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| <b>Name of Program/Department:</b> | <b>Department of Biology</b>                      |
| <b>Year:</b>                       | <b>2021 - 2022</b>                                |
| <b>Name of Preparer:</b>           | <b>Jason Doll, Ph.D. and Jeremy Rentsch Ph.D.</b> |

### **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 to graduating seniors in their final semester in both fall and spring. The overall mean on the exam (65.0%) exceeded the benchmark for both SLO's 1 & 2 (SLO 1: 61%, SLO 2: 59%). In addition, the year's average increased about 3.7% from last year. Achievement in the separate areas of content (SLO 1: 67.9%; SLO 2: 61.4%) met the benchmarks. Achievement in the separate areas increased in three of six of the areas and remained the same in the other three areas this year.

In the fall 2021 semester the department examined the previous year's results by concept area and determined that more concepts in the core areas of Plant Biology, Genetics and Evolution, and Cell and Molecular needed to be reinforced in the appropriate courses. The faculty enhanced their instruction in these areas by devoting additional time in lecture or lab to review. Student performance improved and exceeded the benchmark in all areas except Fundamentals. Faculty will reinforce fundamental concepts in all courses being taught.

In order to get a better understanding of the level of achievement at which FMU biology majors begin the major curriculum, we have also administered the Senior Exit Exam to students enrolled in the first course in the biology major each semester since 2016. Although perhaps not the identical cohort of students, the 2017 and 2018 freshman classes included at least a portion of the students that graduated in fall 2021 or spring 2022. The overall exam averages showed that students in the 2017 and 2018 incoming classes began the major with an average achievement of 40% and by the time they are seniors they have increased their achievement to 65%.

The Biology Department is in the process of examining the 2020-2021 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 2021-2022. The faculty also reviewed core area SLO's to ensure all classes within a core area were achieving shared SLO's.

The department measured student achievement on use of the scientific approach and communication (SLO 3 and 4) through student research projects and presentations at RED and PURE. The department used scoring criteria they developed as a more objective "direct measure" of Biology majors' competence. This year 8/11 (72.2%) questions scored an average of 3.5 or higher for all biology RED posters and 11/11 (100%) or questions scored an average of 3.5 or higher for PURE talks. Our 2021-2022 data indicate that the majority of our questions met our intended benchmark with only three questions from SLO3.0 failing to meet the proposed benchmark of 3.5.

The Biology Department administered an indirect assessment of all SLO's (*Attitude Survey*) to 83% of graduating seniors in Fall 2021 and Spring 2022. At least 80% or more of students responded "strongly agree" or "agree" for the majority of questions (12/15) meeting that benchmark.

## 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: Baseline (average of past 2 year's SLO results) of 61%, Benchmark of 61%, Target (3 year set in 2020) of 62%

SLO 2.0: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at:

Baseline (average of past 2 year's SLO results) of 58.5%, Benchmark of 59%, Target (3 year set in 2020) of 62%

*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, poster, or oral report to cogently communicate results as evaluated by our faculty using a scoring rubric (questions 1-11 on FMU Biology Department Scoring Rubric). We expect each question average to be at or above a score of 3.5 out of 4.0 on our rubric. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

*SLO 4.0:* Students communicated cogently about biology at or above a score of 3.5 on Research Exhibition Day poster presentations and PURE symposium talks as measured by questions 12 & 13 on a rubric developed by the Biology Department used to evaluate reports and presentations. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

## 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 as evaluated by the Biology Exit Exam of:

- Baseline (average of past 2 year's SLO results) of 61%,
- Benchmark of 61%,
- Target (3 year set in 2020) of 62%.

SLO 2.0: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at an overall average as evaluated by the Biology Exit Exam of:

- Baseline (average of past 2 year's SLO results) of 58.5%,

- Benchmark of 59%,
- Target (3 year set in 2020) of 62%.

### *Direct Assessment*

Performance on student learning outcomes 1 and 2 utilized a cumulative exam-(multiple choice format). Historically, the exam had 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 nor have completed all their biology major course work. To address this issue of timing of biology major course work, we administer the exam only to students in the semester they are graduating. However, because students in Senior Seminar are seniors and some are graduating in that semester, we use that course as a means of grouping the graduating students. In the Fall 2021 Senior Seminar course, enrolled students that would not be graduating until Spring 2022 did not take the exam. We followed the same procedure with the Spring 2022 Senior Seminar course. Graduating students that did not take the exam were contacted, arrangements made, and they took the exam in Spring 2022.

