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| **Assurance of Student Learning Report**  **2023-2024** | | |
| *Ogden College of Science and Engineering* | | *Department of Biology* |
| *Biology (056)* | | |
| *Michael Smith, Program Coordinator; Kerrie McDaniel, Doug McElroy, Assessment Coordinators* | | |
| ***Is this an online program***?  Yes  No | Please make sure the Program Learning Outcomes listed match those in CourseLeaf . Indicate verification here  Yes, they match! (If they don’t match, explain on this page under **Assessment Cycle)** | |

**\*\*\* Please include Curriculum Map as part of this document (at the end), NOT as a separate file.**

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| ***Use this page to list learning outcomes, measurements, and summarize results for your program. Detailed information must be completed in the subsequent pages. Add more Outcomes as needed.*** | | | |
| **Student Learning Outcome 1:** Graduates will demonstrate a level of biological content knowledge appropriate to their degree level. | | | |
| **Instrument 1** | Biology Assessment Exam | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 1.** | | **Met** | **Not Met** |
| **Student Learning Outcome 2:**  Graduates will demonstrate an understanding of research ethics and the responsible conduct of research. | | | |
| **Instrument 1** | CITI Responsible Conduct of Research Course modules | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 2.** | | **Met** | **Not Met** |
| **Student Learning Outcome 3:**  Graduates will demonstrate the ability to apply scientific methodology and field/laboratory/analytical skills to a biological question. | | | |
| **Instrument 1** | Representative biology process artifact selected by the student from their required Biology Process Course or Biology Independent Research Experience | | |
| **Based on your results, check whether the program met the goal Student Learning Outcome 3.** | | **Met** | **Not Met** |
| **Assessment Cycle Plan:** | | | |
| During 2023-24 and consistent with it’s five-year assessment plan, the Department of Biology Program Review/Assessment Committee (the ‘Committee’) and faculty (1) assessed 2022-23 artifacts for all SLOs and analyzed results from those assessments; and (2) developed and approved recommendations for program improvements based on assessment findings. These follow-up actions will be undertaken during the 2024-25 academic year, and be fully implemented by Fall 2025. | | | |

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| **Program Student Learning Outcome 1** | | | | | |
| **Program Student Learning Outcome** | **Graduates will demonstrate a level of biological content knowledge appropriate to their degree level.** | | | | |
| **Measurement Instrument 1** | **Biology Assessment Exam**  The Biology Assessment Exam is an instrument, newly developed in 2020-21, designed to assess content knowledge within the program discipline. The exam is constructed around 12 vignettes, 2 each representing the six major areas of emphasis in our core curriculum (Cells, Metabolism, Genetics, Ecology, Evolution, Diversity). The exam is constructed around 14 vignettes, 2 each representing the six major areas of emphasis in our core curriculum (Cells, Metabolism, Genetics, Ecology, Evolution, Diversity); in 2022-23, the assessment exam was expanded to also include 2 vignettes addressing topics related to molecular biotechnology, immunology, and microbiology.  Within each area of emphasis, there are 2 vignettes that are associated with 9 multiple-choice questions. Three (3) questions each test student content knowledge at the introductory, developing, and mastery level. In each area, several questions require interpretation of tables and/or figures, and assess students’ ability to apply the scientific process. This exam design allows for redundant assessment of knowledge by area of emphasis as well as mastery level; in addition, it provides the ability to carry out a meta-analysis of higher-order knowledge and skills such as correct interpretation of data and application of the scientific process.  The exam is given either electronically or in-person as part of BIOL 500, our required program course that is taken by students during their first semester at WKU. This is an appropriate time to deliver this assessment, as (1) many of our program students are employed as GTAs within the department, and we must ensure they possess a satisfactory understanding of core biology content early in their program, and (2) performance on the assessment exam is used by the program and a student’s graduate committee as a basis for determining the extent and nature of any comprehensive examination and/or remedial coursework that will be required in order for a student to complete the program. | | | | |
| **Criteria for Student Success** | Students will score at least 60% or higher, with the score on Introductory and Developing level items at least 60%. | | | | |
| **Program Success Target for this Measurement** | | At least 75% of students will attain the criterion level of success. | **Percent of Program Achieving Target** | 25.0% of students attained the criterion level of success, with 20.0% meeting the sub-criterion. The sample size was 20. | |
| **Methods** | Given that the assessment instrument has been utilized through only 2 assessment cycles (and modified in-between in accordance with follow-up activities derived from analysis of the 2020-21 assessment results), we are reluctant to draw too many conclusions or implications from patterns in the scores within and among content areas. Nevertheless, we can summarize the patterns based on this assessment. Across all mastery levels, students as a group performed best on questions related to the BIOL 120/121 content - cells (65.6% correct responses), metabolism (58.3%), and genetics (49.4%), and somewhat lower on BIOL 122/123 content – evolution (52.2%), ecology (46.7%), and diversity (43.3%). This distribution of scores across content areas was very similar to the pattern observed during the 2020-21 assessment cycle. Overall, students performed worst on the new module related to biotechnology, immunology, and microbiology (38.9%); again, this is not surprising, as these topics are more specialized and targeted at students in our undergraduate Molecular Biotechnology and Medical Laboratory Science programs, which our graduate students have not experienced.  Across all content areas, student performance on introductory-level questions was 56.2%, 49.5% on intermediate-level items, and 46.2% on mastery-level items; this pattern was consistent with that observed during the 2020-21 assessment cycle.  These data are valuable in establishing students’ baseline level of competency upon entering the program. It became apparent from examination of the previous assessment cycle’s findings that coverage of content related to molecular biotechnology, immunology, microbiology, and clinical topics – which is important and relevant to our high proportion of undergraduate pre-professional students within the program – was underrepresented. The assessment findings indicate that the program should expand the assessment instrument to include better coverage of such topics. This expansion was not targeted at our graduate program. | | | | |
| **Based on your results, highlight whether the program met the goal Student Learning Outcome 1.** | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | |
| **Results and Conclsuions:**  The 2021-22 follow-up activity incorporating the new module into the assessment instrument was fulfilled, and met the intent. Our assessment results suggest it would be appropriate and valid to evaluate the extent to which key topics from BIOL 120/121 and BIOL 122/123 and other foundational courses (which form the basis of the assessment exam) are clearly scaffolded across the curriculum. While this is targted directly at enhancing the program for our undergraduate students, it is relevant to the graduate program because many of our GTAs (who make up a plurality/majority of the sample) serve as primary instructors in labs associated with these courses; as such, it is important that they can be mentored effectively in that role in order to help undergraduates enhance their learning and performance.  **Actions:**  1. The Committee analyzed 2022-23 assessment results and develop recommendations for program improvement to bring to program faculty. (Spring 2024)  2. Program faculty reviewed and approved specific program improvement actions to be undertaken based on assessment findings. (Spring 2024).  **Follow-Up:**  1. The Committee will work with program faculty to evaluate the degree to which the coverage of important topics in foundational courses is adequate and aligned to promote student learning and success in subsequent courses. (Fall 2024).  **Next Assessment Cycle:**  2024-25 academic year | | | | | |

