

Name of Program/Department:	Department of Biology
Year:	2017-2018
Name of Preparer:	Ann Stoeckmann, Ph.D.

Biology Department Mission

The mission of the Department of Biology is to produce scientifically literate graduates who display robust knowledge of biological principles from molecules to ecosystems. We train our undergraduate students to use their critical thinking skills and mastery of biological principles to perform inquiry into the biological world and effectively convey biological information. We are committed to experiential learning including laboratory, field, and research experiences. Students graduating from this program will be well prepared for a variety of professional careers or entry into graduate school programs.

Program Learning Outcomes:

The Biology Department prepares students who:

1. understand major concepts in the biological sciences.
2. think critically and apply scientific principles to reach conclusions.
3. use the scientific approach.
4. communicate cogently.

Executive Summary of Report

Presented in this report are the Biology Department's Mission, Program and Student Learning Outcomes, the assessment and results of each, and action items.

Achievement of our senior biology majors on concept knowledge and critical thinking skills (SLO 1 and 2) was assessed with a cumulative exam administered in our Senior Seminar courses both semesters. The overall average on the exam increased slightly this year over last spring (about 2%) and the spring 2017 semester group met the target (SLO 1: 63.2%, SLO 2: 60.9%). In the fall the department examined the previous year's results by concept area and determined that more genetics and evolution concepts and principles needed to be reinforced in the appropriate courses. The faculty enhanced their instruction in this area by devoting additional time in lecture or lab to review and reinforce genetics and evolution concepts and but the exit exam results in that area did not improve. In order to get a better understanding of the level of achievement at which Francis Marion University biology majors begin the major curriculum, we also administered the Senior Exit Exam to students enrolled in the first course in the biology major. Although not the same cohort of students, the overall exam averages showed that students begin the major with an average achievement of 37.8% and by the time they are seniors they increase their achievement to 57.4%. The Biology Department is in the process of examining the 2017-2018 results by core area to determine where instruction needs to be enhanced to improve performance and are also investigating ways to improve our assessment methods for 2018-2019.

The Biology Department measured student achievement on use of the scientific approach and communication through student research project presentations and assignments in courses (SLO 3 and 4). The department used the rubric they developed as a more objective "direct measure" of Biology majors' competence in the application and communication of the scientific approach. The rubric was used in the Spring semester to evaluate student research presentations at our research symposiums (RED and PURE). In two of the three presentation categories evaluated, the goal was met by one of the two sets of students but neither set met the goal in the third category. The department is modifying the rubric and developing additional rubrics for use evaluating other types of student activities that incorporate the use of the scientific approach and communication in 2018-2019.

Student Learning Outcomes

SLO 1.0: Biology majors will identify key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution at an overall average at or above the 65% level.

SLO 2.0: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at or above the 65% level.

SLO 3.0: Students will explain and demonstrate how to 1) ask a question, 2) generate a credible literature review, 3) generate hypotheses, 4) execute hypothesis testing procedures, 5) organize and analyze data or information, 6) draw conclusions, and 7) produce a report to cogently communicate results at or above the 3.5 level.

SLO 4.0: Students will communicate cogently about biology at or above the 3.5 level.

Assessment Methods

Student Learning Outcomes 1 and 2:

SLO 1.0: Biology majors will identify key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution at an overall average of 65% as measured by a common Biology Exit Exam.

SLO 2.0: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at the 65% level as evaluated by the Biology Exit Exam.

Performance on student learning outcomes 1 and 2 utilized a cumulative exam-(multiple choice format). Historically, the exam has been administered to students in the Senior Seminar course but because students take that course in one of their last two semesters prior to graduation some students may not be currently enrolled in or have completed all their course work. To address this issue of timing of exam administration, we have begun administering the exam only to students in the semester they are graduating. In the Fall 2017 Senior Seminar course, enrolled students that would not be graduating until Spring 2018 did not take the exam. We followed the same procedure with the Spring 2018 Senior Seminar course. Graduating students that did not take the exam were contacted and arrangements made and they took the exam in Spring 2018.

To get an indication of how students entering the biology major perform, the cumulative exam was administered to those students in Biological Sciences I Laboratory (BIO 115L) who were taking the biology majors lecture and laboratory courses for the first time. This course is required of all biology majors. The exam was administered on the first laboratory class day within the first two weeks of the beginning of each semester (Fall 2017 and Spring 2018).

