Biotechnology Program
Southeastern Oklahoma State University

Assessment Report
2009-2010

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Table of Contents

I. Departmental Mission Statement 3
II. Departmental Vision Statement 3
III. Statement for Assessment and Student Learning 3
IV. Program Goals 3
V. Program Learning Outcomes 3
VI. Assessment of Each Objective and Outcome 4
    Outcome 1 4
    Outcome 2 4
    Outcome 3 11
    Outcome 4 13
    Outcome 5 16
VII. Faculty Level of Involvement in Assessment Process 16
VIII. Assessing IETV and/or Web-Based Instruction 17
IX. Strengths and Weaknesses of the Program 17
X. Effectiveness of Previous Modifications 23
XI. Modifications to be Made to the Program or the Assessment Plan 24
XII. Communication with Constituents and Stakeholders 24
XIII. Signatures. 25
I. Departmental Mission Statement

The Department of Chemistry, Computer, and Physical Sciences and the Department of Biological Sciences are dedicated to enabling students to discover and achieve their highest potential by providing excellence in teaching, outstanding academic programs, and relevant research opportunities.

II. Departmental Vision Statement

The Department of Chemistry, Computer, and Physical Sciences and the Department of Biological Sciences will continue to exemplify excellence in teaching, grantsmanship, research, and scholarship. They will be innovative and responsive to changing technologies and demographics and continue to pursue partnerships with regional constituencies.

III. Statement for Assessment and Student Learning

The Departments of Chemistry, Computer, and Physical Sciences and Biological Sciences continuously strive to enrich the quality of teaching and learning through self, course, program, and departmental assessment. Through continual assessment the department will be responsive to changing technologies and needs of the marketplace.

IV. Program Goals

- Prepare students for career opportunities in academia, industry, and government;
- Provide students the pre-professional training required for entrance into schools of medicine, osteopath, dentistry, veterinary medicine, optometry, nursing, physical therapy, engineering, pharmacy, and allied public health fields;
- Prepare students for graduate study in biotechnology and related fields.

V. Program Learning Outcomes

1. Demonstrate knowledge of chemical and biological concepts, laws, and theories.
2. Demonstrate knowledge of molecular biology and biotechnology techniques.
3. Demonstrate skill in the synthesis of information by preparing and presenting reports.
4. Show interpersonal skills that promote the accomplishment of team goals in small groups.
5. Be familiar with laboratory hazards or hazardous conditions and take appropriate safety precautions.
VI. Assessment of Each Learning Outcome

Every student majoring in biotechnology is required to take General Chemistry I and II, Chemical Analysis, Organic Chemistry I, 5 upper-level Chemistry elective credits as described in the new program modifications (Organic Chemistry II, Instrumental Chemistry, or other options), Biochemistry, Molecular Genetics, Principles of Biology I and II, Microbiology, Genetics, Human Physiology, Cell and Molecular Biology, and Immunology. They are also required to completed 4 credit hours of Research (CHEM &/or BIOL 4990), and are encouraged to get involved in additional undergraduate research.

A. Outcomes 1 and 2 - Demonstrate knowledge of chemical and biological concepts, laws and theories. Demonstrate knowledge of molecular biology and biotechnology techniques.

Several external standardized tests are used to objectively measure the knowledge of the Biotechnology majors-minors at different stages. The ETS Major Field Test (MFT) in Biology has been administered to all students enrolled in BIOL4981 (Biology Senior Seminar), while the ETS Major Field Test (MFT) in Chemistry has been administered to all students enrolled in CHEM4981 (Chemistry Senior Seminar) for many years. Biotechnology majors are only required to take one of these Senior Seminar courses, and therefore until this year, only scores from either a Biology or a Chemistry ETS exam were obtained for each program graduate. Since approximately 50% of their courses are in Chemistry and 50% are in Biology, in 2009-2010 a new policy was implemented in that Biotechnology majors enrolled in either 4981 class must take both the Biology and the Chemistry ETS exams. This doubles the amount of relevant assessment data recovered for program participants, and provides an indication of their retained knowledge in both Chemistry and Biology topics. Two of the 4 fields on each of the 2 ETS exams are highly relevant to the courses that the Biotechnology majors, while two fields on each test are not covered in their required courses (such as physical chemistry and wildlife ecology).

In addition to the ETS exams, several Chemistry courses taken by Biotechnology majors utilize American Chemical Society (ACS) standardized subject exams as the comprehensive final exam or a major exam score. However, scores are not available for all students in all years, in that some of these courses are electives, or may be taken at other colleges for transfer credit. The Chemistry Department is initiating expanding its use of these exams into additional required courses (such as General Chemistry and an additional overall chemical knowledge exam for seniors from ACS), so additional scores may be available in the future.

For both the ETS and ACS exams, national average scores and percentile rankings are usually available for comparison. Whenever possible, the Biotechnology major scores are compared to both the national averages and the overall class or section average.

1. ETS Major Field Test in Biology

Two Biotechnology students (one in fall 2009 CHEM4990 and one in spring 2010 CHEM4990) Senior Seminar courses (capstone course) completed the ETS Major Field Test (MFT) in Biology. The results are summarized in Table 1. Both the average scores of 21 Biology majors (non-conservation majors) and the national average scores are also included for comparison.

Table 1
Scores (Mean ± SD) of SOSU Biotechnology students on the ETS Major Field Test in Biology

<table>
<thead>
<tr>
<th>Group</th>
<th># of Students</th>
<th>Cell Biology</th>
<th>Molecular Biology &amp; Genetics</th>
<th>Organismal Biology</th>
<th>Population Biology, Evolution, Ecology</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology</td>
<td>2</td>
<td>46.5 ± 7.5</td>
<td>51.0 ± 3.0</td>
<td>53.0 ± 11.0</td>
<td>49.5 ± 14.8</td>
<td>149.5 ± 9.5</td>
</tr>
<tr>
<td>2009-2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biology</td>
<td>21</td>
<td>47.9 ± 9.8</td>
<td>44.4 ± 9.0</td>
<td>46.3 ± 8.7</td>
<td>48.9 ± 11.0</td>
<td>146.0 ± 9.8</td>
</tr>
<tr>
<td>2009-2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nat. Ave.</td>
<td>30,854</td>
<td>55.0 ± 13.2</td>
<td>53.7 ± 13.1</td>
<td>53.1 ± 13.5</td>
<td>53.3 ± 13.3</td>
<td>153.4 ± 13.2</td>
</tr>
<tr>
<td>2005-2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*National averages for August 2005- June 2009 is from ETS website. Percentiles for the 2009-2010 are also available on ETS website.

2. **Analysis and Interpretation of Biology ETS**

The average Biology ETS total scores of the 2 Biotechnology majors were below the national average, but were within one standard deviation of the national mean (Table 1). There was a wide range of scores this year, with the 2 individual total scores ranging from one strong student earning highest overall score in that semester’s group taking the Biology ETS exam at SOSU, with scores more than 1 standard deviation above the national average in all score categories, to the other more average student earning scores consistently below the average SOSU Biology major, but still within 1 standard deviation of the national average in all categories. (The latter student had not completed all of their upper-level Biology courses which are relevant to this assessment tool, but the first student had completed all but 1 Biotechnology major course.) The Biology ETS subscores showed similar variations. The Biotechnology majors’ courses emphasize cell biology, genetics and molecular biology; therefore the most important subscores for the ETS would be the Cell Biology and the Molecular Biology and Genetics subscores. The average Southeastern Biotechnology major score for the Cell Biology and Molecular Biology and Genetics subsections were slightly below the national average, but well within 1 standard deviation. The individual scores for these 2 subscores ranged from 15th to the 45th percentile nationwide, and the 50th to the 70th percentile of all SOSU students taking the Biology ETS exam (including Conservation and Science Education majors).

