

Department of Biology

COLLEGE OF SCIENCE & MATHEMATICS

Bachelor of Science Degree Program

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Student Outcomes Assessment Plan (SOAP)

I. Mission Statement

To provide a diverse undergraduate program that matches the breadth and excitement of modern biology, develops critical thinking skills, and prepares students for the hundreds of career opportunities that use biology as a foundation.

II. Goals and Student Learning Outcomes

Biology majors will be able to integrate and apply basic knowledge into the unifying themes in Biology.

Biology majors will gain knowledge and experiences in the basic methods, instrumentation and quantitative analytical skills used to conduct scientific research in biological science.

Biology majors will develop critical thinking and communication skills, both oral and written, for purposes of conveying biological information to both professional scientists and the lay public

Biology majors will develop intellectual independence, scientific literacy and an appreciation for the connections between biological science and society.

CSU Fresno Biology Graduates will develop the knowledge, abilities and attitudes portrayed in the Department's stated Goals and Outcomes:

Goal 1:

Biology majors will be able to integrate and apply basic knowledge into the unifying themes in Biology.

Outcomes

1 Biology Majors will be able to integrate and apply biological knowledge into the following unifying themes:

1A evolutionary patterns and processes

1B energy transformations and flow

1C nutrient cycles

- 1D homeostasis and equilibria
- 1E molecular information flow
- 1F structure-function relationships
- 1G hierarchy of biological organization
- 1H developmental patterns and processes
- 1I complexity of interactions in biological systems

Goal 2

Biology majors will gain knowledge and experiences in the basic methods, instrumentation and quantitative analytical skills used to conduct scientific research in biological science.

Outcomes:

- 2.1 Scientific Method: Biology Majors will be able to
 - 2.1A apply the scientific method to biological questions
 - 2.1B generate testable hypotheses
 - 2.1C design experiments to test hypotheses
- 2.2 Analytical and quantitative skills: Biology Majors will be able to
 - 2.2A make appropriate measurements and create data sets
 - 2.2B graph and display data
 - 2.2C objectively analyze data
 - 2.2D interpret results of experiments
- 2.3 Lab and field skills: Biology Majors will be able to
 - 2.3A use appropriate equipment and instrumentation
 - 2.3B understand and follow safety procedures
- 2.4 Teamwork skills: Biology Majors will be able to
 - 2.4A work cooperatively in a group
 - 2.4B solve problems in a group

Goal 3:

Biology majors will develop critical thinking and communication skills, both oral and written, for purposes of conveying biological information to both professional scientists and the lay public.

Outcomes:

- 3.1 Critical thinking and problem solving: Biology Majors will be able to
 - 3.1A develop an argument and support it
 - 3.1B recognize and use deductive and inductive reasoning
 - 3.1C integrate concepts within and among disciplines
 - 3.1D synthesize knowledge and apply concepts to solve problems
 - 3.1E distinguish between data and inferences based on data
- 3.2 Biological information skills: Biology Majors will be able to
 - 3.2A understand and evaluate primary biological literature
 - 3.2B integrate published information in oral and written communication
 - 3.2C use biological databases
- 3.3 Communication: Biology Majors will be able to communicate science effectively to their peers and to the broader scientific community using:
 - 3.3A oral presentations
 - 3.3B written scientific papers and reports

Goal 4:

Biology majors will develop intellectual independence, scientific literacy and an appreciation for the connections between biological science and society.