Students are expected to achieve a score of 65% or higher on the exit exam. We regard the mean percent score of the exam results to be a reasonable indicator of student-success in meeting the learning outcomes.

Student Learning Outcome 3 and 4:

SLO 3.0: Students will explain and demonstrate how to 1) ask a question, 2) generate a credible literature review, 3) generate hypotheses, 4) execute hypothesis testing procedures, 5) organize and analyze data or information, 6) draw conclusions, and 7) produce a report to cogently communicate results at or above a score of 3.5 for student presentations at RED and PURE as measured by a rubric developed by Biology Department used to evaluate student presentations.

SLO 4.0: Students will communicate cogently about biology at or above a score of 3.5 for student presentations at RED and PURE as measured by a rubric developed by Biology Department used to evaluate student presentations.

Students apply the process of science (SLO 3) and build communication skills (SLO 4) in courses in our Biology curriculum. There are opportunities to apply the process of science and to build communication skills with assignments and exercises in the laboratory portions of courses and through research projects outside of class. Students may complete independent research projects (SLO 3) and receive credit (e.g., Bio 497, Honor's Thesis) or they may take part in projects and not receive credit but receive a stipend (e.g., Biology Research Experience Program Fellows (BREP) that are supported by our INBRE grant and REAL, the University's quality enhancement program).

After completing their project students may write a report, a thesis, or a paper on their work or they may produce a poster or do an oral presentation (SLO 3 & 4). FMU has two venues on campus for presentations. One is PURE, the Biology Department's research symposium held once per semester. Another is the campus-wide Research and Exhibition Day held every spring.

To evaluate student competence in application and communication of the scientific approach, the Biology Department used a more objective "direct measure" of Biology majors' competence in the application and communication of the scientific approach. The rubric was used two times in the spring 2018 semester. It was used in evaluation of student projects presented as posters at the campus-wide Research and Exhibition Day and oral presentations at the department's PURE Symposium. Biology Department faculty not involved with the research spoke to each presenter and independently evaluated each RED poster (4 - 5 faculty) and PURE oral presentation (7 faculty) utilizing the evaluation rubric.

Because participation in RED and PURE is optional, we expect students to perform quite well on average. As such, we set a target of scores of 3.5 out of 4.0 in all hybrid areas.

Assessment Results

Student Learning Outcomes 1 and 2:

SLO 1.0: Biology majors identified key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution at an overall average of 58% as measured by a common Biology Exit Exam. Since our goal was 65%, this target was not achieved.

SLO 2.0: Biology majors demonstrated competence in critical thinking and the application of the scientific approach at the 57% level as evaluated by the Biology Exit Exam. Since our goal was 65%, this target was not achieved.

Tables 1 and 2 summarize the results for each learning outcome and include the questions in the exam that pertain to each learning outcome. Table 1 summarizes the results for the graduating seniors and includes the results from Spring 2017 for comparison. Table 2 summarizes the results for students entering the major (BIO 115L).

The overall mean on the exam did not meet the benchmark (65%). The year's average decreased, about 4.7% (from 62.1% to 57.4%). Achievement this year in the separate areas of content and critical thinking both decreased when compared to last year's results with critical thinking decreasing less.

In fall 2017 semester, the department examined the breakdown of 2016-2017 results by area. The breakdown of the results suggested a need to enhance instruction in the area of Genetics and the department worked to reinforce concepts in that area. Although more reinforcement had been incorporated, student performance did not improve in the area of Genetics .

Overall results for seniors (Table 1) were 20% higher than the students entering the major (Table 2, BIO 115L) showing overall achievement by biology students by the time they are seniors.

Table 1. Summary of results of the cumulative exam given to graduating seniors in Fall 2017 and Spring 2018. Results from Spring 2017 are included for comparison.

Learning Outcome	Assessment (Exam question that pertains to each learning outcome)	Results (Mean percent correct)	
		Spring 2017	2017-2018
1. Biology majors will identify key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution at an overall average of 65 as measured by a common Biology Exit Exam.	Concepts: 1, 2, 5-7, 9, 10, 12, 14-17, 20-23, 26, 28, 32, 34-36, 41, 43, 47-49	63.2	57.8
a. Plant Biology	5, 16, 22, 27, 29, 31, 39, 47	61.6	53.5
b. Ecology	3, 11, 12, 40, 44, 48	65.9	56.3
c. Cell and Molecular Biology	2, 7, 9, 10, 18, 20, 21, 25, 26, 28, 30, 33, 32, 36, 37, 41, 42, 49, 50	61.7	60.6
d. Genetics and Evolution	11, 17, 22, 23, 39, 46	59.6	53.2
2. Biology majors will demonstrate competence in critical thinking and the application of the scientific approach as evaluated by the Biology Exit Exam.	3, 4, 8, 11, 13, 18-19, 24, 25, 27, 29-31, 33, 27, 28, 40, 42, 44-46, 50	60.9	56.9
Number of students		41	61
Overall Exam Mean		62.1	57.4

Table 2. Summary of results of the cumulative exam given to students in BIO 115L in Fall 2017 and Spring 2018 taking the course for the first time.