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| **Program Student Learning Outcome 2** | | | | | |
| **Program Student Learning Outcome** | **Graduates will demonstrate an understanding of research ethics and the responsible conduct of research.** | | | | |
| **Measurement Instrument 1** | **CITI Responsible Conduct of Research Course Modules**  The Collaborative Institutional Training Initiative (CITI) is a web-based ethics training course for responsible conduct in research that has been adopted by the WKU IRB, IACUC, and IBS Committees as a prerequisite certification to be attained by any investigator seeking approval for a research project through one or more of these committees. All PIs, Co-PIs, and Faculty Sponsors are required to complete CITI RCR training and receive certification (based on a minimum score of 80%) across all course training modules. These module educate and evaluate researchers on up-to-date issues and standards of research ethics, research integrity, and researcher conduct.  The Physical Science RCR Course used to assess this SLO consists of 7 individual modules: (1) Research Misconduct; (2) Data Management; (3) Authorship; (4) Peer Review; (5) Mentoring; (6) Conflicts of Interest; and (7) Collaborative Research. Within each module, participants review a multimedia presentation and several seminal articles related to the topic. At the end, participants demonstrate competency through a five-question multiple choice test, with test items randomly drawn from a larger question pool.  Completion of CITI RCR training is required of all students enrolled in BIOL 500, our required Introduction to Graduate Studies course that is taken by students during their first semester at WKU. This is an appropriate time to deliver this assessment, as students are preparing to initiate a thesis research or investigatory project as part of their Program of Study. Students are required to submit (1) a Completion Certificate indicating that they have attained a minimum score of 80% across all course modules, and (2) individual module scores (percentage of questions answered correctly) from their first attempt. | | | | |
| **Criteria for Student Success** | Students will attain the required minimum score for certification, with at least 60% correct answers on each module from their first attempt, including 80% or higher on at least 4 of the 7 modules. | | | | |
| **Program Success Target for this Measurement** | | At least 75% of students will attain the criterion level of success. | **Percent of Program Achieving Target** | N/A – no data in 2022-23 | |
| **Methods** | All students enrolled in the BIOL 500 course are intended to be assessed. This will generate a sample size of 5-10 each assessment year. However, these data were not collected as anticipated in the department’s five-year assessment plan. Full implementation of this requirement will occur beginning in Fall 2024. | | | | |
| **Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 2.** | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | |
| **Results and Conclsuions:** N/A – no data in 2022-23  **Actions:**  1. The Committee analyzed 2022-23 assessment results and develop recommendations for program improvement to bring to program faculty. (Spring 2024)  2. Program faculty reviewed and approved specific program improvement actions to be undertaken based on assessment findings. (Spring 2024).  **Follow-Up:**  1. The program will integrate and require all students in BIOL 500 to complete the (1) Investigators, Staff, and Students Basic Course, and (2) Physical Sciences Responsible Conduct of Research Course, (3) Basic Biosafety Course, and (4) one other CITI course appropriate to their program of study. (Fall 2024)  **Next Assessment Cycle:**  2024-25 academic year | | | | | |