The required Biotechnology courses do not include much coverage of Organismal Biology, Population Biology, Evolution and Ecology, thus their average subscores in those latter two categories tend to be lower. Although their subscores in the 3rd and 4th categories are below the national average, their average scores are still within one standard deviation of the national average, and higher than the average Biology (non-Conservation) major that year.
Data for the past full five years is not presented because the Biotechnology program is relatively new, and it is only for the last 4 years that we have had more than one or two graduates in a year, and that the data was analyzed separately for a Biotechnology program assessment separated from both Chemistry and Biology programs. The results of the Biology MFT ETS exam for the last 4 years are shown in Table 2, along with the number of Biotechnology students taking the Biology ETS exam in each year. The students performed about the same, with one exception to previous trends. Normally, the first two subscores have consistently been their two best scores, in the 2 subsections most relevant portion to their Biotechnology major courses. This year, the two Biotechnology students had some of their highest subscores in “Organismal Biology” and “Population Biology, Evolution, Ecology”, making their combined average scores stronger in those categories than in the lowest average category, “Cell Biology”. We do not know if this new pattern is significant, or if it has to do with other factors.

Table 2
Scores (Mean ± SD) of SOSU Biotechnology students on the ETS Major Field Test in Biology, for multiple years and in comparison to non-Biotechnology Majors at SOSU

<table>
<thead>
<tr>
<th>Group</th>
<th># of Students</th>
<th>Cell Biology</th>
<th>Molecular Biology &amp; Genetics</th>
<th>Organismal Biology</th>
<th>Population Biology, Evolution, Ecology</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotech 2009-10</td>
<td>2</td>
<td>46.5 ± 7.5</td>
<td>51.0 ± 3.0</td>
<td>53.0 ± 11.0</td>
<td>49.5 ± 14.8</td>
<td>149.5 ± 9.5</td>
</tr>
<tr>
<td>Biotech 2008-9</td>
<td>4</td>
<td>50.3 ± 7.5</td>
<td>47.8 ± 11.4</td>
<td>41.8 ± 5.3</td>
<td>31.5 ± 14.8</td>
<td>139.3 ± 10.4</td>
</tr>
<tr>
<td>Biotech 2007-8</td>
<td>6</td>
<td>55.7 ± 7.5</td>
<td>52.8 ± 11.3</td>
<td>44.0 ± 9.2</td>
<td>46.3 ± 10.0</td>
<td>148.5 ± 7.8</td>
</tr>
<tr>
<td>Biotech 2006-7</td>
<td>5</td>
<td>55.8 ± 15.4</td>
<td>53.4 ± 9.3</td>
<td>50.2 ± 10.7</td>
<td>51.2 ± 13.1</td>
<td>152.4 ± 12.1</td>
</tr>
<tr>
<td>Fall 2009-Spring 2010</td>
<td>20</td>
<td>48.2 ± 13.1</td>
<td>44.3 ± 9.2</td>
<td>46.5 ± 8.9</td>
<td>49.6 ± 10.9</td>
<td>146.3 ± 9.9</td>
</tr>
<tr>
<td>SOSU Biology majors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natl. Ave. 2005-9</td>
<td>30,854</td>
<td>55.0 ± 13.2</td>
<td>53.7 ± 13.1</td>
<td>53.1 ± 13.5</td>
<td>53.3 ± 13.3</td>
<td>153.4 ± 13.2</td>
</tr>
</tbody>
</table>

For an “in-house” comparison, Table 2 also includes the mean subscores and total scores for all SOSU students taking the ETS Major Field Test in Biology in Fall 2008 and Spring 2009, as reported on the ETS summary sheet. These averages only include the scores of Biology majors who are likely to take many similar courses, and not other exam
takers such as Wildlife-Conservation majors and Science Education majors. It is clear that the average subscores for Biotechnology majors was within 2% of or higher than the average SOSU participant in most categories, despite not taking some of the organismal or population biology classes.

3. ETS Major Field Test in Chemistry

Two Biotechnology students (one in fall 2009 CHEM4990 and one in spring 2009 CHEM4990) Senior Seminar courses (capstone course) completed the ETS Major Field Test (MFT) in Chemistry. The results are summarized in Table 3. In addition to the average Biotechnology subscores and total scores, the national averages and averages for 6 SOSU Chemistry majors taking the Chemistry ETS exam during the same year are included. Fewer students take the ETS Chemistry exam, and the average Chemistry scores tend to be lower than the Biology scores.

Table 3
Scores (Mean±SD) of SOSU Biotechnology students on ETS Major Field Test in Chemistry

<table>
<thead>
<tr>
<th>Group</th>
<th># of Students</th>
<th>Physical Chemistry</th>
<th>Organic Chemistry</th>
<th>Inorganic Chemistry</th>
<th>Analytical Chemistry</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotech 2009-2010</td>
<td>2</td>
<td>47.5 ± 5.5</td>
<td>28 ± 0</td>
<td>34.5 ± 7.5</td>
<td>43.0 ± 4.0</td>
<td>135.5 ± 5.5</td>
</tr>
<tr>
<td>Biotech 2008-2009</td>
<td>4</td>
<td>31.8 ± 9.5</td>
<td>36.3 ± 5.7</td>
<td>32.8 ± 6.4</td>
<td>30.3 ± 12.1</td>
<td>130.0 ± 8.5</td>
</tr>
<tr>
<td>All SOSU CHEM majors* 2009-2010</td>
<td>6</td>
<td>37.5 ± 13.5</td>
<td>43.5 ± 5.0</td>
<td>38.2 ± 10.1</td>
<td>38.8 ± 9.0</td>
<td>138.7 ± 8.3</td>
</tr>
<tr>
<td>Nat. Ave. 2005-9</td>
<td>4,711</td>
<td>48.9 ± 15.0</td>
<td>48.8 ± 14.3</td>
<td>48.2 ± 14.5</td>
<td>48.0 ± 14.8</td>
<td>148.1 ± 14.7</td>
</tr>
</tbody>
</table>

All SOSU CHEM major* = These are the mean subscores and total scores for all 6 SOSU Chemistry major students taking the ETS Major Field Test in Chemistry in Fall 2009 and Spring 2010, as calculated manually from the raw scores. Scores for 3 non-Chemistry and Biotechnology majors were excluded.

4. Analysis and Interpretation of Chemistry ETS results

The average Chemistry ETS total scores of Biotechnology majors were below the national average, but were within one standard deviation of the national mean (Table 3). The Biotechnology majors’ total scores corresponded to the 30th nationwide percentile and 5th nationwide percentile ranking for the 2 students. The Chemistry ETS subscores showed similar variations, with the highest total scores falling in the 65th percentile
ranking nationwide, but the average of the 6 Chemistry majors falling in the 25th nationwide percentile ranking.

The average Chemistry ETS total scores and subscores of Biotechnology majors were equal to or within 2-3 points of the average of all SOSU students taking the Chemistry ETS exam in the previous assessment year (2008-2009). While Biotechnology majors are required to take Organic and Analytical Chemistry courses, they do not take separate Inorganic or Physical Chemistry courses taken by several of the other majors, yet still perform comparably in these subsections. This may be due to the broad coverage of the General Chemistry I & II course sequence, which introduces all students to the basic concepts of Inorganic and Physical Chemistry.

In this reporting year, a surprising negative trend was observed, in that the 2 Biotechnology majors scored extremely low in the Organic Chemistry subscore category, not even scoring within 1 standard deviation of the national average (but within 2 standard deviations), and also far below the average of the 6 Chemistry majors. This is likely due to the fact that Biotechnology program modifications were initiated 2 years ago, allowing students to substitute other electives for Organic Chemistry II. One Biotechnology major did not take Organic Chemistry II at all, and the other took it at a community college. In this reporting year, 2 surprising positive points are apparent in Table 3, in that the 2 averaged Biotechnology majors scores were 10 points higher than the average Chemistry major in Physical Chemistry, and also slightly higher in Analytical Chemistry. This is especially surprising in that neither of the Biotechnology majors took Physical Chemistry, but 4 of the Chemistry majors did. The Biotechnology majors may have retained the information from other general chemistry courses, or this may have to do with how ETS categorizes the questions.

