall 2015 will include development of a topic-based, online quiz bank to increase lecture course structure, as well as a bank of assessment questions for exams that evaluate student learning outcomes.

5. Explain how you plan to sustain, and improve upon, the redesigned course components following the one-year funded redesign effort.

For both lecture and lab, we aim to collect data on student learning outcomes in spring 2016 and revise teaching methods accordingly. Our goals will include disaggregating student subpopulations (different underrepresented minority groups, first generation college students) to refine data collection and specifically target activities that benefit URMs and first generation students. We also will collect student data that assesses student values and behaviors in the course (time spent outside of class, classroom culture, course value). Because 203 will be taught fall 2015 (prior to implementation of course design) we have the opportunity to collect these data before and after reforms are implemented. Our goal is to generate a publishable dataset on effective teaching methods from the redesign.

C. Course redesign team members

Each team should consist of 3-4 UNM faculty members who regularly teach the course. Including a commonly employed part-time instructor is desirable. A graduate assistant from the UNM department will also be hired to assist the team. Each team member must commit to participating in the events and processes listed on the page 7 of this document.

UNM Faculty Member (Team Leader);

Name ___Jenn Rudgers____________

Rank/Position _____Associate Professor____________________________

Number of years teaching this course __1___________

Typical number of sections of this course taught each year ____2_________

UNM Faculty Member;

Name __Cara Lea Council-Garcia_______________________

Rank/Position ____Principal Lecturer_____________________________

Number of years teaching this course ___12___________

Typical number of sections of this course taught each year _____trains all TAs_______

UNM Faculty Member;

Name ____Ken Whitney______________________

Rank/Position _______Associate Professor__________________________

Number of years teaching this course ___1_________

Typical number of sections of this course taught each year ___2_______________

UNM Faculty Member;

Name ____Kelly Miller______________________

Rank/Position _____Associate Professor____________________________

Number of years teaching this course _____3_________

Typical number of sections of this course taught each year _______2____________

Graduate Assistant

Each course-reform team must designate a graduate student who will serve as an assistant to the team (see Background to the Gateway and Math Course Reform Program). This position will be funded at 0.50 FTE during the summer 2015, at 0.25 FTE during the 2015-2016 academic year, and at 0.50 FTE during part of summer 2016. Further details, if desired, can be obtained from Gary Smith (925-0725; gsmith@unm.edu). The assistant does not have to be named at this time, but if your proposal is selected, you will need to provide the information listed below by April 15, 2015. If you have a candidate for this position, please provide the information at this time.

Name __Eva Dettweiler-Robinson________________________

Qualifications that led to selection of this person (e.g., PhD student with career aspirations in academia; experience as a teaching assistant; opportunity to engage a student from a under-represented group in preparing-future-faculty opportunity)

Dettweiler-Robinson is a PhD candidate with career aspirations for teaching in a liberal arts college. She has been a teaching assistant in 200 (the Biol 203L), 300, and 400 level courses in the Biology Department. Additionally, she was awarded a teaching assistantship to co-develop and co-teach an upper-level interdisciplinary course with an Anthropology graduate student, overseen by a UNM Biology post-doc. In addition to classroom experience, she read and discussed active teaching methods and how to assess and monitor progress in a companion course.

All team member must sign* below, acknowledging the following:

- Commitment to attend the May 14 and 15, (9am-3:30pm each day) and May 18 (8:30am-12:00pm) 2015

- Commitment to participate in the course-redesign effort continuously from May 2015 through June 2016 including a commitment to the five elements for a scientific approach to optimization of science education

- Commitment to implement the course-redesign elements when teaching the redesigned course during the 2015-2016 academic year, including classroom observations by project staff, and possible administration of surveys to students

- Commitment to attend at least 8 of the 12 teaching professional development activity sessions throughout the year and are responsible for following up with your team after the activity sessions

- Agreement with the content of this proposal

In addition, the *team leader* is responsible for the following:

- Collecting and submitting evaluation data
- Coordinating and facilitating team meetings
- Distributing tasks and responsibilities among team members in a manner agreed upon by the team
- Preparing the annual report at the end of the first year
- Responding to inquiries and correspondence from STEM Gateway

