

**2020-2021 ASSESSMENT REPORT
PROFESSIONAL SCIENCE MASTER'S IN BIOTECHNOLOGY
GRADUATE PROGRAM**

Program: **PSM in Biotechnology**

Degree type: **Graduate program**, College of Arts and Sciences

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Mission Statement

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

PSM in Biotechnology Program Learning Outcomes (no changes made since 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.

Curricular Maps

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

The Curricular map aligning required Biotechnology program courses with Biotechnology PLOs is included in Appendix D. No changes have been made to the Curricular map since 2019. Based on this assessment report process, we propose changing the Curricular map to a new version shown in Appendix E (see below for rationale).

Assessment schedule between APRs

2015-2016: Assessment of **PLO5:** Perform key molecular biology laboratory techniques (such as PCR, gel electrophoresis, DNA isolation, RT-PCR, CRISPR). This is a PLO that was modified significantly when we did our PLO revisions in 2019. No direct assessment or rating of the work products from students was being done at this time.

2016-2017: Assessment of **PLO1:** Interpret concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology. This PLO was modified when we did our PLO revisions in 2019. No direct assessment or rating of the work product from students was being done at this time.

2017-2018: Assessment of **PLO4:** Critically review scientific papers and demonstrate communication skills appropriate for professional level employment in science and technology based business/research/industry. We began doing direct assessment and rating of student work products this year. This is a PLO that was modified significantly when we did our PLO revisions in 2019. The old PLO4 was split into our current PLO4 and PLO5. We did the PLO revisions that year partially based upon our findings during the assessment process.

2018-2019: Assessment of **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.

2019-2020: Alternative assessment reflection on distance learning pivot (no specific PLO assessed)

2020-2021: Assessment of **PLO1:** Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.

October 2021: Academic Program Review of our PSM in Biotechnology program took place

2021-2022: Tentatively plan to do assessment of **PLO3:** Comprehend the need for ethics in science and technology based business/research/industry.

Methods: Program Learning Outcome 1

This year, we chose to assess PLO1:

PLO1: Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.

We chose to assess PLO1 partially because we have not assessed this PLO since 2016-2017 and our program has never performed direct assessment of this PLO (no student work products were evaluated in 2016-2017). The other possible option was to assess PLO3, but we decided to do that in a future year (see Program response and future improvement section below).

One way to interpret PLO1, is that students should be gaining, developing, and then demonstrating mastery in **any** of the three core areas of our program: biology, bioinformatics, or business. The problem with this approach is that every single one of our BTEC courses would fall into this category. Instead, upon faculty discussion, we decided that PLO1 should be reserved for courses where interdisciplinary learning was emphasized and students were able to demonstrate their knowledge in **at least two** of these three core areas. This aligns with the wording of PLO1 that includes the phrase “multiple disciplines”. We produced the assessment rubric that is included in Appendix A. Based on this rubric, student work can only receive a score of up to 6 out of 10 if they demonstrate a strong understanding in only one of the three areas. Scores of 7 or higher require an understanding in two or more of the areas.

The two courses that we chose to assess were BTEC 600: Molecular Biology seminar and BTEC 697: Internship in Biotechnology. These are arguably the two courses in our program that are the most interdisciplinary. All of our other courses are focused primarily on one of the key areas of biology, bioinformatics, or business. BTEC 600 is a speaker seminar where biotechnology professionals who work in a variety of roles are invited to present a seminar to our students. BTEC 697: Internship in Biotechnology is our capstone course where students work and evaluate their experiences at biotechnology companies. Students work in a wide-variety of roles during their internships, covering the areas of biology research, bioinformatics, and bioentrepreneurship. Specifically, we chose these three assignments to assess:

- BTEC 600: Speaker summary report based upon the seminar from Dr. Jacob Glanville (CEO of Centivax). This speaker gave a seminar that was biology **business** based, but contained elements of research and bioinformatics as well.
- BTEC 600: Speaker summary report based upon the seminar from Dr. Elicia Penuel (Senior Scientist at Genentech). This speaker gave a seminar that was **biology** research based, but contained elements of business and bioinformatics as well.
- BTEC 697: Final semester report. These were reports that the students wrote summarizing their roles and the projects that they worked on during the semester at their biotechnology companies. Students worked in very different roles, including in research, business, and bioinformatics positions.

