## Millikin University Student Learning in Biology

#### Department of Biology Chair, Judy Parrish Division of Natural Science and Mathematics July 1, 2016

# <u>GOALS</u>

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.
- <u>Goal 2</u> 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, stem cell research, reproductive issues, etc.

<u>Goal 3</u> 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

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

as a person and

evolution is intentionally included in all appropriate courses taught in the department. How it is incorporated is described in each course syllabus.

Goal #2, the exposure to the various areas of biological study, involves emphasis on the approaches taken to study six major areas of biology: ecology, taxonomy, morphology, function, molecules/cells and reproduction/genetics (Appendix B). Because students are required to take courses in each of these areas, they not only gain additional understanding of the essential nature of

Fit study into broader context

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 in appropriate or absent, no novel data interpretation by student.		
Tables/Figures			
5			

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 in appropriate or absent, no novel data interpretation by student.				
Knowle	edge 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.				
Deliver	y				
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 speisherrammar, and punctuation, only main points presented on sides without being				
	text-laden, tables and figures appropriate, axes labeled, large and easy to read, professional colors				
0	and background used.				
3	Occasional but limited errors in spelsne rammar, or punctuation, some sisnees too busy with too				
	much text, some tables and figures difficult to read, some mistakes in title positionshel of's of				
	background distractshel				
1	Heaving flawed with frequent errors in spelishe rammar, and punctuation, slides with too much				
	text, tables and figures in appropriate or with too much small, hard to read data, colors and				
	background inappropriate.				

## ASSESSMENT DATA

The following data are collected and averaged:

The average improvement between pre- and post- scores on the evolution assessment in Ecology and Evolution, the average score on the evolution assessment given in Diversity of Life, and the average score for evolution assessments for both semesters of senior seminar. The percentage compliance of syllabi for direct ties to evolutionary concepts List of classes taken and grades below C- for objective 2. The ETS field test is also used in assessment of this goal.

Two papers, one from the freshman year, and the senior seminar capstone research paper, are collected and evaluated using the rubric for goal #3 (see above rubric). Transfer and other students without the first paper to evaluate are excluded from the analysis.

Evaluation scores for objective 4 for paper, poster, and presentation We also have assessments of biology secondary education majors available through LiveText on performance of students on the Candidate Assessments and Program Assessments necessary for completion of an NCATE-accredited teacher education program in biology. Results from rubrics for assessing Student Learning (CA10), Social Context of Science (SCI PA8) in two sections, and a science lab safety manual (SCI PA6) are reported.

## ANALYSIS OF ASSESSMENT RESULTS

GREEN LIGHT

- At the introductory level, testing indicates that we are approaching a high level of success. Goal #1 is 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 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 20% improvement from freshman to senior, and the average review score for seniors is 12 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 post-tests 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 Two papers have bee improvement. A verage evaluation score for the senior paper is 11.
- o Goal #4 Average evaluation score for the oral presentation is between 18 and 20,

RED LIGHT

- Goal #1 Little or no improvement between pre and post-tests, or little retention of concepts. Less than 75% of syllability 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.
- o Goal #3
  - evaluation score for the senior paper of less than 11.
- Goal #4 Average oral presentation score for seniors is below 18 and average poster score is less than 13.

\* Results from 2015/2016, compared to results from 2005/2006 to 2014/2015.

Goal #1 Understand and be able to apply the concepts of evolution and natural selection. Summary of the Evolution assessments for 2015/2016

When we gave the test to Ecology and Evolution students early in the semester, 67 students took the exam, averaging 7.01 out of 25 (Table 4). At the end of the semester, 57 students took it, and averaged 17.5 of 25, improving by 41.9 percentage points.

In Diversity of Life, 38 students took the exam, and averaged 16.1 of 25 points

Table 5. Direct coverage of evolution on syllabi for Fall 2015 and Spring 2016 Classes for Biology Majors

Instructor	Evolution directly addressed
Parrish, Robertson, and Wilcoxen	Yes, Yes, Yes
Parrish, and Schroeder	Yes, Yes
Hughes	Yes
Handler	Yes
Robertson	Yes
Schroeder	Yes
	Instructor Parrish, Robertson, and Wilcoxen Parrish, and Schroeder Hughes Handler Robertson Schroeder

\* Table 6. Courses that meet biology content area requirements for majors, number of biology majors enrolled in each course, and number of students failing to meet the required C-.