The common Biology Exit Exam was administered via Blackboard again this year in part due to COVID-19 protocols but also to make it easily available and accessible to all graduating students. Administering the Biology Exit Exam online has shown to be successful and has resulted in high completion rate (93% Spring 2022). Therefore, we have decided to permanently administer all Exit Exams online starting in the 2022-2023 academic year.

To get an indication of how students entering the biology major perform, since 2016 the cumulative exam has been administered to those students in the introductory biology courses who were taking the biology majors lecture and laboratory courses for the first time (BIO 115L, Bio 106, Bio 107, and Bio 108). These courses are required of all biology majors. Students were given a different but comparable form of the exit exam to ensure that the student is not taking the same exam twice. The exam was administered on the first laboratory class day within the first two weeks of the beginning of each semester since 2016. The Fall 2021 and Spring 2022 exams were administered during lab as in past year. However, we will be administering this exam online in the Fall of 2022.

We regard the mean percent score of the exam results for all students to be a reasonable indicator of student-success in meeting the learning outcomes. This year's:

- Baseline (average of past 2 year's SLO results): SLO 1: 61%, SLO 2: 58.5%,
- Benchmarks are SLO 1: 61% or higher, SLO 2: 59% or higher;
- Target: (3 year set in 2020): 62%.

For security the Biology Exit Exam is not provided in the appendix. Copies are available upon request to the department.

### **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, poster, or oral report to cogently communicate results as evaluated by our faculty using a scoring rubric (questions 1-11 on FMU Biology Department Scoring Rubric). We expect each question average to be at or above a score of 3.5 out of 4.0 on our rubric. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

*SLO 4.0:* Students communicated cogently about biology at or above a score of 3.5 on Research Exhibition Day poster presentations and PURE symposium talks as measured by questions 12 & 13 on a rubric developed by the Biology Department used to evaluate reports and presentations. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

### *Direct Assessment*

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 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.

The Biology Department evaluated student competence in application and communication of the scientific approach (SLO 3 & 4) in two ways: 1) evaluating laboratory reports and 2) evaluating presentations.

The assessment rubric below (Scoring Criteria) was used to evaluate both the laboratory reports and presentations. The rubric was initially developed to assess a self-selecting group of research students and is now being more broadly applied to laboratory reports that more students will be subject to.

#### Scoring Criteria:

1. The student clearly states a thoughtful question.
2. The student clearly states a research hypothesis or question.

3. The significance of the research is clearly framed in terms of the 'big picture'.
4. The method of the investigation is appropriate to the problem.
5. All data are sufficiently documented.
6. Student collected sufficient data to justify conclusions made.
7. The data were analyzed in a way that justifies the conclusions made.
8. The student's own work is clearly reflected in the work.
9. The work represents a complete story or concept.
10. The work is self-explanatory (mostly in relation to reports or poster presentations).
11. Charts, figures, and diagrams aid in the understanding of the project.
12. The works cited is sufficiently robust.

To evaluate laboratory reports faculty were surveyed for a random selection of laboratory reports completed by students as a typical part of course-work during the 2020 – 2021 academic year. We asked for laboratory reports relating to authentic research in the classroom. In this case, authentic refers to hypothesis generating, hypothesis testing, data gathering, and analysis in a dynamic system without a predetermined outcome (a so called ‘cookbook’ laboratory). Last year, the laboratory reports were drawn from all academic levels. This year with the continued COVID-19 protocols in place, only one freshman-level course ran authentic research as part of their spring 2021 coursework. From that freshman-level course, eight laboratory reports were randomly selected for further evaluation. Submitted laboratory reports fulfilling the specified criteria were then de-identified and all eight were sent to three biology faculty volunteers who rated the reports for criteria meant to assess specific learning outcomes of the department. These questions were taken directly from, or adapted from, the rubric we have used previously to assess student oral or poster presentations at various events (see Scoring Criteria listed above). Scoring Criteria were scored on a Likert scale with a score of 1 strongly disagreeing with the question and a score of 4 strongly agreeing. Averages and standard deviations were generated for 1) each laboratory report (1 – 8) and 2) each criterion (1 – 12). The scoring of these laboratory reports using these methods does not necessarily reflect the grade the student received on the same piece of work in a classroom setting.