UNM faculty team member (leader)

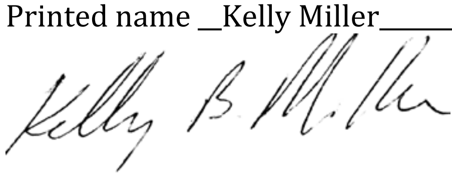
Printed name ___Jenn Rudgers_____________ Signature

UNM faculty team member

Printed name ___Cara Lea Council-Garcia___________ Signature

UNM faculty team member

Printed name __Kelly Miller______________ Signature



UNM faculty team member

Printed name ____Ken Whitney______________ Signature

*If is it not readily possible to obtain all signatures at the time when proposals are due, each unsigned team member may send an email to Gary Smith (gsmith@unm.edu) that lists and acknowledges the commitment and agreement listed above.

Supporting Letter

Proposals must include a letter of support from the Department Chair that (a) certifies that the redesign proposed in the target course has broad support from the unit, and (b) provides assurances that all sections of the course will implement the redesign by the third semester. (It is expected that all sections of targeted courses will utilize the new models developed, but project implementation might only involve a select number of pilot sections during the first semester).

The University of New Mexico

University of New Mexico
MSC03 2010, 286 Castetter Hall
One University of New Mexico
Albuquerque, NM 87131-0001

Chair Name: Rob Miller

Department: Biology

Phone: 505-277-2496

E-mail: rdmiller@unm.edu

Supporting Letter

I am writing to certify that the course redesign proposed for BIOL 203/ BIOL 203L has broad support from the Department of Biology. I assure that all sections of the course will implement the redesign by the third semester. (It is expected that all sections of targeted courses will utilize the new models developed, but project implementation might only involve a select number of pilot sections during the first semester).

Rudgers' teaching assignment for Fall 2015 will be to lead development of the new course. The course will be implemented for the first time in Spring 2016.

Rudgers taught and improved the lecture component of Biol 203. She will continue to instruct this course (which is offered every semester) in a 3 semester rotation. In addition, Rudgers teaches the upper-division Ecology course (Biol 310L) at UNM, providing continuity with the teaching of advanced-level material. Rudgers will serve as the team leader for the UNM Stem Gateway course redesign program, along with team members Cara Lea Council-Garcia, Ken Whitney, Kelly Miller, and TA Eva Dettweiler-Robinson.

Rudgers was a professor at Rice University for seven years before re-locating to the University of New Mexico in 2012. At Rice, she developed inquiry-based laboratories for core courses in the biology curriculum. Dettweiler-Robinson is a third year PhD Candidate in the Biology department. She has taught the laboratory component of Biol 203 for two semesters. Dettweiler-Robinson intends to pursue a career in research and biology education as faculty at a liberal arts college.

Signature of Department Chair Robert D Miller Date 16 March 2015

An electronic signature or typed signature suffices.

University of New Mexico
Biology 203 – Ecology & Evolution
Fall 2014
T Th 2:00 to 3:15 pm MITCH-122 (sect 001)
T Th 5:00 to 6:15 pm MITCH-122 (sect 002)

Course Summary. This course provides an initial foundation in the concepts and models in the fields of evolution and ecology. There will be a strong emphasis on understanding the process of science as applied by ecologists and evolutionary biologists. By the end of this course, you will understand the major drivers of evolution and the major ecological patterns and processes in nature. Evolutionary concepts will include Darwinian principles, evolutionary processes within populations (including natural selection), the fossil record, the origin and diversification of life, and phylogenetics. Ecological concepts will include global patterns of species diversity and abundance, organismal and behavioral ecology, population dynamics, community ecology, ecosystem processes and conservation biology. Your analytical and quantitative abilities will be reinforced and improved, and you will gain skills in critical thinking that will make you a more scientifically-aware citizen.

