Millikin University
Student Learning in Biology 2007-2008

Judy Parrish, Ph. D.
Department of Biology
Division of Natural Science and Mathematics
July 2008

GOALS

The Department of Biology at Millikin University in an attempt to educate students in the knowledge and practice of biology agrees that the following goals are of sufficient rigor and coverage to produce highly competitive graduates of the program. The following goals have been developed and approved by the members of the department**.**

Graduates with a Biology Degree should:

1. Understand and be able to apply the concepts of evolution and natural selection.
2. Have exposure to the following general areas of biology: ecology, taxonomy, morphology, function, molecules/cells and genetics/reproduction.
3. Be able to use and apply critical thinking to life situations.
4. Be able to present in oral and written form a completed research project, using testable hypotheses, logical arguments and appropriate methodologies and equipment.

These goals have been reviewed in terms of the connectivity with the university goals in the following ways.

- Goal 1. Millikin University students will be prepared for **professional success.**
  Our goals (1-4) give biology students a strong biological background to prepare them for success in many professional areas: a strong pre-professional curriculum for medicine, dentistry, veterinary medicine etc; a thorough exposure to research skills needed for graduate, industrial and environmental programs; a rigorous secondary education program for teaching high school science.
- Goal 2 Millikin students will actively engage in the responsibilities of **citizenship in their community.**
  The goal of developing good reasoning and logical skills (3) as well as the knowledge students obtain (goals 1, 2, 4) will be of immeasurable value in dealing with the biological issues facing society such as pollution, health, medical treatment, reproductive issues, etc.
- Goal 3 Millikin students will discover and develop a **personal life of meaning and value.**
  Goal 4, and to some extent 3, help to develop in biology students self confidence that they can do well in the world. It gives them a feeling of self worth by completing the difficult task of taking on an investigation and coming up with a meaningful interpretation and conclusion. This skill is essential to their personal well being. They come away knowing that if they can complete this tough goal, then they are well on their way to dealing with life's difficult challenges.

SNAPSHOT

The Department of Biology is located in the Leighty Tabor Science Center on the second and part of the first and third floors, with an animal facility in the basement and a greenhouse on the fifth floor. The faculty has been selected to provide specialized focus in the areas emphasized in biology goal #1 and 2. We have one geneticist, one molecular/cell biologist, one microbiologist,

one ecologist, one anatomist, two physiologists (one is teaching half-time), a botanist, and an animal behaviorist. Almost all (89%) have Ph.D.s in their special areas and have training to be able to provide backup for at least one other area as well as the skills to teach in more general freshman level courses. The curriculum has been divided into the following study tracks:

- Traditional Biology
    - Pre-Professional Preparation
    - Secondary Education
    - Environmental Biology
- Allied Health Preparation
    - Pre-PT/OT
    - Pre-Med Tech
- Cellular/Molecular Biology

These tracks prepare students for careers in almost any area of biological research, molecular/cellular research, medicine, dentistry, veterinary medicine, environmental biology, high school teaching, physical therapy, occupational therapy, and medical technology. The department advises and provides biological training of 151 (average) majors and annually graduates an average of 28 students. The largest area of specialization for students is Pre-Professional and Allied Health tracks. In addition to providing training for our majors, the department services about 50 pre-nursing majors and 40 exercise science majors by providing courses in anatomy and physiology. We also teach an average of 15 sections of MPSL laboratory science classes per year.

STORY

Student learning in biology requires an extensive exposure to methods and examples of life situations. This is accomplished to a great extent through the hands-on-experience in the laboratory. Our new building has been designed to provide ample laboratory space for the various biological areas listed in departmental goal #2. At maximum, teaching labs can accommodate 16-20 students; these small numbers enable us to give each student personal attention. This personal attention motivates students to perform at a higher level, as they are under the personal view of the instructor. This motivation leads to increased understanding of the concepts associated with our learning areas and this learning becomes self propagating as the student begins to enjoy the connectivity of what he/she is doing in the classroom with what he/she anticipates doing upon graduation.

Just as the curriculum helps the department achieve goals for student learning outcomes and helps students actualize their plans of study, so too does the advising process. Advising in the Department of Biology facilitates and integrates reasoned choices that promote the student's growth as a person and as a major. In order to realize this mission, we work with students to: (1) Develop plans of study for successfully achieving their degree and career goals, (2) Select courses each semester to progress toward fulfilling their plans of study, (3) Use the resources and services on campus to assist in fulfilling their plans of study, and (4) Graduate in a timely manner. One or more times per semester, students meet in person with their academic advisors to discuss fulfillment of the plan of study.

Curriculum Map

Courses listed below each goal provide information and experiences necessary for students to complete the departmental goals in a timely manner during their four years at Millikin.

Academic Year	Goal #1	Goal #2	Goal #3	Goal #4
Freshman	BI 105, BI 108	Only courses level 200 and above can be used for this goal	BI 105, BI 155, BI 108, BI 158	BI 155
Sophomore	Expanded in all other courses taken	See Appendix B	BI 206 and 207 or BI 300	BI 350
Junior	Expanded in all other courses taken	See Appendix B	*Course with research project OR BI 391 or 392	*Course with research project OR BI 391 or 392
Senior	Expanded in all other courses taken	See Appendix B	BI 481 or 482	BI 481 or 482

*Courses with student designed research projects are starred in Appendix B

ASSESSMENT METHODS

Goal #1, understanding the concepts of evolution and natural selection, will be met in two ways. First. students will learn about evolution and natural selection by successfully completing the freshman courses, Ecology and Evolution (BI 105), and Attributes of Life (BI 108). These courses give freshmen a strong background needed to understand evolution and natural selection and the reasons for the diversity of living organisms. Assessment is done using a pre-test and post-test format (Appendix A). Testing is conducted at four times using a test consisting of evolution related questions from the freshman courses, Evolution and Ecology (BI 105) and Attributes of Life (BI 108). The first test will be given at the beginning of BI 105 and the second one at the end of BI 105. A third exam will be given at the end of Attributes BI 108 and a final one when students complete the senior seminar course (BI 481 or 482). Second, the theme of evolution will be included in every course taught in the department. How it is covered will be described in each course syllabus.