Data for the past full five years is not presented because the Biotechnology program is relatively new, and it is only for the last three years that we have had more than one or two graduates in a year. The Chemistry ETS exam data was analyzed separately for a Biotechnology program assessment separated from both Chemistry and Biology programs for the first time beginning last year. Also, Biotechnology majors are allowed to choose between either department to take Senior seminar (CHEM4981 or BIOL4981); for example, in 2007-2008 all 6 Biotechnology majors took BIOL4981, and they took only the ETS Biology exam. The previous reporting year (2008-2009) was the first year that we have implemented a new program policy, requiring that no matter which Senior Seminar class they take, Biotechnology majors must take both the ETS exams (Biology and Chemistry), even if it means requires additional testing time outside of the assigned class meeting time.

5. American Chemical Society Standardized Exam in Analytical Chemistry

Every student majoring in biotechnology is required to take Chemical Analysis. In the lecture portion of this course the student studies the concepts, laws, and theories governing analytical chemistry. The course also has an extensive experimental (laboratory) component which meets for four hours each week. During the laboratory period the student must perform experiments in analytical chemistry in which they are charged with initiating and observing chemical reactions, measuring reaction products, classifying and recording data, analyzing and interpreting the data through graphical and
statistical analysis, and communicating the results through a written laboratory report which must be maintained in the student's Laboratory Manual.

As a part of this course each student is required to take the American Chemical Society (ACS) Standardized Exam in Analytical Chemistry. This exam tests the student's knowledge of both the theoretical and experimental analytical chemistry. The scores obtained by the students have a direct impact on their final grade. The scores are also compared with the national averages.

In Fall 2008 a total of 10 students took the exam, including 6 Biotechnology and 4 chemistry majors or double majors. The Southeastern biotechnology majors had a mean score which was within one standard deviation of the national mean.

In Fall 2009, no declared Biotechnology majors completed Analytical Chemistry. Despite being more than half of the class in 2008, and having several Biotechnology majors enrolled currently in Fall 2010, no ACS Standardized Exam in Analytical Chemistry scores exist for Fall 2009.

6. Analysis and Interpretation of ACS Analytical Chemistry Exam
   Not applicable in 2009-2010.

7. American Chemical Society Standardized Exam in Organic Chemistry
   Under the original program requirements, every student majoring in biotechnology was required to take Organic Chemistry I and II, both with 4 hour laboratories. (As will be discussed in a later section regarding Program Modifications, Organic Chemistry II is no longer an absolute requirement in the Biotechnology Program, but is now an elective.) In the lecture portion of this course the student studies the concepts, laws, mechanisms, and theories governing organic chemistry. The course also has an extensive experimental (laboratory) component which meets for four hours each week. In the laboratory period the student must perform experiments in organic chemistry in which they are charged with initiating and observing chemical reactions, measuring reaction products, classifying and recording data, analyzing and interpreting the data through graphical and statistical analysis, identifying unknowns, and communicating the results through a written laboratory report which must be maintained in the student's Laboratory Manual.

   As a part of Organic Chemistry II each student is required to take the American Chemical Society (ACS) Standardized Exam in Organic Chemistry, which covers material from a typical 2-semester course. This exam tests the student's knowledge of both the theoretical and experimental organic chemistry. The scores are also compared with the national averages. This test is administered during finals week or the week before, in May, and is factored into their final course grade.

   Of the students in the class taking the exam in May 2010, only 1 was a Biotechnology major-minors. The results are summarized in Table 4. (Standard deviations are omitted where appropriate.)
Table 4: Scores (Mean ± SD) on American Chemical Society (ACS) Standardized Exam in Organic Chemistry (2-semester course) in Spring 2010 and Spring 2009.

<table>
<thead>
<tr>
<th>Group</th>
<th>Raw scores (out of 70) Mean ± SD</th>
<th>National Percentile Rankings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnology majors Spring 2010</td>
<td>37 ± n.a. (n&lt;3) (n=1)</td>
<td>45th</td>
</tr>
<tr>
<td>Biotechnology majors Spring 2009</td>
<td>31 ± n.a. (n&lt;3) (n=2)</td>
<td>29th</td>
</tr>
<tr>
<td>SOSU Organic Chemistry II class Spring 2010</td>
<td>38 ± 7.2 (n=13)</td>
<td>48th</td>
</tr>
<tr>
<td>SOSU Organic Chemistry II class Spring 2009</td>
<td>33.6 ± 8.2 (n=17)</td>
<td>36th</td>
</tr>
<tr>
<td>National Ave.</td>
<td>39.22 ± 12.16</td>
<td>50th</td>
</tr>
</tbody>
</table>

8. Analysis and Interpretation of ACS Organic Chemistry Exam

In May 2010, the score of the 1 Biotechnology major was within one standard deviation of both the national average and the SOSU Organic Chemistry II class average on the exam. The raw score (out of 70 questions) of 37 correct, corresponding to 45th national percentile rankings (based on composite norms published by the ACS Division of education for the ACS Form 2008 exam). The score was almost identical to the average of the whole class of mostly Chemistry majors bound for Chemistry Ph.D. and Masters programs or other students trying to gain admission to medical, pharmacy and dental programs.

Some of these other students may have been repeating the course, since it is not unusual for 5-10 students to repeat Organic Chemistry I & II each year, to improve their pre-professional school GPAs and applications.

Data for the past full five years is not presented because the Biotechnology program is relatively new, and it is only for the last three years that we have had more than one or two graduates in a year. Also, the instructor for the Organic Chemistry course prepares a summary of the entire class scores relative to the national scores, but does not analyze the data for the Biotechnology majors separately from the rest of the class. The data in Table 4 was prepared by Biotechnology advisors obtaining the raw scores (individual scantron records or summary table) for the entire class, and generating the necessary values. Biotechnology advisors have only been directly involved in the program assessment reports for the past 2 years, and are maintaining records from this point forward.

Not all Biotechnology majors will take the ACS Exam in Organic Chemistry. As will be discussed in a later section regarding Program Modifications, Organic Chemistry
II is no longer an absolute requirement in the Biotechnology Program, but is now an elective. Also, many Biotechnology majors transfer in from other programs and frequently take their Organic Chemistry I and II at other campuses, and thus the ACS scores are unavailable for many Biotechnology majors.

9. **American Chemical Society Standardized Exam in Instrumental Chemistry**

Under the original program requirements, Biotechnology majors were not required to take Instrumental Analysis (CHEM3525), including a 4 hour laboratory, but due to a recent Program Modification approved in December 2008, they may now substitute Instrumental Chemistry for Organic Chemistry II as an elective.

Chemical Analysis (CHEM3425) is the prerequisite for Instrumental Analysis (CHEM3525). Instrumental Analysis topics include basic electronics, computer control of chemical instrumentation, spectral, electrochemical and chromatographic methods of analysis, and laboratory automation. Students learn how different chemical instruments work, important design and detection principles and criteria, and gain hands-on experience with several instruments in the laboratory sessions. They continue to apply data analysis techniques from Chemical Analysis when analyzing their Instrumental Analysis laboratory data. They keep a written laboratory notebook containing all of their experimental results, and prepare a written laboratory reports each week.

As a part of Instrumental Analysis each student is required to take the American Chemical Society (ACS) Standardized Exam in Instrumental Chemistry, which covers material from a typical 2-semester course. This exam tests the student's knowledge of both the theoretical and experimental Instrumental chemistry. The scores are also compared with the national averages. This test is administered during finals week or the week before, in May, and is factored into their final course grade.

However, since no Biotechnology major took the prerequisite Chemical Analysis in Fall 2009 (described earlier), and other taking it in previous years have graduated, no Biotechnology majors enrolled in Instrumental Analysis in Spring 2010. Thus, no data is provided for this assessment tool in this report.

10. **Analysis and Interpretation of ACS Instrumental Chemistry Exam**

Not applicable in 2009-2010.

B. **Outcome 3 - Demonstrate skill in the synthesis of information by preparing and presenting reports.**

1a. Biotechnology majors take Senior Seminar in either the Biology or Chemistry department (BIOL4981 or CHEM4981), with similar but different formats for reports and presentations. No declared Biotechnology majors took BIOL4981 in 2009-2010.