Outcomes:

- 4.1 Scientific literacy: Biology Majors will be able to
 - 4.1A distinguish science from pseudoscience
 - 4.1B view science as a conceptual framework to understand the world, and not just a collection of facts
 - 4.1C understand the limitations of science
 - 4.1D apply scientific thinking to everyday problems
- 4.2 Biology and society: Biology Majors will be able to
 - 4.2A help the public make informed decisions about biodiversity and biological resources
 - 4.2B appreciate the relevance of biology to society

4.2C understand and appreciate the connectedness of science, society and history

4.2D identify and evaluate ethical issues in biology

III. Curriculum Map

The Biology Majors undergraduate curriculum consists of 57 courses offered, of which 7 courses form a Core sequence, which every Biology Major is required to take. While the entire curriculum is designed to provide comprehensive coverage of Departmental goals and learning outcomes, the assessment methods described in this SOAP focus on Core classes, because every Biology Major must take them. In particular, direct assessments of a broad range of learning outcomes can be embedded in core courses as our plan targets our students' ability to draw upon knowledge and skills acquired during all of their Biology education, not just the content of the core classes. Therefore, the Curriculum Map presented on the following page lists only the core courses in relation to all the above Goals and Outcomes. A complete curriculum map including all the courses offered is being developed and will be available upon request from the Department as an addendum.

The following curriculum map matrix connects the learning outcomes described in section II above with specific Core classes, indicating where each outcome is introduced (i), reinforced/emphasized (r), and mastered (m). See section II for Outcome codes.

Outcomes	BIOL 1A Intro Bio	BIOL 1B Intro Bio	BIOL 101 Ecology	BIOL 102 Genetics (104 Lab)	BIOL 103 Cell Bio (104 Lab)	BIOL 105 Evolution
1A	m	m	r	r	r	m
1B	r	i	m	i	i	r
1C	i	r	m		i	i
1D	i	r	m		r	i
1E	r	i		m	m	r
1F	m	r	i	i	m	r
1G	r	m	r	i	r	r
1H	i	r			r	r
1I	r	r	r	r	m	r
2.1A	r	r	m	i	m	m
2.1B	r	r	r	i	i	m
2.1C	i	r	m	i	i	m

2.2A	i	r	m		i	m
2.2B	i	r	r		i	m
2.2C	r	r	m	i	r	m
2.2D	r	r	m	r	r	m
2.3A	i	i	r		m	
2.3B	r	r	i		m	
2.4A	r	r	m	r	i	r
2.4B	r	r	m	r	i	r
3.1A	i	r	r	i	r	m
3.1B	i	r	r	i	r	m
3.1C	r	r	r	i	r	m
3.1D	i	r	r	m	r	m
3.1E	i	i	m	r	r	m
3.2A	r	r	r	i	m	m
3.2B	r	r	r		m	m
3.2C	i	i	i	i	m	r
3.3A	i	i	r	i	m	r
3.3B	r	r	m	i	r	m
4.1A	r	r	r	i	r	m
4.1B	r	r	r	r	r	m
4.1C	r	r	i	r	r	m
4.1D	r	r	r	i	r	m
4.2A	r	r	r	i	i	m
4.2B	r	m	r	r	m	m
4.2C	r	r	r	i	r	m
4.2D	r	r	r	i	r	m

IV. Assessment Methods

A. Direct Measures

1. Pre and Post Test

A pre- and post-test to assess how well biology majors learn and retain general biology content knowledge covered in the Biology Core (Outcomes 1A-I) will be given each year. The pre test will be given to lower division biology majors in BIOL 1A and the post test will be given to seniors in BIOL 105. Students will be asked in the post test whether they have had all or just a portion of their Biology Core courses at CSU Fresno so that performance comparisons can be made between students who have had all Biology core courses at CSU Fresno vs. transfer students who have not.

2. Primary Trait Analysis of BIOL 101 Ecology Lab Reports

This assessment activity will measure student development in data collection, graphing, data analysis, interpretation of results, and scientific writing. A standard rubric will be used to measure a random sample of lab reports. Peer evaluation within teams of collaborating students, conducted using a standard rubric, will be used to assess teamwork skills.