Goal #2, the exposure to the various areas of biological study, involves emphasis on the approaches taken to study biology: ecology, taxonomy, morphology, function, molecules/cells and reproduction/genetics (See Appendix B). By requiring students to take courses in each of these areas, they will not only gain additional understanding of the essential nature of these concepts to biology but will also see the continued theme of adaptation and diversity that living organisms exhibit. Students will be expected to take 6 courses, one in each area, and pass each course with a grade of C- or better. Students must retake or take another course if their grade is D+ or lower. This applies to every student in every concentration.

Goal #3, the use of critical thinking, is essential to the sciences. Many of our courses include laboratory research and reports that assess critical thinking skills. Our plan is to use a portfolio system to collect three papers, one written the first year at Millikin, one from a research project each student designed either in class or in BI 391 or 392, and the one from senior seminar research during the senior year. These papers must be of an investigative nature that draw conclusions from

data personally collected or analyzed by the student. The following rubric has been used to evaluate how well the student used logic and critical thinking in their work.

	Excellent (5 points)	Adequate (3-4 pts)	Nominal (1-2 pts)
Format	• Paper in proper scientific form, with all standard categories • Tables and figures correctly constructed with good legends • Standard use of grammar and spelling. Fewer than one error per two pages • Logical organization • Literature appropriately used and cited	• Section(s) missing, or some material in wrong section • Same data presented more than once, or inappropriate figures used • Some grammar errors and spelling errors (Fewer than one per page) • Some literature used, but inadequate or improperly cited	• Non-scientific form • Data not presented, or raw data presented • One or more grammatical and spelling errors per page. • Poorly organized • Little or no literature used
Design	• Key variables considered • Appropriate Experimental Design with testable hypothesis • Alternate hypotheses considered • Design adequate to test hypotheses • Appropriate use of data analysis • Includes Control, Experimental groups testing one variable	• Design only partially addresses foreseeable variables • Alternative hypotheses not eliminated • Design insufficient to test hypotheses • Incorrect use of data analysis	• Poor design, does not separate variables • Hypothesis not testable, or design does not test primary hypothesis • No use of data analysis
Conclusions	• Accurately reflect data presented • Correct use of logic • Fit study into broader context • Adequate summary of paper. • Considers where the work should go from here	• Some conclusions not based on results • Contains faulty logic • Study weakly related to broader context	• Many conclusions not related to data • Poor use of logic • No attempt to fit study into broader context

Goal #4, research report and evaluation, will be the culminating experience of graduating biology students. It will consist of the following components:

- Selection of an appropriate research topic.
- A thorough search of relevant research using primary literature.
- Collaborative wet-bench research with a member of the faculty or critical analysis of existing literature on the topic. The culmination of this will be the development of a well-supported position (hypothesis) on the topic.
- Presentation of this position consists of an oral presentation before faculty and peers, a poster display similar to those presented at scientific meetings, and a scientific paper patterned after current research literature.

As the curriculum map indicates, this goal will most likely be fulfilled in Senior Seminar, BI 481 or 482. Because of the large number of majors, the limited resources of faculty and space. and the

limited need for allied students to do research, we have not required wet bench research of all students to satisfy this goal. We have included the option of researching the primary literature in biology in order to meet this goal. Senior Seminar gives our students the opportunity to present their analyses and conclusions in a formal setting. Evaluation of the poster and oral presentation have been based on guidelines presented in the following rubrics. The scientific paper has been evaluated using the rubric for goal #3.

POSTER PRESENTATION	
Content	
5	Emphasis on student testable, novel hypothesis that would extend research in the field.
	All required components included (Abstract, Introduction, Methods and Materials, Results, Discussion, Acknowledgements, Literature Cited) with correct and necessary information included in each section.
	Rigorous experimental data and appropriate statistics presented with emphasis on student interpretation of data.
3	Reasonable hypothesis but difficult to test, not completely novel and would not really extend knowledge in the field.
	All required components included but some with information in wrong section or not included.
	Experimental data and statistics presented data not overly rigorous, statistics unclear or incomplete, student interpretation of data not emphasized.
1	Hypothesis not testable, novel or adequate. No extension of knowledge beyond that already known would result.
	Some components missing and information incomplete.
	Experimental data weak, statistics inappropriate or absent, no novel data interpretation by student.
Tables/Figures	
5	Used effectively and appropriately (proper use of table versus figure, proper type of figure used), high quality with title positioned properly and axes properly labeled.
3	Need for better use of visuals, not all tables/figures of the appropriate type, average quality with mistakes in title positioning or some axes either not labeled or labeled incorrectly.
1	Visuals not used effectively, inappropriate type of table/figure used, minimal quality with title incorrectly positioned or missing and most axes not labeled or labeled incorrectly.
Use of Literature	
5	Thorough search of the literature with fundamental papers used, minimum of 10 relevant, recent (last decade) primary papers used, all in-text citations formatted correctly, Literature Cited formatted correctly.
3	Most literature used was appropriate, but at least one fundamental paper was not found or used, incomplete search of literature but at least 6 relevant, recent primary papers used, most in-text citations formatted correctly, minimal mistakes in Literature Cited section.
1	Student's search of the literature incomplete with crucial papers not found or used, fewer than 6 relevant, recent primary papers used, many mistakes on in-text citations and Literature Cited section.
Aesthetics	
5	Correct spelling, grammar, and punctuation, only main points presented with text minimized and emphasis on tables and figures, tables and figures large and easy to read, text readable from a distance, professional colors used, all margins cut straight, no glue showing, layout correct.
3	Occasional but limited errors in spelling, grammar, or punctuation, too much text with some tables and figures difficult to read, text readably from a distance but should be a bit larger, colors distracting, some margins cut unevenly, minimal glue showing, layout acceptable but some pieces out of place.
1	Heavily flawed with frequent errors in spelling, grammar, and punctuation, too much text, tables and figures minimal, text too small to read from a distance, colors friggin' ugly, many margins uneven and much glue showing, layout with many pieces out of place.

