Biology Major Assessment Report

September 20, 2019

I. Assessment Activities

a. Accreditation. There is no professional accrediting agency for the Biology major. However, several Biology professional societies (American Society for Microbiology, American Physiological Society, Ecological Society of America) have adopted the recommendations in the report, Vision and Change in Undergraduate Biology Education: A Call to Action, published by the National Science foundation and the American Society for the Advancement of Science (http://visionandchange.org), as a foundation for their educational materials and suggested course curricula. The learning outcomes for the Biology major reflect the recommendations in this report. These recommendations are designed to ensure that all biology majors gain a better understanding of the nature of science and the natural world. The focus is on students understanding core concepts and developing specific competencies.

The Biology Department extensively revised our assessment plan in Fall 2013 to reflect the Vision and Change recommendations and the guidelines of the UWRF Assessment Committee. The first year of data collection and analysis using this new plan was in 2015-16 and submitted an assessment report in Fall 2016. During 2016-17 we worked on revising data collection strategies and exploring validated tools for direct assessment tools. Learning outcomes data are reported here for the 2017-19 academic years.

b. Learning outcomes and assessment schedule

A graduate with an undergraduate degree in Biology will be able to:

1. Demonstrate understanding of core concepts in biology:
   a. Evolution - The diversity of life evolved over time by processes of mutation, selection, and genetic change.
   b. Structure and Function - Basic units of structure define the function of all living things.
   c. Information flow, exchange, and storage - The growth and behavior of organisms are activated through the expression of genetic information in context.
   d. Pathways and transformation of energy and matter - Biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of thermodynamics.
   e. Systems - Living systems are interconnected and interacting

2. Apply the process of science
   a. Use observation, experimentation, and hypothesis testing
   b. Evaluate experimental evidence
   c. Develop problem-solving strategies
   d. Develop proficiency in laboratory and field techniques

3. Use quantitative reasoning
   a. Apply quantitative analysis to interpret biological data
   b. Develop and interpret graphs

4. Use modeling and simulation
   a. Apply informatics tools
   b. Use computational modeling of dynamic systems
   c. Analyze large data sets
5. Tap into the interdisciplinary nature of science  
   a. Apply concepts from other sciences to interpret biological phenomena  
   b. Apply physical laws to biological dynamics  

6. Communicate and collaborate with other discipline  
   a. Demonstrate effective scientific writing  
   b. Explain scientific concepts to different audiences  
   c. Work in teams and collaborate across disciplines  
   d. Exhibit cross-cultural awareness, including global issues  

7. Understand the relationship between science and society  
   a. Evaluate the relevance of social contexts to biological problems  
   b. Evaluate ethical implications of biological research  

These learning outcomes reflect fundamental core concepts and competencies necessary for all Biology majors regardless of emphasis, and therefore the outcomes are the same for all options in the Biology major. The specific details of the content may vary, but the core principles are common to all options. The BioCore Guide (Brownell et al., 2014, *CBE Life Sci Educ* vol. 13(2) 200-211) provides a framework for addressing the core concepts in the broad areas of biology (cellular & molecular, physiological, ecology & evolution), and has been vetted by the larger biology education community. This guide informed our approach to assessing these concepts.

Learning outcomes are assessed on a three-year cycle. For this cycle we did not collect specific data during 2016-17, so the outcomes were assessed as indicated below. For some courses, the outcomes identified for 2017-18 were assessed in 2018-19 instead. Data from these two years were combined for analysis.

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<td>Evolution</td>
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<tr>
<td>Structure &amp; Function</td>
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<td>Information flow</td>
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<td>Energy transformation</td>
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<td>Systems</td>
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<td>Quantitative reasoning</td>
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<td>Modeling and simulation</td>
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<td>Interdisciplinary</td>
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<td>X</td>
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<td>Communicate and collaborate</td>
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<tr>
<td>Science &amp; Society</td>
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d. **Modes of delivery.** Learning outcomes were assessed in both lecture and laboratories. In lectures, core concepts were assessed on exams and quizzes, as well as activities and projects where students were asked to apply the concepts (LO1). The ability of students to apply the concepts was also assessed in laboratories via lab reports, discussions and presentations. Similarly, the core competencies were assessed in both lecture and lab. For example, for LO3, exam questions asked students to interpret a graph or identify the correct statistical tool to use for specific data analyses. In laboratories, students were asked to prepare graphs for their lab data or apply statistical tools and other calculations. Most of the courses taken by our majors are offered face-to-face, with a couple of hybrid courses with online lectures. All labs are offered face-to-face. Assessments in online lectures and during summer sessions (where the timeframe is compressed) were very similar to those in face-to-face lectures.