Two Biotechnology majors took CHEM4981, one in Fall 2009 and one in Spring 2010. In CHEM4981, students choose a topic and/or a specific chemistry research journal article on a topic. They then present information on that topic in multiple formats, including a research poster, an oral presentation using PowerPoint slides, a written paper and a scientific abstract. In addition to evaluation by the course instructor,
fellow faculty and students not enrolled in the class are invited to view the posters, listen to the presentations, and ask questions; faculty are also asked to complete evaluation forms.

Students are given feedback in the form of grades on oral and written assignments, as well as comments from their audiences.

1.b. Many other biology and chemistry courses required students to write papers and make oral presentations, although the format varies from year-to-year. In Biochemistry in past Fall semesters, students write a short report on a biologically-active molecule, providing the answer to 5 specific questions, and explain their findings to the class in less than 10 minutes during a laboratory period. In Molecular Genetics in Fall 2008, after completing some review of core material, the students each selected a chapter on an application of biotechnology to a specific field from their assigned textbook, and presented it in 30-45 minutes to the rest of the class.

In addition several biology and chemistry classes require students to maintain laboratory notebooks. In addition to recording data and observations, they are frequently required to explain the main purpose and concepts of the experiment or summarize the overall conclusions.

1.c. Biotechnology majors (4) presented or helped prepare at least 5 scientific poster presentations from August 2009 through July 2010 at regional scientific meeting. In the previous 2 years, at least 15 poster presentations were made. Hours are spent drafting and editing text, and combining it with data (graphs & tables) and photographs to accurately but concisely report results, according to professional scientific standards.

A sampling of the posters presented or prepared by Biotechnology majors in 2009 to 2010 are listed below, with names of Biotechnology faculty and current or former Biotechnology major co-authors names in bold:


University, Durant, OK. Poster presented at OK-INBRE Summer Internship Program Poster session 2010 statewide meeting, OU Health Sciences Center, OKC, July 23, 2010.

v) Bradley Jones*, Tera Puckett, Bethany Bryant, Michael Cloyde, Sharon Jagannati, Sheila Jagannati, Penny Perkins (USDA), and Teresa Golden (2009) Lycopene Effects in Tissue Culture Cells. (Abstract #4 of the 'General Poster Section' March 29). AAAS Southwestern and Rocky Mountain (SWARM) Division of the American Association for the Advancement of Science 84th Annual Multidisciplinary Meeting; University of Tulsa, Tulsa, OK.

2. Analysis and Interpretation of preparing and presenting reports.

Discussions with faculty and students indicate that the students were required to write several papers and reports, and at least one paper or report is required in more than 50% of the Biotechnology program required science courses. Lab courses often require 10 small reports per semester. However, it would be difficult to evaluate all of the papers and make meaningful comparisons, especially given that grades on these assignments are not viewed as a reliable, objective indicator of proficiency.

On exit questionnaires given in Senior Seminar classes and via other offices, approximately 50% of the responses indicate that making presentations or writing papers and lab reports were among the “least favorite” or “most difficult” parts of their undergraduate experience at SOSU. Although they may not appreciate it now, this does indicate that the students are putting significant effort into these assignments.

Given that communication skills are very important in today’s workplace, and that many undergraduates enter college with poor writing skills, these writing assignments will be not be reduced, and actually may be expanded in new ways in the future. For example, a new “scientific writing” exercise was added to Molecular Genetics in Fall 2009, to address perceived short-comings in the technical writing skills of some science majors.

C. Outcome 4 - Show interpersonal skills that promote the accomplishment of team goals in small groups.

1.a. Working with laboratory partners in Biology and Chemistry laboratory courses

In a typical teaching lab exercise, the student laboratory partners frequently must work together in pairs or small groups to prepare and label reagents, collect data, and sometimes interpret results and reach a consensus before moving on to the next step in a protocol. On the one hand they wish to work quickly and to leave the laboratory class at a reasonable time. However, if they rush too quickly, they may make errors which will hurt their lab grade or cause them to stay longer and repeat a step, so they have much motivation to work together carefully.

Some of the upper-level courses required for Biotechnology majors also mimic a research lab setting. For example, instructors of Molecular Genetics (CHEM or BIOL 4124) often incorporate a small project related to their research into the laboratory portion of this course, as long as it matches the stated course goals. The students in the class work in one or more teams to accomplish a research goal over multiple weeks, while learning additional laboratory techniques. The same is true for other 3000 and 4000-level CHEM and BIOL courses, although the projects are frequently of shorter duration.
1.b. Laboratory research collaborations and co-presentations

In addition to smaller reports and presentations prepared for classroom and laboratory assignments, discussed under Objective 3, Biotechnology majors are frequently involved in extended, novel research projects which are suitable for presentation at local and national research meetings. This is in part due to the Research (CHEM or BIOL 4990) requirement for graduation, and in part due to what experiences are important in achieving post-graduation goals.

Research advisors (at SOSU and off-campus) are looking for students who will learn quickly and work efficiently and carefully with them to produce usable results to further their research and for publication. Students may be working only with a faculty member, or may find themselves working with a team of students on a common project. For example, in some bioanalytical projects, multiple students may work in series, with one worker generating the samples, while another worker carries out the instrumental or statistical analysis. In other projects, multiple students may be using the same organism or instrument, but comparing different chemical or biological materials in parallel. Some research questions may be answered in a single semester, while for other projects the work may span several semesters with a series of different students.

While working in a research lab, students not only learn techniques and facts, they also learn something about research “etiquette” and “ethics”. For example, they learn that shared reagents must not be wasted or contaminated, they must show up on time because their partners are waiting for them, and that the data point they generate or their records may prove to be very important months or even years later to a future scientist. Students who do not develop these skills will not be recommended to future supervisors.

While most of the student time is spent generating usable data and analyzing it, a significant amount of time may be spent working with their research supervisor or their peers on preparing research presentations or publications, to communicate their findings to external audiences. The most common format for the presentation of undergraduate student results is a formal research poster. Styles, sizes and content vary with the rules of the host organization and the topic. However, in most cases, helping to assemble these presentations is a valuable way for the student to realize how their work fits in with the rest of the project data, the contributions of their peers, and the rest of the scientific literature.

In Fall 2008, one Biotechnology major presented a poster describing her work done at OU-Health Sciences Center (OKC). The same student was accepted to do a second internship in the same lab in Summer 2009, and presented her new results at the NIH-INBRE Summer Internship poster session, OU-HSC, July 24, 2009. Two other Biotechnology majors wrote and otherwise contributed a section to a multi-author poster; they did not attend the meeting at which another author presented on behalf of the group.

In Summer 2010, two students were selected as OK-INBRE interns and assigned to labs at SOSU for 9 weeks of hands-on biomedically-relevant research, working closely with their assigned research mentors. At the end of the summer, they had to present posters at the OK-INBRE Summer Intern meeting, to present and explain their work to a wide range of biomedical scientists and fellow interns. Both earned 3 credits of OU research experience, which can be transferred to SOSU to be used in place of CHEM4990 (Research) credit. Also in Summer 2010, another Biotechnology major interviewed and was hired as an intern in the Samuel Roberts Noble Foundation (Ardmore) crystallography core lab; he prepared a near-final draft of a poster on his summer work, to be presented at Oklahoma Research Day 2010, and has been invited by his research supervisor to return in the future. He will earn 4 credits of CHEM4990 (Research) for his combined efforts on the research, poster and a paper to be written.
2.a. Analysis and Interpretation of partnerships in Biology and Chemistry laboratory courses

It is difficult to assess these laboratory course interactions directly. In most cases the students learn to work exceedingly well with their partners, based upon the quality of their experimental results, and generally high laboratory grades (relative to exam scores). The best teams seem to be made of two or more students with different strengths and weaknesses; one might be excellent at math but weak in tying together qualitative aspects, while another might be math-phobic but very observant about procedural details. Working as a team also takes some of the stress out of the lab for the partners, in that they can ask each other for clarification on the instructions or calculations, before asking the instructor a potentially embarrassing question. In general, once they are used to working with partners, if asked if students would rather carry out a lab as individuals or as partners, the students will often opt for partners.