Learning Outcome	Assessment (Exam question that pertains to each learning outcome)	Results (Mean percent correct)		
		Fall 2017	Spring 2018	Year
1. Biology majors will identify key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution at an overall average of 60 as measured by a common Biology Exit Exam.	Concepts: 1, 2, 5-7, 9, 10, 12, 14-17, 20-23, 26, 28, 32, 34-36, 41, 43, 47-49	39.1	35.7	37.4
a. Plant Biology	5, 16, 22, 27, 29, 31, 39, 47	27.5	25.3	26.4
b. Ecology	3, 11, 12, 40, 44, 48	46.8	43.8	45.3
c. Cell and Molecular Biology	2, 7, 9, 10, 18, 20, 21, 25, 26, 28, 30, 33, 32, 36, 37, 41, 42, 49, 50	38.7	32.4	35.6
d. Genetics and Evolution	11, 17, 22, 23, 39, 46,	38.1	38.1	38.1
2. Biology majors will demonstrate competence in critical thinking and the application of the scientific approach as evaluated by the Biology Exit Exam.	3, 4, 8, 11, 13, 18-19, 24, 25, 27, 29-31, 33, 27, 28, 40, 42, 44-46, 50	41.0	36.1	38.6
Number of students		144	91	118
Overall Exam Mean		40.0	35.6	37.8

Several factors may be responsible for the exam mean results being below the benchmark. One issue is that some questions in both learning outcomes assessed by the exam may cover content from courses that the student may have completed early in their course progression or are based on material in a subject area that is not reinforced in subsequent upper level courses (e.g., plant biology). In addition, results show that students performed better on the content-based questions (SLO 1) than they did on the critical thinking questions (SLO 2). However, that is not unexpected as critical thinking questions are more difficult. Additionally, poor performance on the critical thinking questions may be exacerbated if a critical thinking question combines content not yet covered or is from an early course and is not reinforced later.

Student Learning Outcome 3 and 4:

SLO 3.0: Students will explain and demonstrate how to 1) ask a question, 2) generate a credible literature review, 3) generate hypotheses, 4) execute hypothesis testing procedures, 5) organize and analyze data or information, 6) draw conclusions, and 7) produce a report to cogently communicate results at or above a score of 3.5 for student

presentations at RED and PURE as measured by a rubric developed by Biology Department used to evaluate student presentations. In two of the three presentation categories, our goal was met by one of the two sets of students evaluated but neither set met the goal in the third category (Scientific Thought).

SLO 4.0: Students will communicate cogently about biology at or above a score of 3.5 for student presentations at RED and PURE and as measured by a rubric developed by Biology Department used to evaluate student presentations. In two of the three presentation categories, our goal was met by one of the two sets of students evaluated but neither set met the goal in the third category (Scientific Thought).

A rubric developed by Biology Department was used to evaluate student presentations. It was used to evaluate poster presentations at Research and Exhibition Day (RED, Table 4) and oral presentations at PURE symposium (Table 5). Scoring results were averaged for questions that fit into the same broad category (“Hybrid”).

Research Exhibition Day saw 13 biology students present their work at this campus-wide event. Francis Marion Biology faculty (4-5) not involved with the research, talked to each student presenter during the poster presentation and used the rubric to independently evaluate each poster. Those data are found below (Table 4):

Table 4: Aggregated Research Exhibition Day evaluations (n = number of faculty evaluators per poster, STD = Standard Deviation). Individual scoring results were averaged for evaluators and for questions that fit into the same broad category (“Hybrid”). Results from Spring 2017 are included for comparison.

