Doctor of Philosophy in Applied Life Sciences Outcomes

Graduation Statistics

KGI currently offers a PhD in Applied Life Sciences. Prior to 2014, KGI also offered a closely related PhD in Computational and Systems Biology. Beginning in 2014, this program was merged into the PhD in Applied Life Sciences. Through the Spring of 2017, 11 students have graduated from KGI's PhD programs. The ethnicity of these graduates was four non-resident aliens, two Asians, and five whites. Six students took 6, 7, 9, 11, 12, and 16 terms, respectively to complete their PhD and five students completed their PhD in 8 terms. Our graduation rate has been 100% since 2010, meaning that all students that have enrolled have graduated or are still in the program.

PhD Program Learning Outcomes

1. PhD students apply rigorous research methodologies to original, independent experimental, theoretical, and/or computational work in applied bioscience
2. MBS and PhD students can integrate the fundamentals of computational and informational science, engineering design, and biomolecular technologies to solve problems in applied life science.

3. PhD students can communicate effectively in an academic as well as in an industry environment composed of students, scientists, engineers, administrators and business professionals.
4. MBS and PhD students have the core business analysis and management knowledge needed for the bioscience industry and can assume leadership roles in realizing the goals of technical and business projects.
5. PhD students develop both a broad understanding of current scientific advances and mastery in an area of interdisciplinary science of relevance to applied bioscience sufficient for conducting original research.
6. MBS and PhD students understand the translation of basic science and engineering discoveries into products and processes, which benefit society.
7. MBS and PhD students adhere to ethical principles in research, development and business issues inherent in the bioscience industries.

Alignment of learning outcomes, evidence, and assessment tools

Learning Outcome	Evidence	Assessment Tool
Prowess in research methods	Research seminar presentation, PhD thesis defense	Content rubric

Ability to conduct relevant scientific research	Qualifying exam (Comp Bio PhD), research proposal (MBS-PhD), publications, dissertation	Content rubric, written comments from committee, peer review publication process
Effective communication skills	Research seminar presentations, publications	Presentation rubric, writing rubric, peer review publication process
Knowledge of scientific fields	Journal club presentation, research report	Content rubric

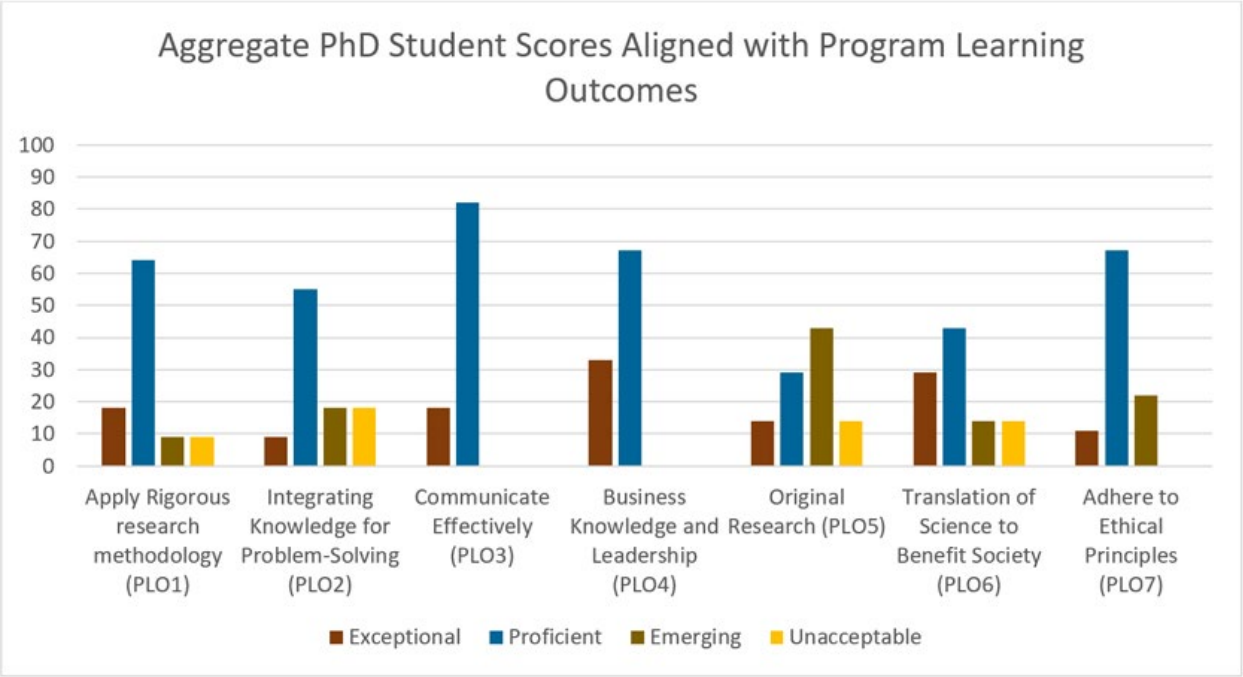
Curriculum Map and Milestones

Because the program is based more on milestones that may be reached at slightly different stages of training, our curriculum map is more based on those milestones rather than specific courses. Also, the pathway into the program is through our MBS program, so many of the milestones build on the student's MBS experience.