Because laboratory reports were acquired this year from freshman-level courses at the end of the academic year, we expected students to not perform quite as well as upper-level students. As such, we deem the proportion of students that achieve scores of 3.0 or greater rather than 3.5 (used to evaluate student achievement in upper-level courses) as our: Baseline (we have no baseline for comparison this year because this is the first year implementing the assessment tool at a lower score in freshman courses); Benchmark: 75%; and Target: 90%.

To evaluate presentations, we used a more objective “direct measure” of Biology majors’ competence in the application and communication of the scientific approach in student projects presented as pre-recorded posters at the campus-wide virtual Research and Exhibition Day in the spring 2021 semester. Biology Department faculty (4) not involved with the research independently evaluated each pre-recorded RED virtual presentation utilizing the Scoring Criteria. The Scoring Criteria (listed above) were scored on a Likert scale with a score of 1 strongly disagreeing with the question and a score of 5 strongly agreeing was used. Although we

were unable to evaluate oral presentations this year at the department's PURE Symposium because it was not held in 2020-2021 due to COVID-19 restrictions, the recorded nature of the virtual poster presentations was very similar to how a project would be presented as an oral presentation at PURE.

Because participation in RED is optional and students have basically self-selected to be included, we expect students to perform quite well on average. As such, we deem the proportion of students that achieve scores of 4 or greater out of 5 in all hybrid areas (questions that fit into the same broad category) as: Baseline (2018-2019 results -because no presentations were evaluated in 2019-2020): 36%; Benchmark: 40%; Target (5 year set in 2019): 40%

## **SLO 1, 2, 3, and 4**

### *Indirect Assessment: Attitude Survey*

We administered a survey of student attitudes to indirectly assess our four SLO's to the graduating seniors in Fall 2021 and Spring 2022 (questions are listed in results section Table 5). The questions were answered on a Likert scale with a score of 1 = strongly disagreeing with the statement and a score of 5 = strongly agreeing. The survey was administered via Blackboard. In addition to offering indirect assessment of our SLO's, survey results also provide data about our courses and program.

The number of questions answered "strongly agree" and "agree" at 80% or greater:

- Baseline (average of past 2 year's results) 12/15 questions,
- Benchmark of 13/15 questions,
- Target (5 year) of 14/15 questions.

## **Assessment Results**

### **Student Learning Outcomes 1 and 2:**

*SLO 1:* Biology majors will identify key concepts in the core areas of Plant Biology, Ecology, Cell and Molecular Biology, Genetics and Evolution: Baseline (average of past 2 year's SLO results) of 61%, Benchmark of 61%, Target (3 year set in 2019) of 62% as evaluated by the Biology Exit Exam.

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 67.9% as measured by a common Biology Exit Exam. Since our benchmark (61%), this was achieved.

*SLO 2*: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach: Baseline (average of past 2 year's SLO results) of 58.5%, Benchmark of 59%, Target (3 year set in 2019) of 62% as evaluated by the Biology Exit Exam.

SLO 2.0: Biology majors demonstrated competence in critical thinking and the application of the scientific approach at the 61.4% level as evaluated by the Biology Exit Exam. Since our benchmark was 59%, this was achieved.

Tables 1 and 2 summarize the results for each learning outcome and includes 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 2019 – 2021 for comparison. Table 2 summarizes the results for students entering the major from 2016 – 2021 (administered in introductory biology courses: Bio 115L, 106, 107, 108).

The overall mean on the exam for Fall and Spring combined (65%) exceeded the benchmark for both SLO 1 & 2 (SLO 1: 61%, SLO 2: 59%). In addition, this year's average increased by 3.7% from last year. Achievement this year in the separate area of content (SLO 1) improved by 3.4% whereas critical thinking (SLO 2) increased by 3.4% when compared to last year's results.

Performance improved in the core areas of Plant Biology, Ecology, Cell and Molecular, Genetics and Evolution, and Animal Diversity compared to the 2020-2021 academic year. Plant Biology, Ecology, Fundamentals, and Animal Diversity exceeding the benchmark of 61% in both Fall and Spring semesters. Cell and Molecular Biology exceeded the benchmark of 61% only in the Spring semester. Genetics and Evolution did not meet the benchmark of 61% in either semester. There was a decrease in the area of Fundamentals (those questions that are broadly applicable to multiple areas of biology but not a separate area in the major) from 76.2% to 72%, however, this remained above the benchmark of 61%.

In the Fall 2021 semester, the department reviewed SLO's for the core areas of organismal, genetics, cell and molecular biology, and ecology. This review consisted of faculty identifying common concepts addressed in each of their courses. The meetings resulted in a shared set of SLO's to guide broad topics while maintaining academic freedom within their course. Following this review, it was determined that the exit exam will be assessed to ensure the questions are directly addressing key concepts within each core area. This review will take place in the coming year.