Poster number	n	Hybrid Scientific Thought Score	STD	Hybrid Scientific Method Score	STD	Hybrid Communication Score	STD
2	5	3.60	0.61	3.24	0.65	3.24	0.65
4	5	3.47	0.50	3.52	0.70	3.40	0.69
11	5	3.53	0.88	3.92	0.27	3.76	0.43
13	4	2.83	0.80	2.80	1.08	2.35	1.28
19	4	2.67	0.85	2.70	0.84	3.20	0.68
21	5	3.40	0.71	3.72	0.45	3.84	0.37
22	5	3.73	0.44	3.52	0.57	3.64	0.56
23	5	2.87	0.81	3.28	0.72	3.12	0.71
28	5	3.27	0.68	3.48	0.57	3.48	0.64
30	5	4.00	0.00	3.96	0.20	3.96	0.20
35	5	3.20	0.65	3.20	0.57	3.08	0.80
37	4	3.25	0.82	2.70	1.05	2.85	1.01
43	5	2.93	1.00	3.28	0.78	3.12	0.65
Average		3.29	0.67	3.33	0.65	3.31	0.67
(Average 2017)		(3.21)	(0.69)	(3.29)	(0.77)	(3.31)	(0.74)

Although the averages in each area were below the 3.5 target, they did all fall within one standard deviation of that number. Furthermore, individual students were able to meet and even surpass the goal of 3.5 in any given category and several students met the target in each hybrid category.

At the spring 2018 P.U.R.E symposium, five biology students presented their faculty-mentored work by giving 12 minute oral presentations about their research. Seven biology faculty evaluated each of these talks with the evaluation rubric developed by the department. Those data are found below (Table 5):

Table 5: P.U.R.E symposium evaluations (n = number of faculty evaluators per presentation, STD = Standard Deviation). Results from Spring 2017 are included for comparison.

Talk number	n	Hybrid Scientific Thought Score	STD	Hybrid Scientific Method Score	STD	Hybrid Communication Score	STD
1	7	3.71	0.55	3.83	0.45	3.83	0.45
2	7	3.62	0.49	3.69	0.57	3.74	0.50
3	7	3.52	0.66	3.63	0.59	3.54	0.60
4	7	3.00	0.93	3.29	0.70	3.29	0.66
5	7	3.19	0.66	3.63	0.64	3.69	0.52
Average (2017 average)		3.41 (3.54)	0.66 (0.60)	3.61 (3.50)	0.59 (0.68)	3.62 (3.60)	0.55 (0.59)

Averages in the hybrid categories of Scientific Method and Communication for the PURE presentations exceeded the score of 3.5 target. In addition, the average in Scientific Method increased over 2017 results. Average in the Scientific Thought category fell slightly below the 3.5 target.

Action Items

To address the concerns below we are developing an action plan to be implemented during the next academic year.

Student Learning Outcomes

SLO 1.0: Biology majors will identify key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution at an overall average of 65% as measured by a common Biology Exit Exam.

SLO 2.0: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at the 65% level as evaluated by the Biology Exit Exam.

SLO 1 and 2:

1. In 2017-2018 the program implemented an alternative scheduling for administering and scoring the Exit Exam to determine how to better assess students only in the semester in which they are graduating and so therefore would be taking or have taken all relevant course work. We decided that the exam would be administered to only students in the semester in which they graduate. In Fall 2017, the exam was administered to only those students graduating at the end of Fall semester. Likewise, at the end of Spring 2018, the exam was administered only to those students graduating in Spring 2018. Any student who completed the Senior Seminar course in the Fall 2017 semester but will not graduate until spring and therefore did not take the exam in fall, was contacted and took the exam at the end of the Spring 2018 semester. This procedure was successful and will be continued in the future.
2. The breakout of the 2016-2017 results into the four core areas (Plant Biology, Ecology, Cell and Molecular Biology, and Genetics and Evolution) showed that student achievement decreased the area of Genetics and Evolution. In Fall 2017, the Biology Program ensured that certain core principles and concepts in that area were reinforced in upper level courses where this material is included in the 2017-2018 academic year (taught in 2017-2018 including but not limited to: Bio 105 and 106 Biological Sciences I and II, Bio 401 Genetics, Bio 409 Evolutionary Biology).

The breakout of the 2017-2018 results into the four core areas showed that student achievement decreased the areas of Plant Biology, Ecology, and Genetics and Evolution. In Fall 2018, the Biology Department will ensure that certain core principles and concepts in those areas are reinforced in upper level courses where this material is included in the 2018-2019 academic year (to be taught in 2018-2019 including but not limited to: Bio 105 and 106 Biological Sciences I and II, Bio 206 and 207 Flora, Bio 201 Conservation Biology, Bio 303 Plant Kingdom, Bio 307 Plant Anatomy/Physiology, Bio 308 Aquatic Ecology, Bio 317 Marine Ecology, Bio 320 Plant Evolution/Diversity, Bio 401 Genetics, Bio 409 Evolutionary Biology).