e. **Internal stakeholders.** The primary internal stakeholders are students majoring in Biology, and faculty in the department. We engaged with students in classes by sharing the learning outcomes with them, providing relevant instruction, and providing feedback on their performance. We also engaged with students outside of class via advising and mentoring, monitoring their learning of content and skills (LO1-LO7) and providing feedback and assistance. Graduating seniors were asked to complete an exit survey that provides indirect
assessment of their achievement of learning outcomes and their success in obtaining jobs or graduate/professional school acceptance. We also note that students in other majors take biology courses, since several majors in the College of Agriculture, Food, and Environmental Science (e.g. Animal Science, Environmental Science) and the College of Education and Professional Studies (e.g. Health and Physical Education, Exercise and Sports Science) require foundational and advanced biology courses.

Faculty were engaged in all aspects of the assessment process, including development of the learning outcomes, identification of artifacts for evaluating the outcomes, collecting data, analyzing data and suggesting action items. In addition, faculty interacted with students engaged in out of class activities and observe their applications of core concepts and competencies in a variety of settings.

f. **External stakeholders.** External stakeholders include alumni, companies who employee our graduates, the regional business community, graduate and professional programs, and the Biology academic community. Alumni were sent a survey regarding their current position and how well the Biology major prepared them for that position. Biology faculty interacted with internship supervisors and program directors to obtain additional feedback regarding student understanding of concepts (LO1) and their skills (LO2-LO7).

g. **Out of classroom learning.** Out of class activities include research experiences (on and off campus), internships, and international experiences. The number of students engaged in these activities was recorded, and samples of products submitted by students that summarize their learning experiences (reports, posters, presentations) were reviewed. The main learning outcomes addressed were content knowledge (LO1), applying the process of science (LO2), and communication and collaboration (LO6). We also contacted supervisors of these experiences to obtain feedback on how well the students were doing in these areas.

h. **Changes to assessment.** The were no changes to the Biology major learning outcomes since the last report. There were a few changes to the course mapping, with respect to where specific outcomes were assessed (updated mapping is provided in Appendix A). We did attempt to streamline the data collection from courses as well as the analysis process. As before, faculty identified exam/quiz questions and other graded items that address these, using the BioCore guide to align assessments with core concepts, and they provided a summary of student performance on these assessments. However, we did not try to combine data from different courses and assessments in a quantitative way. Rather, we viewed these data qualitatively, and discusses whether students were meeting expectations at a level appropriate for each course. For quantitative analysis, we planned to rely on an externally validated assessment, BioMAPS (Couch et al. 2019, CBE Life Sci Educ DOI 10.1187/cbe.18-07-0117). BioMAPS just became available for general use in Spring 2019 and was piloted only in a few Biology courses.

Changes to the curriculum since the last assessment report include:

- A new laboratory research project was incorporated into some sections of BIOL 160, as a result of UWRF joining the Tiny Earth Network in 2018. This is an international collaboration of researchers trying to identify new antibiotics produced by soil bacteria, to address the global crisis of antibiotic resistance. About half of new Biology majors take BIOL 160 with the Tiny Earth project as the lab component, and half take BIOL 160 with the SEA-PHAGES project (with which we have been involved since 2010-11), so that most majors have an authentic research experience during their first semester.
- Another national research collaboration, Prevalence of Antibiotic Resistance in the Environment (PARE), was incorporated into some BIOL 150 courses as part of the lab component. Most majors take BIOL 160, but since that class is only offered in the Fall semester, some majors take BIOL 150 instead.
- Fundamentals of Biological Evolution (BIOL 103), was added to the core required courses for the major rather than as an elective. This change was partly a result of previous program assessment. We recognized that many majors did not address this core area thoroughly in their elective coursework.
- General Microbiology (BIOL 324) was also added to the core major requirements rather than an elective, recognizing the fundamental importance of microbes in all areas of biology.
- A new major in Biomedical and Health Science was approved for 2019-20, replacing the Biomedical Sciences option in the Biology major. The Biology major now has General Biology and Field options. That does not affect the time frame of this report, but will require a separate assessment plan for each major for future reports.
i. **UWRF strategic goals.** We have not made any changes in how the Biology program’s learning outcomes are related to UWRF Strategic goals since the assessment plan was submitted in 2016. However, we updated the descriptions of research projects and partnerships. This section of the assessment plan is included here.

- **Distinctive Academic Excellence:** The Biology program learning outcomes ensure that students completing a Biology major are able to think analytically (LO2, LO3, LO4) and collaboratively (LO5), and are able to communicate their ideas effectively and across disciplines (LO6). These attributes are fundamental to academic excellence. The Biology program provides students with unique opportunities to develop academic skills through foundational and specialized coursework that allow students to apply biology concepts to real world problems (LO7).