CourseTitle	Course Number	Number Enrolled	Number earning D+ or
			below
*A&PI	BI 206	19	0
*A&PII	BI 207	5	0
Genetics	BI 300	37	4

Since Spring 2010, we have required that our seniors take the Educational Testing Service field exam for biology (Fig. 1).



Figure 1. Educational Testing Services Biology Field Test Scores for Millikin seniors 2016.

In 2015/2016, 21 of 33 students (64%) scored at least 150, at the 40<sup>th</sup> percentile or above for all students taking the exam nationwide (scaled overall test score ranges from 120 200). The range of scores was 133 - , 15 of the 24 seniors (62%) taking the

exam scored 150 or above, in 2013/2014, 13 of 21 seniors taking the exam (62%) scored 150 or above; in 2012/2013, 14 of 22 (64%), 15 of 23 (65%) in 2011/2012, and 15 of the 21 (71%) in 2010/2011 s 154.5, compared to 151.8 in 2015, 153.38 in 2014, 154.45 for 2013, 150.8 for 2012, 156.24 in 2011 and 152.05 in 2010. Six of the 33 students taking the exam this year scored above the 75<sup>th</sup> percentile nationwide.

Of the four main subsets of scores, Millikin students performance was above the national averages for population biology, ecology, and evolution, organismal biology, and cell biology, and slightly below the national average for molecular biology and genetics (Table 8).

Tational average for each subset for 2013.					
	Cell Biology	Molecular	Organismal	Population	
		Biology &		Biology and	
		Genetics		Ecology and Evol	
Millikin 2010	52.47	49.04	50.19	56.28	
Millikin 2011	52.76	57.90	56.24	55.57	
Millikin 2012	48.78	49.42	49.63	55.0	
Millikin 2013	51.15	51.1	52.35	60.55	
Millikin 2014	52.49	52.52	51.52	56.24	
Millikin 2015	50.21	49.13	51.71	54.67	
Millikin 2016	55.39	51.27	54.0	55.52	
National Average	53				

Table 8. Mean ETS Biology Field test subset scores for Millikin students in 2010 - 2016, and national average for each subset for 2013.

National Average 53 2013 than 40% is in organismal plant biology for the seventh year in a row (Fig. 2). Three quarters of our students never take a plant course, so their only exposure to plants is in a small section of our Diversity of Life class in the first year. To prepare our students better for work in biology, we need to more strongly encourage most of our students to take a course in plant biology, especially those in the organismal disciplines. However, we are apparently preparing students well in most of the areas, and our students scored well in analytical skills. Our department has a strong emphasis on critical thinking and application rather than memorizing facts, and we are glad to see that this emphasis is reflected in performance. ETS assessment of goal 2, yellow to green light.



Figure 2. Average score of Millikin students for each of the subtypes of questions asked.

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, from the freshmen course, Ecology/Evolution, to the senior course, Senior Seminar, emphasize application of concepts to life situations. In order to assess this critical thinking goal, papers from the freshman year are compared to papers from the senior year to evaluate improvement



Figure 3. Comparison of Freshme

Table 9. Mean scores on departmental rubrics for evaluating senior seminar performance. Actual range of individual scores is listed for recent semesters. Semester (Number of students) A goal of at least 20/25 points earned on the oral presentations has been reached in 9/10 of the most recent evaluated semesters, and was very close to the goal in the 10th (Table 9). In 2009/2010, only 11/32 individual presentation scores were 20 or over, and in 2010/2011, 15 of 21 scored over 20. In 2011/2012, averages were above 20/25 in both semesters, with only 7 of 24 students scoring below 20, and in 2012/2013 only 5 of 22 students did not meet our departmental standards. Seven of 13 did not meet it in 2014, with only 6 of 24 not meeting our goal in spring 2015. This year, 21 of 33 students met or exceeded the goal of 20/25 on the oral presentations. Again, generally students are meeting our expectations in all categories of evaluation of the presentation. It appears that our efforts to improve student preparation for their professional presentations are working, and we will continue to ensure that students receive early and frequent mentoring.