ORAL PRESENTATION	
Content	
7-10	Emphasis on student testable, novel hypothesis that would extend research in the field.
	All required components included (Abstract, Introduction, Methods and Materials, Results, Discussion, Acknowledgements, Literature Cited) with correct and necessary information included in each section.
	Rigorous experimental data and appropriate statistics presented with emphasis on student interpretation of data.
3-6	Reasonable hypothesis but difficult to test, not completely novel and would not really extend knowledge in the field.
	All required components included but some with information in wrong section or not included.
	Experimental data and statistics presented data not overly rigorous, statistics unclear or incomplete, student interpretation of data not emphasized.
1-2	Hypothesis not testable, novel or adequate. No extension of knowledge beyond that already known would result.
	Some components missing and information incomplete.
	Experimental data weak, statistics inappropriate or absent, no novel data interpretation by student.
Knowledge of Material	
5	Clear confident presentation with audience questions answered in a way to illustrate a complete knowledge of the topic.
3	A good presentation but lacking clarity or confidence with inability to answer some audience questions.
1	An awkward, weak presentation with inability to handle audience questions.
Delivery	
5	No reading from notes or screen, eye contact with audience, appropriate voice inflection, no annoying mannerisms, no usage of um/uh or stumbling over words, proper time allowed for each slide, professional clothing.
3	Some reading from notes or screen, some eye contact with audience, minimal voice inflection, few annoying mannerisms, some usage of um/uh and some stumbling over words, some slides rushed through, clothing acceptable.
1	Over-reliance on notes or screen, minimal or no eye contact with audience, no voice inflection (monotone or robotic), many annoying mannerisms, excessive usage of um/uh and much stumbling over words, slides rushed, clothing not professional.
Visual Aids and Aesthetics	
5	Correct spelling, grammar, and punctuation, only main points presented on slides without being text-laden, tables and figures appropriate, axes labeled, large and easy to read, professional colors and background used.
3	Occasional but limited errors in spelling, grammar, or punctuation, some slides too busy with too much text, some tables and figures difficult to read, some mistakes in title positioning, colors or background distracting.
1	Heavily flawed with frequent errors in spelling, grammar, and punctuation, slides with too much text, tables and figures inappropriate or with too much small, hard to read data, colors and background inappropriate.

ASSESSMENT DATA

The following data will be collected and averaged:

- The average improvement scores for objective 1, and evaluation of syllabi for direct ties to evolutionary concepts
- List of classes taken and grades for objective 2.

- Three papers, one from the freshman year, one from a research project the student designed, and the senior seminar capstone paper, will be collected and evaluated using the rubric for objective 3 by the senior seminar instructor.
- Evaluation scores for objective 4

We have not fully settled on the plan of action on our assessments in Goal 3. We are considering the following possibilities:

- Evaluate all three papers collected using the same rubric – the instructor responsible for the senior seminar grade will do the evaluation for students during the senior seminar semester. Transfer students without three papers to evaluate will be excluded from the analysis.
- Until fall of 2008, we will not have freshman papers to compare to senior papers, Therefore, only papers from senior seminar will be evaluated to assess Goal #3 until fall of 2008.

Another issue, which we have not adequately addressed, is the issue of consequences for individual failure to meet the expected objectives. Obviously if the problem is wide- spread, it requires adjustments in the department teaching and curriculum. Individually, however, we need to formulate how students would be remediated in order to bring them up to the level expected by our objectives. There is a need for early feedback to allow time for remediation. Before we began developing firm criteria for performance, no student had failed senior seminar. Since we began developing the rubrics in the Fall of 2005, we have encouraged three students to drop senior seminar and retake it when they were more prepared, two students to redo analysis and posters and present later in the semester, and four students have failed. We are working to ensure that all students have the tools needed to succeed in meeting the goals of the biology department.

ANALYSIS OF ASSESSMENT RESULTS

- GREEN LIGHT –
    - At the introductory level, testing indicates that we are approaching a high level of success. Goal #1 will be judged successful if we are able to demonstrate a 25% improvement between the pre-test and the post-test scores during the freshman year and a maintenance of this through the senior year. Over 90% of syllabi should show direct relationship of evolutionary concepts.
    - Goal #2 – All students complete a course in each content area, all grades for the six courses elected by all graduating students are C- or better, and less than 10% must repeat courses to achieve this goal.
    - Goal #3 – Three papers are placed in the student's portfolio, there is an average of 10% improvement from freshman to junior and from junior to senior, and the average review score for seniors is 10 or better.
    - Goal #4 – At the completion of Senior Seminar capstones, the oral presentation scores average 20 or better and poster evaluation scores average 15 or better.

- YELLOW LIGHT –
    - Goal #1 – Definite improvement between pre and posttests but less than 25 %. Seventy five percent of syllabi for majors courses show direct relationship to evolutionary concepts.
    - Goal #2 – Some students are not completing one or more of the content areas, or more than 10% must repeat courses to achieve a C- or better in each.
    - Goal #3 - Three papers have been placed in the students portfolio, with less than 10% improvement. Average evaluation score for the senior paper is 9.
    - Goal #4 – Average evaluation score for the oral presentation is between 18 and 20, and the poster score between 13 and 15.

- RED LIGHT –
    - Goal #1 - Little or no improvement between pre and post-tests, or little retention of concepts. Less than 75% of syllabi for majors courses show direct relationship of evolutionary concepts.
    - Goal #2 – More than 10% of students do not complete one or more of content areas, or more than 15% must repeat courses to achieve C- or better.
    - Goal #3 - Fewer than 3 papers in the folio, with an average evaluation score of less than 9.
    - Goal #4 - Average oral presentation score for seniors is below 18 and average poster score is less than 13.

IMPROVEMENT PLANS

How we might meet the goals of the department:

Goal #1 – We developed three different versions of the pre-post test and have used each, improving it. The first version had no material from BI 108, and two of the questions used did not directly relate to evolution. The second version, which included concepts from BI 108 ended up being too long, requiring a whole class period to complete, and also had quite a few questions that were only tangentially related to evolution. The final version (Appendix A) is what we will use from Fall 2007 on at the beginning and end of BI 105, Ecology and Evolution, at the end of the second semester in BI 108 and at the beginning of their senior seminar course BI 481 or 482. Faculty efforts to incorporate evolution into their courses will be judged by the course syllabus. All syllabi should contain specific examples of how evolution will be used, and will be assessed by department chair.