3. The department evaluated the exam question types (critical thinking and application of science questions) and for balance between each core area and content vs critical thinking. However, the process was not completed fully this academic year. This objective will be carried over the 2018-2019 academic year.
4. The Biology Department began its investigation of validated questions from Concept Inventories to be used on our exams, however, the process was not completed fully this academic year. This objective will be carried over the 2018-2019 academic year.

SLO 3.0: Students will explain and demonstrate how to 1) ask a question, 2) generate a credible literature review, 3) generate hypotheses, 4) execute hypothesis testing procedures, 5) organize and analyze data or information, 6) draw conclusions, and 7) produce a report to cogently communicate results.

SLO 4.0: Students will communicate cogently about biology.

SLO 3 and 4:

The Biology Department again used the scoring rubric developed primarily for presentations.

1. The department will continue to utilize the rubric in evaluation of senior projects in RED and PURE.
2. The department determined no other modifications to the rubric were needed for presentation –based assignments.
3. Given our rubric was designed primarily for presentation-based assignments, a number of individual questions are not applicable to written assignments. Therefore, in fall 2017 the department began developing additional rubrics for use evaluating other types of student assignments (e.g. oral presentations, in-class poster presentations, and in-class laboratory assignments in appropriate upper-level courses). Work on this objective is not complete and will be carried over the 2018-2019 academic year.
4. We decided to expand the use of the rubric to increase consistency in common courses and lab sections. This objective will be carried over the 2018-2019 academic year.
5. We discussed the feasibility of an evaluation committee to score in-class presentations and written laboratory reports to allow for repeat measures of assignments that would otherwise receive one evaluation from the instructor of record. This objective will be carried over the 2018-2019 academic year. To increase the consistency in the evaluation of student presentations, at RED and PURE in spring 2018, we will again task a group with evaluating all the biology students presenting as we did in 2017.
6. In 2017-2018, we have incorporated more assignments that require students to apply the process of science into our courses.
7. We facilitated the process by which faculty can mentor students in research projects outside of the classroom.
8. To notify students of research opportunities, we continued to use the *Research Opportunities* section of the bulletin board outside the biology office, we increased the frequency of updating of our website section, and we created a new website this year to showcase our active research areas. Additionally, a monitor was installed in the main hallway in the biology program to announce opportunities.

SLO 4: The Biology Program worked on designing a writing assignment program likely using a scaffolding approach to be used in the freshman course sequence. Implementation of a writing program has been rolled into the program's discussion on redesigning our curriculum. The program also sponsored and promoted a workshop for our students on the writing of lab reports and other scientific documents. We made progress but this objective will be carried over to the 2018-2019 academic year.

Appendix 1 – Presentation Rubric

Project: _____ (poster number)

What was most impressive about this project/presentation?

What change could most improve this project/presentation?

Low → High

SCIENTIFIC THOUGHT

Degree to which the student clearly states a thoughtful question. 1 2 3 4

Degree to which the student clearly state their research hypothesis or purpose 1 2 3 4

Is the significance of this research clear in terms of the 'big picture?' 1 2 3 4

SCIENTIFIC METHOD

Is the method of investigation appropriate to the problem? 1 2 3 4

Is the information sufficiently documented? 1 2 3 4

Has the student collected sufficient data to justify the conclusions made? 1 2 3 4

Has the student analyzed the data in a way to justify the conclusions made? 1 2 3 4

Is the student's own work clearly reflected in the project? 1 2 3 4

COMMUNICATION

Does the presentation (display) represent a complete story or concept? 1 2 3 4

Is the presentation (display) self-explanatory? 1 2 3 4

Do the text, charts, and diagrams aid in the understanding of the project? 1 2 3 4

COMMUNICATION (In person only)

Does the presenter give a clear and concise description of the project? 1 2 3 4

Does the presenter communicate effectively in oral responses to questions? 1 2 3 4

RATING GUIDELINES
Low → High
1 – Fair
2 – Good
3 – Excellent
4 – Superior

Presentation type
Poster presentation
Course assignment (BIO _____)
Other _____

Additional Comments may be place on the reverse

**Adapted from Sigma XI Student Research Conference Template*