2018-2019 ASSESSMENT REPORT
PROFESSIONAL SCIENCE MASTER'S IN BIOTECHNOLOGY
GRADUATE PROGRAM

Program: PSM in Biotechnology
Submitter: Cary Lai, Program Director, cklai2@usfca.edu
Additional individuals who should receive feedback: Brian Young, Associate Director, byoung3@usfca.edu
Graduate program
College of Arts and Sciences Division (Sciences)

Curriculum Maps

The Curriculum map aligning the Institutional Learning Outcomes (ILOs) with the Biotechnology Program Learning Outcomes (PLOs) is included in Appendix C.

The Curriculum map aligning required Biotechnology program courses with Biotechnology PLOs is included in Appendix D.

These curricular maps have been updated recently to incorporate the PLO changes that were approved this past year. They also have been updated based upon changes to several individual Biotechnology courses that have been approved by the Curriculum committee this past year:

- BTEC610 replacing MBA6562
- BTEC611 replacing MBA6561
- BTEC612 replacing MBA6563
- BTEC615 replacing MBA6413
- BTEC619 replacing BIOL680
- BTEC640 replacing CS640

Mission Statement

1. **Mission Statement** (no changes made since October 2018):

   Our Mission is to provide motivated students with the knowledge and skills needed to successfully enter a career in the biotechnology industry.

Program Learning Outcomes

2. **PSM in Biotechnology Program Learning Outcomes** (updated in May 2019):

   1. Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.

2. Interpret and execute best practices in biotech-related lab techniques as well as exhibit an ability to assess the novelty of research and prioritize protocols.
3. Comprehend the need for ethics in science and technology based business/research/industry.
4. Critically review scientific papers and demonstrate science communication skills necessary to attain professional level employment in science and technology based research/industry.
5. Demonstrate effective teamwork, team leadership, business communication skills, and networking skills, including exposure to industry members in molecular biology and biotechnology based business/research/industry.

Brief Summary of Most Recent Assessment Plan

Most recent assessment report feedback:

The most recent yearly assessment report for 2017-2018 was submitted in October of 2018. Assessment of PLO4 was performed by direct assessment of student assignments from three Biotechnology program classes – BIOL680, BTEC601, and BTEC688/689.

The Review of our 2017-2018 assessment report from the Dean's office was positive, with positive comments about each section including Timeliness of Submission, Identifying Information, Mission Statement, Program Learning Outcomes, Methods, Results, and Closing the Loop. The Summary statement from that review is included here:

> Summary
> It is clear from this report that PSM in Biotechnology has a clear and on-going assessment process that is established within its degree program. The program has considered previous suggestions from annual reports and taken action to respond to those comments. Well Done! Finally, the college acknowledges that your action plan to address results of your assessment is one of the best in the college.

Closing the Loop follow up from 2017-2018:

One of the conclusions that we drew from performing our program assessment in 2017-2018 was that PLO4 (the PLO that we assessed) was too broad, covering the students' ability to understand and present information from scientific papers (applicable to the Biology science courses) and business communication skills (applicable to the Bioentrepreneurship business courses). We decided to break these into two separate PLOs, the new PLO4 being applicable to the science courses and the new PLO5 being applicable to the business courses:

PLO4: Critically review scientific papers and demonstrate science communication skills necessary to attain professional level employment in science and technology based research/industry.

PLO5: Demonstrate effective teamwork, team leadership, business communication skills, and networking skills, including exposure to industry members in molecular biology and biotechnology based business/research/industry.

These changes to our program learning outcomes were approved by USF's curriculum committee and officially went into effect in May 2019.

Program Learning Outcome Assessed and rubric

3. This year, we chose to assess PLO2:

PLO2: Interpret and execute best practices in biotech-related lab techniques as well as exhibit an ability to assess the novelty of research and prioritize protocols

The rubric used for assessment of PLO2 is included in Appendix A.

Methods: Program Learning Outcome #2

Our program has never assessed PLO2 before (PLO1 was assessed in 2016-2017 and PLO4 was assessed in 2017-2018). There are four BTEC classes that map to PLO4: BTEC640, BTEC685/686, BTEC688/689, and BTEC697. We chose to assess student work from three of these four classes – all of them except for BTEC697. BTEC697 was excluded because it is the Internship in Biotechnology class. Evaluating student work from the Internship class is more complicated because most all of the lab work for this course is done off campus (for example at a local Biotech company), and some of the Biotech internships are not lab based (for example non-research areas of Biotech such as regulatory, project management, or business development).