2.b. Analysis and Interpretation of Laboratory research collaborations and co-presentations.

The total number of external research presentations by Biotechnology majors was slightly down this year compared to last year. This is partly due to the lower number of upper-level Biotechnology majors, the fact that some graduating majors fulfilled their research requirements earlier in their undergraduate plans and thus presented earlier, or the reluctance of some students to commit the large amount of time required to travel to an off-campus meeting. Competition for the research advisors’ time and resources may also play a role; at least 7 presentations were made by other biology and chemistry majors supervised by the same biotechnology research faculty.

The overall quality and impact of these research collaborations and co-presentations are difficult to assess quantitatively, but students who earn good research recommendations from SOSU faculty or other research mentors often perform very well at external internships, graduate programs, and research jobs. Graduate programs, professional schools and potential employers are looking for students with research experience that can actually summarize and explain their research goals, methods and conclusions, and that interacted well with both their research advisor(s) and with collaborators at multiple levels (Ph.D. research scientists, post-doctoral researchers, graduate students, technicians, fellow undergraduates). In research communities, these research posters are considered evidence that the students can work well with others to achieve a common research goal. At some meetings, only one student will present that poster, answering questions from curious viewers. At other meetings, multiple students may be presenting, and will work as a team to answer questions regarding their particular contributions to the joint effort.

Perhaps the best evidence available to demonstrate that Biotechnology majors are proficient in this category is the fact that the student who was eligible for a second internship at OU-HSC was actually requested by that same host lab, and that she also wanted to go back to the same lab. If the host lab was at all displeased with her earlier behavior or lab performance, or if she had not felt satisfied with her experience in that host lab during the previous summer, it would have been very normal for her to have been assigned to a different internship lab for the second summer. Similarly, the Summer 2010 Biotechnology major who interned at the Noble Foundation very much enjoyed his stay in that lab, and his summer research supervisor has sent many excellent comments to his SOSU Biotechnology advisor, and invited the student to return in the future. That fact that both the host labs and the students were eager to continue working together for the second summer indicates very clearly that the Biotechnology student collaborated well with the researchers in that lab.
D. **Outcome 5 - Be familiar with laboratory hazards or hazardous conditions and take appropriate precautions.**

Most of the biology and chemistry classes have weekly laboratory sessions ranging from 2 to 4 hours. In the labs, the students learn safe laboratory procedures by a number of means. They are given safety guidelines in the syllabi or the laboratory manual in the biology classes and professors personally instruct them on the safety procedures. In addition, the chemistry classes have safety videos that the students are required to view. The departments have not been notified of any safety problems in the laboratories and have not had any major accidents or injuries. Safety is a major concern, and students are constantly reminded to use required personal protective devices (such as safety glasses) and follow safety-mandated dress codes; those who do not follow safety instructions are asked to leave the teaching labs. In the research labs, they learn many more nuances of lab safety, specific to the labs and research projects that they participate in.

In previous years, an exit questionnaire administered in BIOL4981 was given to multiple students enrolled in senior seminar. There was a question about whether students were given information concerning safe laboratory procedures. The exit survey indicated that 100% of the respondents had either excellent (50%) or more than adequate (50%) information provided concerning safe laboratory procedures. However, no Biotechnology major took BIOL4981 in the past year. This same survey was not administered to the 2 Biotechnology majors who took CHEM4981; no specific safety questions are asked on the Physical Sciences exit survey, but no voluntary general comments were made regarding safety issues.

**Analysis and Interpretation**

It is difficult to assess this issue directly. While our data does not directly assess whether the students would act appropriately regarding safety in the laboratory, our students perceive that they have been given more than adequate information regarding safety in the laboratory. If we had recurring safety problems or injuries in labs involving Biotechnology majors, that would indicate a need for improvement. In general, no safety issues were raised due to faculty or student comments or due to reported accidents during the past year.

**VII. Faculty Level of Involvement in Assessment Process**

The biotechnology faculty members in the departments of Chemistry, Computer, and Physical Sciences and Biological Sciences were involved in the collecting and analyzing of data and in the writing, proofreading, editing, and compiling of the assessment report. The following is a list of responsibilities for the 2009-2010 academic year.

- **Nancy Paiva** Collected raw data from course instructors, and wrote the first draft, for editing and review by other contributors. Advised and otherwise interacted with biotechnology majors, and arranged for internships and CHEM4990 credits for majors. Wrote Sections VI.A.3, 4, 5, 6; VI.C.1, 2, 3, 4; IX

- **Teresa Golden** Reviewed and edited the first draft. Advised and otherwise interacted with biotechnology majors, gathering data and feedback, and arranged for internships and BIOL4990 credits for majors. Contributed to Sections VI, IX, XI

- **Jerry Polson** Chemistry, Computer & Physical Sciences Department Chair. Reviewed and edited the report, contributed the raw scores and averages for the ETS Chemistry Major Field Test, and contributed to several sections in earlier
versions of the report. (Sections VI.A.1, 2; VI.B.1, 2; VI.D
Biological Sciences Department Chair. Reviewed and edited the report,
contributed the raw scores and averages for the ETS Biology Major Field
Test, and contributed to several sections in earlier versions of the report.
(Sections VI.A.1, 2; VI.B.1, 2; VI.D
In addition, Tim Smith provided the raw data for the ACS Analytical Chemistry exams in
past years, and Loide Wasmund provided the raw data for the ACS Organic 2-semester (Form2008)
Chemistry exam, administered during the corresponding courses that they teach to both
Biotechnology and non-Biotechnology majors.

Dr. Nancy Paiva and Dr. Teresa Golden are the primary academic advisors for the
Biotechnology majors, and also are the primary research supervisors or mentors arranging their
internships for CHEM and BIOL 4990 Research credit. They also take turns teaching
CHEM/BIOL 4124 Molecular Genetics, a course specifically developed for Biotechnology majors,
and teach 3 to 4 of the other required courses. However, many of the other the required courses are
taught by faculty in either the Chemistry or Biological Sciences departments.

VIII. Assessing IETV and/or Web-Based Instruction
The biotechnology program does not have any IETV or web-based course offerings. The
departments do offer several courses online. However, they are not a part of the biotechnology
program. These courses are assessed in the departments' General Education Assessment Reports.

IX. Strengths and Weaknesses of the Biotechnology Program

Strengths:
a) Research Experiences: One major strength of the Biotechnology program remains the
requirement for a minimum of 4 credit hours of Research (CHEM 4990 or BIOL 4990). The
students can fulfill this requirement on campus working with numerous faculty, or off-campus via
various research internships, in coordination with their advisor. As more research funding and
equipment has been acquired on the SOSU campus in recent years, the on-campus option has
become increasingly beneficial, and is often used by students who are totally new to research. Once
a certain confidence and experience level is reached, students are strongly encouraged to participate
in 8-10 week summer internships at the major research campuses in the region; some of these pay
for college credits which are transferable, while in other cases the students can earn CHEM/BIOL
4990 credits. In all research experiences, the students are required to write reports summarizing
what research they did, including the goals of the project, the methods, the results, and how these
relate to the goals. Many students present their reports in the form of research posters at local, state
and national scientific conferences, and learn to discuss their work with other scientists. In some
ways, learning to write and present the report is as important as the techniques learned. The
research experience also often helps the student decide which path to take following graduation.