Rubric-based Evidence of Student Learning

Summative assessment for the PhD program has been strong. Of the five students that successfully completed the program, all were able to pass the summative PhD defense and all had published at least one scientific article..

While the small size of the program makes it difficult to generalize from the results of formative assessment based on faculty review rubrics, the results of this analysis is generally encouraging. Communication skills of KGI PhD students are excellent (PLO 3), in part because scientific communication is also a core learning outcome of the MBS program. Students also perform generally well on the scientific knowledge related assessments (PLOs 1, 2, 5 and 6). That being said, there are several cases of students receiving "emerging" scores within the PhD prospectus and progress talks, and one case of a student failing. In the case where the faculty rubric scores rated a student's prospectus or progress report as "unacceptable", the student was asked to revise the presentation and was scheduled to give a second talk, which was also scored.



Publication Statistics

Publication list of current or recently graduated students:

1. **Leonardi W, Zilbermintz L**, Cheng LW, Zozaya J, Tran SH, Elliott JH, Polukhina K, Manasherob R, Li A, Chi X, Gharaibeh D, Kenny T, Zamani R, Soloveva V, Haddow AD, Nasar F, Bavari S, Bassik MC, Cohen SN, **Levitin A, Martchenko M**., Bithionol blocks pathogenicity of bacterial toxins, ricin, and Zika virus, Sci Rep. (2016); 6:34475 (PMID: 27686742)
2. **Zilbermintz L, Leonardi W**, Tran SH, Zozaya J, Mathew-Joseph A, Liem S, **Levitin A, Martchenko M**., Cross-inhibition of pathogenic agents and the host proteins they exploit, Sci Rep. (2016);6:34846 (PMID: 27703274)
3. **McComb RC, Martchenko M**., Neutralizing antibody and functional mapping of Bacillus anthracis protective antigen-The first step toward a rationally designed anthrax vaccine, Vaccine. (2016);34(1). Review.(PMID: 26611201)
4. **Lokhande S**, Patra BN, **Ray A**., A link between chromatin condensation mechanisms and Huntington's disease: connecting the dots, Mol Biosyst. (2016);12(12):3515-3529. Review, (PMID: 27714015)
5. **McComb RC**, Ho CL, Bradley KA, **Grill LK, Martchenko M**., Presentation of peptides from Bacillus anthracis protective antigen on Tobacco Mosaic Virus as an epitope targeted anthrax vaccine, Vaccine. (2015);33(48):6745-51 (PMID: 26514421)

6. **Zilbermintz L, Leonardi W**, Jeong SY, Sjodt M, **McComb R**, Ho CL, Retterer C, Gharaibeh D, Zamani R, Soloveva V, Bavari S, Levitin A, West J, Bradley KA, Clubb RT, Cohen SN, Gupta V, **Martchenko M**., Identification of agents effective against multiple toxins and viruses by host-oriented cell targeting, Sci Rep. (2015);5:13476 (PMID: 26310922)
7. **Kim K, Zilbermintz L, Martchenko M**., Repurposing FDA approved drugs against the human fungal pathogen, Candida albicans, Ann Clin Microbiol Antimicrob. (2015);14:32 (PMID: 26054754)

Graduation (Completion) Rates

PhD (post MBS)				
Starting Semester (Fall or Spring)	Initial Enrollment (Total)	On Time Graduation Rate (Male)	On Time Graduation Rate (Female)	5 year Completion Rate
2011-12	4	2/3	0/1	50%
2012-13	2	1/1	0/1	50%
2013-14	1	1/1		100%
2014-15	5	1/2	1/3	40%

2015-16	2	Expected graduation in 2018	Expected graduation in 2018	N/A
2016-17	5	Expected graduation in 2019	Expected graduation in 2018	N/A
			Graduation rate (2011-2015)	50%
The PhD program duration ranges typically from 3-5 years. One student who enrolled in each of 2011-12, '12-13, and '14-15 will graduate by December 2017.				

Employment outcomes

Career outcomes, which constitute indirect evidence of student learning, have been strong for the PhD program. When the program was initially designed, it was envisioned that graduates would be able to secure jobs in the bioscience industry in which a PhD was important, as well as more traditional academic jobs. The 2014 Program Review contains data on career outcomes up to that year, which show that all graduates have secured jobs in industry or universities as postdocs or, in two cases,

research associates in computational positions (see table 3). Three PhD students have graduated since this review. Of these students, two students accepted postdoctoral positions (at Stanford University and the University of California, Santa Barbara), and the other accepted a job in a research hospital as a clinical researcher.

Table 3: PhD Graduate Employment (2014 Program Review)

Type of Organization / Role	**Frequency**	**Comments**
Industry (scientist)	3	Bioprocessing, bioinformatics, systems engineer
Industry (non-science)	1	Project manager
Government	3	Two SMART scholars sponsored by govt; one at Lawrence Livermore, the other at DTRA; currently data scientist at USPTO
Academia (postdoc)	2	Michigan State and KGI

Academia (technical staff)	2	Both software engineers, at Caltech and Stanford
Other	1	Pharmacy (has a previous degree in the field)