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| **Program Student Learning Outcome 3** | | | | | |
| **Program Student Learning Outcome** | **Graduates will demonstrate the ability to apply scientific methodology and field/laboratory/analytical skills to a biological question.** | | | | |
| **Measurement Instrument 1** | **Representative Biology Process Artifact**  All students in the program are required to complete a process-based project, culminating in either a master’s thesis (BIOL 599) or a product of independant investigation (BIOL l516), in which application of part or all of the scientific process to address a relevant question in biology. Both of these experiences yield artifacts – such as evidence and argument papers, research presentations or posters, honors CE/T projects, or manuscripts – that allow for assessment of this SLO. Students are required to submit the artifact as part of their BIOL 599 (thesis) or BIOL 516 (non-thesis) course.  Artifacts are assessed by the student’s major advisor and/or graduate committee using the AAC&U LEAP Inquiry and Analysis rubric. Faculty independently assess each artifacts they are assigned; when faculty ratings differ by more than 25% across all rubric elements, artifacts ratings are reconciled either by a third reviewer or by discussion between team members. The Inquiry and Analysis rubric is attached to this report. | | | | |
| **Criteria for Student Success** | Students will receive an rating of 3.0 or higher across all rubric elements, with no rubric element below 3 (out of 4). | | | | |
| **Program Success Target for this Measurement** | | At least 75% of students will attain the criterion level of success. | **Percent of Program Achieving Target** | 50.0% of students attained the criterion level of success, with 28.6% attained the sub-criterion. The sample size was 14. | |
| **Methods** | The mean overall rating was 2.7 out of 4.0, indicating a milestone level of performance across all rubric elements. The six rubric elements are divided into three sub-scores (2 elements each) reflecting different aspects of the SLO: (1) Evidence-gathering; (2) Analysis; and (3) Argumentation. Subscores were highest for evidence gathering (mean subscore 3.1 out of 4.0), followed by analysis (2.7) and argumentation (2.4). Student performance was lowest on the rubric element associated with drawing implications from their analysis, with a mean element score of 2.2. These score trends are not surprising, and are consistent with the Bloom’s taxonomic level of the different rubric elements; however, the absolute scores are below targeted levels. While the percentage of students meeting the criterion score was the same as seen during the 2020-21 assessment cycle, the mean subscores were somewhat lower. This may reflect the fact that, during the current cycle, artifacts from both non-thesis and thesis students were included, while the 2020-21 cycle only included data from students who completed graduate thesis projects; non-thesis projects are generally less rigorous and hypothesis testing-based, so this trend is not surprising. Performance of 056 students was better than that of students in the the department’s undergraduate programs; this indicates that the graduate program operates at a higher degree of academic rigor. | | | | |
| **Based on your results, circle or highlight whether the program met the goal Student Learning Outcome 3.** | | | | **Met** | **Not Met** |
| **Results, Conclusion, and Plans for Next Assessment Cycle (Describe what worked, what didn’t, and plan going forward)** | | | | | |
| **Results and Conclsuions:**  The assessment process again revealed a high level of variability in artifacts among science process courses from which they were drawn. This seems to indicate that faculty mentoring students (especially non-thesis students) do not have a consistent set of expectations regarding what constitutes a valid capstone-level science process artifact. As a follow-up activity from the 2021-22 assessment cycle, program faculty developed and approved a set of minimum standards for the process artifact, effective Fall 2023; however, because students submit process artifacts for assessment during their last semester, there will be a time lag before we see any meaningful changes in student artifacts. Our assessment results from this cycle suggest that the next logical step would be for faculty mentoring thesis and non-thesis students to self-evaluate their assignment to ensure artifacts will address all of the approved minimum standards.  **Actions:**  1. The Committee analyzed 2022-23 assessment results and develop recommendations for program improvement to bring to program faculty. (Spring 2024)  2. Program faculty reviewed and approved specific program improvement actions to be undertaken based on assessment findings. (Spring 2024).  **Follow-Up:**  1. The department will establish a framework and process within the department for faculty mentoring thesis and non-thesis students to self-evaluate and (as needed) correct their process artifact assignments to meet established standards. (Fall 2024)  **Next Assessment Cycle:**  2024-25 academic year | | | | | |