For all three of these classes, assignments from each student were collected and then evaluated for how well they achieve PLO1. Student assignments from all three classes were rated using the same PLO1 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 26 and 41 assignments were rated for each course. Faculty raters also included written comments for each assignment rated.

Results: Program Learning Outcome 1

The complete results of the PLO1 assessment are shown in Appendix B:

The BTEC 600 Glanville talk assignment had a mean score of 6.6 (out of 10) with a standard deviation of 1.4. The BTEC 600 Penuel talk assignment had a mean score of 6.7 (out of 10)

with a standard deviation of 1.6. The BTEC 697 final lab report had a mean score of 6.6 (out of 10) with a standard deviation of 1.1.

Based upon the rubric that was created for this assessment, the cutoff between a score of 6 and 7 was based upon whether the student evaluated more than one of the three key parts of the PLO (biology, bioinformatics, and business). Based on the rubric scoring and qualitative assessment, it did seem as though about half the students only concentrated on one area whereas about half of the students concentrated on more than one area (usually two, very rarely all three). One possibility to increase student performance in achieving higher scores on this PLO in future semesters is to require the student to cover multiple areas in their reports in order to receive a maximal class grade for each of those assignments (the students were not asked to do so previously for these classes). This could help to reinforce the importance of the interdisciplinary nature of our program.

Program response and future improvement

One of the important realizations that we made during this assessment process is that our current curricular map with courses vs. program learning outcomes does not correctly map our courses to PLO1. Our current curricular map (see Appendix D) maps four courses to PLO1 – BTEC 620 (introductory), BTEC 640 (developing), BTEC 686/686 (developing), and BTEC elective (mastery). BTEC 620 and BTEC 685/686 concentrate heavily on one of three core areas (biology). BTEC 640 concentrates heavily only on the core area of bioinformatics. The elective BTEC course can range in discipline from an MBA course to a MSDS course to a biology-based elective. None of these courses that are currently mapped to PLO1 capture the interdisciplinary nature of this PLO that we have focused on during this assessment process.

As shown in Appendix E, we are proposing a revision of our curricular map to instead connect BTEC 600 (developing), BTEC 619 (mastery), and BTEC 697 (mastery) to PLO1. BTEC 600 and BTEC 697 were the two courses that we used effectively in this PLO1 assessment process. Both are interdisciplinary courses as students are exposed to either outside seminar speakers or to their internship classmates that are working in a range of different areas including biology, bioinformatics, and business.

BTEC 619 is our Bioentrepreneurship AGI course. In the Academic Global Immersion course, students travel to a global biocluster where they visit biotech companies, government regulatory institutions, and universities. Previous AGI courses have visited Switzerland, England, Australia, Puerto Rico, San Diego, and Washington D.C. Our BTEC 619 Bioentrepreneurship AGI course embodies the interdisciplinary nature of our PLO1 well. During these visits, students get to meet with professionals and industry leaders that cover all of the areas of biology, bioinformatics, and business. We were not able to use student work products for assessing PLO1 for this report as the AGI trips had to be cancelled this past year due to COVID limitations, but we do plan to begin these trips and the BTEC 619 class again soon as it is a core part of our program.

Our program has never assessed PLO3 before (Comprehend the need for ethics in science and technology based business/research/industry). We were considering assessing PLO3 this year, but realized that although ethics considerations are covered as a topic in many of

the lectures in our biology classes, we did not have any student work products or assignments that were directly connected to ethics in these classes. We are considering adding new ethics-based written assignments to one or more of our biology classes this year which will allow us to more effectively directly assess PLO3.