We are constantly seeking new ways to expand research opportunities for Biotechnology
and other science majors, both on and off campus. We are constantly seeking interactions with
companies and research institutions in the immediate vicinity, Oklahoma, and the rest of the region.
Currently, both Dr. Golden and Dr. Paiva maintain or are pursuing internship arrangements with
area employers, such as the Samuel Roberts Noble Foundation (Ardmore, OK), the USDA
Agricultural Research Station (Lane, OK), ETS-Lindgren (Durant, OK), and other facilities. Dr.
Paiva serves as the OK-INBRE SOSU campus representative, and helps all interested science
majors apply for INBRE-funded summer biomedical internships, both at SOSU and in OKC or
Tulsa. Dr. Paiva helped 2 chemistry majors apply and get accepted to the OSU NSF-funded REU (Research Experiences for Undergraduates) Chemistry summer internships in summer 2009. Positive feedback from both interns and intern host labs indicates that we should continue in these efforts. Dr. Paiva also serves as the NASA Oklahoma Space Grant Consortium (OSGC) SOSU campus representative, and provides NASA fellowship funds to support research participation, travel funds for students presenting at distant meetings, and other rewards to research-active students.

b) Flexibility: Another strength is the flexibility of the Biotechnology program as it relates to career goals. It can be and has been tailored to the needs of pre-medical, dental, optometry and other pre-professional programs, or to those aiming for later Masters and PhD degrees, or prepare students for immediate employment after graduation. In addition to the specified major-minor courses and the university general education requirements, most students need to take another 10 to 20 elective units to complete the required total 124 credits hours for a degree. The basic Biotechnology degree requirements cover most of the prerequisites for most post-graduate degree programs, but students select electives to address any additional entrance requirements for their targeted program. For example, pre-medical students add physics and anatomy, while pre-PhD students may add more upper level science or math courses. We added to this flexibility with the December 2008 Program Modification discussed below.

c) Post-graduation employment or graduate school enrollment. While standardized exam scores and other methods are useful, a practical measure of the value of the Biotechnology degree program is how many graduates are securing jobs in their field, or are moving on to their next targeted educational program.

Two years ago, we reported that of 7 Biotechnology majors who took CHEM4981 from August 2007 to 2008, one is enrolled at the medical school at OSU-Tulsa, one was admitted to a biomedical PhD program in San Antonio (after a requested 1-year deferral due to the birth of a second child), one is pursuing a Masters in Biotechnology while also getting a teaching certification and is now teaching science at a local high school, one joined the Air Force, one is employed at a major oil company in TX, one was recently accepted into an NIH PReP program at OU-HSC (a pre-PhD training program). Only one did not get into his targeted dental training program (OU's dental school), but he did not have much prior dental office experience before applying; he is improved his experience, retook the DAT (dental admissions test), reapplied, was accepted and has completed his first year at OU. Previous Biotechnology program graduates who completed all degree requirements have enjoyed similar post-graduation success in entering graduate programs and employment, and are still doing well in their jobs of degree programs.

Last year we reported that two May 2009 Biotechnology graduates were accepted into the highly competitive Graduate Programs in Biomedical Sciences (GpiBS) at OU-HSC to begin work toward their Ph.D. degrees in August 2009. The December 2007 graduate who deferred admission to the Ph.D. program at UT San Antonio also began her courses in August 2009. This marked a major milestone for the program, in that it proved that the Biotechnology degree plan does sufficiently prepare student for admission into highly-rated Ph.D. programs.

Of 11 graduates in the previous 2 years, we have only heard reports of 2 students having difficulty finding work related to their Biotechnology majors; in both cases, they were unwilling to relocate or to make long-term commitments to graduate programs, combined with the general economic downturn for the country. One of these has recently indicated that he joined the U.S. Air Force, after scoring well enough on aptitude tests to obtain the assignments he wants.
Of the 4 students who completed Biotechnology major-minors in 2009-2010, one has entered the SOSU Masters of Technology in Biology in an effort to prepare himself for admission to an external graduate program and additional graduate studies. Another feels the need to remain in the North Texas area due to family reasons, and has been self-employed; he has recently applied as a chemistry and biology teaching lab instructor, but the outcome of his application is unknown at present. Two other students have not maintained contact with the departments; they were from the OKC area, and were eager to gain employment as technicians upon graduation, but we do not know yet if they have achieved their goals.

d) External review: In April 2010, an external reviewer visited the SOSU campus and reviewed the joint “Self-Study Report” for both Chemistry and Biotechnology. He also toured both the Science and Biological Sciences buildings and met with both Dr. Paiva and Dr. Golden regarding the Biotechnology program. He gave an overall rating of “excellent” to the program.

Weaknesses:

a) Poor or inconsistent advisement of in-coming potential Biotechnology major-minors:

One weakness that we reported last year was, as far as retaining majors or helping them graduate in minimal time and maximum home benefit, the biggest problem has been misadvisement of potential majors by faculty and staff not familiar with the correct sequencing of the courses (due to pre-requisite requirements or scheduling limitations). For example, incoming Freshmen have been told to delay taking General Chemistry I in their first Fall semester, “to reduce their stress”. However this is the prerequisite for all later CHEM courses, and is only offered in the Fall, so this delay puts them an entire year behind in the Chemistry portion of the degree. When this error is discovered too late, they either have to take multiple chemistry courses at the same time, which may prevent them from learning the material as well as possible, or they will have to delay graduation, to allow for scheduling conflicts between dual CHEM and BIOL requirements. Rather than choose between these two painful options for completing the Biotechnology degree, many students decide to switch to other majors (either Chemistry major with a Biology minor or Biology major with a Chemistry minor); we have lost at least as many Biotechnology majors due to bad advising as we have produced.

Progress before 2009: We constantly track down the sources of these errors and have reduced their occurrence, but new sources constantly emerge. During the past year, Dr. Golden, the main Biotechnology advisor in the Biological Sciences Department, has also started encouraging any would-be Biotechnology majors that she encounters in her building to also visit Dr. Paiva, the main Biotechnology advisor in the Chemistry, Computer, and Physical Sciences Department, and vice versa. This helps in a number of ways. First the students have access to 2 advisors to answer questions at any time. Second, since many of the Chemistry courses are only offered during 1 semester each year, Dr. Paiva has a chance to make the students aware of potential scheduling conflicts and solutions, which might be otherwise missed by the Biology course instructors. Third, both faculty can point out internships and other educational opportunities to all Biotechnology majors, and organize tours or activities that fit their interests.

Progress during 2009-2010:

i) Program Director Appointment: Dr. Paiva was officially appointed as the Director of the Biotechnology program in very late 2009, in part to facilitate her assuming the position as OK-INBRE campus representative. In theory, this gives a single point person for SOSU faculty, staff and students to seek information from or to ask for other support, but the appointment has not had much impact on campus to date, at least as far as advising and assessment communications go.
ii) SOSU Website and catalog error corrections: Although the RUSO State Board of Regents approved modifications to the Biotechnology degree requirements in late 2008, months elapsed before a new undergraduate catalog was due to be published. The hard copy and on-line pdf versions of the new catalog reflected the program changes, but were formatted in a very confusing manner, making it unclear for some courses which were electives and which were required. (No draft versions were announced to be available for review by faculty in general.)

Even worse, the on-line degree descriptions were not updated. They only listed dual-listed courses under the BIOL headings, never the alternative CHEM headings, giving potential recruits the false impression that all Research, Senior Seminar, Immunology and Molecular Genetics could only be taken in the Biology department. This also gave external reviewers of scholarship proposals the false impression that the Biotechnology degree was mostly a Biology degree, with a few Chemistry courses tacked on. The Biotechnology degree is supposed to be a Chemistry-intensive program, to set it apart from many less rigorous biology programs at community colleges. This error also contributed to the loss of several earlier Biotechnology majors, who did not realize they had other options for completing their coursework. Corrections will help convey the fact that the Biotechnology major is offered jointly between the departments, not solely based in one or the other.

After several requests before and after the program modifications were approved, Dr. Paiva, citing the Regents approval and her new position as Director of the Biotechnology program, repeatedly asked the new webmaster to update the on-line degree plan links. The problem turned out to be that someone had modified the degree plan to reflect only BIOL prefixes (not the intended CHEM or BIOL headings), and that over time all web links were tied to that bad source. The web master has corrected the errors, severed the bad links, and the situation is now being monitored. Correction of these errors was stated in last year’s report goals for program improvement.