For each of the three classes used, one required course assignment was assessed:

- BTEC685/686: Lab notebooks – throughout the semester, students keep a detailed laboratory notebook that documents all aspects of the experiments that they performed including experimental protocols, lab calculations, data, and analysis of the data. The lab notebooks are collected and graded twice during the semester and are worth 10% of their final course grade

- BTEC640: Final Project Report – students first identify a published Bioinformatics-based research study. Next, they access the data from the paper, write a computer algorithm to analyze the data, and then perform the new analysis. The final project report accounts for 25% of their course grade and the students work on this project inside or outside of class for several weeks.

- BTEC688/689: Project Proposal – after choosing an area of research and devising an experimental plan, students write a formal 10-15 page project proposal that describes the experiments that they plan to undertake during the semester. The project proposal includes background information from published review and research articles, a description of the experiments that the student will undertake, and a description of the

anticipated results and their significance. The project proposal is meant to resemble in form and content a grant proposal that would be submitted to a funding organization like the NIH or NSF. The project proposal is worth 15% of each student's final grade.

For all three of these classes, assignments from each student were collected and then evaluated for how well they achieve PLO2. Student assignments from all three classes were rated using the same PLO2 assessment rubric on a 1-10 point scale, with scores of 4 or lower being weak, scores of 5-6 being satisfactory, scores of 7-8 being good, and scores of 9-10 being excellent (see Appendix A). Between 11 and 16 assignments were rated for each course, reflecting the small size of each course from which the assignments were taken. Faculty raters also included written comments for each assignment rated. Each assignment was assessed by a faculty member affiliated with the Biotechnology program who did not teach the course where the assignment was produced.

Results: Program Learning Outcome #2

The complete results of the PLO2 assessment are shown in Appendix B:

The BTEC685/686 lab notebook assessment had a mean score of 7.3 (out of 10) with a standard deviation of 2.3. The high standard deviation was caused by 3 of the 16 notebooks receiving a 'poor' rating and 5 of the 16 notebooks receiving an 'excellent' rating.

The final project report for BTEC640 assessment had a mean score of 7.5 with a standard deviation of 1.8. The project proposal assessment for BTEC688/689 had a mean score of 7.9 with a standard deviation of 1.2. For BTEC 640, only one assignment was rated 'poor' and for BTEC688/689, no assignments were rated 'poor'.

The three classes used for assessment of PLO2 are usually taken in the order of BTEC685/686 first, BTEC640 second, and BTEC688/689 third. Looking at the assessment numbers described above, we see a trend where the PLO2 mean assessment scores go up as the students progress through the program (from 7.3 to 7.5 to 7.9) and the standard deviations go down (from 2.3 to 1.8 to 1.2).

The steady rise in assessment scores over the three courses can be interpreted as the steady improvement that occurs in students as they continue through our Biotechnology Master's program, as they achieve competency and then excellence as lab scientists. The decrease in the standard deviations over these three courses was primarily due to fewer students receiving 'poor' ratings of 4 or lower. This again can be interpreted as improvement in student learning as they progress through the program – the skills that they are learning in their introductory courses allow their continual improvement as they advance from course to course.

Last year, when we performed direct assessment of PLO4, we had mean scores of 7.5, 7.6, and 8.1 for three assignments from three separate courses. These scores were slightly higher than the scores from this year's assessment of PLO2. Our program did not perform direct assessment before last year.

Closing the Loop

We believe that our PLO2 assessment demonstrates steady and progressive improvement in our students in their ability to interpret and execute lab techniques. Many of our students will go on to pursue careers as research scientists, so training them in these areas is paramount.

While all of the faculty raters were comfortable with assessing student work for the first part of PLO2, “Interpret and execute best practices in biotech-related lab techniques”, the second part of PLO2, “exhibit an ability to assess the novelty of research and prioritize protocols” was sometimes more challenging to measure. The BTEC685/686 rater in particular found this more difficult to assess. The BTEC685/686 class is a directed lab course – students are given all of their step-by-step protocols to follow throughout the semester. Therefore, prioritizing protocols is just not regularly done in BTE685/686. This is not an issue for the more advanced BTEC688/689 course where students control their experiments much more independently and prioritizing protocols definitely comes into play.