Feedback from previous year's assessment report

For the 2019-2020 year, we used the alternative assessment format that reflected on the distance learning pivot. No specific PLO was assessed for last year's report. We found that this process was useful though as our program as a whole and our individual faculty learned a lot from the shift to remote learning. Although, we plan to remain a program with primarily in-person classes, we did find that some classes such as our BTEC 600 seminar class could be effectively delivered in a remote format with some advantages as compared to an in-person class (for example the ability to book speakers from around the country/world).

Appendix A: Biotechnology PSM PLO1 assessment rubric:

PLO1: Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.

Criteria	Ratings			
	Weak (1-4)	Satisfactory (5-6)	Good (7-8)	Excellent (9-10)
PLO1: Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology.	Student does not demonstrate competent understanding of any of the three distinct biotechnology disciplines	Student demonstrates a strong understanding of only one biotechnology discipline. For example, demonstrates understanding of the role of biology but not bioinformatics or business.	Student demonstrates at least a moderate understanding of the role of at least two distinct biotechnology disciplines, possibly including i. biology, ii. bioinformatics, or iii. business.	Within the one work product, student demonstrates their thorough understanding of at least two distinct biotechnology disciplines, possibly including i. biology, ii. bioinformatics, or iii. business.

Total Points: _____ out of 10

Rater notes:

Appendix B: Assessment raw data:

BTEC600: Molecular Biology Seminar

PLO1: Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology

Student	Work assessed	Rating (1-10)	Comments
1	Glanville speaker report	9	biology and business well-covered
2	Glanville speaker report	7	bioinformatic covered ok, business well
3	Glanville speaker report	6	business well-covered, only some biology
4	Glanville speaker report	6	business only, good specifics
5	Glanville speaker report	7	good business, some biology
6	Glanville speaker report	5	business only
7	Glanville speaker report	7	business good, some biology
8	Glanville speaker report	10	business, bioinformatics, and biology all covered
9	Glanville speaker report	7	business good, some biology
10	Glanville speaker report	5	business only
11	Glanville speaker report	6	business only, good details
12	Glanville speaker report	5	business only
13	Glanville speaker report	7	business good, some biology
14	Glanville speaker report	4	business only, brief
15	Glanville speaker report	7	business well-covered, some biology
16	Glanville speaker report	9	both business and biology strong
17	Glanville speaker report	7	business good, a little bit of bioinformatics and biology
18	Glanville speaker report	6	business very good, not others
19	Glanville speaker report	8	Business strong, some biology
20	Glanville speaker report	6	business only, well-written
21	Glanville speaker report	7	business strong, some biology
22	Glanville speaker report	7	business strong, some biology
23	Glanville speaker report	6	business good, not much others
24	Glanville speaker report	4	business only, not in depth
25	Glanville speaker report	5	business only, somewhat brief
26	Glanville speaker report	8	good business and bioinformatics
27	Glanville speaker report	5	business only, description just ok
28	Glanville speaker report	6	business strong (not others)
29	Glanville speaker report	10	business, bioinformatics, and biology all covered well
30	Glanville speaker report	6	business only, good description
31	Glanville speaker report	8	business and biology good
32	Glanville speaker report	8	business good, limited amount of biology included
33	Glanville speaker report	7	business good, a little bit of bioinformatics
34	Glanville speaker report	6	business excellent
35	Glanville speaker report	6	business excellent

36	Glanville speaker report	6	business good, others not very much included
37	Glanville speaker report	7	business good, some biology
38	Glanville speaker report	5	business pretty detailed, lacks others
39	Glanville speaker report	8	business and bioinformatics strong
40	Glanville speaker report	5	business only - not too detailed