The relevant courses in the Biotechnology degree plans should read:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM or BIOL 4124 Molecular Genetics</td>
<td>4</td>
</tr>
<tr>
<td>CHEM or BIOL 4314 Immunology</td>
<td>4</td>
</tr>
<tr>
<td>CHEM or BIOL 4981 Senior Seminar</td>
<td>1</td>
</tr>
<tr>
<td>CHEM or BIOL 4990 Research (4 hours)</td>
<td>4</td>
</tr>
</tbody>
</table>

iii) New Advisement Sheets: The Dean of the School of Arts and Sciences has initiated the creation of (or revision of) advisement sheets to go with each degree plan for each major provided by the different departments. A draft document was created by Dr. Polson and edited by Dr. Paiva to reflect the inclusion of “CHEM or BIOL” headings for all dual listed courses relevant to the Biotechnology majors. Hopefully, the same corrected document will be used by both Chemistry and Biology departments, as well as the advising centers. We believe these new advisement sheets will be very helpful, if properly implemented.

b) “Excessive” Organic Chemistry requirement:
As we reported last year, many ex-biotechnology advisees have verbally stated that one of the reasons they are changing majors is that they do not want to take Organic Chemistry II, or they try to take it and either drop it or fail it. Many do well in the laboratory portion (which is listed as a separate course and receives a separate letter grade), but have difficulty in the lecture, or have difficulty seeing the relevance to a Biotechnology degree. Organic Chemistry II builds upon many essential concepts covered in Organic Chemistry I, but emphasizes more complicated synthesis
routes and names, memorizing reaction conditions and catalysts, and detailed mechanistic discussions and predictions.

While Organic Chemistry II could certainly be beneficial to Biotechnology majors, given the chemistry and logic skills that it teaches, it is certainly not as essential to their degree as the basics covered in Organic Chemistry I. Also, there are other courses currently offered at SOSU and others which may be developed, which may be of greater benefit to the students. Organic Chemistry II is a requirement for admission to many professional and graduate programs, so some students would still need to take Organic Chemistry II as an elective for their long-term career goals. Also, it seems ironic that Organic Chemistry II is not actually required for Chemistry majors, and it is not a required pre-requisite for Biochemistry (CHEM4115). Chemistry majors and minors are only required to take as far as Organic Chemistry I, with Organic Chemistry II as a possible elective. (Currently, there is also a debate among medical school faculty as to whether or not to require both Organic Chemistry I and Organic Chemistry II for admission; it is a good test of logic skills, but the relevance of the remainder of the material to practicing medicine is under debate.)

Progress: Program Modification: Based on the perceived program weakness, in Fall 2008 we applied for a Program Modification (described below) which altered the required Biotechnology curriculum to make Organic Chemistry II one of a short list of CHEM elective courses from which the Biotechnology majors can select. We received Regents approval in December 2008.

A copy of the successful Program Modification application was attached in the Appendix in 2008 (but is omitted this year to save space), entitled “Appendix I: 2008 Approved Biotechnology Program Modification Request”. As stated within this document, students can now choose between three options of 5 CHEM credit hours of CHEM electives, consisting of either

i) CHEM 3153 Organic Chemistry II and co-requisite CHEM 3162 Organic Chemistry II Laboratory (the existing requirement, for a total of 5 credit hours)

ii) CHEM 3525 Instrumental Analysis (with laboratory included in the 5 credit hours)

or

iii) a total of 5 elective credits of a combination of 4000-level CHEM elective courses, including CHEM 4970 (Special Topics) and/or CHEM 4193 Metabolism, in consultation with their Biotechnology advisor. At least 2 of these 5 credits must emphasize laboratory techniques, instrumentation, or computer technology.

Remaining weakness: We still need to ensure that the changes are correctly displayed on all sources accessible to students, as discussed above. To date, several Biotechnology majors have been opting to take Instrumental Analysis or the other electives in lieu of Organic Chemistry II, is their post-graduation plans do not require Organic Chemistry II. So far we have observed a drop in the number of reported Organic Chemistry II ACS exams scores (but an increase in the “average” score obtained by the student who self-selected to take the Organic Chemistry II class), and perhaps a drop in the average ETS Chemistry Organic subscores. It is too early to tell if the modification will increase the number of Biotechnology program graduates and retention rates within the major.

c) Need more technology-based experiences: Some external reviewers suggested that there is a need for additional “Technology” classes in a Biotechnology program, beyond what is already included.

We are exploring options for modifying the required curriculum, and to add more upper level elective courses, to address this concern.
Progress: In Spring 2009, Dr. Paiva offered a Biofuels Technology half-course, which enrolled 5 students, including 2 Biotechnology majors, 2 Biology majors, and 1 Chemistry major. Dr. Golden is also considering offering a tissue culture or similar techniques course, when her teaching schedule permits. In Spring 2010, Dr Paiva may also offer a new Biotechnology half-course, using OK-INBRE teaching resources which have become available recently. There is also a need for earlier Biotechnology-related courses, especially to explore research careers in the region.

d. A single ETS exam (neither Chemistry nor Biology ETS exam alone) is not a good assessment tool for Biotechnology major-minors.

As we reported last year, currently, Biotechnology majors are allowed to choose to take their 1 credit Senior Seminar (capstone) course (BIOL4981 or CHEM4981) in either department, since the credit hours are fairly evenly split between these two departments. However, they are co-enrolled with a mixture of either Chemistry or Biology majors, and currently take only one ETS exam which is tailored toward the courses that the Chemistry or Biology majors take. Biotechnology majors are not required to take Inorganic Chemistry or Physical Chemistry or certain other Biology courses, putting them at a disadvantage to the Chemistry majors on at least 2 Chemistry ETS sections. Biotechnology majors are not required to take Ecology or Evolution or certain other Biology courses, putting them at a disadvantage to the Biology majors on at least 2 Biology ETS sections. We also miss an opportunity to assess their knowledge in at least half of their degree courses by only administering one of the ETS exams. In other respects, the two Senior Seminar courses are very similar, so it does not seem necessary to have the Biotechnology majors take both departments’ courses.

Progress: We have successfully modified our assessment plans by expanding the required ETS exams for Biotechnology majors. Beginning in Fall 2008, all Biotechnology majors enrolled in either BIOL4981 or CHEM 4981 were required to take both the Biology and Chemistry Major Field Test ETS exams. Both tests were successfully administered to the one Biotechnology student enrolled in BIOL4981 in Fall 2008 and to the 3 students enrolled in CHEM 4981 in Spring 2009, plus 2 students enrolled in CHEM 4981 in 2009-2010. In contrast, in the 2007-2008 year, all 6 of the Biotechnology majors took BIOL4981, so no Chemistry ETS data was available. It will take a few assessment cycles to accumulate significant data from both tests, but we feel we have successfully addressed this issue, as long as the instructors of BIOL4981 and CHEM 4981 continue to accommodate our requests.

We will also continue to search for other standardized exams, specifically oriented to biotechnology majors. We are considering producing a separate 4981 section for Biotechnology majors, given these and other issues surrounding the course.

e. Perceived Weakness (and also a possible Strength): Many recent Biotechnology graduates and enrollees are transfer students, with varying backgrounds.

As far as assessment purposes are concerned, it is very difficult to accurately assess the education (learning outcomes) of students at Southeastern when they complete many of the prerequisite courses at other universities or community colleges. For example, as stated earlier, many students complete the Organic Chemistry I & II requirements elsewhere, leaving us with no ACS standardized exam scores. Similarly, if they complete a significant number of chemistry or biology courses at another school, especially with lesser course coverage, it is questionable how their ETS exam scores should be interpreted or weighted in the overall program assessment. The current perception is that, although we have had some very brilliant and hard-working transfer students, the transfer students in general do poorer on the standardized and ETS exams. (At some
future point in time, when more data is accumulated, we will attempt to analyze this further.)

Many transfer students are often the hardest to advise, in that given the sequencing of the required courses, and that some are only offered once a year, it is very difficult to have them complete the Biotechnology requirements in only 2 years; usually at least 1 additional semester is required. When correctly advised, Biotechnology majors who complete all of their coursework at SOSU are perceived to do better in their courses and be more satisfied with their undergraduate experience.