Maybe the best way to assess whether students were effectively performing their lab techniques is by actually observing them performing lab experiments. Having a faculty member who is not teaching the lab class monitor and assess actual lab work would be challenging and cumbersome though. This would either involve the assessing faculty member sit in on several labs or to figure out a way to video students performing several experiments. We will think about these options for when we assess PLO2 next, likely in several years.

A relatively small number of assignments were rated for each of three courses used for assessment (between 11 and 16). While this small number is not ideal for assessment this will likely not be a continuing problem in future years. The cohort of students taking these classes was smaller than normal and next year between 23 and 34 students will be in each class.

Appendix A: Biotechnology PSM PLO2 assessment rubric:

PLO2: Interpret and execute best practices in biotech-related lab techniques as well as exhibit an ability to assess the novelty of research and prioritize protocols

Criteria	Ratings			
	Weak (1-4)	**Satisfactory (5-6)**	**Good (7-8)**	**Excellent (9-10)**
PLO2: Interpret and execute best practices in biotech-related lab techniques as well as exhibit an ability to assess the novelty of research and prioritize protocols	Student unable to accurately or reproducibly perform biotech-related lab techniques. Struggles with the ability to assess the novelty of research and/or the prioritization of protocols.	Student demonstrates the ability to perform biotech-related lab techniques competently, but with minor accuracy or reproducibility errors. Able to assess the novelty of research and can prioritize protocols.	Student demonstrates the ability to perform biotech-related lab techniques competently and accurately. Able to assess the novelty of research and can prioritize protocols.	Student demonstrates expertise in performing biotech-related lab techniques and fluency with assessing novelty of research and prioritizing protocols.

Total Points: _____ out of 10

Rater notes:

Appendix B: Assessment raw data:

BTEC685/686: Molecular Genetics and Biotechnology			PLO2: Interpret and execute best practices in biotech-related lab techniques as well as exhib
Student	**Work assessed**	**Rating (1-10)**	**Comments**
1	lab notebook	10	clear, organized, easy to follow experimental process and data interpretation
2	lab notebook	4	most protocols used straight from what was given to class with little added details or modifica
3	lab notebook	9	clear description of protocols
4	lab notebook	6	protocols hard to follow in places
5	lab notebook	10	clear, organized, good understanding of techniques and interpretation
6	lab notebook	8	protocols well-written and annotated, lacking some interpretation/analysis
7	lab notebook	7	first 2/3 fine, last 1/3 protocols lack details and explanations
8	lab notebook	7	clear but lacking some explanations/analysis
9	lab notebook	9	protocols and rationale clear
10	lab notebook	10	excellent
11	lab notebook	7	somewhat overuse of standard given protocols
12	lab notebook	2	hard to follow, missing protocols and explanations
13	lab notebook	8	good descriptions of protocols and explanations
14	lab notebook	4	hard to follow in places (handwriting an issue); missing some experimental info
15	lab notebook	9	good descriptions of experiments and analysis
16	lab notebook	7	used 'standard' protocol quite a bit, but with experiment annotation
	average rating	**7.3125**	
	standard deviation	**2.35849528**	

BTEC640: Bioinformatics			PLO2: Interpret and execute best practices in biotech-related lab techniques as well as exhib
Student	**Work assessed**	**Rating (1-10)**	**Comments**
1	Final project report	7	Adequate summary, partial analysis
2	Final project report	9	Reflection of how the previous study's analysis could be improved if reanalyzed was good
3	Final project report	9	Clear description of previous study and analysis
4	Final project report	6	Data reanalysis not clearly laid out
5	Final project report	3	Poor description of what was done in previous study
6	Final project report	8	Good analysis of previous study and reanalysis of data
7	Final project report	6	Good summary of previous work, new interpretation not as clear
8	Final project report	9	Data excellent
9	Final project report	9	Clear and well-written
10	Final project report	9	Data description excellent, clear understanding of research displayed
11	Final project report	7	Data description not as clear in places
12	Final project report	8	Strong data analysis and prioritization
	average rating	**7.54545455**	
	standard deviation	**1.83402191**	

BTEC688/689: Advanced research projects

PLO2: Interpret and execute best practices in biotech-related lab techniques as well as exhib

Operational interpretation of PLO2: Can student demonstrate they understand scientific que