Students and faculty in the program are actively engaged in research in the laboratory, field, and classroom. These activities support UWRF’s strategic initiatives related to undergraduate research. A distinctive feature of our program is the integration of authentic research experiences into first-year biology courses as well as in upper level courses (LO2). The UWRF Biology program is the only one in the UW-System to implement the Howard Hughes Medical Institute’s SEA-PHAGES program, which incorporates research on bacteriophage genomics (LO4) into first-year biology courses, with opportunities for students to present and publish their work (LO6). A second national collaborative project, the Tiny Earth Network, was added to some sections of BIOL 160 starting in 2018-19. This project, administered by the Wisconsin Institutes for Discovery, allows students to isolate bacteria with the potential to produce new antibiotics. First year students can continue both of these research projects in the Freshman Research Experience course (BIOL 195). We are also incorporating authentic research experiences into BIOL 150, which is taken by a smaller number of Biology majors. A new project for BIOL 150 is the Prevalence of Antibiotic Resistance in the Environment (PARE) project. Faculty in upper-division courses also regularly require projects with a research focus. In addition, many students take advantage of opportunities for independent research with faculty in the department, or in summer research programs at other institutions.

- **Global Education and Engagement:** The ability of our students and graduates to communicate scientific concepts across disciplines and cultures (LO6) supports this strategic goal. Several courses require students to consider biological problems in a global context. Furthermore, Biology faculty have established international opportunities in Taiwan, Costa Rica, Europe (Sweden, Germany, Poland), where students are engaged in biomedical or environmental projects while experiencing another country’s culture. Additionally, students participate in international internships and study abroad programs. These opportunities are taken for academic credit that counts as biology major electives. Through the generous donation of alumnus Dr. John Butler, the Butler International Scholarship is now supporting one student to each year engage in research at a European scientific institute.

- **Innovations and Partnerships:** The Biology program supports this strategic goal through courses that engage students in innovative research projects (LO2), often in collaboration with scientists at other institutions. Course content is continuously updated as appropriate to ensure that students are able to apply the concepts they learn to current problems. Recently developed courses focus on new areas of biology such as Epigenetics, Stem cells and regenerative medicine, and Genomics. Newly developed partnerships with programs such as the University of Minnesota Clinical Laboratory Scientist program allow students to earn certification in specific skills while completing their biology major. We have finalized a 3+1 articulation agreement with this program, which is nationally recognized with a high probability of employment following certification. We also now have a 3+1 articulation agreement with Palmer College of Chiropractic, and 3+4 and 4+4 articulation agreements with the Lake Erie College of Osteopathic medicine (the largest medical school in the United States), with associated programs in dentistry and pharmacy, as well as a 3+2 articulation agreement with the Echocardiography program of the Mayo Clinic.

j. **Prior action plans.** Progress on action plans included in the last assessment report are included here:
1. Action item: Core concepts and competencies (LO1)
      Encourage students to take BIOL 103.
      Progress: BIOL 103 has been added to the core requirements so all majors now take it.

2. Action item: Advocate for an internship office in CAS and more support for faculty engaged in undergraduate research with students outside of class.
   Progress: Ongoing, no specific progress made. With turnover in various administrative offices, these efforts should be renewed.

3. Action item: Clarify expectations for faculty mentoring undergraduate research.
   Progress: We revised our departmental criteria to have more clear guidelines, but discussions of specific expectations for undergraduate research are ongoing. We received feedback from the CAS Promotions committee with questions and requested revisions, and are currently discussing those.

4. Action item: Modify the senior exit survey to include indirect assessment of learning outcomes.
   Progress: These questions were added to the exit survey.

5. Action item: Enhance communication with alumni and external stakeholders.
   Progress: Ongoing – we continue to struggle to connect to these groups. Responses to surveys has been poor, and we are continuing to seek other ways to get feedback.

   Progress: We developed a new form for submitting course data, that is focused more on qualitative assessment and requires less quantitative information. It is still cumbersome for faculty to complete, so we will continue to make this process more efficient. We continue to struggle with collecting information about learning outcomes in out-of-class activities, so we will continue to work on this item.

   Progress: The BioMAPS assessment for assessing core concepts (LO1) tool was not made generally available until Spring 2019, and we piloted this tool in a couple of classes this spring. We plan to implement it in a more comprehensive way starting in 2019-20. A new tool for Quantitative reasoning skills (LO3), BioSQUARE, will be piloted when this competency is assessed in 2020-2021. The EDAT tool for experiment design will be used again in 2019-20, with modifications.