This issue can also be viewed as a program strength, in that we have had some excellent transfer students, and the transfers have helped us increase the numbers of Biotechnology graduates in the early years of the program. Dr. Golden and Dr. Paiva have discussed approaching local community colleges (such as Grayson CC and Murray State in Tishomingo) to advertise the SOSU Biotechnology program, but also to make potential transfers aware of strategies that could improve their success. We do have a formal articulation agreement with Tulsa Community College (TCC), which needs to be re-reviewed in light of the new Program Modification; while Organic Chemistry II was an absolute requirement, we had previously advised their students to complete both Organic Chemistry I & II at the same institution (preferably at TCC if they were obtaining an Associates degree), but that situation has changed.

Dr. Paiva and others are also pursuing scholarship funds that could help support entering Biotechnology majors throughout their 4 years at SOSU.

f. Perceived Weakness (NEW): “Not enough faculty involved in the Biotechnology program.” In April 2010, an external reviewer evaluated the Chemistry departments, with the Biotechnology program reviewed as a semi-separate entity. Both Dr. Paiva and Dr. Golden met separately with the reviewer to give input and answer questions. He recommended that 2 faculty were not enough to really increase the program size, especially since they both also advise Chemistry and Biology majors, and he recommended that another faculty member be hired to increase the strength of the program.

While this is a welcome suggestion, hiring new faculty may be a low priority until the budget improves. However, the surge in enrollment is increasing demand for numerous programs and increasing tuition revenues. In the meantime, Dr. Paiva will be exploring the use of additional OK-INBRE and other regional research resources to bring in adjunct faculty, guest lecturers, and other local scientists to supplement the resources at SOSU, at little or no cost to the campus.

X. Effectiveness of Previous Modifications
Since the program modifications are so recent, it is difficult to assess their impact, and some of this has been addressed in previous sections.

Two Biotechnology majors did elect to take Instrumental Analysis in Spring 2009 to substitute for Organic Chemistry II and lab. They indicated that their primary goals after graduation were to obtain jobs as research technicians, so any experience with instrumentation that they received will probably be much more valuable to them than Organic Chemistry II knowledge in their immediate employment. Although these students struggled with Instrumental Analysis, they were not confident that they would have passed Organic Chemistry II on the first try, and were grateful for the alternative. A third Biotechnology major (a transfer from Grayson Community College) also took Instrumental Analysis in Spring 2009 as an additional elective, to complete a total Chemistry credit requirement, and to prepare himself for the job market. Two other Biotechnology majors opted to take Organic Chemistry II in Spring 2009, and completed the course; one is enrolled in a PhD program, and the other is entering a Masters program after
graduation in December 2009. Another Junior-level Biotechnology major took a 2-credit Special Studies laboratory course (CHEM4972: Biofuels Technology) in Spring 2009, and plans to opt out of Organic Chemistry II by completing another 3 credit hours of suitable CHEM credit hours before graduating in May 2010; Organic II is not required for her targeted Masters program. Another Junior-level Biotechnology major passed Organic Chemistry I in Fall 2009, and has stated that she will opt out of Organic Chemistry II.

Although it is too early to assess the impact of this program modification, Biotechnology majors do appear to be very interested in the new elective options, and we may be able to attribute the retention of at least 2 additional Biotechnology majors to these modification, if these 2 students complete their remaining graduation requirements (anticipated graduation in May 2010 or December 2010).

Our changes to our assessment plan, that of requiring all Biotechnology majors enrolled in either BIOL4981 or CHEM 4981 to take both the Biology and Chemistry Major Field Test ETS exams, appears to have met with little resistance so far, and did generate additional scores for analysis. However, only 6 Biotechnology majors graduated during the last 2 years, so the data set was small.

XI. Modifications to be Made to the Program or the Assessment Plan

No new modifications to the program or assessment plan are envisioned for the coming year, although the implementation of recent modifications will require additional monitoring or other work. The main priorities are implementation of the new degree plans listings and advising tools, establishing additional sites for interns to gain research experience, and additional advertisement of the program to area high schools and community colleges.

XII. Communication with Constituents and Stakeholders

1) Students: Students do receive feedback on their chemistry standardized exam scores, in some format, since these are a component of their overall course grade. In general, the instructors tend to normalize the results during the grade calculations, such as dividing all scores by the highest score in the class, or other means. It is unclear if they are ever told their actual raw score and their national percentile rankings, unless they specifically request that information from the instructor. Students also frequently learn of their relative performance on ETS exams in a similar fashion, but it is highly dependent upon who is teaching the Senior Seminar section. From an informal survey of both past instructors and students recently taking Senior Seminar, there is often little or no discussion of the meaning of the scores with students, and sometimes the scores arrive very late in the semester, too late for incorporation into the grades. However, unless a separate "Biotechnology" Senior Seminar section is created, any alterations to these policies are up to the instructors and chairs. Students do receive much verbal and written feedback on poster presentations, research performance, oral reports, papers, and many course assignments.

Students do provide feedback on many course-specific surveys generated by instructors, the very generalized and Spring-only “SUMA surveys” and written comments, departmental exit surveys (which vary in composition), and other informal discussions. The recent program modification (changing Organic Chemistry II from a requirement to an elective) was initiated due to informal comments, largely from students transferring out of the Biotechnology major. We also receive sporadic updates from graduates of the Biotechnology program, telling us which courses have served them well in their post-graduation activities, and which they would have changed if possible, and how they are surviving in their new environments.
2) Graduate Programs, Professional Schools and Employers: These stakeholders provide indirect feedback by their acceptance or rejection of Biotechnology applicants to their program, and whether or not these students are retained in their programs. To date, Biotechnology majors have had a high success rate in getting accepted to the professional schools or graduate programs of their choice, including NSU Optometry school, OSU-Tulsa Medical School, OU Dental School, OU Pharmacy School, OU-HSC GPIBS PhD program, UT San Antonio PhD program. The first student to complete all 4 years of the Biotechnology program at SOSU did not graduate until May 2006, and that student completed her final year of Optometry school, graduating in May 2010, indicating that we prepared her well. Another Biotechnology major just passed his Year 2 osteopathic medical board exams at OSU-Tulsa, and is ranked highly in his class. As stated previously, one Biotechnology major completed two internships in the same lab at OU-HSC, as is now enrolled in a PhD program at the same institution; both Dr Paiva and Dr Golden received excellent feedback on that student’s performance, from the internship lab head, the internship program directors and an assistant dean of admissions at OU-HSC.

The graduate programs and professional schools are interested in the results of their own assessment tools, such as letters of recommendation, grade point averages, Graduate Record Exam scores (GRE for graduate programs), and field-specific exams (MCAT for medical school, PCAT for pharmacy school, DAT for dental school, OAT for optometry school, etc.). In writing many letters of recommendation for Biotechnology applicants, some standardized test scores might be conveyed if appropriate and if known, but the letters emphasize grades in relevant courses, research experience, work ethic, and other areas.

Dr Paiva and other faculty have taken multiple groups of students on tours of graduate and professional programs in recent years, or funded students to attend their open houses, and the faculty in both departments have hosted recruiters and speakers from several programs. This makes students aware of opportunities, but also makes the program officers aware of our students.

A bulletin board display of Biotechnology (and Chemistry) graduates and their career choices, and recent internships completed by undergraduates, is being constructed on the second floor of the Science Building; after some feedback, it may be displayed in digital format on a departmental webpage, for recruitment and inspiration purposes.

3) Faculty: It is very common for faculty to alert the Biotechnology advisors when a major has done very well on an assignment or standardized exam, or if a Biotechnology major is doing poorly in a course. The Biotechnology advisors also try to make their fellow faculty aware of scheduling conflicts that arise when course times are changed from one semester to the next; faculty are becoming more responsive to requests to resolve course conflicts, as the Biotechnology majors make up a larger percentage of certain upper-level courses. Unfortunately, currently there is no formal mechanism used for conveying Biotechnology assessment analysis to other faculty, nor central resource for the transmission of standardized test scores to Biotechnology advisors.

XIII. Signatures.

Department Chair's Signature [Signature] Date 9-8-10

Department Chair's Signature [Signature] Date 9-8-10

Dean's Signature [Signature] Date 9-8-10

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