Student	Work assessed	Rating (1-10)	Comments
1	Project proposal	8	Explains question and why protocols chosen address these. More explanation of why optimiza
2	Project proposal	9	Describes CIS/mRNA display well & why it would help in discovering better antibodies (better t
3	Project proposal	6	Bit murky explanation of why ScFv library would be an improvement over camelid single doma
4	Project proposal	7	Fairly good explanation of why they want to measure viability of cells in product. Somewhat m
5	Project proposal	9	Explains fairly well CIS display technology in context of other display techniques, and antibody
6	Project proposal	9	Explains well screening technology and antibody development hurdles
7	Project proposal	9	Explains fairly well CIS display technology in context of other display techniques, and antibody
8	Project proposal	7	Explains the scientific question (can less invasion HPV diagnostic be developed) but fails to exp
9	Project proposal	6	Explains the scientific question (how do we get a better xCT antibody) well but fails to clearly e
10	Project proposal	9	Explains the scientific question very well and experiments fairly well
11	Project proposal	8	Explains the scientific question (can less invasion HPV diagnostic be developed) well, explain tl

	average rating	**7.90909091**
	standard deviation	**1.22102788**

Appendix C: Institutional Learning Outcomes vs. Program Learning Outcomes:

	PLO1	PLO2	PLO3	PLO4	PLO5
Institutional Learning Outcomes X Program Learning Outcomes	1. Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.	2. Interpret and execute best practices in biotech-related lab techniques as well as exhibit an ability to assess the novelty of research and prioritize protocols.	3. Comprehend the need for ethics in science and technology based business/research/industry.	4. Critically review scientific papers and demonstrate science communication skills necessary to attain professional level employment in science and technology based research/industry.	5. Demonstrate effective teamwork, team leadership, business communication skills, and networking skills, including exposure to industry members in molecular biology and biotechnology based business/research/industry.
Institutional Learning Outcomes					
1. Students reflect on and analyze their attitudes, beliefs, values, and assumptions about diverse communities and cultures and contribute to the common good.			X		
2. Students explain and apply disciplinary concepts, practices, and ethics of their chosen academic discipline in diverse communities.	X		X	X	
3. Students construct, interpret, analyze, and evaluate information and ideas derived from a multitude of sources.	X			X	X
4. Students communicate effectively in written and oral forms to interact within their personal and professional communities.				X	X
5. Students use technology to access and communicate information in their personal and professional lives.		X			
6. Students use multiple methods of inquiry and research processes to answer questions and solve problems.	X	X			
7. Students describe, analyze, and evaluate global interconnectedness in social, economic, environmental and political systems that shape diverse groups within the San Francisco Bay Area and the world.			X		X

Appendix D: Curricular Map – Courses vs. Program Learning Outcomes:

	PLO1	PLO2	PLO3	PLO4	PLO5
Biotechnology course Curricular Map 2018-19	1. Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.	2. Interpret and execute best practices in biotech-related lab techniques as well as exhibit an ability to assess the novelty of research and prioritize protocols.	3. Comprehend the need for ethics in science and technology based business/research/industry.	4. Critically review scientific papers and demonstrate science communication skills necessary to attain professional level employment in science and technology based research/industry.	5. Demonstrate effective teamwork, team leadership, business communication skills, and networking skills, including exposure to industry members in molecular biology and biotechnology based business/research/industry.
KEY: I = Introductory; D = Developing; M = Mastery					
Courses or Program Requirement					
BTEC601: Career Preparation Seminar - seminar, 1 unit				I	I
BTEC610: Global and U.S. Regulatory Affairs - lecture, 2 units			D	D	D
BTEC611: Legal-Social-Ethical Biotech - lecture, 2 units			M	D	D
BTEC620: Molecular Biology - lecture, 4 units	I		I	I	
BTEC612: Local, National, Global Biotech - lecture, 2 units				D	I
BTEC615: Bioinnovation Management - lecture, 2 units				D	M
BTEC619: Bioentrepreneurship AGI - fieldwork, 2 units				D	M
BTEC685/686: Molecular Genetics and Biotechnology - lab, 4 units	D	I		D	
BTEC688/689: Advanced Research Methods - lab, 4 units		M		D	
BTEC640: Bioinformatics - lecture, 4 units	D	D			
BTEC600: Molecular Biology seminar - seminar, 1 unit				D	D
BTEC697: Internship in Biotechnology - fieldwork, 4 units		M		M	M
BTEC elective: lecture, 4 units	M			D	