Goal #2 – The first step in completing this goal was to develop a list of courses that provide meaningful exposure to the six areas of emphasis in Biology (shown in Appendix B). We submitted our curricular changes to the Division of Natural Sciences and Mathematics and to the College of Arts and Sciences for approval in November 2006, and began to use the new requirements for biology majors entering in the Fall of 2007. We have developed a check sheet to be included in the advising folder of each student. It will be the annual responsibility of the advising professor to check the progress of advisees to be certain they are in compliance both for exposure and grades. The number falling into the C- or below category will be used to assess our effectiveness in giving the students the exposure they need.

Goal #3—During the spring semester of 2006, we collected and evaluated the writing of seniors in the Senior Seminar course BI 482. We used the results to determine the appropriate standard that students should meet in order to deem our teaching efforts acceptable. We began collecting papers from BI 155 in the fall of 2005, will ask for course research papers beginning with this class of students for junior and senior project classes, and will have data in spring of 2009 to compare freshman, junior, and senior papers. These papers will be evaluated by the senior seminar instructor using the writing rubric for Goal #3 and placed in their student folders.

Goal #4 – The senior seminar instructor evaluates the performance of seniors in the seminar course BI 482 using the evaluation rubrics on oral presentations, posters, and papers.

Results from 2007/2008, compared to preliminary results from 2005/2006 and results from 2006/2007

Goal #1 *Understand and be able to apply the concepts of evolution and natural selection*.

Summary of the Evolution assessments for 2007/2008

When we gave the test to EE students early in the semester, 17 students took the exam, averaging 8.82 out of 25. At the end of the semester, 15 students took it, and averaged 15.3.

Neither AOL instructor gave the assessment during BI 108, so those data are lacking for 2008.

The 30 seniors who took the assessment in 2007/8 senior seminars averaged 15.3 of 25. One senior earned a 23-25, five 20-22, one 18-19, ten 15-17, and 13 below 15.
In 2006/2007, 35% of seniors did not earn at least a 60% on the assessment. In 2007/2008, 43% of the seniors did not pass the assessment.

Table 1. Breakdown of percent correct answers for each question on the pre and post test for knowledge of evolution

Question	% Correct New Freshmen* (17)	% Correct Midyear Freshmen* (15)	% Correct Senior Seminar (30)
1 Species	47	100	90
2 Evolution	23.5	80	63.3
3Adaptation	41.1	73.3	76.7
4 Mutation	94	100	96.7
5Analogous	47	40	66.7
6 Vestigial	23.5	86.6	80
7 Nat. Sel	23.5	60	90
8 Converg.	0	66.6	56.7
9Wallace	58.8	60	73.3
10 Char. Dis	0	66.6	23.3
11 Lyell	17.6	33.3	56.7
12 Mech. (5)	49.4	82.7	65
13aNatSel	29.4	66.6	53.3
13bMutatio	11.7	20	30
14 Direc.Sel	41.2	53.3	66.7
15 Disr. Sel	47	53.3	60
16 Phylog.	52.9	100	100
17 Fitness	0	66.7	56.7
18. Variatio	52.9	66.7	86.7
19 Endosym	0	60	70
20 Nat Sel	13.7	48	45
Average 2007/2008	8.82%	61.2%	61.2%

Average 2006/2007	23.11%	63%	60%
2005/2006	28.4	78.8	75.6%

The data from all three years have similar trends, showing that the students do not have much understanding of evolution when they start the program, and that their performance improves much more than our 25% target, with more than 3 times as many right answers on the test at the end of the first semester. The retention of the basic understanding of evolution was similar, with scores from senior seminar being very similar to scores on the ecology and evolution post test. We will ensure that students know that all but the pre-test, given at the beginning of BI 105, will count as at least quiz grades for the students. In senior seminar, students have known that the "test" would not affect their grades, and some have not devoted appropriate time to completing the test in a way that we can really assess retention and understanding.

In addition to the above effort to assess our teaching of evolution as a central theme of biology, the faculty developed new syllabi for courses taught starting in the spring of 2006 including departmental goals and a demonstration of how evolution is addressed in each course. In spring 2006, only 6 of 14 majors syllabi included departmental goals (42.86%), and only 3 of the 14 showed directly how evolution is addressed in the course (28.57%). In both 2006/2007 and 2007/2008, all biology majors' course syllabi included departmental goals (100%). Seventy-five percent of Fall 2006 syllabi, and eighty percent of Spring 2007 syllabi, directly demonstrated how courses covered evolutionary themes. In fall 2007, 81.8% and in spring 2008, 91% of the majors courses directly demonstrate how evolution is incorporated into them, (Table 2 a and b). We will encourage further improvement in intentional linkage of evolution to material in the remaining courses.

Table 2a. Direct coverage of evolution on syllabi for Fall 2007 Classes for Biology Majors

Class	Instructor	Evolution directly addressed
BI 105 Ecology and Evolution	Parrish and Robertson	Yes and Yes
BI 206 Anatomy and Physiology I	Burgoon	No
BI 300 Genetics	Matthews	Yes
BI 302 Histology	Burgoon	Yes
BI 303 Entomology	Robertson	Yes
BI 306 Animal Physiology	Wilkinson	Yes
BI 314 Ecology	Horn	Yes
BI 326 Plant Biology	Parrish	Yes
BI 413 Advanced Cell Biology	Handler	Not for all
BI 407 Molecular Genetics	Galewsky	Yes

Table 2b. Direct coverage of evolution in syllabi for Spring 2008 Classes for Biology Majors

Class	Instructor	Evolution directly addressed
BI 108 Attributes of Life	Matthews and Hughes	Yes and No
BI 207 Anatomy and Physiology II	Burgoon	Yes
BI 301 Comparative Anatomy of Vertebrates	Burgoon	Yes
BI 305 Cell and Molecular Biology	Galewsky	No
BI 307 Parasitology	McQuistion	Yes
BI 322 Neurobiology	Handler	Yes