3. Primary Trait Analysis of the Evolution Term Paper

Evolution (BIOL 105) is considered a culminating course in the Biology Core that provides a means for students to integrate and apply biological knowledge from an evolutionary perspective. Each student in the course will write a term paper on a topic in evolutionary biology. To complete the assignment, each student must select a topic in biology, research the topic through the primary scientific literature, and discuss the information on that topic from an evolutionary perspective. Primary trait analysis of Evolution term papers, conducted with a standard rubric, will be used to ascertain students' abilities to interpret the primary literature (Outcome 3.2A) and integrate concepts (Outcome 3.2B), as well as their understanding of evolution (Outcome 1A) and their scientific writing skills (Outcome 3.3B).

4. Effect of Student Research Experience on Biological Knowledge

Recognizing the importance of learning science via direct participation in research, the Department of Biology encourages majors to enroll in Independent Study (Biol 190) with faculty whose research interests them. A targeted assessment project focusing on undergraduate research during 2009-10 found a significant positive effect of research experience on students' performance on the Post-Test, which was modified by adding survey questions about research experience. This modified Post-Test will continue to be used to document the effect of student research experience on overall knowledge of biology and ability to synthesize information within broader themes in Biology.

5. Effect of Student Research Experience on Critical Thinking & Synthesis Skills

The 2009-10 project on student research experience also documented a significant positive effect of research participation on Evolution Term Paper scores (on the standard rubric). Following the procedure used in that study, a short survey form will be used to document students' research experience at the end of the semester in Biol 105. After term papers are scored using the standard rubric, students will be classified into two groups (those with and without research experience) to measure the effect of

research experience on students' critical thinking, literature review and synthesis, and writing skills.

B. Indirect Measures

1. Tabulation of student research activity

Each year, as part of the Department's annual report, faculty will tabulate the number of student publications, poster and oral presentations at scientific meetings, funding awards and honors. Faculty will also estimate the level of new funding made available to student researchers working in their lab. These findings should provide direct evidence that some students have mastered the process of scientific inquiry and communication. Our target is to maintain a high level of output from student research in the form of publications and presentations. Currently, the department produces an average of 3 student publications & presentations per faculty member per year.

2. Pipeline Analysis:

Pipeline analysis (conducted at the end of the review period) will follow the progress of students that became Biology majors. This assessment is entirely dependent upon assistance from the office of Institutional Research, Assessment and Planning, and their ability to provide us with the appropriate data. We will carry out detailed analyses of student records data to answer questions such as:

- Are students taking CORE courses in sequence?
- At what points do we lose students from the major?
- Do they leave the university or transfer to other majors?
- Do we disproportionately lose minority students?
- Does the success of transfer students differ from that of continuing students?
- Can we identify predictors of success (or failure) that will allow us to provide more effective support to at-risk students?

3. Alumni Survey:

Surveys will attempt to measure:

- How graduates feel about the currency, breadth and depth of their Biology education
- Student satisfaction with various aspects of the Biology undergraduate program (e.g., courses, faculty, etc.).
- Relevance of degree to, and level of preparation for, current occupation
- Whether students continued with advanced degrees
- Survey will be mailed to graduates a minimum of one year after graduation, and at the end of the Department's review cycle.

V. Student Learning Outcomes X Assessment Methods Matrix

	Pre- & Post Test	Ecology Lab Reports	Evolution Term Paper	Research Experience (<i>Post-Test</i>)	Research Experience (<i>Evolution Term Paper</i>)	Student Research Tabulation	Pipeline Analysis	Alumni Survey
1A	X		X	X	X			
1B	X	X						
1C	X	X						
1D	X	X						
1E	X							
1F	X							
1G	X	X	X					
1H	X							
1I	X	X						
2.1A		X	X	X	X	X		
2.1B		X	X	X	X	X		
2.1C		X		X		X		
2.2A		X		X		X		
2.2B		X				X		
2.2C		X				X		
2.2D		X	X	X	X	X		
2.3A		X				X		
2.3B		X	X			X		
2.4A		X				X		
2.4B		X				X		
3.1A			X	X	X	X		
3.1B			X	X	X	X		
3.1C			X		X			
3.1D			X	X	X	X		
3.1E		X	X		X	X		