Course Philosophy. With a continually increasing rate of new information and discoveries in the field of biology, no single person can master all of the factual information currently available. Both scientists and medical professionals must instead synthesize and organize information in ways that help them solve problems. This course focuses on developing skills to help you evaluate and integrate information. The emphasis is on critical thinking and understanding the process of scientific inquiry. Yes, you will learn some new vocabulary and facts along the way, but the intention is to improve your ability to process information during the activity of problem-solving, rather than engaging in rote memorization.

Learning Objectives.
Students who successfully complete this course will be able to:
(1) recognize the major drivers of evolution
(2) recognize the major ecological patterns in nature
(3) apply the scientific process to simple ecological and evolutionary problems
(4) make informed predictions on how organisms respond (in both evolutionary and ecological time frames) to environmental conditions (abiotic forces) and to species interactions (biotic forces).

Instructors:
Dr. Kenneth D. Whitney, whitneyk@unm.edu
Dr. Jennifer A. Rudgers, jrudgers@unm.edu

Office Hours:
Whitney – (First 8 weeks); T 3:20 to 4:20 pm, or by appointment; Room 282 Castetter
Rudgers – (Second 8 weeks); T 3:20 to 4:20 pm, or by appointment; Room 286 Castetter

Text. Freeman, S. et al. *Biological Sciences.* You may use either the or 4th or 5th edition. Additional readings may be assigned periodically; these will be available from the reserve desk at Centennial Library and/or on *e-reserves*, or posted in some other way online.

Resources. Lecture powerpoints and supplemental study materials will be posted on the course Blackboard Learn site: https://learn.unm.edu. You can also find the syllabus, instructor contacts and other useful information here.

iClickers. i Clickers are required for this class. Be sure that the clicker ID number is registered under *your name*. If you have already purchased an iClicker remote for another class, there is no need to purchase another. Clickers can be purchased in used condition, as long as you register the clicker ID number under *your own name*. In most class sessions, we will ask one or two questions that you will answer using your clickers. The main purpose of these questions is to determine which concepts you have mastered and which concepts need further explanation. Because the purpose of clicker questions is to provide you and your instructors with feedback, most of your In-class Participation grade (8%) is awarded on the basis of participation, regardless of whether you answer correctly.

Course Assessment. Lecture grades will be based on four exams and several in-class clicker activities and assignments. The exams generally consist mostly of short answer and/or short essay questions and require a calculator. Please note that calculators *cannot* be shared during exams and cell phones may not be used as calculators. Letter grades are assigned from a percentile scale with 90 and above = A, 80-89 = B, 70-79 = C, 60-69 = D, and anything below 60 = F, although the instructors may adjust these criteria depending on circumstances.

Grading Assessment

	% of total grade
Exam 1	23
Exam 2	23
Exam 3	23
Exam 4	23
In Class Activities and Participation	8
Total	**100**

Readings. Readings are listed in the course schedule. Keep up with the readings!

Attendance. In-class activities count for 12% of the grade. These activities will not be announced in advance in order to encourage attendance and class participation. Regular attendance, reading, participating in questions and discussions, asking questions, and careful note-taking are keys to mastering the material in this course. These also form the basis of your class participation grade.

Missed exams. Best advice - don't miss any exams. Exams may be taken only at the indicated time, *unless* ***prior*** arrangements have been made more than one week ahead with the instructors. If you miss an examination you must provide a documented medical or other legitimate excuse ***within 48 hours***. If the instructors accept the excuse, the grade assigned to the missing exam will the average of that earned on the other three exams. **No makeup exams will be given**. Missing two exams, for any reason, will result in a failing grade.

Students with Disabilities. Note that it is your responsibility to request accommodations for individual learning needs. If you have a documented disability that will impact your work in this class, please speak with an instructor privately *during the first two weeks of class*. All discussions will remain confidential. For further information, contact one of the instructors or Student Support Services within the Center for Academic Program Support (277-3506).

Academic Integrity. We do not tolerate academic dishonesty. Students who cheat will fail the course.