We began administering the exit exam to students entering the major in 2016. Table 2 summarizes the results for those students for five academic years (2016 – 2022). Although perhaps not the identical cohort of students, the 2016 and 2017 freshman classes included at least a portion of the students that graduated in Fall 2020 or Spring 2021. The overall exam averages showed that students in the 2016 and 2017 incoming classes began the major with an average achievement of 40% (Table 2) and by the time they are seniors they have improved their achievement to 61% (Table 1). A similar improvement was observed with 2017 and 2018 incoming class. The average achievement in 2017 and 2018 was 40% (Table 2) which improved to 65% (Table 1). There has been a general decrease in incoming scores since the 2017 and 2018



incoming class. The lowest score was observed in Spring 2021 (Table 2: no assessments were given in Fall 2020 due to COVID-19 restrictions and exams were given in-person at the time).

Test discrimination (ability for a question to differentiate between students that understand the material and those that do not) was measured using Blackboards generated “discrimination” score. Scores range from -1.0 to 1.0 with higher values suggesting better discriminatory power. Discrimination scores for questions that are below 0.10 are considered poor questions. Individual question scores ranged from -0.22 to 0.61 and averaged 0.29. Overall, the exam questions provide a reliable indicator of students knowledge in the subject area. We will continue tracking this metric and investigate questions that fall below 0.1 and determine if they need improvements.

Benchmarks were achieved during the 2021-2022 academic year. However, the COVID-19 pandemic seems to have reduced the scores for students entering the Biology program. We will closely monitor these students as they move through our program. The new core area SLO’s give faculty the guiding concepts to build their course work around and will serve to focus on specific areas so graduating seniors have mastered the identified areas.

**Table 1.** Summary of results of the cumulative exam given to graduating seniors in Fall 2021 and Spring 2022. Results from 2019-2021 are included for comparison.

| Learning Outcome   | Assessment<br>(Exam question that pertains to each learning outcome)           | Results<br>(Mean percent correct) |             |              |             |             |
|--|--|-----------------------------------|-------------|--------------|-------------|-------------|
|  |  | 2019 - 2020                       | 2020 - 2021 | Fall 2021    | Spring 2022 | 2021 -2022  |
| 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 61% (benchmark) as measured by a common Biology Exit Exam. | Concepts: 1, 2, 5-7, 9, 10, 12, 14-17, 20-24, 26, 27, 34-36, 41, 43, 44, 47-49 | 61.0                              | 64.5        | 67.1         | 68.6        | 67.9        |
| a. Plant Biology   | 5, 16, 22, 25, 27, 31, 39, 47  | 59.3                              | 65.1        | 65.6         | 65.9        | 65.8        |
| b. Ecology   | 3, 12, 28, 29, 40, 44, 48  | 63.5                              | 55.7        | 63.6         | 64.4        | 64.0        |
| c. Cell and Molecular Biology  | 2, 7, 9, 10, 11, 18, 20, 21, 24, 26, 28, 30, 33, 36, 37,41, 42, 49, 50         | 56.8                              | 61.9        | 59.5         | 65.8        | 62.6        |
| d. Genetics and Evolution  | 4, 13, 17, 23, 32, 35, 38, 46  | 52.8                              | 49.7        | 58.8         | 60.5        | 59.6        |
| e. Fundamentals  | 8, 15, 19, 34, 43  | 79.6                              | 76.2        | 73.3         | 70.7        | 72.0        |
| f. Animal Diversity  | 1, 6, 14, 45   | 54.6                              | 59.0        | 60.0         | 64.0        | 62.0        |
| 2. Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at an overall average of 59% (benchmark) as evaluated by the Biology Exit Exam.                                | 3, 4, 8, 11, 13, 18,19, 25, 28-33, 37-40, 42, 45, 46, 50                       | 59.0                              | 58.0        | 60.9         | 62.0        | 61.4        |
| Number of graduates  |  | 58                                | 74          | 20           | 41          | 61          |
| Number of students completed exam<br>(% of graduating seniors)   |  | 55<br>(95%)                       | 70<br>(95%) | 20<br>(100%) | 38<br>(93%) | 58<br>(95%) |
| <b>Overall Exam Mean</b>   |  | <b>60.0</b>                       | <b>61.3</b> | <b>64.4</b>  | <b>65.6</b> | <b>65.0</b> |