BI 323 Animal Behavior	Robertson	Yes
BI 324 Ornithology	Horn	Yes
BI 330 Microbiology	McQuistion	Yes
BI 404 Evolution	Matthews	Yes
BI 414 Human Side of Medicine	Handler	Yes

For Goal #2 *Have exposure to the following general areas of biology: ecology, taxonomy, morphology, function, molecules/cells and genetics/ reproduction.*

The Biology Department determined which courses best cover the six general areas of biology, with one course fitting into no more than two categories. Each student must choose which of the two categories that course will satisfy. After a review of transcripts of 20 recent graduates in the three general tracks, we found that our Allied Health students were often not taking courses that cover ecological concepts. Because their programs are often very tight, we decided to allow the summer immersion, field ecology (BI 220) to count to satisfy the ecology area for Allied Health. We submitted our proposal to require all biology majors to successfully complete at least one course from each of the six content areas (Appendix B) for division and school approval. This requirement became effective for students entering the program during the 2007/2008 academic year, but we encourage our more senior students to study in all six areas. During the approval process, the acceptable grade for successful completion was changed from a "C" to a "C-". In 2006/2007, 17.26% of the students of the content area courses taught in the fall, and 16.04% of the students taking content area courses offered in the spring, received grades below "C" and would have had to repeat the course or take another course in the content category to complete the program. With the change to acceptance of a "C-", in fall of 2006 only 7.1% and in spring of 2007 only 8.33% of the grades were below C- in content area courses. In fall 2007, only 8.94% and in spring 2008 only 6.94% of the grades earned were below C- (Table 3).

Table 3. Biology courses for majors

Fall 2007 Course offerings			
Course Title	Course Number	Number enrolled	Number with C- or lower
Genetics	BI 300	42	6
Histology	BI 302	11	1
Advanced Cell	BI 413	10	0
Molecular Genetics		15	0
Animal Phys	BI 306	12	1
Ecology	BI 313	14	0
Plant Biology	BI 326	9	2
Senior Seminar	BI 481	10	1
		123	11
Percent below Cutoff Grade of C-			8.94%

Spring 2008 Course offerings			
Comp. Vert. Anat	BI 301	5	1
Molec. Cell Biol	BI 305	36	2
Parasitology	BI 307	11	0

Neurobiology	BI 322	16	0
Animal Behavior	BI 323	6	2
Ornithology	BI 324	9	1
General Microbiol	BI 330	19	1
Evolution	BI 404	11	1
Humanistic Med.	BI 460	7	0
Senior Seminar	BI 482	22	2
		144	10
Percent Below Cutoff Grade of C-			6.94%

Goal #3 *Be able to use and apply critical thinking to life situations. (This success is inferred by their ability to write critically in biology)*

Most of our courses emphasize application of concepts to life situations. Most of our students take genetics as sophomores, and the rest take Anatomy and Physiology. In both, there is considerable emphasis on application of concepts. Our efforts to evaluate this goal began in the Spring 2006 semester. For their Senior Seminar course (BI 482), all seniors are required to write a critical paper on a research topic they are actively involved in via independent research or as a strong interest. Scores for the ten students in fall 2007 senior seminar ranged from 10 – 15/15 on the paper, 10 – 19/20 on the poster, and 16 – 24/25 on the oral presentation (Table 4).

Table 4. Individual scores on departmental rubrics for evaluating senior seminar performance. Fall 2007 Senior Seminar

Student Category	1	2	3	4	5	6	7	8	9	10	Mean
Total Paper	**12**	**14**	**11**	**13**	**12**	**15**	**11**	**12**	**12**	**10**	**12.2**
Format	4	4	3	4	3	5	3	5	4	4	3.9
Design	4	5	4	5	4	5	4	3	4	3	4.1
Conclusions	4	5	4	4	5	5	4	4	4	3	4.2
Total Poster	**19**	**14**	**15**	**15**	**17**	**15**	**18**	**12**	**18**	**10**	**15.3**
Content	5	3	4	3	4	3	4	3	5	3	3.7
Tables/Fig	5	4	4	4	5	4	4	3	4	3	4.0
Lit Use	5	3	4	3	3	3	5	3	5	2	3.9
Aesthetics	4	4	3	5	5	5	5	3	4	2	4.0
Oral Total	**23**	**17**	**19**	**16**	**21**	**19**	**17**	**16**	**24**	**20**	**19.2**
Content	10	7	8	4	7	6	7	7	10	7	7.3
Knowledge of Material	5	4	3	3	5	4	4	3	5	4	4.0
Delivery	4	3	4	5	4	4	3	3	5	5	4.0
Visual Aids and Aesthetics	4	3	4	4	5	5	3	3	4	4	3.9

From the average scores for the format, design and conclusion categories of the senior seminar paper, our department concluded that a cutoff of around 10 points could be used as an indicator of teaching success for data evaluation and curriculum improvement decisions. Perhaps 11-12 points would be a more rigorous green light.