II. Assessment Results

a. Direct assessment results. Direct assessment data for the learning outcomes assessed in this cycle are summarized in the tables below. Faculty submitted data from courses where these outcomes were assessed. These items were sorted by course level (Freshman/Sophomore or Junior/Senior). Items were primarily test/quiz questions and class activities for LO1, and project reports and exam questions for LO3-7. Scores (percent with acceptable performance) were compiled to provide an overview of how well students were meeting the outcomes. In this cycle, we assessed outcomes that were not included in the previous cycle, so we cannot identify trends. We will now have a baseline for each learning outcome to be able to identify trends in the report.

**LO1: Core concepts.** Faculty assessed whether students demonstrated understanding of core concepts, through test and quiz questions, and completing activities or assignments in class. The percent of students meeting expectations for these outcomes is presented in the charts below. These compiled data were presented at a department meeting, and we discussed whether the results were acceptable, and whether we planned to make changes in instruction or assessment. We did not try to average the percentages reported, since the assessment artifacts were different in each course. Instead, we view these results holistically and discussed overall trends. We discussed the benefit of aligning outcomes for individual courses and developing common assessments that can be used in multiple course settings. A summary of the assessment results is included in the table below. Shaded cells indicate the % of students meeting
expectations for the outcome. Some courses included multiple assessment for a core concept, so more than one cell may be shaded in a column.

<table>
<thead>
<tr>
<th>%</th>
<th>Information flow</th>
<th>Energy transformation</th>
<th>Systems</th>
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<tbody>
<tr>
<td></td>
<td>Fr-So</td>
<td>Jr-Sr</td>
<td>Fr-So</td>
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<tr>
<td>95</td>
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<td>70</td>
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**Information flow** – The growth and behavior of organisms are activated through the expression of genetic information in context. Students performed well overall for this outcome, meeting expectations suitable for the course level at the 70% level or above. As these concepts are reinforced in upper level courses, students demonstrate more depth of understanding.

**Energy Transformations** - Biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of thermodynamics. While most students still met expectations at the 70% level or above for this outcome, overall they did less well on this outcome. For one assessment the average was 65%, the only one that was not above the minimum acceptable performance. These concepts tend to be some of the most challenging for students. They performed better on in class assignments and activities where they had a chance to discuss the information and receive feedback, and scores were typically lower on exam questions.

**Systems** - Living systems are interconnected and interacting. Again, students met expectations at the 70% level or above, but overall performance was somewhat lower than for the previous concepts. The concept of systems in biology may not be emphasized in secondary curricula to the same extent as other concepts. Class activities revealed areas were students were struggling more to understand this concept, and we can use this information to enhance lecture material.

While we work toward having more consistent assessments of these concepts, it will be valuable to compare our classroom assessments to an instructor-independent assessment that can be used developmentally. The BioMAPS exam is now available for general use via a web-based system. We piloted this tool in a couple of classes this spring to evaluate the type of data returned. An example is included below. The sample size for these data is small, but we can see some possible trends in terms of fewer lower scores seen for upper level students (BIOL 345). Student performed best on the Structure and Function concept, consistent with our in-class assessment results (2016 report). One valuable component of this exam is the summary of specific exam answers with the percent correct for each, so we can identify specific content that is more difficult, as well as possible misconceptions that can be addressed.
**LO3-LO7, Core competencies.** Faculty assessed whether students achieved specific competencies in five areas. Aggregate data for Freshman-Sophomore and for Junior-Senior classes are shown in the table below.

<table>
<thead>
<tr>
<th>Competency</th>
<th>Example assessments</th>
<th>Range for Fr-So courses</th>
<th>Range for Jr-Sr courses</th>
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<tbody>
<tr>
<td>Quantitative reasoning (LO3)</td>
<td>Statistical analyses in lab projects</td>
<td>30-90%</td>
<td>80-90%</td>
</tr>
<tr>
<td>Modeling and simulation (LO4)</td>
<td>Concept mapping, gene annotation, modeling in lab projects</td>
<td>90-95%</td>
<td>85-95%</td>
</tr>
<tr>
<td>Interdisciplinary connections (LO5)</td>
<td>Exam questions, lab reports, discussions</td>
<td>70-90%</td>
<td>85-95%</td>
</tr>
<tr>
<td>Communicate and collaborate (LO6)</td>
<td>Lab projects, lab group dynamics, group lab notebooks</td>
<td>70-90%</td>
<td>85-100%</td>
</tr>
<tr>
<td>Science and society (LO7)</td>
<td>Lab reports, case studies, research abstracts, exam questions, assignments</td>
<td>75-95%</td>
<td>95-100%</td>
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**Quantitative reasoning (LO3)** - This outcome had the widest range of student performance in the freshman and sophomore classes, with some student performing well below expectations. This is likely due to the fact that there is no math prerequisite for biology courses. Some students may be taking Math 30 at the same time as BIOL 160, while others have completed Calculus. Introductory Biology labs requires a variety of math skills involving algebra (dilutions, making solutions) and statistical analyses (correlations, means, P-values). These skills are reinforced repeated in subsequent lab courses, and student performance improved in upper level courses. This improvement is likely a combination of students’ completing their math courses, and the repeated chances to practice these skills.