Course Schedule

Week	Date	Lecture	Text chapter (5th ed)
1	19 Aug	History of Evolutionary Thought	25
	21 Aug	History of Evolutionary Thought (cont.): Darwin and Wallace	25
2	26 Aug	Hardy-Weinberg Equilibrium	26
	28 Aug	Natural Selection	26
3	2 Sep	Nonrandom mating	26
	4 Sep	Drift, Gene Flow, Mutation	26
4	9 Sep	Species Concepts, Speciation	27
	11 Sep	**Exam I**	
5	16 Sep	Speciation II	27
	18 Sep	Phylogenetics	28
6	23 Sep	Phylogenetics II	28
	25 Sep	Origins and evolutionary history of life	28
7	30 Sep	Diversity of Bacteria, Archaea, Protists, Fungi	29,30,32
	2 Oct	Diversity of Plants, Animals	31, 33-35
8	7 Oct	**Exam II**	
	9 Oct	*FALL BREAK (no class)*	
9	14 Oct	The science of ecology	52
	16 Oct	The physical environment and biomes	52
10	21 Oct	Behavioral ecology and life history	53
	23 Oct	Population dynamics	54
11	28 Oct	Demography	54
	30 Oct	Species interactions I	55
12	4 Nov	**Exam III**	
	6 Nov	Species interactions II	55
13	11 Nov	Community structure and dynamics	55
	13 Nov	Patterns of species diversity	55
14	18 Nov	Energy flow and food webs	56
	20 Nov	Ecosystem processes	56
15	25 Nov	Biodiversity and global change	57
	27 Nov	*THANKSGIVING BREAK (no class)*	
16	2 Dec	Conservation biology	57
	4 Dec	**Exam IV**	