**Table 2.** Summary of results of the cumulative exam given to students in BIO 115L taking the course for the first time in 2016 - spring 2022.

| Learning Outcome   | Assessment<br>(Exam question that<br>pertains to each<br>learning outcome)     | Results<br>(Mean percent correct) |               |                |             |               |             |
|--|--|-----------------------------------|---------------|----------------|-------------|---------------|-------------|
|  |  | 2016-<br>2017                     | 2017-<br>2018 | 2018 -<br>2019 | 2021 (sp)   | 2021-<br>2022 | Average     |
| 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% (benchmark) 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 | 39.5                              | 37.4          | 37.4           | 29.6        | 33.9          | 35.6        |
| a. Plant Biology   | 5, 16, 22, 27, 29, 31, 39, 47  | 28.7                              | 26.4          | 28.9           | 19.2        | 24.8          | 25.6        |
| b. Ecology   | 3, 11, 12, 40, 44, 48  | 50.5                              | 45.3          | 46.7           | 31.5        | 29.6          | 40.7        |
| c. Cell and Molecular Biology  | 2, 7, 9, 10, 18, 20, 21, 25, 26, 28, 30, 32, 33, 36, 37, 41, 42, 49, 50        | 37.9                              | 35.6          | 36.4           | 25.5        | 25.8          | 32.2        |
| d. Genetics and Evolution  | 4, 13, 17, 23, 35, 38, 46  | 34.8                              | 38.1          | 30.6           | 25.8        | 32.5          | 32.3        |
| e. Fundamentals  | 8, 15, 19, 24, 34, 43  | n/a                               | n/a           | 50             | 43.5        | 32.2          | 41.9        |
| f. Animal Diversity  | 1, 6, 14, 45   | n/a                               | n/a           | 50.1           | 28.2        | 33.3          | 37.2        |
| 2. Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at an overall average of 59% (benchmark) as evaluated by the Biology Exit Exam.                                | 3, 4, 8, 11, 13, 18, 19, 24, 25, 27, 29-31, 33, 37-40, 42, 44-46, 50           | 41.1                              | 38.6          | 39.3           | 27.6        | 26.0          | 34.5        |
| Number of students completed exam  |  | 132                               | 235           | 321            | 54          | 151           | 178.6       |
| <b>Overall Exam Mean</b>   |  | <b>40.3</b>                       | <b>40</b>     | <b>38.3</b>    | <b>28.7</b> | <b>30.4</b>   | <b>35.0</b> |

### **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, poster, or oral report to cogently communicate results as evaluated by our faculty using a scoring rubric (questions 1-11 on FMU Biology Department Scoring Rubric). We expect each question average to be at or above a score of 3.5 out of 4.0 on our rubric. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

SLO 3.0: This year 8/11 (72.2%) questions scored an average of 3.5 or higher for all biology RED posters and 11/11 (100%) or questions scored an average of 3.5 or higher for PURE talks (Table 1)

*SLO 4.0:* Students communicated cogently about biology at or above a score of 3.5 on Research Exhibition Day poster presentations and PURE symposium talks as measured by questions 12 & 13 on a rubric developed by the Biology Department used to evaluate reports and presentations. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

SLO 4.0: This year, 2/2 (100%) of questions received a score of 3.5 or higher for both RED poster presentations and PURE symposium presentations (Table 2).

A rubric developed by Biology Department was used to evaluate student RED poster presentations and PURE symposium presentations. Presented research was completed by students with a faculty mentor and presented at several in-house venues. The 2021-2022 academic year saw a return of both of these activities after a two-year hiatus due to the Covid-19 pandemic. We have also revised the way we are thinking about these SLOs, and data associated with them. As such, this year's data will not be compared to previous years but will serve as a new baseline for years to come. SLOs 3.0 and 4.0 are assessed using separate questions on a common rubric. The rubric is composed of 13 questions attached to a Likert scale from 1-4, where a 1 reflects poor performance on that question and a 4 reflects exemplary performance. Questions 1-11 are relevant to SLO3.0 and questions 12 & 13 are relevant to SLO 4.0. A copy of the scoring rubric can be found as supplementary materials. Biology faculty volunteer to assess student presentations, scores are entered into a spread sheet where averages and standard deviation were calculated. As students who present at RED and PURE are self-selecting, we set our expectations high with a three-year target of all questions receiving an average score of 3.6 or higher and a current benchmark of all questions receiving an average score of 3.5 or higher.