**Modeling and simulation (LO4)** – We defined models and simulations broadly for the purposes of assessing this outcome, including simple concept mapping and also sophisticated computer modeling programs. The types of assessment artifacts were quite varied. Overall, though, students performed well when asked to interpret abstract or concrete models of biological phenomena.

**Interdisciplinary connections (LO5)** – For this outcome, students were expected to understand the chemistry and physics concepts important in biological processes. This was assessed primarily via exam questions, as well as class discussions and activities. Approximately half the students in General Biology are also taking chemistry courses, while others wait until their second or third semester. Physics is typically taken during the
junior year. We saw a corresponding improvement in upper level courses compared to freshman and sophomore courses. Even in those courses, it was sometimes difficult to make the connections between these disciplines, so it would be helpful for us to make these more explicit.

Communication and collaboration (LO6) - Students had many opportunities to practice these skills throughout their coursework. Many of the activities in class are group work where students bring their individual learning to the group to collaborate on solving problems and organizing information. Some presentations are made as individuals, while others are group presentations. Lab work is typically done in groups with collaborative group presentations. Overall, students met or exceeded expectations for this outcome, with improvement seen in upper level classes. We noted that students achieved better outcomes when given a chance to incorporate feedback on their presentations.

Science and society (LO7), Students performed well on this outcome, when asked to discuss ethical issues or other aspects of the impact of science on society and vice versa. We observed better outcomes in more advanced courses, likely due to students having more in depth understanding of the science concepts and processes, as well as more understanding of the human experience through their general education courses.

b. Modes of delivery. Some outcomes (LO1, LO5) were assessed primarily in lecture, while others (LO3, LO4, LO6, LO7) were assessed in both lecture and lab settings. Since most biology courses include labs, all students experienced both types of course structure. Assessments in online courses and summer courses with compressed timeframes were comparable to those used during in-person, full semester courses.

c. Out of class experiences. The number of students engaged in out of class activities is shown in the following table:

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<thead>
<tr>
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<th>2016-17</th>
<th>2017-18</th>
<th>2018-19</th>
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<tbody>
<tr>
<td>Internship</td>
<td>10</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Research</td>
<td>34</td>
<td>34</td>
<td>36</td>
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<tr>
<td>International</td>
<td>30</td>
<td>26</td>
<td>26</td>
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<tr>
<td>Total</td>
<td>74</td>
<td>74</td>
<td>76</td>
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</table>

Internships: The numbers for internships and international experiences are likely to be low. It was difficult to gather that information unless faculty worked directly with students. While the numbers reflect a small percentage of Biology majors that have these opportunities, they seem to be very valuable for the students who are able to have them, in terms of reinforcing learning outcomes (LO1, LO2, LO6) and establishing contacts for future opportunities. Products of these activities include reports, presentations, and posters. The nature of these experiences is highly variable, but based on the products and informal discussion with students and their mentors/supervisors, they are achieving these outcomes at a high level, at or beyond what would be expected for a student at that point in their academic career.

The main issue with respect to internships is the limited number that are available. There are a small number of internships available on a regular basis (Department of Natural Resources, St. Croix Medical Examiner). Without the support of an Internship Office in our college, it take enormous effort by faculty and students to establish a formal internships. Most often, students are on their own to make the connections and then work with faculty to set up the internship credits.

Research: Biology faculty were very active in undergraduate research, primarily by integrating students into their own research projects. Nearly 100 students participated in these activities in 2014-15 and 2015-16, many of them earning biology elective credits. A few students participated in summer research experiences off campus, e.g. through an REU program. A review of reports, posters, and presentations submitted by these students demonstrates successful achievement of learning outcomes (LO1, LO2, LO6) overall. Most of these students have presented their results at the Fall Gala, and many have also presented at regional (Wisconsin Science & Technology Symposium, American Society for Microbiology North Central Branch), national (NCUR), and international (FASEB Experimental Biology) meetings. Student presentations have
received excellent feedback and some were recognized as being exceptional, with the students awarded conference prizes and receiving invitations to present at Posters in the Rotunda. Overall the conclusion is that students who take these opportunities seriously and are willing to put in the additional time and effort that they require typically do very well in achieving the associated learning outcomes (LO1, LO2, LO6). Our discussion of these results also addressed the challenges for faculty mentors with respect to the time required for these activities, which limits time available for our own scholarship and teaching.