3.2A			X	X	X	X		
3.2B			X	X	X	X		
3.2C						X		
3.3A						X		
3.3B		X	X		X	X		
4.1A			X					X
4.1B								X
4.1C								X
4.1D			X		X			X
4.2A								X
4.2B								X
4.2C								X
4.2D								X

VI. Timeline for Implementation of Assessment Methods and Summary Evaluations

Year 2006 to 2007

Method 1. Pre and Post Test

Method 2. Student Research Tabulation

Year 2007 to 2008

Method 1. Pre and Post Test

Method 2. Ecology Lab Reports

Method 3. Student Research Tabulation

Year 2008 to 2009

Method 1. Pre and Post Test

Method 2. Student Research Tabulation

Year 2009 to 2010

Method 1.	Pre and Post Test
Method 2.	Evolution Term Paper
Method 3.	Research Experience (Post-Test)
Method 4.	Research Experience (Evolution Term Paper)
Method 5.	Student Research Tabulation
Year 2010 to 2011	
Method 1.	Pre and Post Test
Method 2.	Research Experience (Post Test)
Method 3.	Student Research Tabulation
Year 2011 to 2012	
Method 1.	Pre and Post Test
Method 2.	Ecology Lab Reports
Method 3.	Evolution Term Paper
Method 4.	Research Experience (Post-Test)
Method 5.	Research Experience (Evolution Term Paper)
Method 6.	Student Research Tabulation
Year 2012-2013	
Method 1.	Pre and Post Test
Method 2.	Research Experience (Post-Test)
Method 3.	Student Research Tabulation
Method 4.	Pipeline Analysis
Method 5.	Alumni Survey

VII. Process for Closing the Loop

The Department of Biology follows a three-step process to analyze the results of its assessment activities, identify areas of strength and/or weakness in its programs in terms of meeting departmental goals and learning Outcomes, find alternative strategies where needed, and

implement any necessary curricular changes.

1. **Annual Report:** The Assessment Coordinator with help from colleagues in the Assessment Committee is responsible for ensuring assessment activities occur regularly according to the above timeline. The committee meets on a regular basis to monitor ongoing assessment, to report any new results or issues to the rest of the faculty, and to compile information for the Department's annual report at the end of each academic year. Faculty members in the department also often undertake additional assessment projects related to specific curricular objectives such as development of new courses or redesign of old ones. This ongoing cycle of data gathering, analysis, and discussion of results among all faculty members allows us to be more responsive in closing the loop on both a small-scale and on a continual basis.
2. **Departmental Discussion:** The assessment committee reports on current assessment activities and results on a regular basis at least once every semester. These reports are presented and discussed by all faculty members during Departmental meetings. Faculty members may undertake additional assessment to address any particular issue highlighted by the results of ongoing assessment. Faculty members may also undertake any relevant minor curricular changes as necessary. These regular meetings serve to maintain an ongoing conversation about assessment within the department enhancing our ability to close the loop based on results of ongoing assessment.
3. **Departmental Retreat:** The Department intends (subject to availability of funds) to hold a full-day faculty retreat every 2-3 years to conduct a more detailed self-assessment and discuss the overall trajectory and progress of the undergraduate program. Past retreats (which were less frequent) have helped develop the Department's recent curricular overhaul, revise the curriculum map, and prepare for external program review. Retreats also allow faculty to engage in a broader and deeper conversation about departmental goals, teaching philosophies, and curricular and classroom strategies to take advantage of new approaches and technologies.
4. **Program Review:** The most comprehensive self-assessment takes place at the time of the Department's external Program Review conducted every 7 years. The most recent review process in 2006 provided feedback leading to a significant overhaul of the Biology curriculum, in which the course requirements were streamlined to facilitate student progress towards graduation.