Category	#	Student Learning Outcome	Objective A	Bloom's A	Objective B	Bloom's B	Objective C	Bloom's C	Objective D	Bloom's D
Global	1	Understand that science is an ongoing process, not a collection of facts	Explain evolution as a process	Cognitive: Comprehension	Recognize current research activities of UNM Biology faculty	Cognitive: Knowledge	Summarize the evidence for the theory of common descent and describe why this theory is more acceptable to scientists than the hypothesis of separate types.	Cognitive: Evaluation; Affective: Organizing		
Global	2	Understand that we are all players in natural ecological and evolutionary processes and patterns	Describe the significance of biological interactions in agriculture, the environment, and human health and well-being	Cognitive: Knowledge; Affective: Valuing	Explain evolutionary challenges related to human activity including populations that evolve too quickly (e.g., antibiotic resistance) and populations that evolve too slowly (e.g., conservation genetics, hosts of emerging diseases)	Cognitive: Comprehension; Affective: Organizing	Use ecological principles to explain the consequences of human activity (current economic and social issues) including how human population size and resource use relate to environmental quality	Cognitive: Evaluation; Affective: Valuing		
Evolution	4	Describe major events in the history of life on earth	Explain how life might have originated on this planet	Cognitive: Knowledge	Identify major biological innovations in energy use, body plans, and other key traits.	Cognitive: Knowledge	Relate broad patterns in the fossil record to major biological and geological events	Cognitive: Comprehension		
Evolution	5	Describe Darwin and Wallace's theories and understand how the principles of natural selection can lead to adaptation and speciation	Describe the historical development of a basic principle in biology	Cognitive: Knowledge	Give examples of adaptation	Cognitive: Comprehension	Apply the criteria for natural selection to new contexts (requires knowledge of the criteria)	Cognitive: Application		
Evolution	6	Contrast different modes of speciation and distinguish among different species concepts	Give examples of both allopatric and sympatric speciation	Cognitive: Comprehension	Compare the advantages and disadvantages of different species concepts	Cognitive: Analysis				
Evolution	7	Compare and contrast the ways in which genetic drift, gene flow, mutuation, and natural selection affect evolution	Use Hardy-Weinberg Equilibrium as a null model to calculate allele frequencies; interpret deviations from equilibrium in evolutionary terms	Cognitive: Application	Apply Hardy-Weinberg Equilibrium to new data	Cognitive: Application				
Evolution	8	Understand and explain relatedness among organisms	Use and build phylogenies (tree diagrams)	Cognitive: Application	Define and give examples of homology and homoplasy	Cognitive: Comprehension	Evaluate how comparisons of the DNA sequences of universal genes provide support for hypotheses of evolutionary relationships among organisms.	Cognitive: Evaluation		
Ecology	9	Identify key factors in the study of ecology at each level of the hierarchy of biological organization	Define and compare the levels of organization used in ecology	Cognitive: Comprehension	Distinguish between biotic and abiotic factors	Cognitive: Analysis	Explain how abiotic factors affect biotic factors (and the reverse) and give examples at each level of biological organization	Cognitive: Comprehension		
Ecology	10	Understand how single species populations grow and are regulated	Give examples of how traits of individuals (morphology, behavior, physiology) affect population-level dynamics	Cognitive: Comprehension	Distinguish between density-dependent and density-independent population regulation in the context of new examples	Cognitive: Analysis	Show how population data can be analysed using statistics, graphs, life tables, and/or survivorship curves	Cognitive: Application		
Ecology	11	Understand how species interactions affect populations, communities, and ecosystems	Compare and contrast the principal interactions between different species and how they affect the respective species	Cognitive: Analysis	Give examples of how species interactions can affect communities and ecosystems	Cognitive: Comprehension	Show how pairwise interaction models (Lotka-Volterra) predict the outcome of species interactions	Cognitive: Application		
Ecology	12	Understand the structure and function of communities	Explain the general distribution of biodiversity in terrestrial and aquatic systems as a function of climate, seasonality, geography, abiotic conditions, and resource availability	Cognitive: Comprehension	Explain and give examples of how communities change in both space (biomes and gradients) and time (succession)	Cognitive: Comprehension	Evaluate the consequences of continued species loss for communities and ecosystems	Cognitive: Evaluation		
Ecology	13	Understand how energy and nutrients move within and between biotic and abiotic components of ecosystems via physical, chemical and biological processes	Use a food web to identify and distinguish producers, consumers, and decomposers. Explain the pathway of energy transfer through trophic levels and the reduction of available energy at successive trophic levels.	Cognitive: Analysis	Diagram and explain the biogeochemical cycles of an ecosystem, including water, carbon, and nitrogen cycles	Cognitive: Comprehension	Evaluate how the biogeochemistry or energy flow of ecosystems will respond to climate change and human activity.	Cognitive: Evaluation		
Skills	14	Engage in self-initiated learning and discovery	Make observations on biological systems, collect data	Cognitive: Knowledge	Formulate hypotheses	Cognitive: Synthesis	Design an experiment to test a hypothesis	Cognitive: Synthesis	Learn how to sketch predictive graphs	Cognitive: Synthesis
Skills	15	Work with real data and gain graphical literacy	Enter and organize data in Excel	Cognitive: Application	Given a dataset, select the figure type appropriate for graphical display of the data	Cognitive: Application	Given a dataset, create and interpret a graph that depicts means and measures of variance	Cognitive: Application	Given a dataset, apply simple statistical analyses to data	Cognitive: Application
Skills	16	Apply fundamental models (mathematical equations) in evolution and ecology	Use the Hardy-Weinberg law to understand allele frequencies in populations; use it to solve novel problems	Cognitive: Application	Use single population models (exponential, logistic) to predict population growth	Cognitive: Application	Use pairwise interaction models (Lotka-Volterra) to predict the outcome of species interactions	Cognitive: Application	Calculate and compare metrics of biodiversity	Cognitive: Application
Skills	17	Read, distill, and synthesize primary scientific literature	Write an explanation of a biological principle or information from the biological literature.	Cognitive: Comprehension	Assess the accuracy of science reports presented in the media by distilling conclusions from an article in the biological literature and compare your distillation to that from a media interpretation	Cognitive: Analysis				
Skills	18	Gain competency in collaboration with diverse groups	Identify roles and responsibilities of group members	Cognitive: Knowledge	Take multiple roles within small group projects	Cognitive: Application	Solve an ecological/evolutionary problem as part of a group	Cognitive: Application		