average rating

6.6

standard deviation

1.446481141

BTEC600: Molecular Biology Seminar

PLO1: Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology

Student	Work assessed	Rating (1-10)	Comments
1	Penuel speaker report	6	Good analysis of Biomarker experience, limited business discussion
2	Penuel speaker report	4	Discussion of her experience, background - not much about science
3	Penuel speaker report	9	Coverage of translational science, clinical trials, some statistical analysis
4	Penuel speaker report	7	Good discussion of PK/PD (clinical) only some biology research
5	Penuel speaker report	8	Good discussion of biomarkers for clinical and molecular profiling
6	Penuel speaker report	8	Discussion of clinical trials and cancer biology
7	Penuel speaker report	7	Good PK/PD clinical, some biology
8	Penuel speaker report	8	Biomarker discussion - both clinical and biology-based
9	Penuel speaker report	4	Biomarker discussion only, brief
10	Penuel speaker report	6	Clinical trial using biopsies, not much biology
11	Penuel speaker report	6	Clinical trials with biomarkers only
12	Penuel speaker report	8	Biomarker PK/PD, cancer biology
13	Penuel speaker report	9	Clinical trials and checkpoint with cancer biology
14	Penuel speaker report	9	PK/PD and ctDNA discussion
15	Penuel speaker report	5	Biomarker discussion only
16	Penuel speaker report	9	Clinical trials and checkpoint PD1/PDL1 biology
17	Penuel speaker report	6	Clinical trial discussion only
18	Penuel speaker report	8	Biomarker analysis and CD-DNA profiling
19	Penuel speaker report	8	Biomarkers with clinical trials and cancer biopsy
20	Penuel speaker report	6	Clinical trial discussion only
21	Penuel speaker report	7	Clinical trial, some tumor biology discussion
22	Penuel speaker report	6	PK/PD and clinical trials
23	Penuel speaker report	9	Clinical trials and RNASeq with next-gen sequencing
24	Penuel speaker report	4	Only brief biomarker discussion
25	Penuel speaker report	6	Biomarkers with PK/PD
26	Penuel speaker report	6	Biomarkers with PK/PD
27	Penuel speaker report	5	Brief - clinical trial only
28	Penuel speaker report	8	Biomarkers, clinical trials, ctDNA
29	Penuel speaker report	8	Clinical trials and PD1/PDL1 biology included

30	Penuel speaker report	8	PK/PD, clinical and CRISPR
31	Penuel speaker report	6	Biomarkers only
32	Penuel speaker report	4	Biomarkers only, brief
33	Penuel speaker report	7	Clinical, biomarkers, tumor markers
34	Penuel speaker report	5	Cancer biomarkers only
35	Penuel speaker report	8	Biomarkers, good relation to cancer biology
36	Penuel speaker report	7	Good clinical, some biology
37	Penuel speaker report	7	Good clinical, some ctDNA and PD1 discussion
38	Penuel speaker report	4	Clinical only - brief
39	Penuel speaker report	7	Clinical including safety, some biology
40	Penuel speaker report	6	Emphasis only on clinical
41	Penuel speaker report	5	Biomarkers with PK/PD

average rating **6.682926829**

standard deviation **1.556261938**

BTEC697: Internship in Biotechnology

PLO1: Review and evaluate concepts from multiple disciplines (biology, bioinformatics, business) within biotechnology

Student	Work assessed	Rating (1-10)	Comments
1	Final semester report	6	Primarily biology summary
2	Final semester report	8	Mixture of biology and bioinformatics
3	Final semester report	7	Biology focused, a small amount of bioinformatics
4	Final semester report	9	Good mix of bioinformatics, biology, and business
5	Final semester report	7	Business focused, some biology
6	Final semester report	6	Only biology
7	Final semester report	8	Mix of biology and business
8	Final semester report	7	Biology focused
9	Final semester report	7	Biology focused
10	Final semester report	8	Mix of biology and business
11	Final semester report	9	Mix of biology and bioinformatics
12	Final semester report	6	Biology focused
13	Final semester report	6	Business only
14	Final semester report	6	Biology focused
15	Final semester report	6	Biology focused
16	Final semester report	6	Biology focused
17	Final semester report	5	Business focused
18	Final semester report	5	Biology only
19	Final semester report	8	Contains bioinformatics, biology, and business
20	Final semester report	5	Biology only, somewhat brief
21	Final semester report	6	Business only focused
22	Final semester report	6	Business only

23	Final semester report	7	Business, some biology
24	Final semester report	6	Biology focused
25	Final semester report	6	Business focused
26	Final semester report	6	Business focused

average rating [6.615384615](#)
standard deviation **1.13408723**

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