Due to the large number of Biology majors, it is impossible to provide mentored research experiences for all of them. Therefore, the Biology department has made a commitment to providing authentic research experiences in several classes. These course labs provide students an opportunity to engage in scientific discovery while learning the process of science (LO2). Most biology majors now take BIOL 160, which includes a research project in the lab. About on one third of students also take BIOL 195, Freshman Research, which continues the research projects from the previous semester. Besides giving presentations in classes, students in these classes have presented the results of their research at local, regional, and national conferences. Two students from the phage research section of BIOL 160 present at the HHMI PHAGES Symposium in Ashton, VA, each year, and for the past 7 years their abstract has been selected for a talk as well as poster (among 12 abstracts out of about 100). Students in the Tiny Earth sections presented their work at the Tiny Earth Symposium in Madison, WI. Students also presented at the Fall Gala and at regional conferences such as the Minnesota Academy of Science conference and American Society for Microbiology North Central Branch meeting. These conferences included judges who evaluate the posters and the student’s ability to present the research. We conclude that integrating these research experiences into classes successfully supports these learning outcomes (LO1, LO2, LO6).

**International:** The international experiences organized by Biology faculty (Taiwan, Costa Rica, Germany, Sweden) also have been successful in supporting these learning outcomes. Student reports and posters demonstrate achievement at or above expectations (LO1, LO2, LO6). We do not have complete information about all of the students taking advantage of semester abroad and other university wide international experience, so that is an area where we can improve our data collection efforts.

**Other:** There are additional out of class activities that are worth mentioning, even though we are not formally assessing them. Students in the pre-health fields are required to document volunteer or shadowing hours as part of their applications to professional schools. Occasionally a student will use those experiences to earn credit for Independent study, and submit a journal or report. Participation in discipline-based student organizations provides another opportunity for students to reinforce learning outcomes (LO6, LO7). Active student organizations during this assessment period include the Pre-Health Society and Pre-Veterinary Club, which bring in speakers, visit potential job sites and professional programs, and participate in service projects such as Relay for Life and Dan’s Bandana Project. Based on informal discussion with students and the activity of these clubs, they are successful at helping students apply these learning outcomes.

d. **Indirect assessments.** Informal discussions with students participating in the out of class experiences described above indicate that they feel that their course work prepared them well for these experiences overall. They also describe these experiences as very important for enhancing their understanding of biology concepts and skills. Graduating seniors completed an exit survey administered through D2L. The data for 2018-19 are shown in the graphs below. Data for 2016-18 were stored in a D2L survey associated with our former Department Associate’s account, and we are working to recover it. Students were asked to express their level of agreement with the following outcomes statements:

1. In general, the quality of instruction in the Biology courses I took was good.
2. The departmental laboratory facilities were good.
3. The Biology major gave me the skills and understanding that I sought.
4. The required courses and electives in this major provided me with an adequate depth of knowledge.
5. The required courses and electives in this major provided me with an adequate breadth of knowledge.
6. I was able to get my biology courses on time and in the desired sequence.
7. I received helpful and appropriate advising.
8. I received adequate personal attention from the Biology faculty.
9. Contact with the Biology faculty was a significant advantage of attending UW-River Falls.

10. Upon graduation, my expectations concerning my ability to compete in the job market or graduate/professional school will have been fulfilled by attending UWRF.

11. The laboratory component of Biology classes I took was valuable.

12. I would recommend the Biology department at UWRF to my friends and colleagues.
The majority of responses were “agree” (including “strongly agree” and “somewhat agree”) for all statements, and no particular trends were observed comparing to previous years. Overall, students seem to be satisfied with the Biology program. The statement with the highest overall scores was about overall satisfaction with the instruction in Biology courses. Slightly lower scores were received for the statements about the “breadth of knowledge” and “the skills and understanding” provided by the program. The lowest scores were received for the statement about their ability to compete in the job field, though the responses were still in the “agree” range. These responses may have more to do with the job market than the major itself, but it may be worth exploring this aspect more thoroughly. Satisfaction with laboratory facilities also received somewhat lower scores, which is not entirely surprising. Although we have made substantial improvements in facilities with lab remodeling and new equipment purchases, there are still significant equipment and space needs, especially for independent research projects.