Our 2021-2022 data indicate that the majority of our questions met our intended benchmark with only three questions from SLO3.0 failing to meet the proposed benchmark of 3.5. Those questions were 6, 7, and 9. Question 6 refers to the student collecting sufficient data to justify

their conclusions, question 7 refers to whether or not the student used an appropriate method of analysis to reach their conclusions. Question 9 refers to the presentation being a complete story or concept. It should be noted that all of these scores are within a standard deviation of the benchmark, but still represent areas for improvement. It should also be noted that poster presentation are not necessarily only for complete stories and evaluators may fail to see that works in progress can represent well-expressed ideas – but not complete projects.

|   | PURE Symposium      |      | RED                 |      |
|---|---------------------|------|---------------------|------|
|   | 2021 - 2022 average |      | 2021 - 2022 average |      |
|   | Average             | STD  | Average             | STD  |
| Question 1 - State thoughtful question                      | 3.85                | 0.33 | 3.70                | 0.47 |
| Question 2 - State clear hypothesis                         | 3.63                | 0.55 | 3.61                | 0.53 |
| Question 3 - Explain research significance                  | 3.67                | 0.46 | 3.66                | 0.46 |
| Question 4 - Investigate appropriately?                     | 3.74                | 0.51 | 3.87                | 0.24 |
| Question 5 - Sufficiently document                          | 3.70                | 0.48 | 3.66                | 0.45 |
| Question 6 - Enough data collected?                         | 3.63                | 0.48 | 3.34                | 0.66 |
| Question 7 - Analyzed correctly?                            | 3.78                | 0.31 | 3.38                | 0.62 |
| Question 8 - Student contributions clear?                   | 3.93                | 0.21 | 3.71                | 0.48 |
| Question 9 - Represent a complete story?                    | 3.85                | 0.26 | 3.49                | 0.41 |
| Question 10 -Self-explanatory poster or clear presentation? | 3.52                | 0.56 | 3.51                | 0.50 |
| Question 11 - Clear figures, charts, etc?                   | 3.63                | 0.48 | 3.65                | 0.44 |

Table 1: Truncated scoring rubric questions with PURE symposium and RED presentation results. Questions 1-11 are relevant for SLO3.0. In the spring of 2022, there were eight poster presentations with an average of seven evaluations each and three PURE symposium talks with an average of nine evaluations each. Only questions 6,7, and 9 failed to meet our 2021-2022 benchmark of a score of 3.5 or higher per question.

|  | PURE Symposium      |      | RED                 |      |
|--|---------------------|------|---------------------|------|
|  | 2021 - 2022 average |      | 2021 - 2022 average |      |
|  | Average             | STD  | Average             | STD  |
| Question 12 - Clear project description?       | 3.89                | 0.24 | 3.80                | 0.24 |
| Question 13 - Effective response to questions? | 3.96                | 0.10 | 3.74                | 0.29 |

Table 1: Truncated scoring rubric questions with PURE symposium and RED presentation results. Questions 12 & 13 of the rubric are relevant for SLO4.0. In the spring of 2022, there were eight poster presentations with an average of seven evaluations each and three PURE symposium talks with an average of nine evaluations each. Each question met our 2021-2022 benchmark of a score of 3.5 or higher per question.

## SLO 1, 2, 3, and 4

### *Indirect Assessment: Attitude Survey*

The number of questions answered “strongly agree” and “agree” at 80% or greater:

- Baseline (average of past 2 year’s results) 13/15 questions,
- Benchmark of 13/15 questions,
- Target (5 year) of 14/15 questions.

We administered a survey of student attitudes about the biology SLOs to graduating seniors in Fall 2021 and Spring 2022. In addition to offering indirect assessment of our SLO’s, survey results also provide data about our courses and program. The number of questions answered “strongly agree” and “agree” at 80% or greater was 12/15 questions (80%) and did not meet the benchmark of 13/15 questions (87%).

Table 5 lists the questions used on the survey and summarizes the attitude survey results. At least 80% or more of students responded “strongly agree” or “agree” for the majority (12/15 questions, 80%) of the questions. Students felt less strongly (< 80% “strongly agree or “agree”) on three questions: “Courses in biology have strengthened my understanding of biological concepts in plant biology (72%)”; “I am able to demonstrate the relationship between multiple variables by using statistical analysis” (78%); and “The Biology department at FMU offers a sufficient variety of courses.” (74%). Overall average ranking of “strongly agree or agree” was 88%.