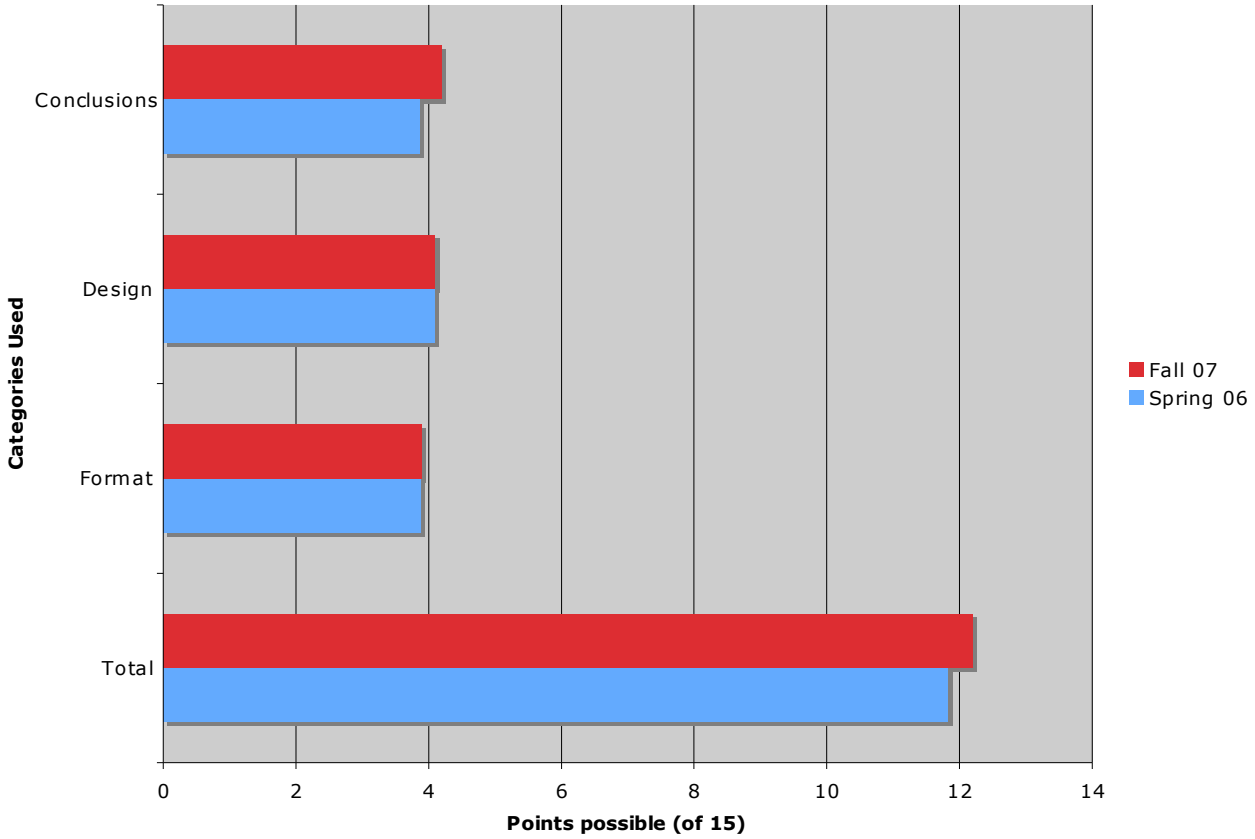

Figure 1. The mean scores for written reports required for senior seminar in biology. Data were only available from rubrics for Spring 2006 and Fall 2007.

We did not have papers from the same students from BI 105 and the course that included a research project to make comparisons and analyze changes. We will be able to do that starting in the Fall of 2008. Papers from senior seminar were not evaluated according to the same rubric in Fall of 2006 and Spring of 2007, as faculty were not satisfied with the rubric. We modified the rubric, and used it in fall of 2007. That rubric will be used to evaluate three papers from each student from BI 155, an upper level course with a required student project, and the senior seminar paper, once the student completes senior seminar. The full assessment, including improvement in individual writing proficiencies, will be assessable beginning in fall 2008.

Goal #4. *Be able to present in oral or written form a completed research project, using testable hypotheses, logical arguments and appropriate methodologies and equipment.*

This goal is assessed by means of a poster and an oral presentation in the Senior Seminar Course. Students are required, using either personally conducted wet bench research or using published literature, to develop a testable hypothesis and then proceed to develop a logical argument supporting or falsifying that hypothesis. This is often easier to do with experiments actually performed by the student. Twenty students were evaluated during the spring semester 2006, 13 in Fall 2006, and ten in fall 2007 (Fig. 2).

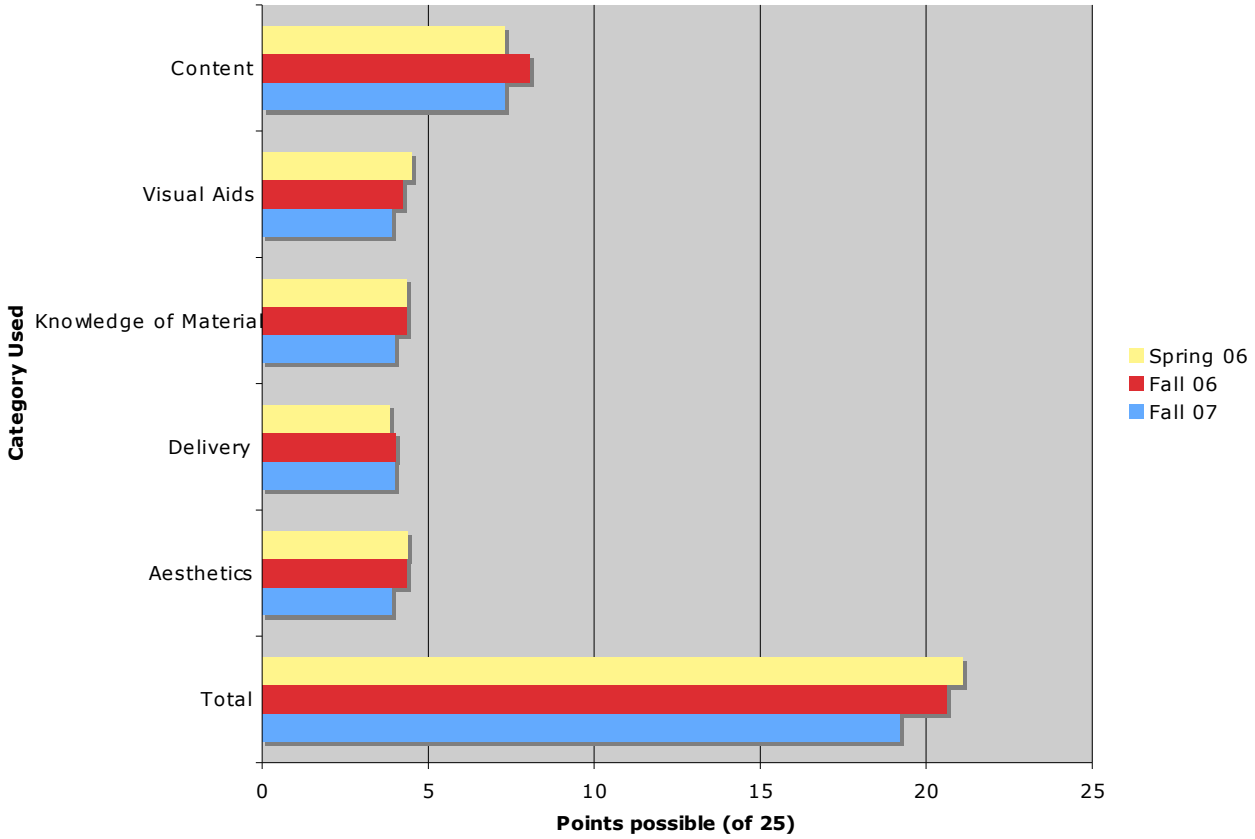

Figure 2. Mean scores for different areas of oral evaluation, from a total of the five areas, for spring and fall of 2006 and fall of 2007. In the new rubric, points possible for content changed from 5-10 in 2007, and visual aids and aesthetics were combined for only 5 points. For 2006 comparisons, content scores were doubled. For 2007, the same score is compared for visual aids and for aesthetics. The total score remains 25. Only semesters for which the rubric was used are included.