Students were also asked about their plans following graduation. Of these respondents, 60% said they either had accepted a job offer or were accepted into graduate or professional school, or were going into the military or a volunteer program (Americorps). An additional 27% said they were planning to apply to graduate or professional school.

Students were also asked about their preparedness with respect to the core concepts and competencies. Overall, they thought that they were well prepared, with means ranging from 4.4-4.9 for the core competencies (LO1) and 3.7-4.7 for the competencies (LO2-LO7). The lowest score was for LO4, ability to use modeling and simulation. That is the competency that we think is least well integrated into Biology courses, so it is not surprising that students feel less well prepared. Based on the BioMAPS pilot results, students may be over-estimating their preparation in the core concepts, and therefore it is important that we have that external tool in addition to our course assessments.
e. **Alumni.** Maintaining contact with alumni continues to be one of the most challenging aspects of assessment. We sent a survey to approximately 250 graduates from 2016-2019 and received 39 responses. Of those, 47.3% are enrolled in a graduate or professional program, and 52.5% are employed. 53.6% of those employed indicated that their current position is related to their biology major ("agree" or "strongly agree"). A majority of respondents also agreed or strongly agreed that the biology major prepared them well for their current (or desired) position, and helped them to be informed citizens (see graphs below; 5=strongly agree, 1=strongly disagree).
In open-ended responses, alumni most frequently mentioned the availability, concern, and helpfulness of Biology faculty as the most valuable aspect of the program (50%). They also cited hands on experience in field labs and course lab experiences, especially in early classes, as well as research experiences (24%). They also mentioned small class sizes and variety of electives. When asked what may have been missing from their program, they mentioned a variety of specific courses and skills that would be helpful for their particular position. These included field biology courses such as nutrient cycling and ecological stoichiometry, and data science and statistical programming, anatomy, and histology courses in the biomedical area. A few suggested there should be more information about research opportunities.

The alumni who responded were satisfied that their major provided good preparation. The only specific action we will take is to try to maintain better contact with alumni.

f. **External stakeholders.** We have tried to survey professionals who have direct contact with students and alumni, such as work or internship supervisors and faculty and directors of graduate and professional programs, but have not had a good response. The responses we have gotten suggest that students are well prepared in science concepts (LO1), science process skills (LO2) and communication skills (LO6). We do
regularly receive feedback from internship supervisors, suggesting that students are well prepared in the relevant learning outcomes (LO1, LO2, LO6). Comments from internship supervisor evaluations include:

“She was very reliable and professional. She met all the goals established for our internship. She demonstrated learning and interacted very well with patients. She is a very fast learner, she is very dependable, she is professional and a hard worker. She anticipates what needs to be done and completes tasks without being asked. It would be a pleasure to work with her again, I appreciate all of her help this summer.”

“She performed well beyond what was expected of her. She met every expectation we had for her and more. Reliability, trustworthy, honest, competent, compassionate, efficient, and extremely responsible.

Another example of evidence that our students are doing well in outside programs is the fact that the Mayo School of Health Sciences regularly recruits UWRF biology majors for its programs. This is a direct result of our students enrolling in the first class Surgical First Assistant program and performing at a very high level. We have long term relationships with the WI Department of Natural resources. We also have established articulation agreements with the Mayo Echocardiogram, Sonography, and Radiography programs, University of Minnesota Medical Lab Scientist program, Palmer College of Chiropractic, and Lake Erie College of Osteopathic medicine. These agreements were possible because of the reputation of the program and students.

Again, the specific action we will take is to continue to find ways to get feedback that is more aligned with the learning outcomes for the major.

III. Action plans

a. Summary of where/how performance is or is not meeting program expectations

Overall, the performance of biology majors on the items assessed met expectations. Students demonstrated understanding of the specific core concepts assessed at a level appropriate for that stage in their academic careers. We did not observe any significant differences in course associated with the different options in the major. Assessment of quantitative skills (LO3) showed that some students performed below expectations in the introductory courses, but performance was at or above expectations in upper level courses. The BioMAPS pilot suggested that, while students are able to achieve the learning outcomes related to core concepts in courses, they may not have the depth of understanding to apply those concepts on an instructor-independent assessment or in a different context.

b. Maintain/improve learning outcomes

LO1, Core concepts – no specific action needed for any of the three core concepts assessed.

LO3 – Quantitative reasoning – Through advising, students will be encouraged to complete math courses and take Biostatistics early in their academic career.

LO4, Modeling and simulation – no specific action needed.

LO5, Interdisciplinary connections – Faculty are encouraged to help students make connections between other disciplines, especially chemistry and physics, and biology concepts.

LO6, Collaboration and communication – no specific action needed.