Students in the Biology department must select a single “organismal” course. This can include plants, ichthyology (fish), ornithology (birds), vertebrate zoology, or herpetology (reptiles and amphibians). Thus, students are not required to take a plant course. This could explain the lower ranking for “Plant Biology”. The Biology department has started to offer “Biostatistics and Research Methods” every spring semester. This will increase the opportunities for students to take this course as an elective and should improve their confidence in statistical analysis. We are also putting more emphasis on data and statistical analysis in introductory biology courses when presenting concepts. This year, the Biology Department has started offering new courses such as BIOL-400 Fisheries Science and Management; BIOL-216 Ichthyology, Ornithology; and Ecotoxicology. These additional courses will address students concerns with the variety of courses offered.

The survey was administered via Blackboard and several of the students that completed the exit exam did not complete the survey. That coupled with a lower proportion in the fall means the percentage of graduates (83%) does not match the percentage that completed the exit exam (95%). Greater emphasis on completing the Attitude Survey will be expressed next year.

Table 5: Attitude survey questions asked and the results (percentages) from graduating in 2019 – 2022 results for the total of Strongly Agree and Agree are provided. Previous year’s results are included for comparison.

| SLO  | Question on the Attitude Survey  | Total of Strongly Agree & Agree |             |             |
|------|--|---------------------------------|-------------|-------------|
|      |  | 2019-2020                       | 2020-2021   | 2021-2022   |
| 1    | Courses in biology have strengthened my understanding of biological concepts in:                     |                                 |             |             |
|      | a. Genetics and Evolution  | 89                              | 89          | 92          |
|      | b. Cell and Molecular Biology  | 70                              | 84          | 88          |
|      | c. Ecology   | 83                              | 90          | 88          |
|      | d. Plant Biology   | 76                              | 76          | 72          |
| 2, 3 | I am able to demonstrate the relationship between multiple variables by using statistical analysis.  | 70                              | 74          | 78          |
| 3    | I am able to identify a hypothesis or purpose of a study.  | 94                              | 99          | 96          |
| 3, 4 | I feel prepared to write a comprehensive lab report.   | 94                              | 91          | 88          |
| 3    | I understand and can employ a range of laboratory techniques/methods to study biological processes.  | 93                              | 98          | 92          |
| 3    | I am able to identify primary sources.   | 93                              | 92          | 92          |
| 3    | I am able to use the correct citation methods in my work cited.                                      | 93                              | 97          | 92          |
| 4    | I can explain biological concepts to others.   | 91                              | 91          | 94          |
| 2    | Courses in Biology at FMU have strengthened my ability to think critically.                          | 87                              | 92          | 92          |
| N/A  | The Biology department at FMU offers a sufficient variety of courses.                                | 80                              | 84          | 74          |
| N/A  | The methods and skills I have mastered as a biology major at FMU will help me in my future pursuits. | 89                              | 94          | 92          |
| N/A  | It is important that the Biology department introduces students to various careers in biology.       | 96                              | 95          | 94          |
|      | <b>Overall average</b>   | <b>87</b>                       | <b>90</b>   | <b>88</b>   |
|      | Number of students completed survey<br>(% of graduating seniors)                                     | 54<br>(93%)                     | 68<br>(92%) | 50<br>(83%) |

## 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: Baseline (average of past 2 year's SLO results) of 61%, Benchmark of 61%, Target (3 year set in 2020) of 62%

SLO 2.0: Biology majors will demonstrate competence in critical thinking and the application of the scientific approach at:

Baseline (average of past 2 year's SLO results) of 58.5%, Benchmark of 59%, Target (3 year set in 2020) of 62%

## SLOs 1 and 2:

1. The program scheduled the administering and scoring of the Exit Exam 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 administered the exam to only students in the semester in which they graduate. In Fall 2021, the exam was administered to only those students graduating at the end of Fall semester. Likewise, at the end of Spring 2022, the exam was administered only to those students graduating in Spring 2022. Any student who completed the Senior Seminar course in the Fall 2021 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 2022 semester. This procedure was successful again this year with the majority of graduating students completing the exam (100% in Fall 2021, 93% in Spring 2022, overall 95%) and will be continued in the future.
2. The breakout of the 2021-2022 results into the four core areas showed that student achievement did not meet the benchmark in the areas of Genetics and Evolution and Cell and Molecular. However, there was an overall increase compared to the 2020-2021 academic year. In Fall 2021, the Biology Program ensured that certain core principles and concepts in those areas were reinforced in upper level courses where this material is included in the 2021-2022 academic year (taught in 2021 -2022 including but not limited to: Bio 105 and 106 Biological Sciences I and II, Bio 107 and 108 Integrated Biological Concepts I and II, Bio 301 Cell Biology, Bio 407 Immunology, Bio 302 Developmental Biology , Bio 401 Genetics, Bio 409 Evolutionary Biology).