Secondary Education Program

are included in our assessment report). Also, until fall 2007, allied health majors

performed by 3 faculty members in a manner very similar to how posters are presented at professional poster symposia.

Another issue, which we have not adequately addressed, is the issue of consequences for individual failure of a student 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 will be remediated in order to bring them up to the level expected by our objectives. We need to be sure that all students, especially transfers, attend senior seminars so that they can understand and plan for their own capstone experience. First year students are required to attend 5 seminars each semester, but students who transfer into the department as upper classmen sometimes attend only when they are enrolled. Advisors need to strongly encourage our transfer students to attend and to start thinking about what they will choose to work on for their capstones. There is also a need for early feedback to allow time for remediation on projects. Some students do excellent research with a faculty member, worthy of presentation at regional and national meetings, or even publication. Others have worked with little mentoring, often

performance, no student had failed senior seminar. Since we began developing the rubrics in the Fall of 2005, we have encouraged five students to drop senior seminar and retake it when they were more prepared, eight students to redo analyses and posters and present later in the semester, three to take an incomplete and prepare an acceptable analysis over the summer or winter break, and five students have failed. Students are now required to work with a mentor throughout the preparation for senior seminar, and that mentoring relationship is becoming more formalized and successful. Students cannot sign up for the class until they have written approval from a mentor and an approved topic. Average scores on paper, poster, and presentation have improved and are more consistently reaching the standards adopted by the department. We are working to ensure that all students have the tools needed to succeed in meeting the goals of the biology department. We also plan to start keeping our own data about what our alums are doing, with senior seminar mentors responsible for keeping up with each student (via phone, visits, Facebook, e-mail, etc.).

### 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 28.04% to 70%, in their knowledge of evolutionary principles. At the end of the next semester, freshman scored 64.5%. From the test results of graduating seniors, this knowledge appears to be retained fairly well. Seniors performed even better than the students who had freshly studied evolutionary principles, 78.4%, retaining the concepts well. GREEN light.

Biology faculty are successfully showing how evolution is incorporated into their majors courses, with all demonstrating how courses directly relate to evolutionary concepts. GREEN light.

Goal 2. In 2015/2016, biology majors took 224 upper division classes that meet the criteria for goal #2, with 92% of students earning a C- or above. The responsibility of keeping track of successful progress for each student needs to be completed by faculty advisors, and we are making some progress along these lines. GREEN light.

Scores for Millikin students on the ETS biology field tests exceed or are very close to national averages (for students completing programs that choose to use the test), demonstrating that our program is effective at preparing students in biology. We have results slightly above the national averages in 3 of the 4 subsets of the discipline on the ETS test. Our students also perform below standards in plant organismal biology, an area not required in our program. YELLOW to GREEN light.

Goal 3. Results assessing the critical skills of our students using scientific papers show that our seniors have developed the skills we feel are necessary for them to succeed in their future careers. The average score f design and conclusions was 13.78 out of 15. This exceeds the minimum cutoff value of 12, which indicates we are providing satisfactory instruction for students to succeed in this area. We

# APPENDIX A Biology Content Category Courses Fall 2012 revised 6-1-2012 BIref\* 136.9 5 EM.62 65t16 0.48 f\* []TMT

Complete from Each Category with "C-" or better. (Does include First Year Core Courses)						
Each Course May Count for Only ONE Category (e.g., if BI 325 Vert.Bio is taken for Taxonomy, then it cannot also be counted for Morphology or any other category.) Refer to "Biology Projected Course Offering Schedule" for availability of specific course.						
Field Ecology	Entomology	Essen. Of A&P	Essen. Of A&P	Genetics	Genetics	
Ecology	Virology	A & P I	A & P I	Histology	Animal Behavior	
Animal Behavior	Ornithology	A & P II	A & P II	Molecular	Evolution	

and Cell Biology