LO7, Science and Society – no specific action needed.

We will use the new BioSkills guide (Clemmons et al. 2019 QUBES Hub doi:10.25334/Q4FT92) to refine out course-level learning outcomes and assessment. This guide is based on the Vision and Change recommendations and developed by the same group that produced the BioCore guide for core concepts.
c. **Comparability of learning** – Assessments occurred in both lecture and lab setting. We did observe that assessments in labs showed a higher level of accomplishment overall, sometimes because students had opportunities to receive and incorporate feedback. Since most biology classes include labs and all majors take both lecture and lab courses, this would not result in differences in student experiences. We have very few online or hybrid courses, and have not directly determined whether student achievement in those courses or in compressed summer offering differs from face to face courses. We will include that analysis in the next cycle of assessment.

d. **Out of class experiences.** Student performance in out-of-class experiences is at or above expectations, based on faculty evaluation of the students with whom they work. However, we do not yet have a formal system to collect assessment data about these experiences, and plan to develop a more effective procedure. These activities greatly enhance students’ educational experiences and students frequently cite these experiences as a valuable part of their education. It would be good to encourage more students to participate. However, faculty are at their limit of what they can provide with respect to mentoring. Additional support will be needed to increase participation. We will continue to offer research experiences in course labs in order to provide this experience within the curriculum. Through advising, we will encourage students to take advantage of internships and international opportunities.

e. **Indirect assessment.** The exit survey will continue to be given to graduating seniors each spring. In 2020, we will add fall graduates. We do not plan to make any changes to the survey, but try to increase participation.

f. **Alumni.** The alumni survey will continue to be administered every three years. No changes are planned to the survey. However, we will investigate additional strategies for communicating effectively with alumni.

g. **External/professional stakeholders.** The stakeholders survey will continue to be administered every three years. No changes are planned to the survey. However, we will investigate additional strategies for communicating effectively with stakeholders.

h. **Assessment process.** Now that we have been through a full cycle of assessing all of the learning outcomes, we have a better idea of where these are met in courses throughout the curriculum. We will use the new BioSkills guide to refine the course-level learning outcomes and assessments for the core competencies (LO2-LO7). We will supplement the course assessment reporting with the use of the BioMAPS exam, given at the beginning of the first semester (in BIOL 160), the end of the first year (after completion of the introductory courses, in BIOL 110) and during the senior year. We used the GenBioMAPS tool in our pilot, but we will consider using one of the specialized exams (Molecular/Cellular Biology and Ecology/Evolution), which may be more appropriate for the new Biomedical and Health Science major and for the options within the Biology major.

One thing that makes the assessment of senior challenging is the lack of a single course taken by all students in the major. Therefore, we will consider offering BIOL 481, Senior seminar, again. We stopped offering this course several years ago due partly to staffing considerations, but it would be helpful to have a senior class where assessments could be administered, and where senior would be able to demonstrate skills in communication (LO6) and other competencies.

The types of assessments used in different courses are variable. We are planning to start a series of discussions, beginning with the General Biology instructors, about the specific learning outcomes and depth of knowledge expected. We will also share assessment strategies, with the goal of possibly identifying some common assessments. There are new, published, validate assessments available for some of the core competencies, such as the BioSQUARE tool. We will explore the feasibility of using some of these in our assessment.
<table>
<thead>
<tr>
<th>Action to be taken</th>
<th>Lead Person</th>
<th>Due date for completion</th>
<th>Review/Follow up date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement BioMAPS assessment at appropriate time points</td>
<td>Assessment Coordinator, Course instructors</td>
<td>First administration in Spring 2020</td>
<td>First data set reviewed in Fall 2020, then annually</td>
</tr>
<tr>
<td>Investigate validated assessment tools for core competencies</td>
<td>Assessment Coordinator, Course instructors</td>
<td>Tentatively plan to Implement BioSQUARE for LO3 in 2020-21</td>
<td>Review data in Fall 2021</td>
</tr>
<tr>
<td>Consider reinstating BIOL 481, Senior seminar</td>
<td>All department faculty</td>
<td>Decide by Spring 2020 for Fall 2020 semester</td>
<td>Review in Fall 2021</td>
</tr>
<tr>
<td>Discussions among instructors about course learning outcomes and assessment</td>
<td>General Biology instructors</td>
<td>First discussions in Fall 2019</td>
<td>Report to department in Fall 2020</td>
</tr>
<tr>
<td>Determine mechanisms for more effective communication with alumni and external stakeholders</td>
<td>Assessment Coordinator, Department faculty</td>
<td>Ongoing</td>
<td>Review progress in Fall 2020</td>
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