The breakout of the 2021-2022 results into the four core areas showed that student achievement the Fundamentals decreased. In Fall 2022, the Biology Department will ensure that certain core principles and concepts in the fundamentals are reinforced in upper-level courses where this material is included in the 2022-2023 academic year including but not limited to: Bio 105 and 106 Biological Sciences I and II, Bio 107 and



108 Integrated Biological Concepts I and II, Ecology courses (Bio 308, 317, 318, 400, 402, 411, 412), Bio 401 Genetics, Bio 409 Evolutionary Biology.

3. The Biology Department reviewed the four core areas (Cell Biology, Genetics, Organismal Biology, and Ecology). This review consisted of all faculty teaching in these areas to identify shared SLO's that are covered. This resulted in a new set of shared SLO's that faculty can use to guide their courses to ensure students taking any class within the core area will be taught similar broad concepts. As a result, we will review the exit exam to ensure the questions being asked match the shared core concepts. The department will evaluate the exam and make necessary changes in the 2022-2023 academic year.
4. The department evaluated the Biology Exit exam question types and quality based on individual exam item analysis results, critical thinking and application of science questions, and for balance between each core area and content vs critical thinking. This action item will be carried over the 2021 -2022 academic year.
5. The Biology Department continued its investigation of validated questions from Concept Inventories to be used on our exams. This action will be carried over the 2021 -2022 academic year.

### **Student Learning Outcomes**

*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, poster, or oral report to cogently communicate results as evaluated by our faculty using a scoring rubric (questions 1-11 on FMU Biology Department Scoring Rubric). We expect each question average to be at or above a score of 3.5 out of 4.0 on our rubric. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

*SLO 4.0:* Students communicated cogently about biology at or above a score of 3.5 on Research Exhibition Day poster presentations and PURE symposium talks as measured by questions 12 & 13 on a rubric developed by the Biology Department used to evaluate reports and presentations. Our current benchmark is for 11/11 questions to receive average scores of 3.5 or higher assessed separately across events (i.e., RED, and PURE data will not be averaged together). Our three-year target will be to improve these scores such that 11/11 questions receive average scores of 3.6 or higher.

### **SLOs 3 and 4:**

In 2020-2021 we were unable to hold face-to-face and the RED and PURE events. PURE was not held. RED was virtual in Spring 2021.

1. Plans for 2022-2023 academic year
  - Continue to recruit students to participate in RED and PURE.
  - Mentor students to make-up for the few weaknesses seen in this year's data (*e.g.* questions 6, 7, and 9).
  - Continue to refine the assessment rubric.
2. In Fall 2022 we will ensure that faculty that do projects with students (including course related projects, independent study, and honors thesis) reinforce the areas of the scientific process and communication (those concepts found in the evaluation rubric) with their research students. And that faculty incorporate more assignments that require students to apply the process of science into our courses. Those criteria all represent skills or concepts that scientists in training should be intimately familiar with and should fit seamlessly into any biology course.
3. We will encourage faculty to implement more authentic research into undergraduate classrooms at all levels. Low numbers of laboratory reports and averages seen this year may reflect too few opportunities for students to write. Scores may improve significantly if students are asked to write several more reports over their undergraduate education. In addition, we will remind faculty to encourage use of our writing center for improving students' mastery in writing.
4. 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 installed in the main hallway in the biology department will continue to be used to announce opportunities.

**SLO 1, 2, 3, and 4:** We will encourage faculty to implement more statistical analysis into courses where appropriate and to enhance instruction:

1. The breakout of the 2021-2022 survey results showed that student attitude did not meet the benchmark in the areas of statistical analysis and Plant Biology. In Fall 2022, 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 2022-2023 academic year.
2. The breakout of the 2021-2022 survey results show that student attitude did not meet the benchmark in the areas sufficient variety of courses being offered by the Biology department. New courses have been or are scheduled to be offered including; BIOL-400 Fisheries Science and Management; BIOL-216 Ichthyology, Ornithology; and Ecotoxicology.