Prior to their oral presentations, students constructed and displayed a poster using guidelines appropriate for a national meeting. The average score of 17 for the students in Spring 2006 is above the minimum average score of 16 set by the department at the beginning of the study, but averages in falls of 2005, 2006, and 2007 were below the standard. Since fall 2007 when we began requiring that students use a poster template for an electronic poster, poster quality has improved (Attachment C and D). Mean scores on the posters fell below 15, or 75%, only in fall of 2006 (Fig. 3).

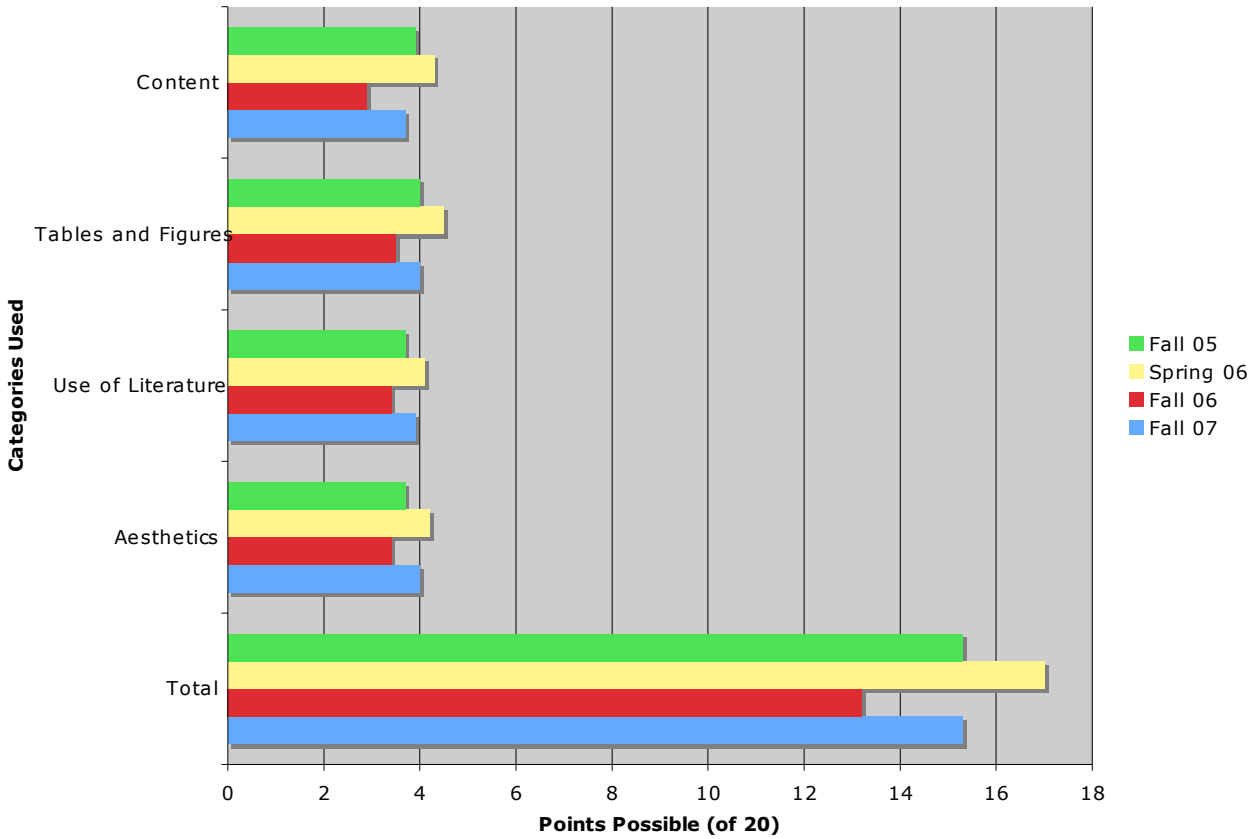

Figure 3. Mean poster evaluations scores for each area of evaluation and totals for fall 2005, spring 2006, fall 2006, and fall 2007, when the rubrics were used.

Report Summary

Overall it appears that we have set realistic goals and that progress is being made toward achieving these goals.

- Goal 1. Freshmen students demonstrated a more than 25% improvement, from 8.82% to 61.2%, in their knowledge of evolutionary principles. From the test results of graduating seniors, this knowledge appears to be retained fairly well. Seniors performed very similarly to the students who had freshly studied evolutionary principles, 60%. Green light.

  Biology faculty are successfully showing how evolution is incorporated into their majors courses, with over 80% demonstrating how courses directly relate to evolutionary concepts. Green to yellow light.
- Goal 2. In the fall of 2007, biology majors took 123 upper division classes that meet the criteria for goal #2, with 112, or 91%, earning a C- or above. In the spring of 2008, 144 upper level classes were taken, with 134, or 93%, earning a C- or above. There were 32 seniors, two of whom did not successfully complete the requirements for graduation. Three additional students graduated without having successfully completed an ecology content area course. Although we will not require the 6 content areas of students who are juniors and seniors at this time, we are monitoring each student folder to keep track of distribution of courses and grades. This responsibility needs to be completed by faculty advisors, but is not at this time. Green to Yellow light.