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Description automatically generated**INQUIRY AND ANALYSIS VALUE RUBRIC**

*for more information, please contact value@aacu.org*

**Definition**

Inquiry is a systematic process of exploring issues/' objects/works through the collection and analysis of evidence that result in informed conclusions/ judgments. Analysis is the process of breaking complex topics or issues into parts to gain a better understanding of them.

*Evaluators are encouraged to assign a zero to any work sample or selection of work that does not meet benchmark (cell one) level of performance.*

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|  | **Capstone**  **4** | **Milestones**  **3 2** | | **Benchmark**  **1** |
| **Topic selection** | Identifies a creative, focused, and manageable topic that addresses potentially significant yet previously less explored aspects of the topic. | Identifies a focused and manageable/doable topic that appropriately addresses relevant aspects of the topic. | Identifies a topic that while manageable/doable, is too narrowly focused and leaves out relevant aspects of the topic. | Identifies a topic that is far too general and wide-ranging as to be manageable and doable. |
| **Existing Knowledge, Research, and/or Views** | Synthesizes in-depth information from relevant sources representing various points of view/approaches. | Presents in-depth information from relevant sources representing various points of view/approaches. | Presents information from relevant sources representing limited points of view/approaches. | Presents information from irrelevant sources representing limited points of view/approaches. |
| **Design Process** | All elements of the methodology or theoretical framework are skillfully developed. Appropriate methodology or theoretical frameworks may be synthesized from across disciplines or from relevant subdisciplines. | Critical elements of the methodology or theoretical framework are appropriately developed; however, more subtle elements are ignored or unaccounted for. | Critical elements of the methodology or theoretical framework are missing, incorrectly developed, or unfocused. | Inquiry design demonstrates a misunderstanding of the methodology or theoretical framework. |
| **Analysis** | Organizes and synthesizes evidence to reveal insightful patterns, differences, or similarities related to focus. | Organizes evidence to important patterns, differences, or similarities related to focus. | Organizes evidence, but the organization is not effective in revealing important patterns, differences, or similarities. | Lists evidence, but it is not organized and/or is unrelated to focus. |
| **Conclusions** | States a conclusion that is a logical extrapolation from the inquiry findings. | States a conclusion focused solely on the inquiry findings. The conclusion arises specifically from and responds specifically to the inquiry findings. | States a general conclusion that, because it is so general, also applies beyond the scope of the inquiry findings. | States an illogical, or unsupportable conclusion from inquiry |
| **Limitations and Implications** | Insightfully discusses in detail relevant and supported limitations and implications. | Discusses relevant and supported limitations and implications. | Presents relevant and supported limitations and implications. | Presents limitations and implications, but they are possibly irrelevant and unsupported. |

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| **CURRICULUM MAP TEMPLATE** | | |  |  |  |
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| **Program name:** | 056 Master of Science-Biology | | |  |  |
| **Department:** | Biology | | |  |  |
| **College:** | Ogden | | |  |  |
| **Contact person:** | Carl Dick | | |  |  |
| **Email:** | [carl.dick@wku.edu](mailto:carl.dick@wku.edu) | | |  |  |
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| **KEY:** | |  |  |  |  |
| **I = Introduced** | |  |  |  |  |
| **R = Reinforced/Developed** | |  |  |  |  |
| **M = Mastered** | |  |  |  |  |
| **A = Assessed** | |  |  |  |  |
|  |  |  | **Learning Outcomes** |  |  |
|  |  |  | **LO1:** | **LO2:** | **LO3:** |
|  |  |  | Graduates will demonstrate a degree of biological content knowledge appropriate to their degree level. | Graduates will demonstrate the ability to apply scientific methodology and field/ laboratory/ analytical skills to a biological question. | Graduates will demonstrate an understanding of research ethics and responsible conduct of research. |
| **Course Subject** | **Number** | **Course Title** |  |  |  |
| BIOL | 500 | Introduction to Graduate Studies and Research in Biology (First Semester) | R,A | R | R,A |
| BIOL | 4xxG | Elective Courses in Biology (TBD by student's committee) | M |  |  |
| BIOL | 5xx | Elective Courses in Biology (TBD by student's graduate committee) | M |  |  |
| BIOL | 599 | Thesis Research/Writing | M | M,A | M |
| BIOL | 516 | Investigations/Biology | M | M,A | M |