- Goal 3. Results assessing the critical skills of our students using scientific reports show that our seniors have developed the skills we feel are necessary for them to succeed in their future career. The average score for evaluating paper format, design and conclusions was 12.2 out of 15 for fall 2007. This exceeds the minimum cutoff value of 10 which indicates we are providing satisfactory instruction for students to succeed in this area. In spring 2008, average grade for the papers was 85.9%, the equivalent of 12.9 of 15. We collected BI 155 papers from all 2005-06 freshmen to put in their portfolio folders, and will ask them to include a research paper when they take a course requiring a project. These papers will be evaluated with the rubric at the time of their senior seminars. Yellow light, as the group for whom we started collecting the papers will not take senior seminar until 2008/2009.
- Goal 4. Average oral presentation scores for the ten students in fall 2007 were 19.2, just below the cut off value we established of 20 for a "green light". The twenty students in senior seminar spring 2008 averaged 90.5% on their presentations, equivalent to 18.1 of 20. Oral presentation grades averaged 87% for 16 students in spring 2007. Although the rubric was not used, similar criteria were used, and the rubric "cut-off" for a green light was 20/25, or 80%.
  Poster scores fell below the 15/20 for a "green light" only in the fall of 2006, while the mean was 17 in Spring 2006 and 15.3 in both falls 2005 and 2007. Poster mean grades were 69% (13.8/20) in spring 2007 and 89.95% (17.8/20) in spring 2008. Green light.
- Although the rubrics have not been used consistently yet in grading, we have found that having them, and making them available within the syllabus for senior seminar, has made expectations more clear to our students and evaluation more consistent. The responsibility for instructing senior seminar rotates through the department, with a different person in charge each semester.

APPENDIX A

Evolution and Natural Selection Survey – Biology Department

Name_____

1. Natural populations of organisms that can interbreed and produce fertile young and are reproductively isolated from other such groups are known as _____.
2. A change in frequency of a particular trait in a population over time is_____.
3. A particular structure, behavior, or physiological function that allows organisms possessing it to survive and reproduce more than individuals in the population that lack it _____.
4. A permanent change in a cell's DNA, usually caused by errors in copying the DNA, that is the raw material for evolution_____
5. A structure with similar function but different ancestral origins is a(n)_____ structure. (Example: bee's wings and bird's wings)
6. A structure that no longer has a function in an organism, that has a function in related organisms, is a(n)_____structure. (Example: pelvic bones in whales)
7. What is **the** mechanism of adaptive evolution?_____
8. The apparent similarity between marsupial mammals in Australia and ecologically equivalent mammals in other parts of the world is an example of _____ evolution.
9. _____ came up with a theory of evolution by natural selection independently of Darwin, and caused Darwin to hurry to publish.
10. Divergent evolution in which two species evolve away from one another, acquiring greater differences, as a result of competition or the risk of lowered survival and fertility caused by hybridization_____ _____
11. _____ wrote *Principles of Geology,* a book that Darwin took with him on his voyage and convinced him that the earth is old enough for evolution to have occurred.
12. The five major mechanisms of evolution are:
    _____
    _____
    _____
    _____
    _____

13. What TWO evolutionary mechanisms play a major role in resistance to HIV?_____ and _____ _____.
14. A type of natural selection that acts to eliminate one extreme from an array of phenoptypes is called_____ selection.
15. A type of natural selection that eliminates intermediate phenotypes while favoring both extremes is called _____ selection.
16. The evolutionary history of an organism, represented in the form of an evolutionary tree, is called _____.
17. The genetic contribution of an individual to succeeding generations, a relative term comparing the contribution of one individual to others in a population gene pool _____.
18. The advantage of sexual reproduction over asexual reproduction is that sex generates _____ _____ (which makes evolution by natural selection possible) and asexual does not.
19. The _____ Theory suggests that chloroplasts and mitochondra of eukaryotic cells were derived from bacteria living in other bacteria.
20. Explain the mechanism of natural selection using conditions that lead to adaptation. (essay on back)

APPENDIX B

Biology Content Category Courses

Fall 2007

revised 1

Complete **One** from Each Category with "C-" or better. (Does **Not** Include First Year Core Courses)
Complete at least ONE with embedded research project OR take research (BI 391/392)

Each course may count for only one category.
(e.g., if Vert. Bio. is taken for Taxonomy, then it cannot be counted for Function or any other category

Ecology	***Taxonomy***	***Morphology***	***Function***	***Molecules/ Cells***
BI 220/320* Field Ecology (PT/OT & Allied Health)	**BI** Medical Entomology	**BI 204** Essent. of A&P **(Sec. Ed only)**	**BI 204** Essent. of A&P **(Sec. Ed only)**	**BI 300** Genetics/Lab
BI 314* Ecology	**BI 303** Entomology	**BI 206** A & P I (PT/OT, PA & Allied Health & Sec. Ed.)	**BI 206** A & P I (PT/OT, PA & Allied Health & Sec. Ed.)	**BI 302** Histology
BI 323* Animal Behavior	**BI 307*** Parasitology	**BI 207** A & P II **(PT/OT, PA & Allied Health)**	**BI 207** A & P II **(PT/OT, PA & Allied Health)**	**BI 305** Molecular and Cell Biology/Lab
BI 380* Ecological Journey	**BI 325*** Vertebrate Biology	**BI 301** Comparative Anatomy	**BI 301** Comparative Anatomy	**BI 312** Immunology
	BI 326* Plant Biology	**BI 302** Histology	**BI 304** Developmental Anatomy	**BI 330*** Microbiology
	BI 328 Ornithology	**BI 303** Entomology	**BI 306** Animal Physiology	**BI 407*** Molecular Genetics
	BI 330* Microbiology	**BI 304** Developmental Anatomy	**BI 308*** Plant Physiology	**BI 413** Advanced Cell Biology
	BI 380*	**BI 322**	**BI 312**	

	Ecological Journey	Neurobiology	Immunology		
	BI 404 Evolution	**BI 326*** Plant Biology	**BI 322** Neurobiology		
			BI 325* Vertebrate Biology		
			BI 328 Ornithology		
			BI 413 Advanced Cell Biology		

*__Courses with student/designed research projects – students must take at least one of these courses__

Appendix C. Examples of posters.